INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 24, No. 5, p. 80-89, 2024
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Population size and conservation management of the rose-ringed parakeet (*Alexandrinus krameri*) in the town of Maroua, far north Cameroon

Ghislain Noé Kougoum Piebeng[*1], Madi Namissa[1], Simon Awafor Tamungang[2,3], Daksala Wansang[1], Leonce Syntcha Djakam[1], Sandra Ateufack Nguekeng[1], Alexis Teguia[4]

[1]*Department of Biological Sciences, Faculty of Science, University of Maroua, Cameroon*

[2]*Department of Animal Biology, Faculty of Science, University of Dschang, Cameroon*

[3]*Department of Forestry and Wildlife Management, College of Technology, University of Bamenda, Cameroon*

[4]*Department of Animal Production, Faculty of Agronomy and Agricultural Science, University of Dschang, Cameroon*

Article published on May 10, 2024

Key words: Abundance, Rose-ringed parakeet, Distribution, Conservation, Maroua, Cameroon

Abstract

The present study was carried out in the town of Maroua, Far North Region of Cameroon with the main objective of contributing to the knowledge of the population status of the Rose-ringed Parakeet (RRP) with a view to its sustainable management. The Rose-ringed Parakeet (RRP) inventory was carried out using the linear strip transect method. The counts were made from 27 July to 20 September 2023 for the rainy season and from 15 November 2023 to 2 February 2024, all between 6 a.m.-9:30 a.m. for the morning and 4 p.m.-6 p.m. for the evening on all sites. The information collected in the field was processed and analysed using Distance 6.0, PAST 4.03 and QGIS.3.22 software. It appears from this analysis that the population of RRP is estimated at 47,391 individuals in the study site with an average density of 20.6 individuals per hectare. In the rainy season, the surface density was estimated at 12,488 individuals/ha for a total of 28,723 individuals while in the dry season, the density was 7.1815 individuals/ha for a total of 16,517 individuals. Depending on the type of habitat, the abundance of parakeets was higher in mixed zones composed of housing and plantations compared to other habitats. RRP are found everywhere in the territory of the city of Maroua. Modelling the spatial distribution using the IDW interpolation method using QGIS software shows that RRP in general and in the rainy season are more abundant in the Maroua 1 subdivision, and this distribution was dependent on the availability of food resources. Les principales activités humaines rencontrés sont le pâturage et l'exploitation forestière. The main human activities encountered were pasture and logging. Although RRPs are still encountered in large numbers in Maroua, conservation should be done as a priority in the districts of Maroua 1 and Maroua 3.

***Corresponding Author:** Ghislain Noé Kougoum Piebeng ✉ kougoumghislain@yahoo.fr

Introduction

Birds represent the animal group most used for environmental monitoring, ahead of large mammals (Ricard *et al.*, 2017). They play a role in crop protection by controlling populations of harmful insects. They enable the development of tourist activities through their various forms (Kouzi, 2012). Birds are a source not only of aesthetic pleasure, sound and color to our existence, but also a source of economic growth, providing income and motivation for conservation through ecotourism (Jaquemet, 2010). They also provide a wide variety of ecosystem services. Rose-ringed parakeets (RRP), for their part, are involved in the pollination of plants and can disperse seeds over long distances through their excrement (Blanco *et al.*, 2018). The potentially ubiquitous ecological role of the parakeet may contribute to the resilience of ecosystems against overgrazing and forest degradation, particularly through their dependence on declining basal tree species (Ellison *et al.*, 2005).

The RRP, despite its ecological and socioeconomic importance, is one of the most successful invasive birds in the world (Menchetti and Mori, 2014; Le Gros *et al.*, 2016), with exotic populations established in more than 35 countries (Menchetti *et al.*, 2016). The rose-ringed parakeet often occurs around human habitation (Grandi *et al.* 2018; Mentil *et al.* 2018). It is a social species and is native to parts of eastern and southern Asia and from eastern to central Africa (Parr and Juniper, 2010). Humans have been responsible for translocating this species across the globe as part of the pet trade, and many are purchased for companionship (Menchetti *et al.*, 2016; Vall-llosera *et al.*, 2017). The RRP with its shrill cry is a granivore-frugivore which exploits both local and exotic species (buds, fruits, seeds). It is also considered a major pest in India, its native area, where it attacks fruit and cereal trees (Clergeau *et al.*, 2015). It nests very early in tree cavities and seems to compete in certain regions with other cavity-dwelling species such as the Nuthatch, *Sitta europaea* (Strubbe and Matthysen, 2009). Studies also show potential impacts on Stock Doves, *Columba oenas* or bats (Hernandez-Brito *et al.*, 2014) or on the feeding of small passerines (Peck *et al.*, 2014) and during the breeding period, it displays aggressive behaviour towards other birds that fly around its nests (Clergeau *et al.*, 2015).

Several works have already been carried out on the RRP all over the world and in Africa. In this context, we will cite for example the study on the introduction and nesting of the RRP in Algeria (Amina *et al.*, 2005), and the study on the establishment of the RRP *Psittacula krameri* (syn: *Alexandrinus parakeet*) in Algeria and first data on its trophic ecology in this region (Bendjoudi *et al.*, 2005). On the other hand, in Cameroon, no previous study has been carried out on RRP. This work was initiated with the overall objective of contributing to knowledge of the state of the RRP population with a view to its sustainable management in the city of Maroua. Specifically, it is: estimate the abundance and density of the Rose-ringed parakeet in the town of Maroua, map the spatial distribution of RRP; identify and assess the impact of different threats on this bird species.

Material and methods

Study area

This study was carried out in the town of Maroua which is the capital of the Far North Region of Cameroon and capital of the Diamaré department (Fig. 1).

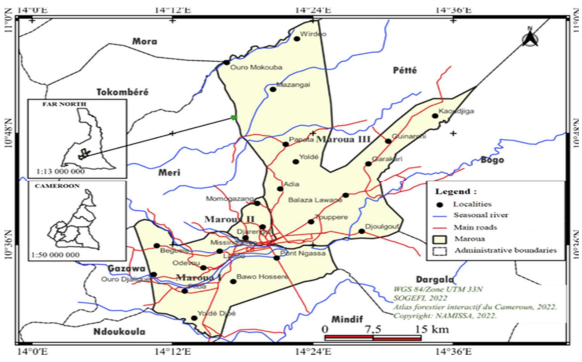

Fig. 1. Map of the study area

It is located between 10° 29´ and 10° 41´ North latitude, 14° 15´ and 14° 27´ East longitude, with an average elevation of 400 m and an area of 56 km².

The climate of the Far North region is Sudano-Sahelian, characterized by the alternation of two seasons, a dry season which goes from October to May and a rainy season from June to September. Annual rainfall is between 700 and 1200 mm (Oumarou *et al.*, 2022). The rainiest months are August and September. Temperatures vary around 20°C to 35°C in the cool season (rainy season) and a peak of 45°C is registered in periods of extreme heat at dry season.

The dominant vegetation is the shrub savannah characteristic of the Sudano-Sahelian zone. It is made up of thorny steppes and periodically flooded meadows (Madi *et al.*, 2012). Due to its ecological diversity, the city of Maroua has several plant species established by humans or found in nature (Madi *et al.*, 2012). The flora is quite diverse, the different plant formations have been decimated for the establishment of homes. The vegetation in the town of Maroua consists of grassy steppes and woody strata, mainly consisting of thorny trees (*Acacia albida, Ziziphus mauritiana, Tamarindus indica, Azardirachta indica, Acacia seyal,* etc.), whose heavy exploitation causes the scarcity of this resource.

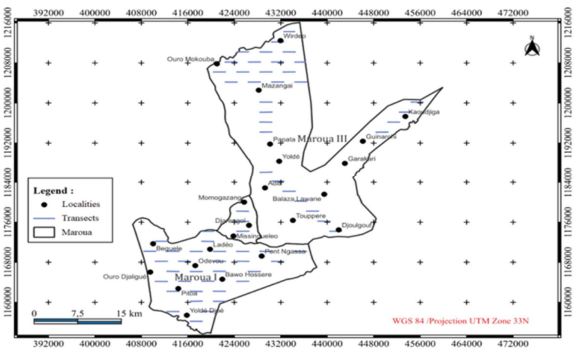

Fig. 2. Map showing transect layout

Estimation of the abundance and density of the Rose-ringed Parakeet

Sampling design

This inventory was carried out from July 10 to September 10, 2023, the period corresponding to the rainy season, and from November 15 to January 30, 2024, the period corresponding to the dry season. The distance sampling method described by Buckland *et al.* (2003) was used for the RRP inventories. For this purpose, in the study area, 64 linear transects, measuring 2000 m in length, were covered. The spacing between transects was at least 2000 m (Fig. 2). The starting points of each transect and their coordinates were determined on the map and precisely located on the ground using a GPS (Global Positioning System). The transects were placed to cover all the different types of habitats encountered in the town of Maroua.

Data collection along transects

The distance sampling method was used (Buckland *et al.*, 2003). It consisted of silently and slowly traversing the transect line, and noting the number of ring-necked parakeets seen or heard, the observation distance (which separates the observer from the animal observed), the perpendicular distance between the line of the transect and the bird (or its song); and the type of habitats in which the parakeets were observed. The inventories were carried out in the morning from 6:30 a.m. to 9:30 a.m. and in the evening between 4 p.m. and 6 p.m.

Spatial distribution of rose-ringed parakeets in Maroua

Occurrence data for any parakeets seen or heard were georeferenced for spatial analysis. These data (georeferenced occurrences and relative abundances of the species) were imported into QGIS version 3.22 software to model and map the spatial distribution of ring-necked parakeets in the study area. This modelling was done using the IDW (Inverse Distance Weighting) interpolation method. This method assumes that the influence of the plotted variable decreases with distance from the sampled location. Setting high power allows concentration on known points on the interpolated values based on their distance from the output point.

Identification and assessment of the impact of different threats on the parakeet

It was essentially based on the determination of the index of anthropogenic disturbance observed during the field inventory. The various threats encountered

were noted (logging (logging or collection), destruction of nests, use of pesticides and grazing (presence of livestock)). The kilometric contact pressure indices (KCPI) for anthropic activities were calculated. This made it possible to identify areas of high concentration of human activities.

$$KCPI = \frac{\text{Number of contacts observed by type of pressure}}{\text{Total inventory effort (km)}}$$

Data analysis

Estimation of density and abundance

The collected data were introduced and then encoded in Microsoft Office Excel 2016. The estimation of density and abundance was obtained using the Distance 6.0 program. For this, we carried out 5 tests of different models. Among the 5 tests carried out with each data series (Models Half-normal Cosine, Hazard-rate Cosine, Hazard-rate Simple polynomial, Uniform Cosine and Uniform Simple polynomial), we retained the model with the lowest AIC (Akaike Information Criterion). The AIC being a parameter based on the principle of parsimony, makes it possible to identify, among several models, the one which is the simplest and requires the fewest different parameters to describe the distribution of the distances obtained for a given species. If the associated statistical tests (Chi2 test, Kolmogorov-Smirnof tests, Cramer von Mises tests) are closest to the value 1 and the Coefficient of variation (CV%) < 30% maximum, then the test is valid. This program requires high precision in perpendicular distance measurements and allows data analysis for sufficiently observed species. The confidence interval was taken at 95% for all estimated densities and abundances.

The application of the GLM Generalized Linear Model to the data made it possible to know what levels of threat indices have an effect on the ring-necked parakeet species. For this purpose, PAST software version 4.03 was used. The Kruskal-Wallis test made it possible to compare the abundance of each population of ring-necked parakeets at the threshold of 0.05.

Results

Estimation of global abundance and density of Rose-ringed Parakeet

RRPs were observed 176 times for a total of 613 individuals (Fig. 3). The estimate of the average abundance of ring-necked parakeets in Maroua is 47,391 individuals with a number varying between 37,609 and 59,717 for a 95% confidence interval (Table 1). That of the average density is 20.6 individuals/hectare, with a coefficient of variation of 11.75%, which is less than 30%. The Chi2 test (p = 0.94) is excellent because its value is close to 1.

Fig. 3. Pictures of some Rose-ringed Parakeets in the town of Maroua

Table 1. Overall estimate of density, abundance and 95% confidence interval of RRP in Maroua

Species		EV	CV (%)	df	CI at 95%
RRP	Density	20,605	11,75	174	16,352 - 25,964
	Abundance	47391	11,75	174	37609 - 59717

RRP: Rose-ringed Parakeet; EV: Estimated value; CV: Coefficient of variation; df: degree of freedom; CI: Confidence interval

The probability curve of detection of RRPs as a function of the perpendicular distance to the transect according to the Half-normal + Cosine model decreases when the perpendicular distance increases (Fig. 4). The detection function is a decreasing function.

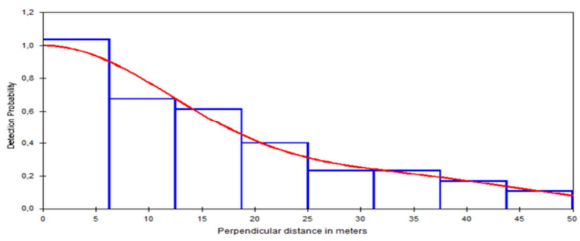

Fig. 4. Rose-ringed parakeet overall detection function curve

Table 2. Estimated densities (D), abundances (A) and 95% confidence interval of Rose-ringed Parakeets depending on the seasons in the town of Maroua

Species	Seasons		EV	CV (%)	df	CI at 95%
Rose-ringed Parakeet	Rainy	D	12,488	14,98	108	9,2961 - 16,777
		A	28723	14,98	108	21381 - 38587
	Season	D	7,1815	15,55	65	5,2744 - 9,7781
		A	16517	15,55	65	12131 - 22490

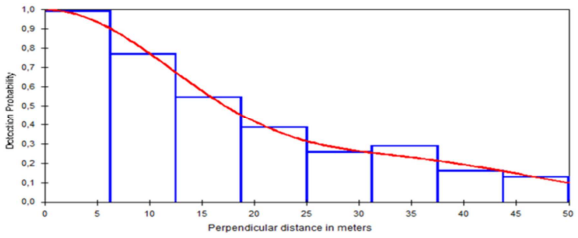

Fig. 5. Rose-ringed Parakeet detection function in rainy season

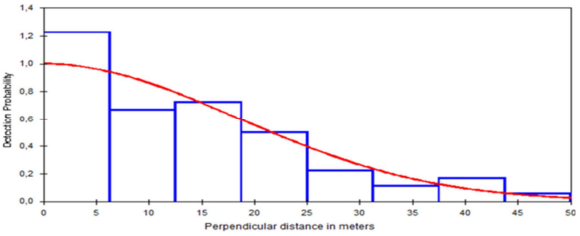

Fig. 6. Rose-ringed Parakeet detection function in dry season

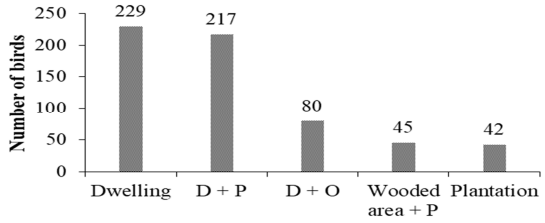

Fig. 7. Diagram of Rose-ringed Parakeet abundances based on habitat type

D : Dwelling ; P = Plantation ; O = Orchard

Estimation of abundance and density according to the seasons

Parakeets were observed 110 times in the rainy season totaling 377 individuals while in the dry season, they were observed 66 times totaling 236 individuals. In the rainy season, the average population of ring-necked parakeets is estimated at 28,723 individuals in a range between 21,381 and 38,587 individuals (Table 2). The average density is estimated at 12.49 individuals per hectare, with a coefficient of variation of 14.98%, which is high. The statistical tests are all satisfactory, with a Chi2 (p = 0.99) and a coefficient of variation (CV < 30%). The detection function (Fig. 5) clearly illustrates the shape of the probability curve of detection of ring-necked parakeets as a function of the distance perpendicular to the transect according to the Half-normal + Cosine model.

In the dry season, the actual abundance of parakeets is between 12,131 and 22,490 individuals. The average estimate is 16,517 individuals, or a density of 7.18 individuals per hectare. However, the statistical tests are all excellent, with Chi2 (p = 0.65) and a coefficient of variation less than 30%. The detection function (Fig. 6) clearly illustrates the shape of the detection probability curve for ring-necked parakeets as a function of the distance perpendicular to the transect according to the Half-normal + Cosine model.

Comparison of abundance according to habitat types

The dwellings contain the largest number of individuals (229 individuals), compared to 217 individuals in the mixed zone composed of dwellings and plantations, 80 individuals in the habitat composed of dwellings and the orchard, 45 individuals in the mixed zone composed of the wooded area and plantations and 42 individuals in the growing environment (plantation) (Fig. 7). However, no significant difference was observed according to the Kruskal Wallis test between the abundances of ring-necked parakeets in the 4 types of habitats (P = 0.39) at the 5% threshold.

Spatial distribution of the Rose-ringed Parakeet in the study area

Global spatial distribution of RRP in Maroua

Spatial modelling of the spatial distribution of the RRP (Fig. 8) shows that the species is found

throughout the territory of Maroua. There are four (04) types of concentration zones. Dark blue areas are areas of very low abundance where only one individual is observed. The areas in green are places of low abundance where at least 4 parakeets are observed. Orange zones are areas where the abundance of parakeets is average and where at least 7 individuals are observed. The brown zones present areas of high abundance of parakeets where the number of individuals observed is greater than 12. It appears on this map that the high density of parakeets in the town of Maroua is located in the district of Maroua 1.

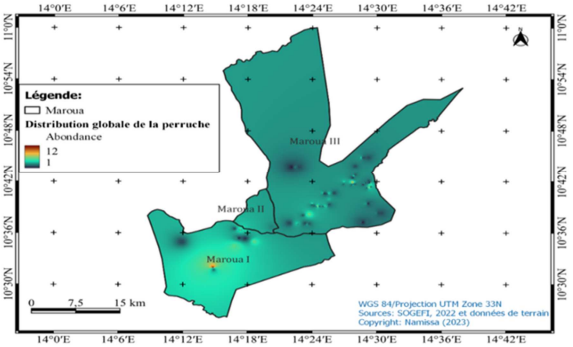

Fig. 8. Global spatial distribution map of ring-necked parakeets in the study area

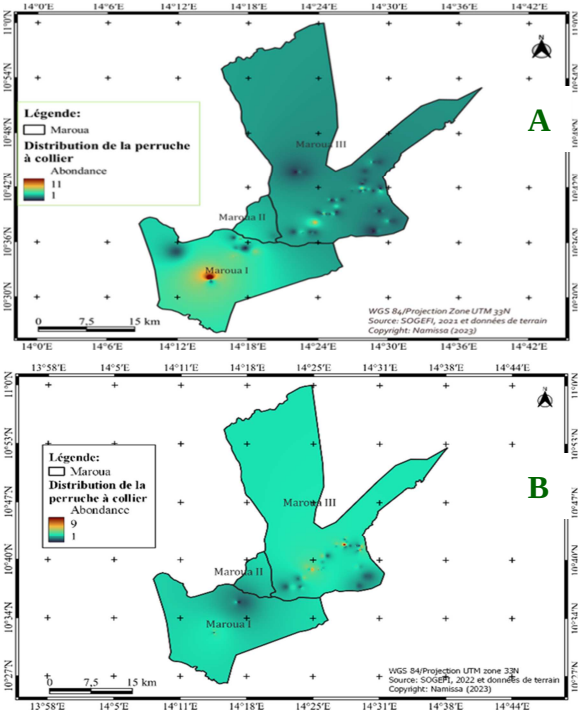

Fig. 9. Maps of spatial distributions of Rose-ringed Parakeets in rainy (A) and dry (B) seasons

Spatial distribution of Rose-ringed Parakeets according to season

Ring-necked parakeets were encountered mainly in the territory of the town of Maroua in the rainy season than in the dry season (Fig. 9). It appears that in the rainy season (Fig. 9A), the high density of parakeets is found in the Maroua 1st district and a few concentration points of these birds were also observed in the Maroua 3rd district. In the dry season (Fig. 9B), we observe the high density of ring-necked parakeets in the Maroua 3 Subdivision.

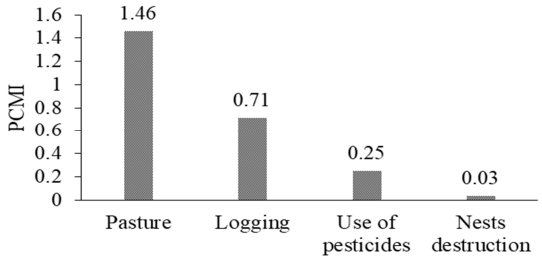

Fig. 10. Encounter rate for the different human activities in the study area

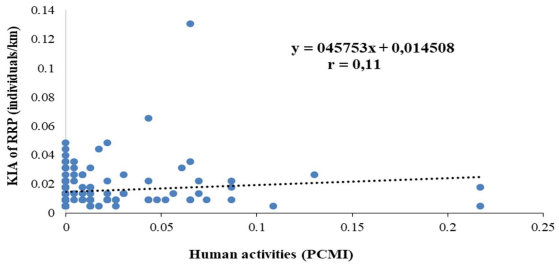

Fig. 11. Regression analysis of variation in Rose-ringed Parakeet KIA in relation to human activities in the study area

KIA : Kilometric index of abundance ; PCMI : Pressure Contact Mileage Index

Identification and assessment of the impact of anthropogenic activities on parakeets Distribution of human activities

The data collected on human activities allowed us to distinguish four (04) types of human pressures in the study area (Fig. 10). Pastoralism is the main and most important anthropogenic activity in the study site. His Pressure Contact Mileage Index (PCMI) was 1.46 for 230 km travelled. It is justified on the ground by the presence of numerous breeders, cattle as well as

the traces of oxen. Logging is the second most common anthropogenic activity in the study area. Indeed, it is defined through the cutting of various woods, pruning for livestock and for making hedges, its PCMI is 0.71 for a total of 230 km of transects. The use of pesticides for agriculture (presence of packaging and sachets of pesticides encountered in the field) presents the third activity in the study area, with a PCMI equal to 0.25. The destruction of nests and nesting trees constitutes the fourth threat to the ring-necked parakeet, with a PCMI of 0.03.

Effect of human activities on the abundance of ring-necked parakeets

There is a significant correlation (r = 0.11) between the increase in the concentration of RRP in relation to human activities (Fig. 11). It appears from this figure that human activities influence the distribution of ring-necked parakeets in the study area; the greater the human activities in the area, the fewer RRP are present.

Discussion

Data from the inventory reveal that Rose-ringed Parakeets (RRP) are present in large numbers in the town of Maroua. The overall average estimate of the abundance of ring-necked parakeets throughout the territory of the city of Maroua is 47,391 individuals. These values exceed those of the estimates made by Peck in 2011 in the United Kingdom which were of the order of 32,167 individuals. The results of this study show a strong increase in the numbers of ring-necked parakeets, which is a common phenomenon in population dynamics. These corroborate with the results of Vangeluwe (2014), Weiserbs (2010), and Clergeau *et al.* (2008) who showed that RRP are growing rapidly in their introduced site. The estimated density of RRP in the town of Maroua is 20.6 individuals/km². This value is far higher than the estimate made by Moussa (1994), which was of the order of 7.35 individuals/km² in the Kédougou department in Senegal.

Estimates of numbers depending on the seasons show that parakeets were observed in large numbers in the rainy season than in the dry season. The average estimate of population abundance of RRP in the rainy season in the study area is 28,723 individuals. These values are close to the estimates made in 2012 by Peck (2013) in the United Kingdom, which were of the order of 29,133 individuals. Regarding the dry season, 16,517 individuals were estimated in the town of Maroua. From the results of this study, parakeets are more abundant in the rainy season than in the dry season. The difference in parakeet estimates between two seasons can be justified by the presence of increasingly abundant food resources in the rainy season. These results are in agreement with those of Clergeau *et al.* (2008) and Weiserbs (2010) who showed that the expansion of the Ring-necked Parakeet is based on suitable habitats and the presence of abundant food in terms of quantity, quality and diversity. Since parakeets have a wide feeding niche and particularly enjoy nutritious parts of plants such as flowers, fruits, leaves and seeds (Shiels and Kalodimos, 2019). In addition, vegetation structure is important in structuring avian communities (Earnst and Holmes, 2012). Several studies have shown that the diversity of habitats and vegetation, including the food resources they contain, play an essential role in structuring bird communities. An abundance of RRP has been observed in Maroua in orchards (mango plantations), homes and wooded areas. These results are similar to the observations made by Clergeau *et al.* (2009) who showed that RRP are more abundant in wooded areas, orchards, gardens and parks. The variation in abundance levels of RRP observed in different types of habitats is due to the season and the availability of different food resources.

The analysis of the overall spatial distribution of the ring-necked parakeet showed that the species is potentially present throughout the territory of the city of Maroua, but with a high density in Maroua 1 subdivision. The high density of these parakeets in this subdivision could be justified on the one hand by the low human pressure encountered in this area and on the other hand by the availability of food resources. In this subdivision, we find gardens, orchards and cereal fields, resting and dormitory sites, the availability of tree species (*Acacia nilotica*

and *Acacia albida*) for nesting, which are ideal conditions for the survival and reproduction of these birds in Maroua. The same observations were made by Clergeau *et al.* (2009) who showed that parakeets are observed mainly in green spaces or areas with trees, whether in town or in the countryside, it seems that this is one of the constants of their habitat. The fundamental element in the distribution of parakeets is the presence of a food resource which can be located on the ground or in trees. In the rainy season, the Maroua 1 subdivision also presented an area of high density of parakeets, with a few concentration points in the Maroua 3 subdivision. The high concentration of parakeets in these two subdivisions could be justified by the low anthropogenic pressure and an environment favourable to their development. The low presence of parakeets in the Maroua 2 subdivision is justified by the fact that the majority of the territory of this district is occupied by mountains without large trees and other plant resources that these birds could use. In the dry season, the high-density zone is in the Maroua 3 subdivision. This high density of parakeets in this territory can be justified by the presence of gardens, wooded areas made up of trees such as *Acacia albida* and other plant species which provide them with food for their nutrition and that of young birds emerging from the nests. Their diet in the dry season consists mainly of leaves, fruits and seeds of domesticated plants and wild species. These observations are similar to those made by Weiserbs (2010) on the diet of parakeets in Belgium. The reduced abundance of RRP in the dry season in certain areas could be explained by the fact that the available food resources would be of insufficient quantity and nutritional quality to ensure the maintenance of their populations during this arid period, which obliges them to migrate to other areas more favourable to their survival (Morgue, 2019).

The main causes of threats to birds are due to human activities and the effects of climate change (Birdlife International, 2018). Note that the territory of the town of Maroua is under anthropogenic pressure such as the exploitation of wood for heating, agricultural activities, poaching, etc. as well as the climate change which has been felt in recent years in Cameroon and in the Far North region in particular. Grazing (large herds of cattle, goats, and sheep) is noted as the most practiced activity in the study area. This most often causes violent conflicts between breeders and farmers. The various anthropogenic activities seem not to have any real effects on the population of RRP, proof that these birds have already become accustomed to human presence. In fact, its birds are observed in the fields, around homes in towns and villages. Certain dormitories capable of housing several dozen birds have been observed for several years in the heart of the town of Maroua at the IRAD (Institute for Agricultural Research and Development) camp of Pitoaré.

Conclusion

It appears from this study that the town of Maroua is home to a significant population of the RRP. The abundance of the species in the rainy season was highest compared to the dry season. The mixed zone composed of housing and plantation shelters the greatest number of individuals compared to the other types of habitats (mixed zone composed of housing and orchard, the residential zone, wooded zone and plantation and the plantation zone). RRP are more concentrated in the territory of the Maroua 1 subdivision compared to other districts. This spatial distribution of parakeets varies depending on the seasons and the availability of food resources. The threats encountered on the RRP during this inventory are mainly pastoral activities and logging. All the information provided by this work constitutes a solid database for surveillance, population control and conservation of this (invasive) species which has been able to colonize a wide range of habitats, sometimes to the detriment of local species.

Recommendation(s)

Promote the results of this study initially to the competent authorities in terms of biodiversity management, then provide additional efforts in a continuous inventory in order to ensure better control of the ring-necked parakeet population, a protected species in Cameroon, but also considered a crop pest.

Acknowledgements

We thank the conservation authorities of the Far-North Region and local population for their involve ment in this work.

References

Amina F, Moulaî R, Jacob JP. 2005. Introduction et nidification de la Perruche à collier *(Psittacula krameri)* en Algérie. Aves **42** (3), 257-262.

Bendjoudi D, Voisin JF, Doumandji S, Baziz B. 2005. Installation de la Perruche à collier *Psittacula krameri* dans l'Algérois et premières données sur son écologie trophique dans cette région. Alauda **73**, 329-334.

BirdLife International. 2018. Etat des populations d'Oiseaux dans le monde : prenons le pouls de la planète. Cambridge, UK : BirdLife International.

Blanco G, Hiraldo F, Tella JL. 2018. Ecological functions of parrots: an integrative perspective from plant life cycle to ecosystem functioning. Emu **118**, 36–49.

Buckland ST, Anderson DR, Burnham KP, Laake JL. 2003. Distance sampling: estimating abundance of biological populations. Oxford University press, Inc., New York.

Clergeau P, Vergnes A, Delanoue R. 2008. La Perruche à collier *Psittacula krameri* introduite en Île-de-France : distribution et régime alimentaire. Muséum National d'Histoire Naturelle.

Clergeau P, Vergnes A, Delanoue R. 2009. La perruche à collier *Psittacula krameri* introduite en Ile-de-France : distribution et régime alimentaire. Alauda **77** (2), 121-132.

Clergeau P, Leroy O, Lenancker P. 2015. Dynamique de population de la perruche à collier *Psittacula krameri* introduite en Île-de-France. Alauda **83** (3), 165-174.

Earnst S, Holmes A. 2012. Bird-habitat relationships in interior Columbia Basin shrubsteppe. Condor **114** (1), 15-29.
DOI: 10.1525/cond.2012.100176

Ellison AM, Bank MS, Clinton BD, Colburn EA, Elliott K, Ford CR. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. Frontiers in Ecology and the Environment **3**, 479–486.

Grandi G, Menchetti M, Mori E. 2018. Vertical segregation by breeding ring-necked parakeets *Psittacula krameri* in northern Italy. Urban Ecosystem **21**, 1011–1017.
https://doi.org/10.1007/s11252-018-0779-1

Hernández-Brito D, Carrete M, Popa-Lisseanu AG, Ibañez C, Tella JL. 2014. Crowding in the city: losing and winning competitors of an invasive bird. PLoS One **9**, e100593.

Jaquemet S. 2010. Rôle des Oiseaux marins tropicaux dans les réseaux trophiques hauturiers du sud et de l'océan Indien. Océan, Atmosphère. Université de la Réunion, Français.305P.

Kougoum, PGN, Tamungang SA, Téguia A. 2017. Breeding biology of African grey parrot *(Psittacus erithacus)* in Kom National Park (South-Cameroon) and implications to the species conservations. International Journal of Biological and Chemical Sciences **11**(5), 1948-1966.
https://doi.org/10.4314/ijbcs.v11i5.2

Kouzi P. 2012. Etat de connaissances bibliographiques de l'avifaune de Kisangani et ses environs (province Orientale, République démocratique du Congo). Mémoire master 2. Université de Kisangani.37Pp.

Le Gros A, Samadi S, Zuccon D, Cornette R, Braun MP, Senar JC, Clergeau P. 2016. Rapid morphological changes, admixture and invasive success in populations of ring- necked parakeets *(Psittacula krameri)* established in Europe. Biological Invasions **18**, 1581-1598.

Madi OP, Sali B, Woin N. 2012. Utilisations et importance socio-économiques du *Moringa oleifera* au Maroua, Cameroun. Journal of Applied Biosciences **60**, 4421– 4432.

Menchetti M, Mori E. 2014. Worldwide impact of alien parrots (Aves Psittaciformes) on native biodiversity and environment: a review. Ethology Ecology and Evolution **26**, 172–194.

Mentil L, Battisti C, Carpaneto GM. 2018. The impact of *Psittacula krameri* (Scopoli, 1769) on orchards: First quantitative evidence for Southern Europe. Belgian Journal of Zoology 148(2). https://doi.org/10.26496/bjz.2018.22

Menchetti M, Mori E, Angelici FM. 2016. Effects of the recent world invasion by ring-necked parakeets *Psittacula krameri*. In: Angelici F (ed) Problematic Wildlife. Springer, Cham. https://doi.org/10.1007/978-3-319-22246-2_12

Mousa SD. 1994. Impact de la commercialisation de certaines espèces d'oiseaux au Sénégal. ORSTOM. 39p

Oumarou Y, Dapsia DJ, Ndih AC, Fameni TS, Haïwa G, Mohamadou A. 2022. Effets des fientes de volailles, du tourteau de neem [*Azadirachta indica* (A. Juss)] et du compost à base de bouse de bovin sur la croissance et le rendement du cotonnier *(Gossypium hirsutum* L.*)* et les propriétés phisico-chimiques du sol dans la localité de Zokok-Laddéo de la région de l'Extrême-Nord au Cameroun. Afrique Science **21**(4), 138-149.

Parr M, Juniper T. 2010. Parrots: A guide to parrots of the world. Bloomsbury Publishing, London.

Peck HL. 2013. Investigating ecological impacts of the non-native population of Rose-ringed parakeets *(Psittacula krameri)* in the UK. PhD thesis, 212p.

Peck HL, Pringle HE, Marshall HH, Owens IP, Lord AM. 2014. Experimental evidence of impacts of an invasive parakeet on foraging behavior of native birds. Behavioral Ecology **25**, 582–590.

Ricard J, Garcin A, Jay L, Mandrin J. 2017. Les Vertébrés, Biodiversité et regulation des ravageurs en arboriculture fruitiere. Centre technique interprofessionnel des fruits et légumes CtiffBalandran 30127 (France).33p.

Shiels AB, Kalodimos NP. 2019. Biology and impacts of Pacific Island invasive species. *15. Psittacula krameri*, the Rose-Ringed Parakeet (Psittaciformes: Psittacidae). Pacific Science **73**, 421–449.

Strubbe D, Matthysen E. 2009. Experimental evidence for nest-site competition between invasive Ring-necked Parakeets *Psittacula krameri* and native Nuthatches Sitta europaea. Biological Conservation **142**, 1588-1594.

Vall-llosera M, Woolnough AP, Anderson D, Cassey P. 2017. Improved surveillance for early detection of a potential invasive species: the alien rose-ringed parakeet *Psittacula krameri* in Australia. Biological Invasions **19**, 1273–1284. https://doi.org/10.1007/s10530-016-1332-x

Vangeluwe D. 2014. Rapport des activités et des résultats réalisés en 2014. Institut Royal des Sciences Naturelles de Belgique, Centre de baguage.

Weiserbs A. 2010. Invasive species: The case of Belgian Psittacidae. Impacts, risks assessment and range of control measures. Aves **47**(1), 21-35.