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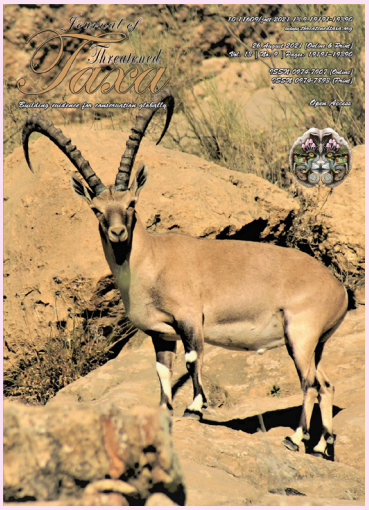

COMMUNICATION

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Anna Niang & Papa Ibnou Ndiaye

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COMMUNICATION

A large mammal survey in Koyli Alpha Community Wildlife Reserve and its surroundings in the Great Green Wall extension area in Senegal

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Abstract: Wildlife in the Great Green Wall (GGW) area, northern Senegal, is threatened by the cumulative effects of anthropogenic activities, drought, and climatic changes. To support conservation planning in line with the GGW management objectives, we studied large mammal diversity in the Koyli Alpha Community Wildlife Reserve in the GGW extension area. We interviewed local communities, made reconnaissance & transect walks, placed camera traps, and carried out fixed point surveys to map the distribution of mammals & to estimate their relative abundance. The surveys were conducted between May 2017 and December 2019. We identified the presence of nine mammal species belonging to six families: one lagomorph, Cape Hare *Lepus capensis*; seven carnivores, Common Jackal *Canis aureus,* Pale/Sand Fox *Vulpes pallida,* Wild Cat *Felis silvestris,* Marsh Mongoose *Atilax paludinosus,* Honey Badger *Mellivora capensis,* Zorilla *Ictonyx striatus,* Common Genet *Genetta genetta*, and one primate, Patas Monkey *Erythrocebus patas*. Our results indicate that the most of the observed species range broadly across the Koyli Alpha Reserve. The Wild Cat and the Sand Fox were also found outside the reserve around the village of Koyli Alpha. Camera trapping events of humans and domestic animals were high throughout the survey area, and the majority of the large mammals observed were mainly nocturnal. The diversity of large wild mammals identified during this study points to the urgent need for the implementation of a management plan of the biodiversity in this area of the Ferlo.

Keywords: Biodiversity, camera trapping, Ferlo, Koyli Alpha Reserve, management plan, nocturnal.

French: La faune sauvage de la zone d'extension du projet de reboisement de la grande muraille verte (GMV) au Nord du Sénégal est menacée de disparition suite aux effets cumulatifs d'activités anthropogéniques, de la sécheresse et du changement climatique. Afin de contribuer à la conservation de cette biodiversité, en rapport avec les objectifs du projet de la GMV, nous avons étudié la biodiversité de grands mammifères sauvages dans la réserve naturelle communautaire de Koyli Alpha et ses environs, dans la zone d'extension du projet de la GMV. Nous avons effectué des enquêtes auprès des populations locales, des prospections de transects de reconnaissance à pied, des piégeages photographiques et des suivis au point fixe pour pouvoir cartographier la distribution géographique des mammifères et estimer leurs abondances relatives. Les travaux ont été effectués entre mai 2017 et décembre 2019. Nous avons identifié pour cette période la présence de neuf espèces de mammifères appartenant à six familles : une lagomorpha, Lièvre du cap (Lepus capensis); sept carnivores, Chacal doré (Canis aureus), Renard pâle/roux des sables (Vulpes pallida), Chat sauvage (Felis silvestris), Mangouste des marais (Atilax paludinosus), Ratel (Mellivora capensis), Zorille (Ictonyx striatus), Genette commune (Genetta genetta), et un primate, Singe patas (Erythrocebus patas). Nos résultats indiquent que la plupart des espèces observées vivent dans et aux environs de la réserve naturelle communautaire de Koyli Alpha. Le chat sauvage et le renard ont aussi été observés aux environs du village de Koyli Alpha. Le nombre d'événements du piégeage photographique sur lesquels des images d'humains et d'animaux apparaissent est élevé pour cette zone d'étude, et la majeure partie des grands mammifères sauvages observés sont de mœurs nocturnes. La diversité de grands mammifères identifiée par cette étude met en exergue le besoin urgent de mettre en place un plan d'aménagement de la biodiversité dans cette partie du Ferlo.

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Author contributions: AN has participated in all the stages of field works, data analysis and the writing of the manuscript. PIN has contributed in all the stages of this work to the design of the study project up the manuscript submission and revisions.

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INTRODUCTION

Throughout history, humans have profoundly changed their environment through degradation and overexploitation of natural resources. These environmental modifications are usually related to natural resource extraction, use of unsustainable agricultural practices, infrastructure development, and human population growth, and these actions have negative impacts on biodiversity. Habitat loss is of particularly high prevalence in Africa and South America, and it is greatly affecting the vertebrates living in these regions (Visconti et al. 2020). Suitable habitat for mammals has declined globally by 5–16 %, and Africa with declines of up to 25% today and South America were the most affected regions (Baisero et al. 2020). According to these authors, loss of habitats of mammals is expected to affect a higher proportion in 2050 if adequate conservation management plans are not implemented. The Great Green Wall (GGW) of the Sahara and Sahel is an African reforestation initiative to combat desertification, reduce poverty, and to address the effects of climate change.

The GGW initiative has been envisioned by African leaders, and is led by the African Union. It is being implemented in targeted countries between Senegal and Djibouti. The GGW involves many actors and comprises a vast mosaic of healthy and productive landscapes from western to eastern Africa supporting resilient livelihoods with the aim of contributing to multiple environmental and development targets (Davies 2017). The initiative started in 2005 and extends over 7,000 km in length and 15 km in width, from Dakar (Senegal) in western Africa to Djibouti (Djibouti) in eastern Africa. In Senegal, the project is under the responsibility of the "Agence sénégalaise de la reforestation et de la grande muraille verte (ASERGMV)", a reforestation agency created in response to climate change and increasing poverty of local populations.

In Senegal, the GGW crosses Ferlo – the most hostile climatic zone of the country in the northern parts, which underwent two long drought periods in 1973–1974 and 1985–1986. These droughts led to ecological, economic, and social imbalances. The implementation of the GGW has made a notable contribution to the restoration of the original ecosystems, and to revive the economic and social activities of local populations in this region. The Food and Agricultural Organization of the United Nations (FAO) also supported local populations and the Senegalese's administration through the Agence Nationale de la Grande Muraille Verte (ANGMV) for instating a community wildlife reserve, 'Réserve Naturelle Communautaire (RNC) de Koyli Alpha' also called 'FAO wildlife reserve', as a response to the long drought. The main objective of the creation of this protected area was to restore degraded ecosystems, promote resilience and productivity of the agro-sylvo-pastoral systems through the involvement of local communities in the management of biodiversity and wildlife habitats (http://www.fao.org/senegal/actualites/detail-events/fr/c/1203521/, consulted 08/23/2020).

Many studies have been undertaken in the Ferlo area as part of the GGW project (Guisse et al. 2013; Boëtsch et al. 2019), but only a few of them have focused on wildlife (Niang 2017; Niang et al. 2019a,b). Generally, there is a scarcity of data on wildlife of this region of Senegal (Poulet 1972; Bourlière et al. 1976). Therefore, the aim of this study was to describe the diversity of large mammals present in the GGW portion in Senegal, to document their distribution and their interactions with domestic animals, as well as the local human population. We focused on Koyli Alpha for a more detailed study. Our main goal was to determine the status of large mammalian diversity of this area in the context of climate change, and generate scientific data to support decision-making in order to restore the wildlife habitat of this region. We believe that the impacts of the drought of 1973–1974 and 1985–1986, combined with the effects of climate change and anthropogenic activities, highlight the need to better understand the dynamics of the large wild mammals present in the GGW.

MATERIALS AND METHODS

Study area

The study was carried out in a 45 km^2 area in Koyli Alpha (latitude 15.730; longitude -15.511), department of Linguere, region of Louga (Image 1). Local populations belonging to the Peulh ethnic group adhere perfectly to the orientation of the GGW project. The main economic activities of these local communities are cattle farming and cattle trade. Therefore, livestock grazing is highly prevalent in this area. The FAO helped to implement a community wildlife reserve of about 700 ha, Réserve Naturelle Communautaire à Koyli Alpha (RNC). The main objective of this reserve is to contribute to the conservation of the biodiversity of the region by protecting the remaining wildlife and reintroducing other species that have been extirpated. People are allowed access to the reserve at certain times, and the RNC is open for livestock grazing during the dry season.

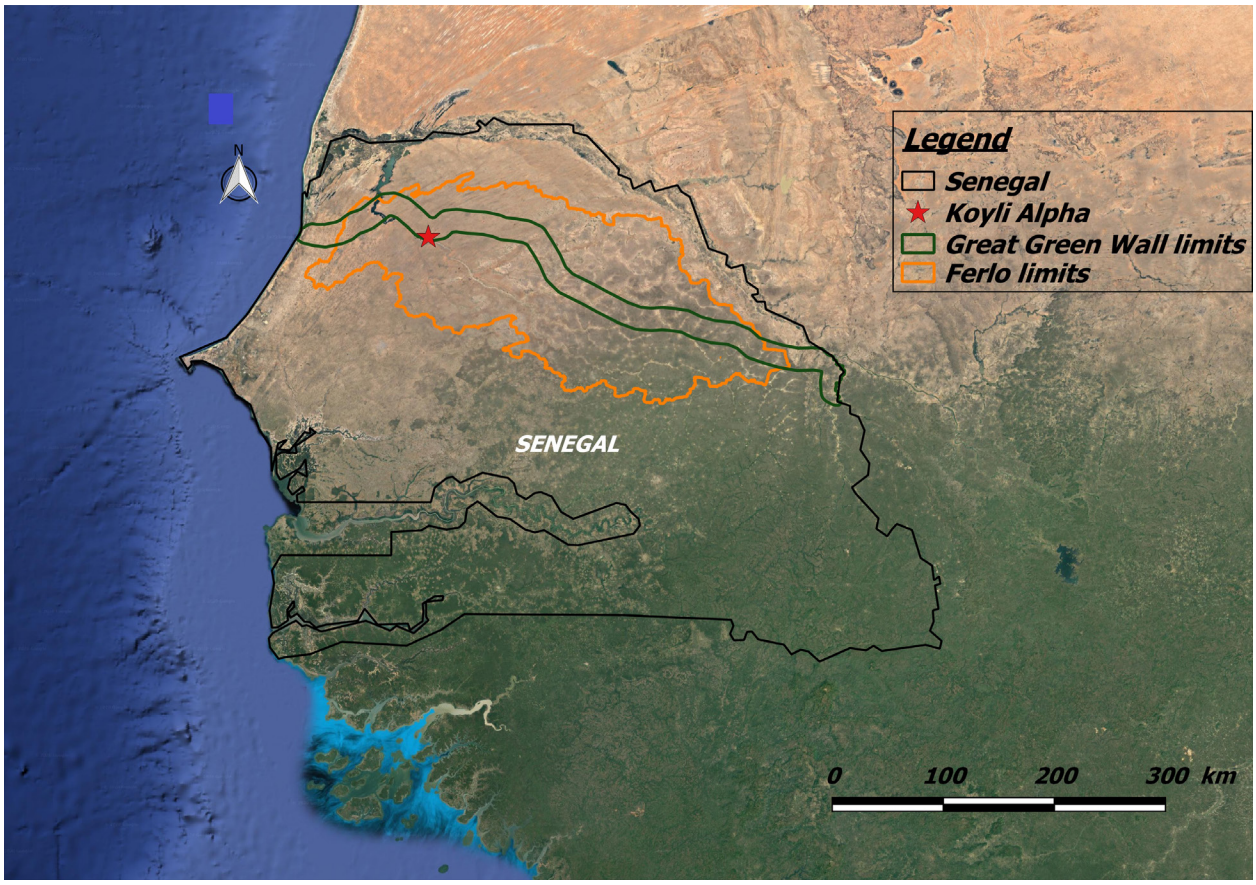

Image 1. Location of the survey area in northern Senegal, showing the village of Koyli Alpha the extension of the Great Green Wall in Senegal and the limits of the ecogeographic zone of the Ferlo (preparedby P.I.Ndiaye, Projection: UTM Zone 28N datum WGS 84; data source: Google Earth, Global Administrative Areas and GMV)

The climate is hot and dry tropical, characteristic of the continental Sahelian domain which lies between the isohyets 100 and 500 mm (CSE 2018). Annual rainfall ranges from 200 to 400 mm and the mean annual temperature is about 28 ºC (t_{max} 43 ºC, t_{min} 16 ºC). The dry season occurs from October to June and the rainy season from July to September (Agence Nationale de l'Aviation Civile et de la Météorologie du Sénégal 2018; CSE 2018; Niang 2017). Vegetation is characterized by a dominance of the tree species *Balanites aegyptiaca, Acacia senegal* and *A. radiana.*

Data collection

Data was collected between May 2017 and December 2019. At the beginning of the study, we conducted semi-structured interviews with the local community. We interviewed 30 people randomly selected from both genders with age ranging between 25 and 80 years in Koyli Alpha to get an idea of the state of the wildlife in this area. All interviewees were Peulh, who are known to possess a good understanding of their environment because they are mainly cattle herders. Results from the interviews allowed us to refine subsequent field surveys using four methods: 1) reconnaissance walks (recces), 2) line transects, 3) camera-trapping, and 4) fixed-point surveys.

These field surveys aimed at confirming the diversity of terrestrial mammals in the area around Koyli Alpha. Reconnaissance walks consist of walking in a predetermined direction along the path of least resistance throughout the survey area, but where one is allowed to deviate from the main direction (Kühl et al. 2008; Ross & Reeve 2011; Ndiaye et al. 2018). Reconnaissance walks were used during the prospection outside of the study areas – in two reforestation plots of the GGW (2012A and 2012B), in RNC, and along the watercourse of Lac de guier. Within the protected areas, we used line transects sampling to assess the presence or absence of large mammals (Plumptre 2000; Marshall et al. 2008). With the line transect methodology, one walks in a straight line and cannot deviate from the transect bearing (Image 2). Transects were prospected

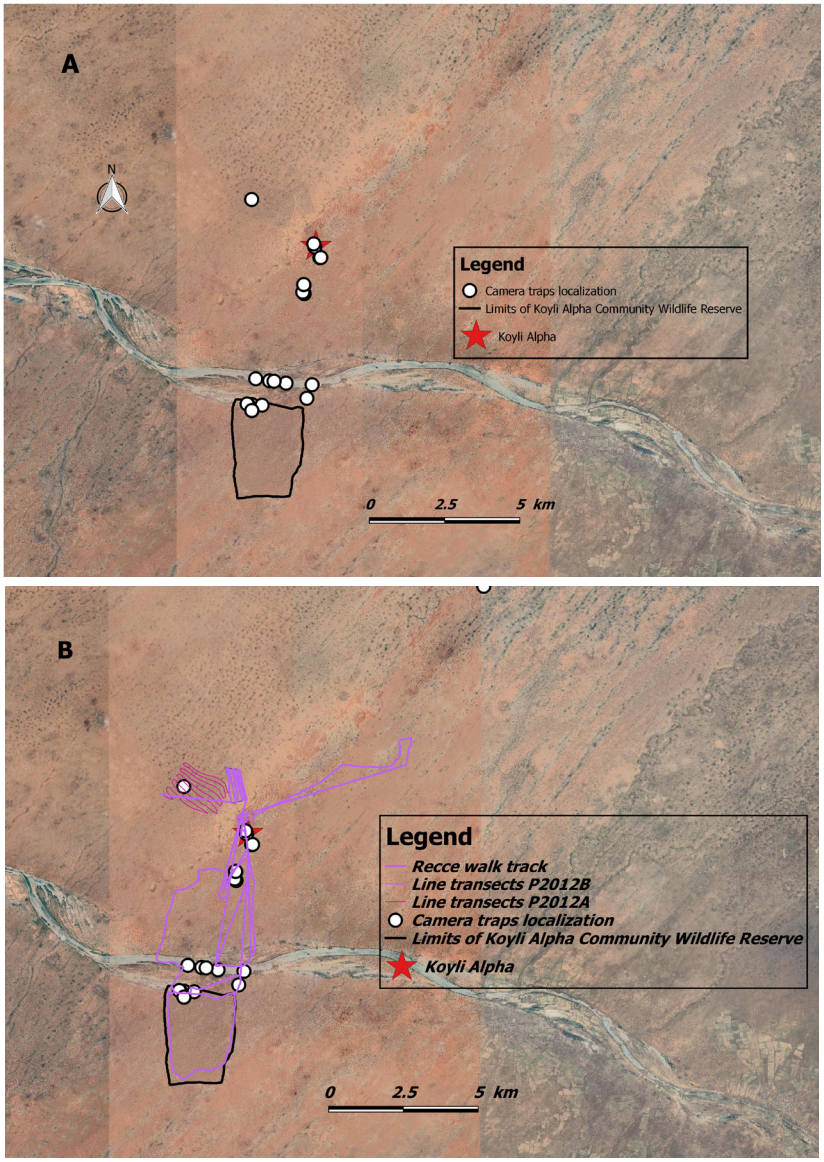

Image 2. A—Location of the camera traps | B—prospected transects inside and outside of the reforestation plots (Parcelles 2012A and 2012B), around the lac de guier course of water and the FAO wildlife reserve (created by P.I.Ndiaye, Projection: UTM Zone 28N datum WGS 84; data source: Google Earth, Global Administrative Areas and GMV).

in the morning between 0600 and 1200 h and in the afternoon between 1600 and 1900 h with a speed of up to 1.5 km per hour for a total of 43 days between May 2017 and December 2019.

Fixed point surveys were used as an additional method to increase our chances of detecting wildlife, and to collect additional information on the species we observed. For example, after detecting a group of Patas Monkey we stayed at a fixed point near the Koyli Alpha wildlife reserve between 0700 and 1900 h to determine its group size.

In addition, 33 camera traps were placed in strategic sites, such as water points and ground holes, to maximize the probability of detection of large mammals (Image 2). Camera traps (Bushnell Trophy Cam HD Essential) and Scout Gaurd were operational for 24 hours a day during 24/24. The camera traps are triggered by a highly sensitive passive infra-red (PIR) motion sensor with a delay of 0.3 seconds. We use a recommended minimal exploratory logistical set-up (Orban et al. 2018; Rovero et al. 2013) of 1,000 camera trap days. Camera traps were set to record only photos.

Data processing and analysis

Observations from the fixed point survey near the RNC (15.68329; -15.52626) between 0700 and 1900

h have allowed us to determine the group size of one group of Patas Monkeys.

Data captured with camera traps were stored on memory cards labelled with the site, location and camera trap number, downloaded and saved on a hard drive. Large terrestrial mammals were identified based on the author's knowledge and using relevant field guides (Kingdon 1997; Kingdon & Hoffmann 2013), and were then assigned relevant IUCN Red List status according to Red List of Threatened Species (www.iucnredlist.org 29.ii.2020). Large terrestrial mammals that could not be individually distinguished (species without individually identifiable morphological characteristics) and captured within 15 minutes of each other at the same station were considered the same individual and recorded as a single detection event. After 15 minutes, they were considered a new detection. Photographs with two individuals of the same or different species were considered as two events in the dataset. To calculate the photo-capture rate index (PCRI) of each species, we first identified independent captures (i.e., captures that were 15 minutes apart for each station), then we divided the number of independent captures obtained at each trap by trapping specific effort (i.e., number of trapping days that a particular trap was active) and expressed the estimate as observations per 100 trapping days (Carbone et al. 2001; Lahkar et al. 2018). We calculated the 95% confidence interval of the PCRI for each species using the variations between individual camera stations.

All observations from transect and fixed-point surveys as well as the trap specific PCRI were mapped to display the geographic distribution of species. All spatial tasks were conducted using the open source software QGIS 2.6.1.

RESULTS

Interviews with the local communities

During the interviews, local communities indicated the presence of seven terrestrial large mammals' species: Common Genet *Genetta genetta,* Honey Badger *Mellivora capensis,* Jackal *Canis* sp., Wild Cat *Felis silvestris,* Patas Monkey *Erythrocebus patas,* Cape Hare *Lepus capensis*, and Crested Porcupine *Hystrix cristata*; and the suspected disappearance of five large species: Roan Antelope *Hippotragus equinus,* Spotted Hyaena *Crocuta crocuta,* Striped Hyaena *Hyaena hyaena,* Common Warthog *Phacochoerus africanus*, and Leopard *Panthera pardus*. Poaching was not reported to occur in this area, however, derived animal products were reported to be used by traditional healers.

Abundance and distribution of mammals

The combination of various methods during this study has permitted us to identify nine species of large wildlife mammals (Table 1). Local communities have reported the presence of these species during the interviews. However, they pointed to the increasing difficulties of seeing them actually. Cape Hare, Wild Cat and Sand Fox were observed widely throughout the study area (Figure 1), whereas Patas Monkeys, Common Genet, and Common (Golden) Jackal were observed only in the RNC. Most of the observations or trapping events were recorded on the edges of the Lac de guier. We also discovered that some species, namely the Wild Cat and Sand Fox, were using the same habitats at the same time.

Fixed-point surveys near the RNC of Koyli Alpha have permitted us to count 47 individuals in the single group of Patas Monkeys that we observed in the study area.

During the camera trapping surveys, we obtained a total of 7,076 photographs of wild animals, domestic animals, and humans. Most of the observations were of domestic animals (6,094) or humans (543), with only 439 observations being of large wild mammals. These observations were on nine species belonging to seven families and three orders (Table 1, Appendix 1). Simultaneous presence of large wild mammals and domestic animals in the same picture was rarely observed during this study (only 12 pictures), and only from three cameras placed near a village (Appendix 1). These observations occurred at night or early in the morning.

DISCUSSION AND CONCLUSION

Diversity of terrestrial large mammals in Koyli Alpha

Interviews with members of the local communities were of great help in guiding our research. They gave us an overview of the animal diversity and their distribution in Koyli Alpha. Our results however revealed that the number of large mammalian species in Koyli Alpha is greater than what is assumed by the local communities. Except for the Patas Monkey, the species of large mammals present in Koyli Alpha are mainly nocturnal carnivores. For this reason, it is more difficult to detect their presence with recces and line transect surveys, which may explain the scarcity of results with reconnaissance walks and line transects. In addition, local communities mentioned the disappearance of Dorcas

Table 1. Repertory of the large wild mammals encountered in the Great Green Wall area and some indications to evaluate their relative abundance.

Orders	Families	Species	Direct observations during recces and transect surveys		Index		Camera trapping				IUCN Red List category
			Nb. Obs	%	Nb. Index	%	Nb. Capture	%	Capture rate from total event	PCRI (95%)	
Carnivora	Canidae	*Canis aureus*	10	2.74	50	10.2	13	0.18	0.0088	0.075 (0.020; 0.182)	LC
		Vulpes pallida	30	8.22	11	2.25	300	4.24	0.0132	0.105 (0.039; 0.215)	LC
	Felidae	*Felis silvestris*	51	13.97	41	8.40	43	0.61	0.0220	0.125 (0.061; 0.217)	LC
	Herpestidae	*Atilax paludinosis*	1	0.27			51	0.72	0.0154	0.098 (0.040; 0.192)	LC
	Mustelidae	*Ictonyx striatus*	0	0			1	0.01	0.0022	0.166 (0.004; 0.641)	LC
		Mellivora capensis	2	0.55	60	12.30	5	0.07	0.0066	0.272 (0.060; 0.609)	LC
	Viverridae	*Genetta genetta*	2	0.55	40	8.20	7	0.10	0.0088	0.075 (0.020; 0.182)	LC
Lagomorpha	Leporidae	*Lepus capensis*	41	11.23	276	56.56	0				LC
Primates	Cercopithecidae	*Erythrocebus patas*	228	62.47	10	2.05	19	0.27	0.0066	0,063 (0.013; 0.175)	NT
NA	NA	Domestic animals	-	-	-	-	6094	86.12	0.2499	10.71	
NA	NA	Humans	-	-	-	-	543	7.67	0.0403	4.24	
		Total	**365**	**100**	**488**	**100**	**7076**	**100**			

Nb. Obs—indicates the total number of direct observations of the species of large wild mammals | **Nb. Index**—indicates the number of observations of the signs of presence of the large wild mammals (for example footprints and droppings) | **Nb. Capture—**indicates the number of camera trap photos of the large wild mammal species; capture rate from total event is the ratio of independent photograph to the number of trap day (number of 24h periods during which cameras were operating) | **PCRI**—photo-capture rate index (see Materials and Methods for details).

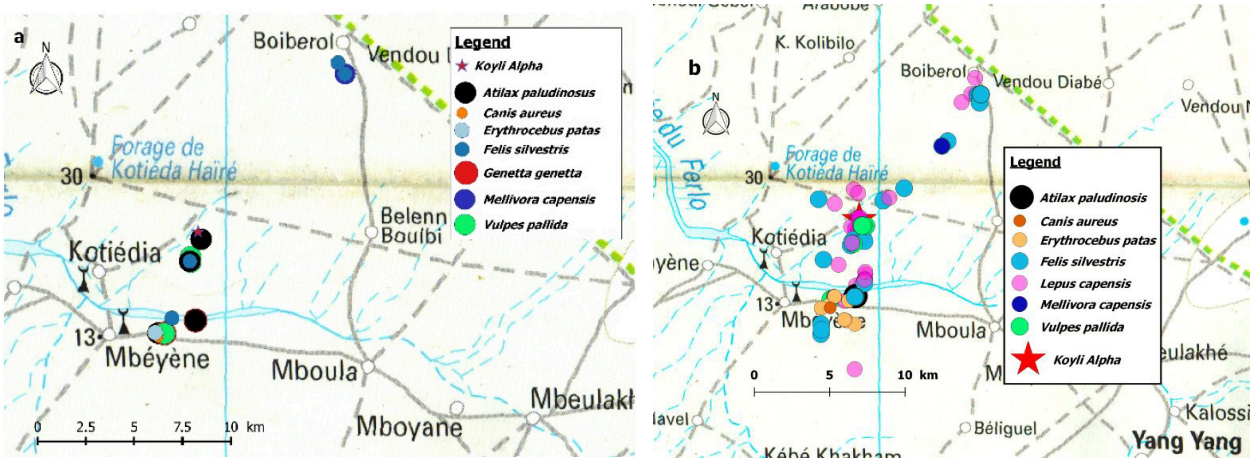

Figure 1. Map of the occurrences of terrestrial large mammals in the study area, using results from: a—trapping cameras; and b—Reconnaissance walks and linear transect surveys. (preapared by P.I. Ndiaye, Projection: UTM Zone 28N datum WGS 84)

Gazelle, Red-fronted Gazelle, Mhorr Gazelle, Common Warthog, and Striped Hyaena. The disappearance of these species in Koyli Alpha was supported by our surveys. The local communities of Koyli Alpha showed great interest to learn more and to be involved in the GGW program. Several initiatives to reintroduce extinct or endangered species such as the Scimitar-horned Oryx *Oryx dammah*, the African Spurred Tortoise *Centrochelys sulcata*, and the Dorcas Gazelle *Gazella dorcas* are currently underway in Ferlo to restore animal

diversity, in parallel with reforestation activities of the GGW program. Large wild mammals living in Ferlo are exposed to many types of anthropogenic and natural pressures related to the hot and dry climate and the local population with low economic power (Davies 2017; Baisero et al. 2020). Hence the establishment of the Ferlo Biosphere Natural Reserve and the RNC of Koyli Alpha (Abáigar et al. 2013, 2017) may be a necessary initiative to improve the protection of large mammals in this hot and dry sahelian ecosystem.

Impacts of anthropic factors and global climate change on the diversity of large wild mammals

The scarcity of observations of large wild mammals during the transect surveys in Koyli Alpha can be indicative of the risk of species extinction as presented by Baisero et al. (2020). Our data support the hypothesis of Davies (2017), that reported that human population growth combined with increasing wealth are the major factors behind biodiversity declines in the Sahel. Already large areas of Senegal are classified as 'Near Threatened' in accordance to the UICN Red List of Ecosystems. Biodiversity loss in these Sahelian ecosystems will be a great concern because they support an impressively large number of endemic species that are not found elsewhere on the planet. Specific to our study, both the Sand Fox and Patas Monkeys are endemic to this area. These species are distributed only in the Sahel – from Senegal to Ethiopia for Sand Fox and from Senegal to Sudan for Patas Monkey, respectively (www.iucnredlist.org, consulted 05.iii.2020; De Jong et al. 2020).

Distribution of large mammals in relation to the presence of domestic animals and human population

The high percentage of domestic animals and humans on camera trapping pictures and as recorded on transects indicate that some species of large wild mammals can continue to cohabit with domestic animals and humans despite the difficult ecological and social conditions of this site. However, it should be noted that the presence of human populations in large numbers in the study area is linked to the presence of livestock. In addition, the large wild mammal species found in the area are mostly nocturnal carnivores. This may justify an absence of interspecific competition between the species. Thus, the implementation of a good management plan of habitat and their natural resources can provide the conservation of large wild mammals in this area.

Methodological considerations

The camera trapping method has been used widely across the globe as a scientific tool to study medium to large terrestrial mammals and birds in often remote and difficult habitats. The number of publications per year that used camera trapping increased from less than 50 during 1993–2003 to more than 200 during 2004–2014 (Bahaa-el-din et al. 2018; Bruce et al. 2018; Rovero & Zimmermann 2016; Orban et al. 2018; Lahkar et al. 2018). Here, combining interviews and direct observations with camera trapping surveys allowed us to gain a comprehensive understanding of mammal diversity in the study area. Camera traps further provided detailed information on the high spatial and temporal overlap between wild mammals, humans and domestic animals.

Conclusions

This study reveals the presence of nine species of terrestrial large wild mammals that survive in the arid conditions of Koyli Alpha area. Most of the species recorded are nocturnal carnivores, and only a few direct observations were made during day time surveys. Our results contribute to a deeper knowledge of the mammal diversity in this extension area of the Great Green Wall, which can be used for developing management and conservations plans of the large wild mammals in this area.

REFERENCES

Abáigar, T., M. Cano & C. Ensenyat (2013). Habitat preference of reintroduced dorcas gazelles (*Gazella dorcasneglecta*) in North Ferlo, Senegal. *Journal of Arid Environment* 97: 176–181. https://doi.org/10.1016/j.jaridenv.2013.06.004

Abáigar, T., C. Enseñat & H. Fernández (2017). Evaluation de la création de la Reserve de Khoily Alpha. Report CGP/INT/157/EC.

Agence Nationale de l'Aviation Civile et de la Météorologie du Sénégal (2018). Données climatique de la station de Linguère. (www.anacim.sn/meteorologie/)

Baisero, D., P. Visconti, M. Pacifici, M. Cimatti & C. Rondinini (2020). Projected global loss of mammal habitat due to land-use and climate change. *One Earth* 2: 578–585.

Bahaa-el-din, L. & J. J. Cusack (2018). Camera trapping in Africa: Paving the way for ease of use and consistency. *Afrcan Journal of Ecology* 56: 690–693. https://doi.org/10.1111/aje.12581

Boëtsch, G., P. Duboz, A. Guisse & P. Sarr (2019). La grande muraille verte : une réponse africaine au changement climatique. CNRS Editions, Paris, 380pp.

Bourlière, F., G. Morel & G. Galat (1976). Les grands mammifères de la basse vallée du Sénégal et leurs saisons de reproduction. *Mammalia* 40: 401–412.

Bruce, T., R. Amin, T. Wacher, O. Fankem, C. Ndjassi, M.N. Bata, A. Fowler, H. Ndinga & D. Olson (2018). Using camera trap data to characterise terrestrial larger-bodied mammal communities in different management sectors of the Dja Faunal Reserve, Cameroun. *African Journal of Ecology* 56: 759–776. https://doi.org/10.1111/aje.12574

Carbone, C., S. Christic, K. Conforti, T. Coulson, N. Franklin, J.R. Ginsberg, M. Griffiths, J. Holden, K. Kawanishi, M. Kinnaird, R. Laidlaw, A. Lynam, D.W. Macdonald, D. Martyr, C. McDougal, L. Nath, T. O'Brien, J. Seidensticker, D.J.L. Smith, M. Sunquist, R. Tilson & W.N. Wan Shahruddin (2001). The use of photographic rates to estimate densities of tigers and other cryptic mammals. *Animal Conservation* 4: 75–79. https://doi.org/10.1017/S1367943001001081

CSE (2018). Annuaire sur l'environnement et les ressources naturelles du Sénégal. Centre de Suivi Ecologique, Quatrième édition, Dakar (Sénégal), 385pp.

Davies, J. (2017). *Biodiversity and the Great Green Wall : Managing nature for sustainable development in the Sahel.* IUCN, Ouagadougou, Burkina Faso, xiv+66pp.

De Jong, Y.A., A.B. Rylands & T.M. Butynski (2020). *Erythrocebus patas.* The IUCN Red List of Threatened Species 2020: T174391079A17940998.en. Accessed on 29/02/2020. https://doi.org/10.2305/IUCN.UK.2020-2.RLTS.

Guissé, A., G. Boëtsch, A. Ducourneau, D. Goffner & L. Gueye (2013). L'Observatoire hommes-milieux international Tessékéré (OHMi): un outil de recherche pour étudier la complexité des écosystèmes arides du Sahel. *Comptes Rendus Biologies* 336: 273–277. https://doi.org/10.1016/j.crvi.2013.04.007

Kingdon, J. (1997). The Kingdon Field Guide to African Mammals. A & C Black Publishers Ltd., London, 476 pp.

Kingdon, J., D. Happold, T. Butynski, M. Hoffmann, M. Happold & J. Kalina (2013). *Mammals of Africa* (6 vols). Bloomsbury Publishing, London.

Kühl, H., F. Maisels, M. Ancrenaz & E.A. Williamson (2008). *Lignes directrices pour de meilleures pratiques en matière d'inventaire et de suivi des populations de grands singes.* Gland, Suisse: Groupe de spécialistes de primates de la CSE de l'UICN.

Lahkar, D., M.F. Ahmed, R.H. Begum, S.K. Das, P. Lahkar, H.K. Sarma & A. Harihar (2018). Camera-trapping survey to assess diversity, distribution and photographic capture rate of terrestrial mammals in the aftermath of the ethnopolitical conflict in Manas National Park, Assam, India. *Journal of Threatened Taxa* 10(8): 12008–12017. https://doi.org/10.11609/jott.4039.10.8.12008-12017

Marshall, A.R., J.C. Lovett & P.C.L. White (2008). Selection of line-transect methods for estimating the density of group living animals: lessons from the primates. *American Journal of Primatology* 70: 1–11. https://doi.org/10.1002/ajp.20516

Ndiaye, P.I., S.M. Lindshield, L. Badji, L. Pacheco, E.G. Wessling, K.M. Boyer & J.D. Pruetz (2018). Survey of chimpanzee (*Pan troglodytes verus*) outside protected areas in southeastern Senegal. *African Journal of Wildlife Research* 48: 013007. https://doi.org/10.3957/056.048.013007

Niang, A. (2017). Inventaire des grands mammiferes sauvages dans la zone de reboisement de la grande muraille verte au ferlo (nord, senegal). M.Sc. Thesis, Faculté des Sciences et Techniques, Université Cheikh Anta Diop de Dakar (Sénégal), 33pp.

Niang, A., A.Y. Diallo & P.I. Ndiaye (2019a). Inventaire des grands mammifères sauvages dans la zone de reboisement. In: Boëtsch, G., P. Duboz, A. Guisse & P. Sarr (eds.). *La grande muraille verte.* CNRS Editions, Paris, 380pp.

Niang, A., P.I. Ndiaye & C.T. Bâ (2019b). Impact du projet de reboisement de la Grande Muraille Verte sur la conservation des grands mammifères sauvages dans la zone du Ferlo, au Nord du Sénégal. Communication orale à la 4ème édition des Journées Scientifiques du Conseil Africain et Malgache pour l'Enseignement Supérieur (JSDC-4, CAMES), Bénin, 2–5 décembre 2019.

Orban, B., G. Kabafouako, R. Morley, C. Vasicek, H. Melville & J. Gaugris (2018). Common mammal species inventory utilizing camera trapping in the forests of Kouilou Département, Republic of Congo. *African Journal of Ecology* 56: 750–754. https://doi.org/10.1111/aje.12551

Plumptre, A.J. (2000). Monitoring mammal populations with line-transect techniques in African forests. Journal of Applied Ecology 37: 356–368. https://doi.org/10.1046/j.1365-2664.2000.00499.x

Poulet, A.R. (1972). Recherches Ecologiques sur une Savane Sahélienne du Ferlo Septentrional, Sénégal : Les Mammifères. *Terre & Vie Revue Ecologie* Appl. 26: 440–473.

Ross, C. & N. Reeve (2011). Survey and census methods: population distribution and density, pp. 111–132. In Setchell, J.M. & D.J. Curtis (eds.). *Field and Laboratory Methods in Primatology: A Practical Guide, 2nd Edition*. Cambridge University Press, Cambridge.

Rovero, F. & F. Zimmermann (2016). Camera Trapping for Wildlife Research. Pelagic Publishing, Exeter, UK, 320pp.

Rovero, F., F. Zimmermann, D. Berzi & P. Meek (2013). Which camera trap type and how many do I need ? A review of camera features and study designs for a range of wildlife research applications. *Hystrix, Italian Journal of Mammalogy* 24: 148–156. https://doi.org/10.4404/hystrix-24.2-6316

Visconti, P., R.L. Pressey, D. Giorgini, L. Maiorano, M. Bakkenes, L. Boitani, R. Alkemade, A. Falcucci, F. Chiozza & C. Rondinini (2011). Future hotspots of terrestrial mammal loss. *Philosophical transactions of the royal society B* 366: 2693–2702.

Appendix 1. Images of large wild mammals identified in Koyli Alpha (Ferlo, Senegal).

Patas Monkey (*Cercopithecus/ Erythrocebus patas*)

Golden Jackal (*Canis aureus*) Honey Badger (Mellivora capensis)

Wild Cat (*Felis silvestris*) Zorilla (*Ictonyx striatus*)

Pale Fox (*Vulpes pallida*)

Common Genet (*Genetta genetta*) Cape Hare (*Lepus capensis*)

Water Mongoose (*Attilax paludinosis*)

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