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Ecology

Seasonal variation in the abundance and density of columbids (Birds: Columbidae) in a region with high hunting pressure

Variação sazonal na abundância e densidade de columbídeos (Aves: Columbidae) em uma região com alta pressão de caça

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ABSTRACT

Assessing the abundance and densities of highly hunted bird species, such as those from the Columbidae family (pigeons and doves), is essential to developing effective conservation strategies. The present study sought to investigate multiple Columbidae species populations in three rural areas of Agreste Sergipe (Brazil), assessing whether there is seasonal variation in their abundance and density measures. During one year, linear transects were used to record species richness and abundance, which were then used to calculate species densities. A total of 4,229 columbids belonging to eight species were recorded, with Columbina talpacoti, Columbina picui, and Columbina minuta being the species that were most abundant and had the highest densities. Greater abundance and density were also observed during the rainy season for most species. Of the registered species, more than half had low abundances and tend to decrease in numbers throughout the year. The observed low and decreasing numbers for most of the columbid species here studied may be a reflection of the natural fluctuations expected by population dynamics. These fluctuations could be due to species sharing responses to similar environmental and/or anthropic factors. In order to enhance conservation strategies for these bird species, long-term studies and monitoring should be conducted to better understand how different factors indeed impact their local population dynamics.

Keywords: Census; Cinegetic birds; Monitoring; Northeast Brazil

RESUMO

A avaliação da abundância e densidade de espécies de aves altamente caçadas, como as da família Columbidae (pombas e rolas), é essencial para desenvolver estratégias eficazes de conservação. O

presente estudo buscou investigar as populações de múltiplas espécies de Columbidae em três áreas rurais do Agreste sergipano (Brasil), avaliando se há variação sazonal nas suas medidas de abundância e densidade. Durante o período de um ano, transectos lineares foram utilizados para registrar a riqueza e abundância de espécies, que então foram usadas para calcular as densidades de cada espécie. Foi registrado um total de 4.229 columbídeos pertencentes a oito espécies, sendo Columbina talpacoti, Columbina picui e Columbina minuta as espécies mais abundantes e com maiores densidades. Maior abundância e densidade também foram observadas durante a estação chuvosa para a maioria das espécies. Das espécies registradas, mais da metade apresentou baixa abundância e tendência de decréscimo ao longo do ano. O baixo e decrescente número de indivíduos observado para a maioria das espécies de columbídeos aqui estudadas pode estar refletindo às flutuações naturais esperadas pela dinâmica das populações. Estas flutuações podem se dar devido a respostas partilhadas das espécies a fatores ambientais e/ou antrópicos semelhantes. A fim de elevar as estratégias de conservação destas espécies de aves, estudos e monitoramentos de longo prazo devem ser realizados para melhor entender como diferentes fatores de fato impactam suas dinâmicas populacionais locais.

Palavras-chave: Censu; Aves cinegéticas; Monitoramento; Nordeste do Brasil

1 INTRODUCTION

Considered cosmopolitan, the Columbidae family (doves and pigeons) has a total of 369 species (IUCN, 2022), distributed in all terrestrial habitats, from dense forests to deserts, to temperate and tropical zones, being one of the most successful families of birds in the world (Baptista et al. 1997; Gibbs et al. 2001). Columbids are commonly found in altered environments, such as rural and urbanized areas (Sick, 1997), with most species occurring in grassland areas, benefiting from deforestation and agricultural production (Sick, 1997).

Despite their evolutionary success, ~37% of Columbidae species are either considered extinct or endangered by the the International Union for Conservation of Nature (IUCN), with hunting being one of their main threats (Baptista et al. 1997; Gibbs et al. 2001; Walker 2007). That is, of the 369 species, 16 are extinct (EX), one is extinct in the wild (EW), 12 are critically endangered (CR), 20 are threatened (EN), 39 are vulnerable (VU) and 48 are near threatened (NT) (IUCN 2022). In Brazil, two of the 23 species recorded for the country (Pacheco et al. 2021) are critically endangered (see *Columbina cyanopis* Pelzeln, 1870; and *Paraclaravis geoffroyi* Temminck, 1811) (ICMBio

2022; IUCN 2022). Several studies carried out in Brazil indicate the Columbidae as the most exploited family among birds for food use (Sick, 1997; Bezerra et al. 2011, 2012; Fernandes-Ferreira et al., 2012; Alves et al., 2013; Barbosa et al., 2014; Santos et al., 2018; Soares et al., 2018), and for this reason many of its species suffer considerable hunting pressure, especially in Northeast Brazil, where hunting occurs in an uncontrolled manner, without any surveillance from the government environmental agencies (Alves et al., 2009; Bezerra et al., 2011, 2012; Fernandes-Ferreira et al., 2012; Barbosa et al., 2014; Santos et al., 2018; Soares et al., 2018; Silva et al., 2021). Hence, some species are no longer easily found in the northeast of Brazil due to over-exploitation by hunters who usually kill hundreds of columbids per hunt (Silva et al., 2021).

A number of different factors may influence the distribution, abundance and density of columbids. Rainfall seasonality, for example, can act as an environmental predictor for patterns of distribution and abundance of birds, including arid and semi-arid tropical environments with a marked rainy season (Oliveira e Silva et al., 2017). In seasonally dry environments, the rainfall dynamic is often described as the most important factor influencing periodic fluctuations in the abundance of birds and food resources (Rivera-Milan et al., 1992; Carvalho et al., 2015; Araújo et al., 2017; Oliveira e Silva et al., 2017). Temperature is another predictor of bird distribution and abundance patterns because it affects activity patterns, foraging, and reproduction (Santillán et al., 2018). As temperatures rise, birds tend to reduce their foraging and breeding activities (Andreasson et al., 2020). While functional traits, such as size and weight (Nee et al., 1991; Blamires et al., 2002), and intra or interespefic interactions (predation and competition; Nicoll & Norris, 2010; Guillaumet & Russell, 2022) classifies as biotic factors that may influence population dynamics, hunting pressure (Benitez-Lopez et al., 2017), land use and the presence of human settlements (Sekercioglu et al., 2012; Pizo & Tonetti, 2020) are the anthropogenic factors that may unnaturally impact species abundance and density measurements over time and space. Larger and heavier birds are typically less abundant, especially in the dry season and near human settlements,

because they require more food resources, which are usually scarcer during the dry season, and are more hunted by humans. As these refereed variables have the potential to alter the spatial and temporal dimensions of population dynamics (Ehrlén & Morris, 2015), understanding how different predictors alter the observed birds abundances is critical for species conservation.

Although birds are among the most researched animal grouping, studies on population density estimates for columbids are scarce. Among the studies that estimated the population density of columbids in Brazil, Souza et al. (2007) recorded a high density of *Zenaida auriculata* (Des Murs, 1847) in breeding colonies in the Northeast of the country. Fontoura (2013) and Fontoura & Orsi (2014) estimated the population density of columbids in disturbed landscapes in the north of Paraná state, southern Brazil, and observed that the density of the *Z. auriculata* species was higher than that of the species *Columbina talpacoti* (Temminck, 1811) and *Columbina picui* (Temminck, 1813), suggesting that the conversion of natural landscapes into agricultural areas may have favored the increase in the population density of *Z. auriculata*, through the increase of resource availability (e.g., soybeans, corn, wheat). In terms of conservation, relatively little attention has been directed to the Columbidae family (Walker, 2007), despite its high number of threatened species (Baptista et al., 1997; Gibbs et al., 2001; Walker, 2007). Thus, this study sought to investigate populations of Columbidae in three rural semi-arid environments under high hunting pressure for columbids in the Sergipe state (Brazil; Silva et al, 2021). We conducted an assessment in order to identify variations in population abundance and density across the rainy and dry seasons, aiming elucidate the species' temporal dynamics within the local context. We hypothesized that the abundance and density of columbids would vary depending on the species' size and weight, as well as the climatic season. We predicted that the largest and heaviest columbid species would present the lowest abundance and density, while the smallest and lightest species would present the highest abundance and density. Due to the expected increase in food availability during the rainy season

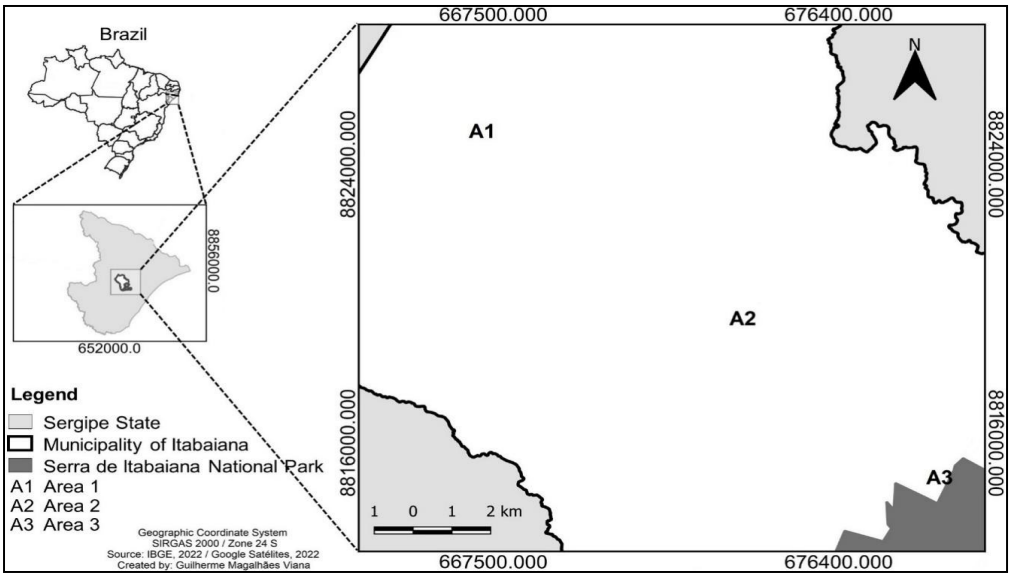
(Oliveira & Silva et al., 2017), we also predicted that the abundance and density of the columbids would be higher during this period.

2 METHODS

2.1 Description of the study area

The municipality of Itabaiana is located in the central region of the state of Sergipe (Brazil), in a transition zone between the Caatinga and the Atlantic Forest, called Agreste (IBGE, 2014). Currently, only 9% (2,905.55 ha) of the territory of the municipality of Itabaiana is covered by forest, with the remainder corresponding to open and anthropized areas (SFB 2017). The main causes of deforestation in the region have been the expansion of the urban area and the increase in agricultural activities (lettuce and coriander crops). According to the Köppen-Geiger classification, the climate in the region is As' – tropical with dry summers (Alvares et al., 2013). Precipitation occurs between April and September, peaking in May (175 mm) and the average annual temperature is 24 °C (Climate-data.org 2021).

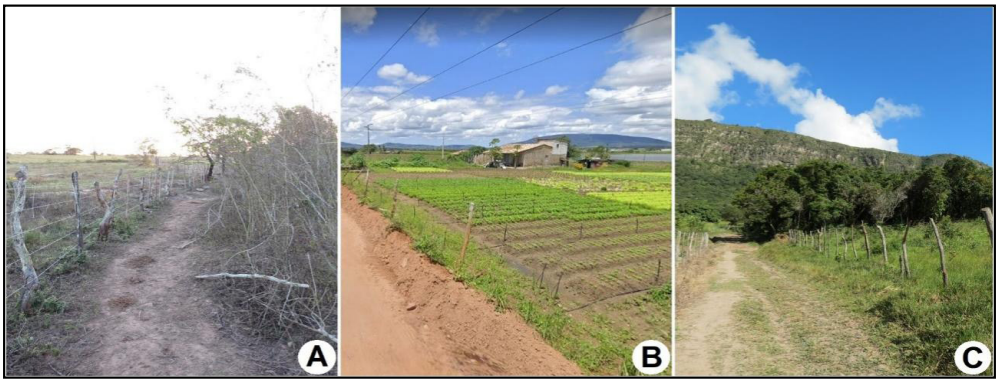
Figure 1 – Municipality of Itabaiana (Sergipe State, Brazil) with the location of the the three sampled rural areas



Source: Authors (2023)

The study was carried out in three rural areas (Figure 1), composed, in general, of a small number of residences, where the main economic activity is agriculture, based mainly on family horticulture. Area 1 (A1), located in the northwest part of the municipality, is predominantly composed of pastures and small patches of native vegetation (Figure 2). Area 2 (A2), located in the central part of the municipality, although it also has small patches of native vegetation, is characterized by the presence of vegetable plantations and a dam built for human local populations supply and agricultural use (Oliveira et al. 2015) (Figure 2). Area 3 (A3), located in the southeast part of the municipality, also consisting of pastures and vegetable plantations, standing out for its proximity to secondary forests patches of the Serra de Itabaiana National Park (PARNASI), one of the main conservation units in Sergipe, classified as an ecotonal forest formation between the Dense Ombrophylous Lowlands Forest and Submontane Semideciduous Seasonal Forest (Dantas & Ribeiro, 2010) (Figures 1 and 2). Information on the size and location of each area is presented in Table 1.

Figure 2 – Landscape characteristics of the three rural areas sampled in the municipality of Itabaiana (Sergipe state, Brazil). A) Area 1 = characterized by the presence of pastures and small fragments of native vegetation; B) Area 2 = characterized by the presence of plantations (vegetables) and a dam built for supply and agricultural use; C) Area 3 = characterized by proximity to fragments of secondary forests of the Serra de Itabaiana National Park. Photos: Cleverton da Silva



Source: Authors (2023)

Table 1 – Size and location (coordinates) of the three rural areas sampled in the municipality of Itabaiana, Sergipe state, northeastern Brazil

Area	Size in hectares (km²)	Coordinates
A1	852 (8,52)	10°37'26.980"S, 37°28'41.099"W
A2	489 (4,89)	10°40'26.130"S, 37°24'40.896"W
A3	521 (5,21)	10°42'50.422"S, 37°21'55.087"W

Source: Authors (2023)

2.2 Data collection

To record the richness and abundance of columbids, three 1.5 km transects were established in each of the rural environments (3 transects x 3 areas = nine transects in total) (Figure 1), spaced by at least 300 m from each other (Bibby et al., 2000; Anjos et al., 2010). During the layout of the transects, we sought to cover most of the local phytophysiognomies (open areas – pastures and plantations; closed areas – primary and secondary forests). This method consists of walking continuously along a predefined trail, at a constant average speed, while recording all birds detected visually and auditorily (Bibby et al., 2000). According to Bibby et al. (1998), this method is indicated for data collection in large and open areas, as is the case of the rural areas sampled in this study, as these tend to allow the recording of more birds per unit of time. In addition, they reduce the chance of double registration of individuals and are considered the best strategy for studying species that are conspicuous, mobile, relatively easy to identify and that easily flee in the presence of the observer (Bibby et al., 1998). Between April 2021 and March 2022, the transects were covered twice a month, from 06:00h to 10:00h, totaling 24 visits in each transect. Each transect was walked only once per day. When birds were detected, we recorded the species and the number of individuals. The detection distance established for each side of the trail was 50 m long. Therefore, birds seen further than 50 m were not considered.

2.3 Data analysis

Density estimates are one of the main statistical tools used to study population ecology and for monitoring wildlife (Williams et al., 2002; Nichols & Williams, 2006;

Burgar et al., 2018). Estimating density periodically makes it possible to monitor the species, assessing whether there is an increase, decline or stability in the population in the long term (Nichols & Williams, 2006). From the data collected in the transects, the density (D) of the species was calculated, considering it as the ratio between the number of individuals recorded along the entire transect (N) and the sampled area in km^2 (A). The formula used to calculate the density was therefore: D = N/A (adapted from Buckland et al., 2008). To assess whether the abundance of each species differed between seasons, Generalized Linear Models (GLMs) were built using the R environment (R Core Team, 2022). The abundance of each species was the response variable and the areas and the weather season were the explanatory variables in each model, with months as sampling units (N = 12; six in the rainy season and six in the dry season). Monthly database was created summing the number of individuals per species recorded in each day of field campaigns. The residuals were evaluated to fit the best distribution family for each model (Jones et al., 2022). GLMs were chosen since the models allows to build a linear relationship between the response and explanatory variables, even if their relationship is not linear (Zuur et al., 2012). This is made possible because it is not the mean of the response but a function of the mean that is made linearly dependent of the predictors (Zuur et al., 2012). The basic assumptions for Generalized Linear Models (linearity, homogeneity of variance, normality of residuals, and independence of the data) were evaluated by residual analysis.

3 RESULTS

In 324 km of transects covered (108 km in each area), a total of 4,229 Columbidae belonging to eight species — *Patagioenas picazuro* (Temminck, 1813), *Leptotila verreauxi* Bonaparte, 1855, *Leptotila rufaxilla* (Richard & Bernard, 1792), *Zenaida auriculata* (Des Murs, 1847), C*olumbina minuta* (Linnaeus, 1766), *Columbina talpacoti* (Temminck, 1811), *Columbina squammata* (Lesson, 1831), and *Columbina picui* (Temminck, 1813) — were recorded (Table 2). Six of the eight columbid

species recorded were observed in all three areas. The eared dove (*Z. auriculata*) was recorded only in areas A1 and A2, while the gray-fronted dove (*L. rufaxilla*) was exclusive to area A3. Some species, such as the plain-breasted ground-dove (*C. minuta*), the scaled dove (*C. squammata*), the gray-fronted dove (*L. rufaxilla*) and the white-tipped dove (*L. verreauxi*) were only recorded in the transects present inside or on the edge of the forest fragments present in each of the studied areas.

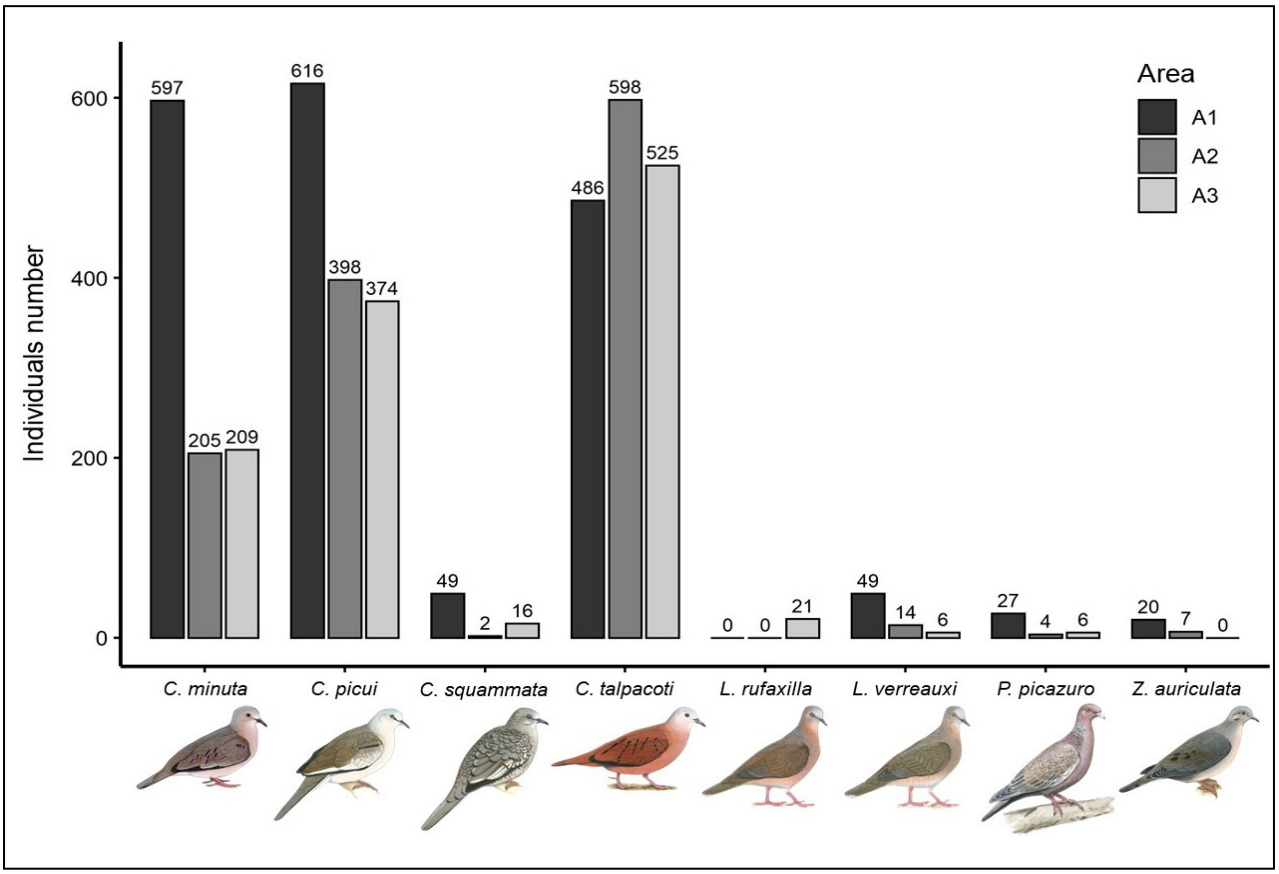
Table 2 – Size, body mass (BM), number of individuals (N) and density (D) of columbids recorded between April 2021 and March 2022 in three rural areas (A1, A2 and A3) in the municipality of Itabaiana, Sergipe state, Brazil

Species	Size (cm)	BM (g)	A1		A2		A3	
			N (%)	D (ind/ km²)	N (%)	D (ind/ km²)	N (%)	D (ind/ km²)
P.picazurs	34	210-402	27 (1.4)	3.1	4 (0.3)	0.8	6 (0.5)	1.1
L. verreauxi	23-30	114-276	49 (2.6)	5.7	14 (1.1)	2.8	6 (0.5)	1.1
L. rufaxilla	28	131-183	-	-	-	-	21 (1.8)	4
Z. auriculata	22-28	116-155	20 (1)	2.3	7 (0.5)	1.4	-	-
C. minuta	14-15	26-42	597 (32.3)	70	205 (16.6)	41.9	209 (18)	40.1
C. talpacoti	15-18	35-56	486 (26.3)	57	598 (48.6)	122.2	525 (45.3)	100.7
C. squammata	18-22	48-60	49 (2.6)	5.7	2 (0.1)	0.4	16 (1.3)	3
C. picui	15-18	41-51	616 (33.4)	72.3	398 (32.4)	81.3	374 (32.3)	71.7
Total (%)			1844 (43.6)		1228 (29)		1157 (27.3)	

*The taxonomy of the species followed Pacheco et al. (2021). Size and body mass were obtained, respectively, in Grantsau (2010) and Dunning (2008)
Source: Authors (2023)

The most representative species, in terms of abundance and density, were the ruddy ground-dove (*Columbina talpacoti*), the Picuí ground-dove (*Columbina picui*) and the plain-breasted ground-dove (*C. minuta*) (Table 2; Figure 3). The less abundant and with lower density were those species with greater size and body mass (*Leptotila rufaxilla, Leptotila verreauxi*, *Patagioenas picazuro*, *Z. auriculata*) (Table 2; Figure 3). For almost all species, a significant difference was observed in the number of individuals recorded between the rainy and dry seasons, with the highest number of records in the rainy season (Figure 4; Table 3).

Figure 3 – Abundance of columbids (Aves: Columbidae) recorded between April 2021 and March 2022 in three rural areas (A1, A2 and A3) in the municipality of Itabaiana (Sergipe state, Brazil). *C* = *Columbina*; *L* = *Leptotila*; *P* = *Patagioenas*; *Z* = *Zenaida*



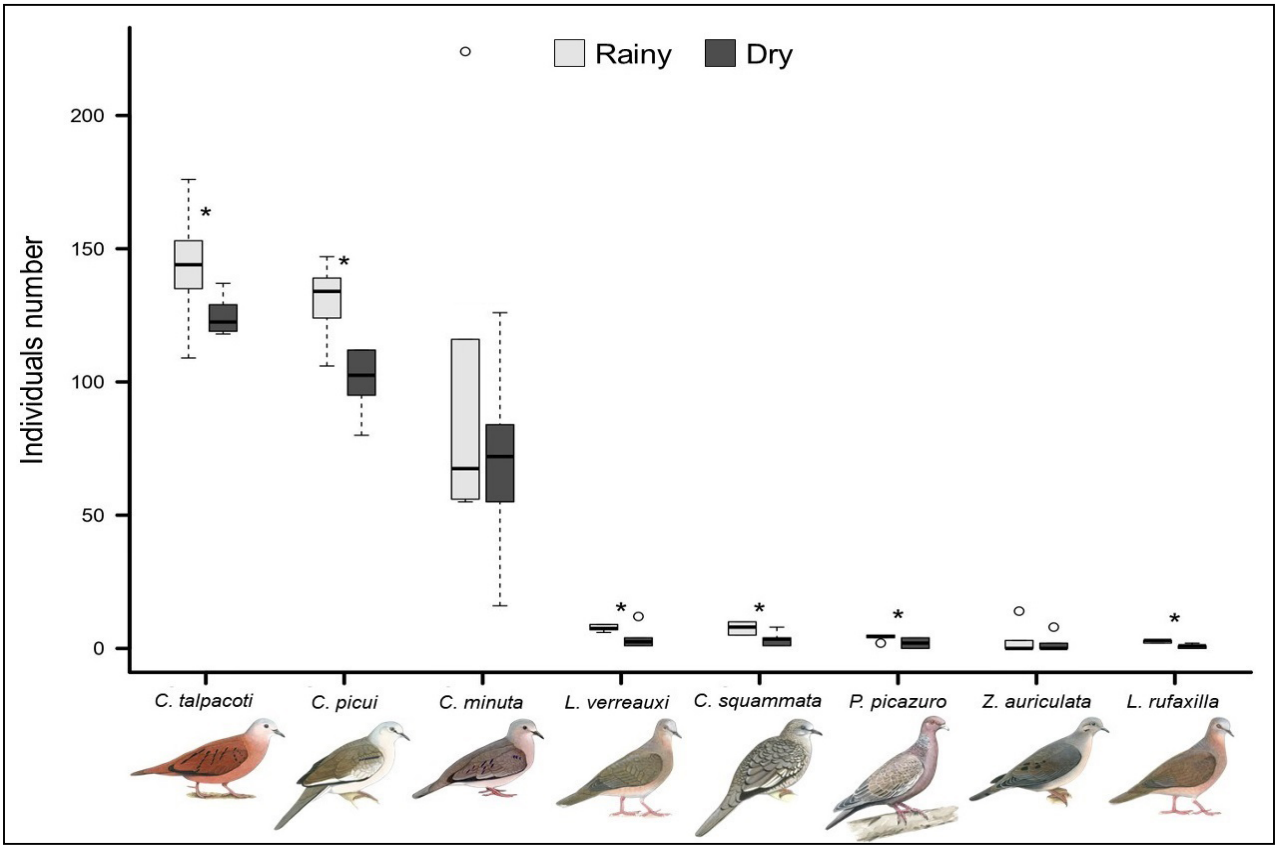
Source: Authors

Table 3 – GLM results for differences in the columbids recorded between could/dry and hot/wet seasons in three rural areas (A1, A2 and A3) in the municipality of Itabaiana, Sergipe state, Brazil. Bold values represent statistical differences between seasons

Species	Error distributon	Deviance	F	t/z	P-value
Columbia minuta	Negative binomial	1.056	-	-1.030	0.304
Columbia picui	Poisson	23.409	-	-4.818	<0.001
Columbia squamata	Poisson	9.558	-	-2.977	0.003
Columbia talpacoti	Poisson	4.642	-	-2.154	0.031
Leptotila rufaxilla	Quasi-poisson	6.060	15.537	-3.635	0.005
Patagioenas picazuro	Poisson	4.667	-	-2.090	0.037
Zenaida auriculata	Negative binomial	0.127	-	-0.358	0.721

Source: Authors (2023)

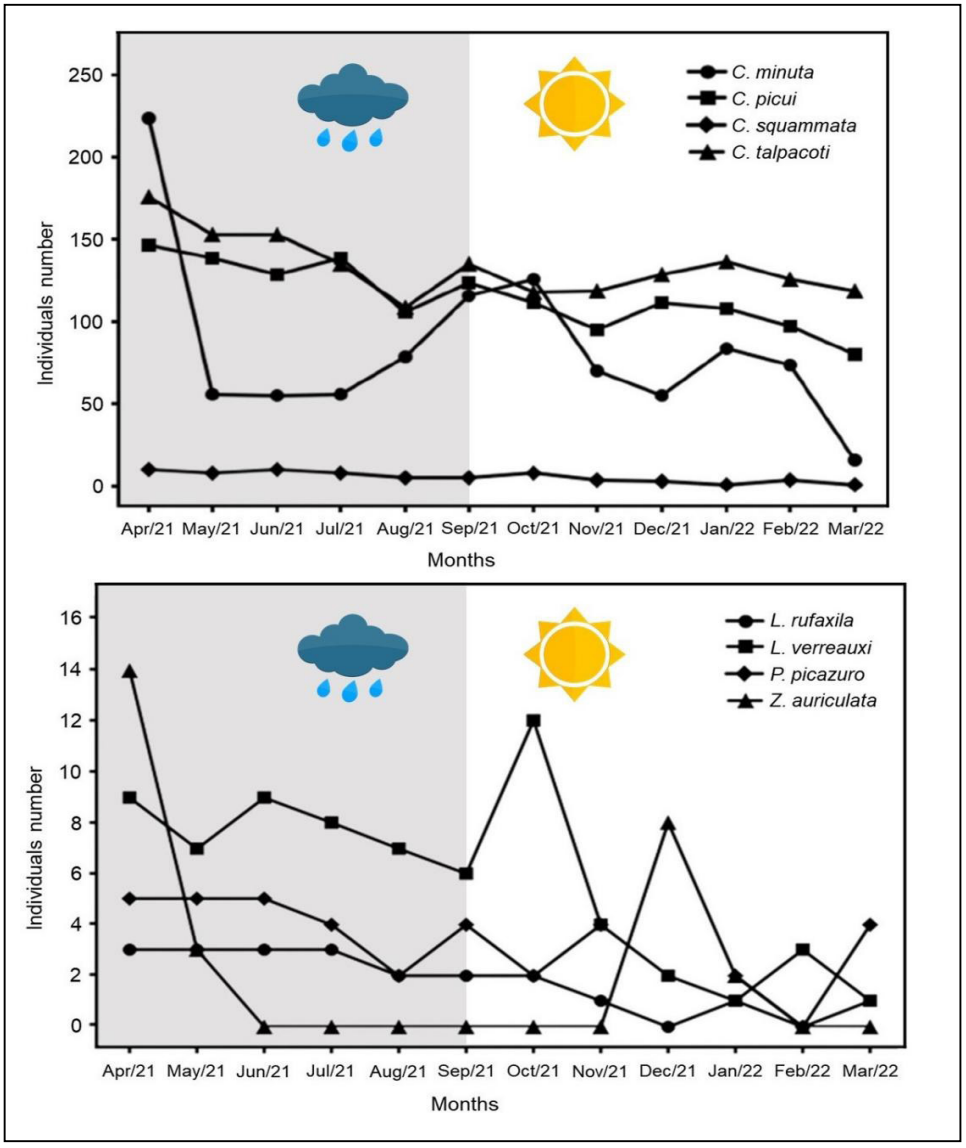
Figure 4 – Boxplots showing seasonal variations in the abundance of columbids from three rural areas in the municipality of Itabaiana (Sergipe state, Brazil), during the wet and dry seasons. Asterisks indicate a significant difference ($P < 0.05$) between the rainy and dry seasons. The horizontal line, inside the boxplots, indicates the median; the limits of the boxplots indicate the interquartile range; the vertical lines (whiskers), in the boxplots, represent minimum and maximum values; and the white points are outliers. *C* = *Columbina*; *L* = *Leptotila*; *P* = *Patagioenas*; *Z* = *Zenaida*



Source: Authors (2023)

Overall, the number of recorded individuals of each species varied little between months, but with most species showing a decreasing trend throughout the year (Figure 5). The species *C. minuta*, *L. verreauxi* and *Z. auriculata* were the ones that varied negatively the most in abundance throughout the year (Figure 5). Five species had very low abundances throughout the year in the study areas, while three species had higher abundances (Figure 5).

Figure 5 – Variation in the abundance of Columbidae species recorded in the three rural areas of the municipality of Itabaiana (Sergipe state, Brazil). The darker area represents the wet season, while the lighter area represents the dry season. *C* = *Columbina*; *L* = *Leptotila*; *P* = *Patagioenas*; *Z* = *Zenaida*



Source: Authors (2023)

4 DISCUSSION

In the present study, we hypothesized that the abundance and density of the columbids would vary depending on the size and weight of the species and on the climatic season. We predicted that the largest and heaviest columbid species would

present the lowest abundance and density, while the smallest and lightest species would present the highest abundance and density. We also predicted that the columbid abundance and density would be higher during the rainy season. Our findings supported our initial hypothesis, with the largest and heaviest columbids being the least abundant and dense species in the area, while the smallest species were the most abundant and dense. Also, the abundance and density of most of the species increased during the wet season, especially for the smallest species.

With the exception of the species *C. minuta* and *Z. auriculata*, where no differences were observed in abundances between the rainy and dry seasons, all other species showed higher abundances in the rainy season. This result corroborates the hypothesis that in semi-arid regions, where seasonality decisively influences the availability of food resources, the abundance of animals is usually greater during the rainy season (Dean & Milton, 2001; Schwinning & Sala, 2004; Araújo et al., 2017; Oliveira e Silva et al., 2017). Therefore, the greater availability of seeds and fruits allows an increase in the abundance of most species during the rainy season (Dean & Milton, 2001; Carvalho et al., 2015; Araújo et al., 2017; Oliveira e Silva et al., 2017).

The fact that *C. minuta* is described as a persistent species in areas with extreme drought (Fernandes-Ferreira, 2014), being able to obtain the necessary resources for its survival, may explain the fact that its population did not present a significant difference between the seasons. According to our data, the abundance of *Z. auriculata* was constant throughout the year, however, there is a peak in the dry season (December 21; Figure 5). Such peaks may be related to the periodic migrations that *Z. auriculata* performs along the Brazilian Northeast in search of food during the dry season (Souza et al., 2007; Oliveira Souza et al., 2022), such as the exploration of corn plantations present in the studied region, where most of its individuals were recorded in foraging activity. According to Silva and Guadagnin (2017), *Z. auriculata* has been strongly associated with areas of grain crops (e.g., corn, sorghum). Precisely during the dry season, when resources become scarce even for the human population, the

hunting of columbids in the region tends to increase, as hunters reported that it is easier to observe the birds in trees with dry branches and without leaves (Silva et al., 2021). Thus, it should be interesting to evaluate if hunting is influencing the abundance and density of these species in the study site, especially in the dry season.

Records of *L. rufaxilla* only in area A3 are possibly due to its proximity to PARNASI, where there are records of its occurrence (Silva et al., 2022). Unlike its congener (*L. verreauxi*), *L. rufaxilla* is more forestry, preferring the closed and dense understory of secondary forests (Sick, 1997), as well as forest fragments found on the slopes of PARNASI. It is interesting to note the low abundance and density of species with larger size and body mass (*P. picazuro*, *Z. auriculata*, *L. verreauxi,* and *L. rufaxilla*). The low abundance and density of the other large size species may be related to uncontrolled hunting in the region, as reported by local hunters (Silva et al. 2021). According to these hunters, these larger, "meatier" columbids are no longer abundant in the region due to over-exploitation for food use. It is also worth mentioning the low number of records of *C. squammata*, which may also be related to excessive hunting, given that it is highly hunted in the region to be used as pets (Silva et al., 2021). It is important to note that the population density of birds is usually lower in areas that are under hunting pressure (Benítez-López et al., 2017). Natural fluctuations on the populations of these columbid species also need to be considered, since their monitoring occurred for only one year. Natural fluctuations and the impact of hunting would be better understood if long-term monitoring and studies were conducted in the region (Magurran et al., 2010; Pollock et al., 2022).

The results obtained in this study are fundamental to help future conservation plans for this group of birds. However, the data available so far for the Columbidae species recorded in the sampled areas are not sufficient to state the conservation status in which their populations are found and to estimate their viability, since this was the first study in the region that was dedicated to quantify the populations of these birds. Decisions regarding the conservation of species are, most of the times, related

to time (Wright et al., 2020). This means that the persistence of a species in a given area may not be guaranteed in the long term, that is, the species may be in "extinction debt" (change in the population dynamics of the species that will lead to its extinction in the future) (Kuussaari et al., 2009). Among the Columbidae species recorded in this study, it is possible that some of them may already depend on conservation measures to survive, as is the case of *C. squammata*, *P. picazuro* and *Z. auriculata*, which had fewer records and are no longer easily detected in the region (Silva et al., 2021). To evaluate if hunting pressure is the main predictor for the low abundance and density of some of the columbid species in the area, it is necessary that data from annual and consecutive censuses of columbids be related to hunting data, based on hunters' reports and apprehensions carried out by environmental authorities. In this way, it will be possible to more realistically assess the impacts of hunting on the persistence of species.

It is well understood that knowing the state of the target species' populations, specifically detecting drastic population declines, is required for an effective conservation plan in order to avoid possible local extinctions. The detection of a population decline can be seen as a trigger for the elaboration of priorities for effective conservation (Nichols & Willians, 2006). A constant monitoring program makes it possible to monitor temporal variations in populations through repeated counts in the same locations over consecutive years. It is one of the main ways to detect fluctuations in population size, whether due to natural variations or caused by human actions (Conroy et al., 2012). At the same time, local hunting monitoring can provide subsidies to understand the impacts of hunting on population fluctuations of columbids.

5 CONCLUSION

We conclude that most columbid species, particularly those with larger size and body mass, have small and possibly declining populations in the studied area. Seasonality showed to be an important predictor for such declines. It is important

to note that the hunt of columbids in the region may have a greater impact on the populations, as there have been reports of hunters preferring to hunt during the dry season (Silva et al., 2021). Thus, long-term monitoring of columbids becomes essential for the development of adequate population models that can predict the future of species in the region, allowing for more assertive action to protect species that show a sharp decline. In order to conserve these bird species, future research should focus on identifying different predictors that can explain the low abundance of many Columbids.

DATA AVAILABILITY

Silva, Cleverton; Ruiz, Juan; Azevedo, Cristiano; Ribeiro, Adauto (2023), "Seasonal variation in the abundance and density of columbids (Aves: Columbidae) in a region with high hunting pressure", Mendeley Data, V1, doi: 10.17632/txwwnmj6m7.1

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