Bat Community Response to Forest Loss and Habitat Conversion in Southern Cameroon

Macronycteris gigas

The Rufford Foundation
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INTRODUCTION

One of the central concerns of wildlife ecology is the understanding of the interactions between animals and their environment. For many species, survival and distribution depend on abiotic and biotic factors. To date, habitat loss of native forest habitat, agriculture and various development projects are a primary threat to the long term persistence of many species (Whitmore 1997). It affects species richness and abundance (Cosson et al. 1999), forest structure (Echeverria et al. 2007), and can result in species extinction (Laurance et al. 2002; Turner 1996). In Central Africa, the rate of habitat loss due to human activities is particularly fast (Brooks et al., 2002). Indeed, the requirements of increased food production in the last half of twentieth century have led to major changes in land use, frequently involving fragmentation and loss of forest habitats (Racey and Entwistle, 2005). If animal community responses to habitat conversion have been largely studied in many tropical areas, the negative effects of gradual loss of African forests on animals are poorly documented. Such studies are needed in Africa to develop conservation strategies of many species.

Bats are the only group of mammals with powered flight, which allows them access to various habitat types. They are characterized by a remarkably long lifespan and a low reproduction rate which makes them a suitable indicator group of the state of ecosystem (Medellin et al., 2000). It is well known that many populations of bats have declined in their natural habitat for reasons that are poorly understood (Racey and Entwistle 2003).With some 1300 species, bats are the second most diverse group of mammals (Simmons 2005). Despite their high diversity, they are currently the most persecuted group of vertebrates in the world. Because of their abundance, diversity and range of responses to habitat change, bats have been recognized as an ideal group with which to study the effects of fragmentation in tropical forests (Meyer *et al*., 2010). Cameroon occupies a unique geographical position between west and Central Africa. This country is characterized by different phyto-geographic zones and 48% of Africa's known mammals. The bat fauna of Cameroon has been investigated for many decades. However, despite the huge collection material deposited in various museums, our knowledge about the ecology, distribution and biology of the bat fauna of this country is still very fragmentary. Indeed most of the recent studies in this country have yielded new faunistic records (Sedlacek 2006; Bakwo fils 2009; Bakwo Fils et al 2012; 2014; LeBreton et al 2014) and even new species (Hassanin et al, 2014). As a result bats are animals that rarely make it onto the agenda of policy makers, yet there is a real need for a policy environment that recognizes their fundamental role in seed dispersal, pollination, and pest insect's suppression. The lack of knowledge about most species complicates the development of sound conservation plans. In Cameroon, bats face a high risk of extinction due to hunting, persecution and habitat destruction.

Objectives

The goal of this project was to evaluate the effects of habitat conversion on a bat assemblage in the Dja reserve in order to predict future trends in the distribution and abundance of bat species in the face of increasing deforestation.

Specifically:

- compare the bats species richness, composition and species abundance between agriculture clearing, secondary forest, primary forest and human settlement;
- compare the activity pattern of different species (spatial use of different habitats).
- describe the factors that influence bats choice of roosting and foraging habitats.

MATERIAL AND METHODS

- **Study site**

With its 526 000 hectares, the Dja Biosphere Reserve (figure 1) is the largest protected area in Cameroon and is an UICN biosphere reserve (UICN, 1987). The vegetation is described as semi-deciduous lowland tropical rainforest (Letouzey, 1968) between 400 and 800 m elevation. The climate is characterized by two wet and two dry seasons, with major and minor rainfall peaks generally occurring in October and May respectively. Four main habitat types occur in this reserve: Upland forest; *Rapphia* swamp; *Uapaca* swamp and the inselberg associated forest. During the last decades, activities such as continued human migration to the area, deforestation resulting from unsustainable commercial logging activities, clearance of the natural vegetation to provide land for commercial and subsistence agriculture, illegal hunting and trapping and uncontrolled bush burning have led to a serious degradation of the vegetation. These changes have inevitably affected the resident fauna including bats.

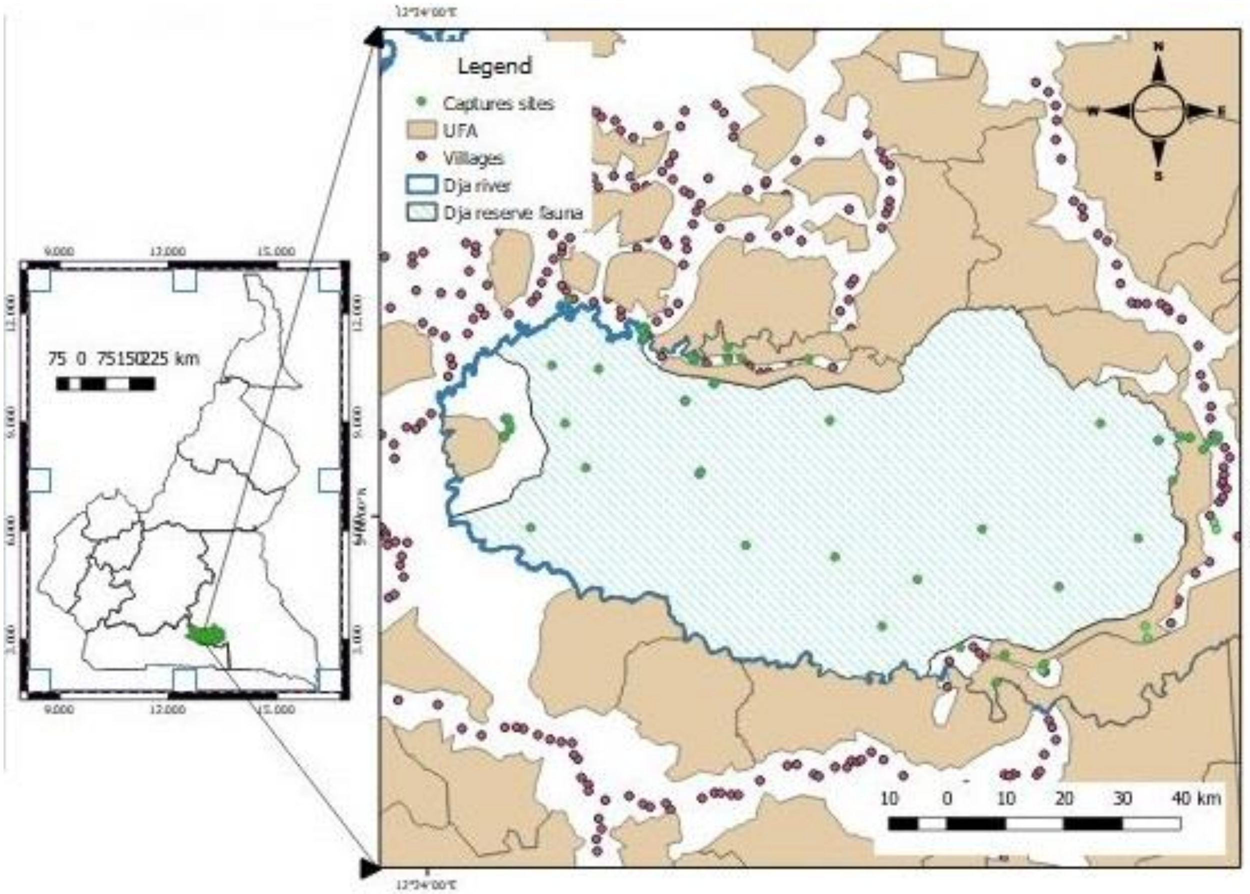

Figure 1*: Map of Dja biosphere reserve showing captures sites*

FIELD WORK

Captures was conducted over 12 months. Each habitat (: primary forest, secondary forest, agriculture clearing and human settlement) was sampled monthly for bats species and theirs numbers (see figure 2 and table 1). Each sampling event was consist in seven consecutive capture nights using ten mist nets per site (ground-level nets and canopy nets). Mist nets were checked every fifty minutes from 6: 00 pm to midnight. Each individual caught was kept in cloth bags. Each individual was weighed (Pesola balance, nearest 0.5 g), measured (forearm, nearest mm) and aged (adult or juvenile based on ossification of phalanges) and sexed before release. We done a punch marked for each individual before release with a code in the left wing (Bonaccorso and Smythe, 1972) to determine whether a bat was been captured previously. We have also investigate caves located at Swarm, Mintoum and Nemeyong villages in the northern and southern part of the Dja Biosphere Reserve and eight trees located in Nsimalen (western part), Mintoum (easthern part) and Malen I (northern part) villages. These roosting sites were investigated during the day where five species (*Doryrhina cyclops*, *Hipposideros ruber*, *Hipposideros caffer*, *Nycteris hispida* and *Nycteris thebaica*) were observed.Identification was based on morphometrics. We used identification keys of Rosevear (1965) and Hayman and Hill (1971) and Paterson and Webala (2012) for morphometric identification. A sample of skin from the wing membrane was taken for genetic analyses. This was done on live bats using non-lethal Stieffel 3mm biopsy punches (Pierce and Keith, 2011).

Figure 2: *A view of some different habitats investigated in the Dja biosphere reserve*

Data analysis

Monthly abundance indices of each bat species was determined. Species diversity estimations was calculated with Estimate S 9.0 (Colwell, 2009). We construct Rank-abundance curves to compare the number of species, relative abundances of species, number of rare species and equitability in each habitat type (Stoner, 2005). Species richness was compared among habitats by calculating rarefaction null models, (Gotelli & Colwell, 2001). Species composition was compared with a nonmetric multidimensional scaling (NMDS) and analysis of similarity ANOSIM, (McCune et al., 2002). To analyze individual species responses to the disturbance gradient, we compared the abundance of each habitat. At the spatial scale, we considered each habitat as a resource state available for bats and assumed that capture rates reflect resource use by each species. Pairwise spatial niche overlap among species was estimated via Pianka index O_{ij} (Piaka, 1973). Randomizations and Spatial niche overlap calculations was performed with EcoSim v. 6.0 (Gotelli and Entsminger, 2001).

RESULTS

Bat assemblages

A total of 322 individual bats belonging to four Families, 16 Genera and 24 species were captured (Table 1). Of these, 16 species were captured in primary forest. Despite the high number of species in primary forest, more individuals were captured in human habitations (n=126), mainly due to the high number of *Megaloglossus woermanni* (n=51). Overall *Megaloglossus woermanni* a nectarivorous bat was also the most common bat (27.64%, n=89), followed by *Epomops franqueti* (19.57%, n=63) and *Roussettus aegyptiacus* (13.35%, n=43). Insectivorous bats represent 23.60 % of bat captured while frugivorous represent 76.40%. Nevertheless, in level of species, insectivorous represent 66.66% bat captured while frugivorous represent 33.34%. Primary forest was the habitat type with the height number of species (16 species) following by Agricultural clearing (14 species), Human habitation (10 species) and Secondary forest (8 species) (Table 1).

Table 1: *Number of captures and sampling efforts within the four habitat types in the Dja biosphere reserve.*

Family	Species	Agriculture clearing	Human habitation	Primary forest	Secondary forest	Total	Species code
Pteropodidae	*Casinycteris argynis*	6	4	3	1	14	a
	Myonycteris angolensis	-	1	-	-	1	b
	Epomops buettikoferi	-	2	2	-	4	c
	Epomops franqueti	16	24	19	4	63	d
	Megaloglossus woermanni	16	51	2	20	89	e
	Hypsignathus monstrosus	-	-	2	-	2	f
	Roussettus aegyptiacus	4	25	7	7	43	g
	Myonycteris torquata	3	4	3	4	14	h
Hipposiridae	*Hipposideros ruber*	2	5	1	4	12	i
	Hipposideros caffer	2	-	20	-	22	j
	Macronycteris gigas	6	-	-	-	6	k
	Doryrhina cyclops	16	-	2	6	24	l
Nycteridae	*Nycteris grandis*	1	-	-	-	1	m
	Nycteris hispida	2	-	-	-	2	n

	Nycteris thebaica	1	-	-	-	1	o
Vespertillonidae	*Neoromicia nana*	1	2	-	-	3	p
	Glauconycteris albogutata	-	-	1	-	1	q
	Glauconycteris argentata	-	-	2	-	2	r
	Glauconycteris sp.	-	-	-	2	2	s
	Pipistrellus nanulus	-	8	1	-	9	t
	Pipistrellus sp.	1	-	-	-	1	u
	Myotis bocagei	-	-	3	-	3	v
	Scotoecus hirundo	-	-	2	-	2	w
	Scotophilus sp.	-	-	1	-	1	x
	Total	**77**	**126**	**71**	**48**	322	**-**
	Number of night	**21**	**21**	**21**	**21**	84	
	Total Species	**14**	**10**	**16**	**8**	24	
	Number of nets used	**124**	**124**	**126**	**130**	504	
	Length of net (m)	**1695**	**1695**	**1703**	**1650**	6743	
	Hours worked (h)	**126**	**126**	**126**	**126**	504	

Species diversity estimators indicated species averages: 24.82, 19.16, 11.88 and 9.57 for Primary forest, Agricultural clearing, Human habitation and Secondary forest respectively. Those results show that we have investigated 64.46%, 73.07%, 84.17% and 89.59% in Primary forest, Agricultural clearing, Human habitation and Secondary forest respectively. Rarefied curves truncated at 48 individuals also suggested the same order in the most species richness (figure 3). Nevertheless NMDS indicated that composition of species assemblages in Primary forest (16 species) was distinct from those in other habitats (Figure 4).

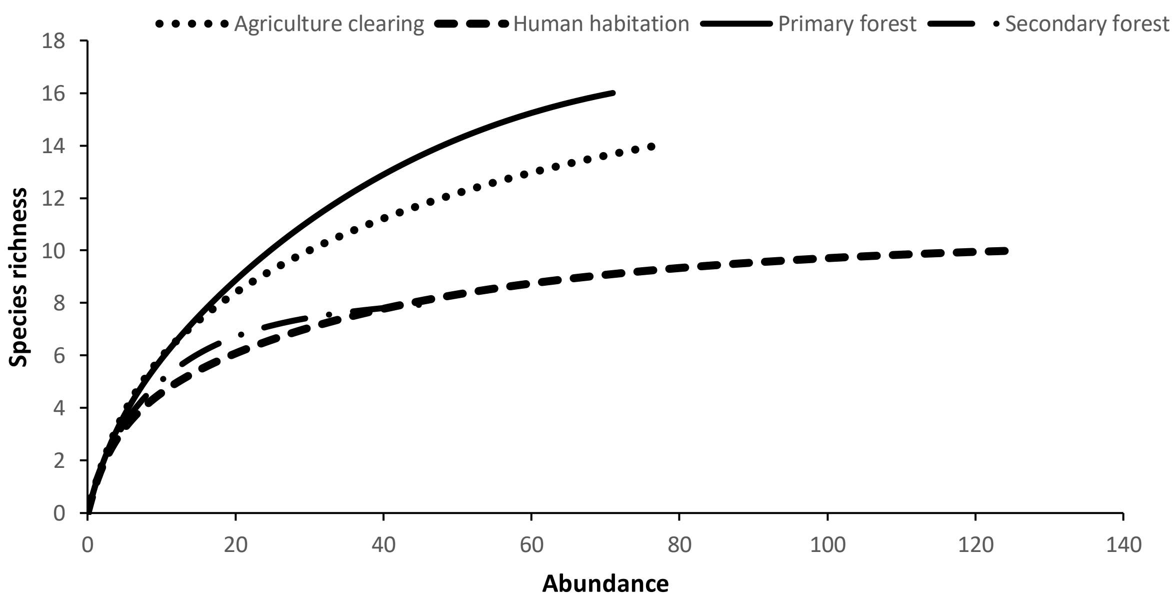

***Figure 3**: Rarefaction curves of observed species richness at each habitat.*

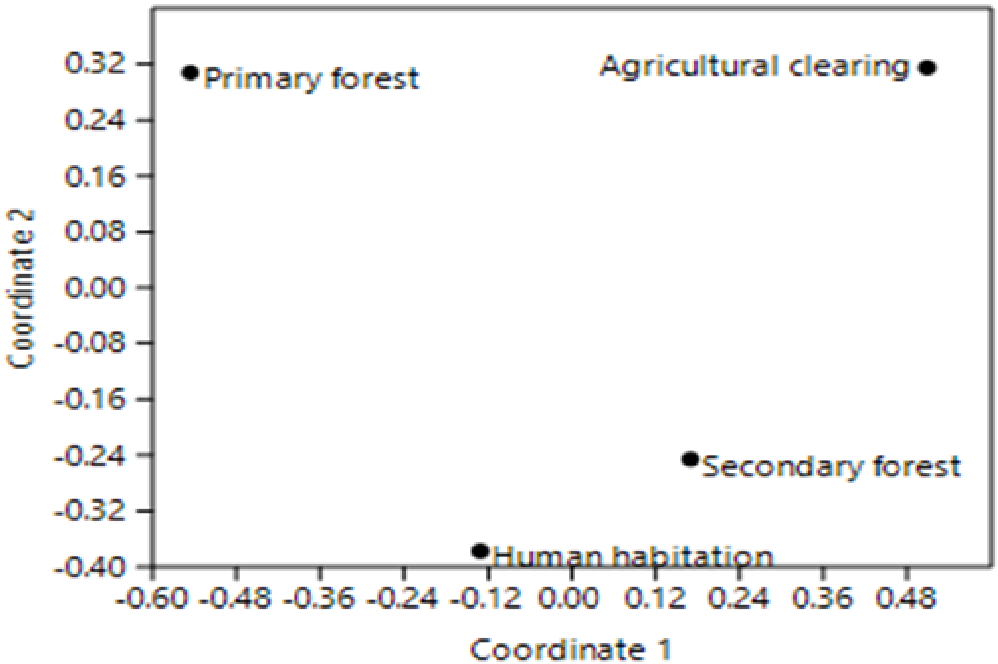

Figure 4: *Bat species assemblages of four habitat types along the first two axes of Non-metric Multidimensional Scaling (NMDS) ordination in Dja Biosphere reserve.*

Rank-abundance graphs show a different group of species dominating each assemblage (figure …). *Hipposideros caffer* was the dominant species in Primary forest following by *Epomops franqueti* (28.17% and 26.76% of captures, respectively). In Agricultural clearing three species (*Doryrhina cyclops*, *Megaloglossus woermanni* and *Epomops franqueti*) were dominants with 20.78% of captures every one. Human habitation and Secondary forest were dominated by *Megaloglossus woermanni* with 40.48% and 41.66% of captures respectively. Differences in overall species composition were statistically significant among habitats (ANOSIM, R = 0.1402, P = 0.0002), but we observed a similarity between Agricultural clearing and Secondary forest (table 2).

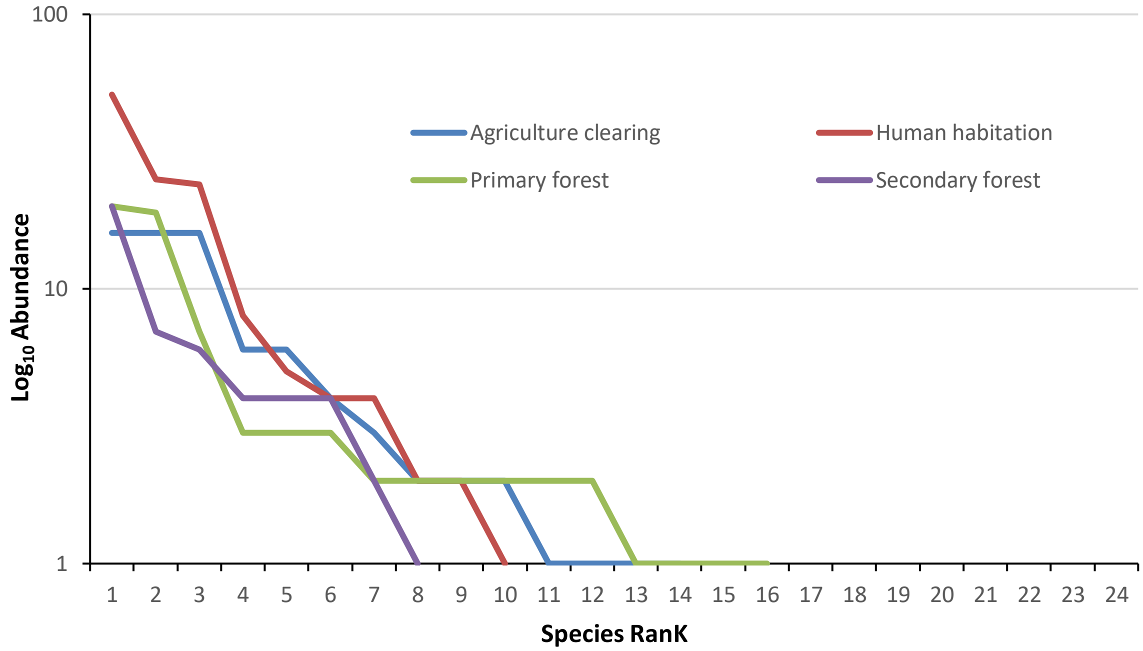

Figure 5: *Rank abundance curves for each habitat.*

Table 2: *ANOSIM test showing pairwise similarity between habitats*

	Agriculture clearing	Human habitation	Primary forest	Secondary forest
Agriculture clearing	1	0,426	0,0006	0,897
Human habitation		1	0.1047	0,0186
Primary forest			1	0,018
Secondary forest				1

Diversity and activity patterns of bat species

Abundances and species richness of bat in the four habitats types do not differed statistically significantly (ANOVA, $F = 1.653, 1.775$; $P = 0.1908, 0.1659$ respectively). However, we observed a negative correlation between these two parameters according to habitats and seasons (figure 5). Spatial niche overlap between bat species ranged between 0 and 1show that some species sharing a same space whereas some others don't use the same space (table 3).

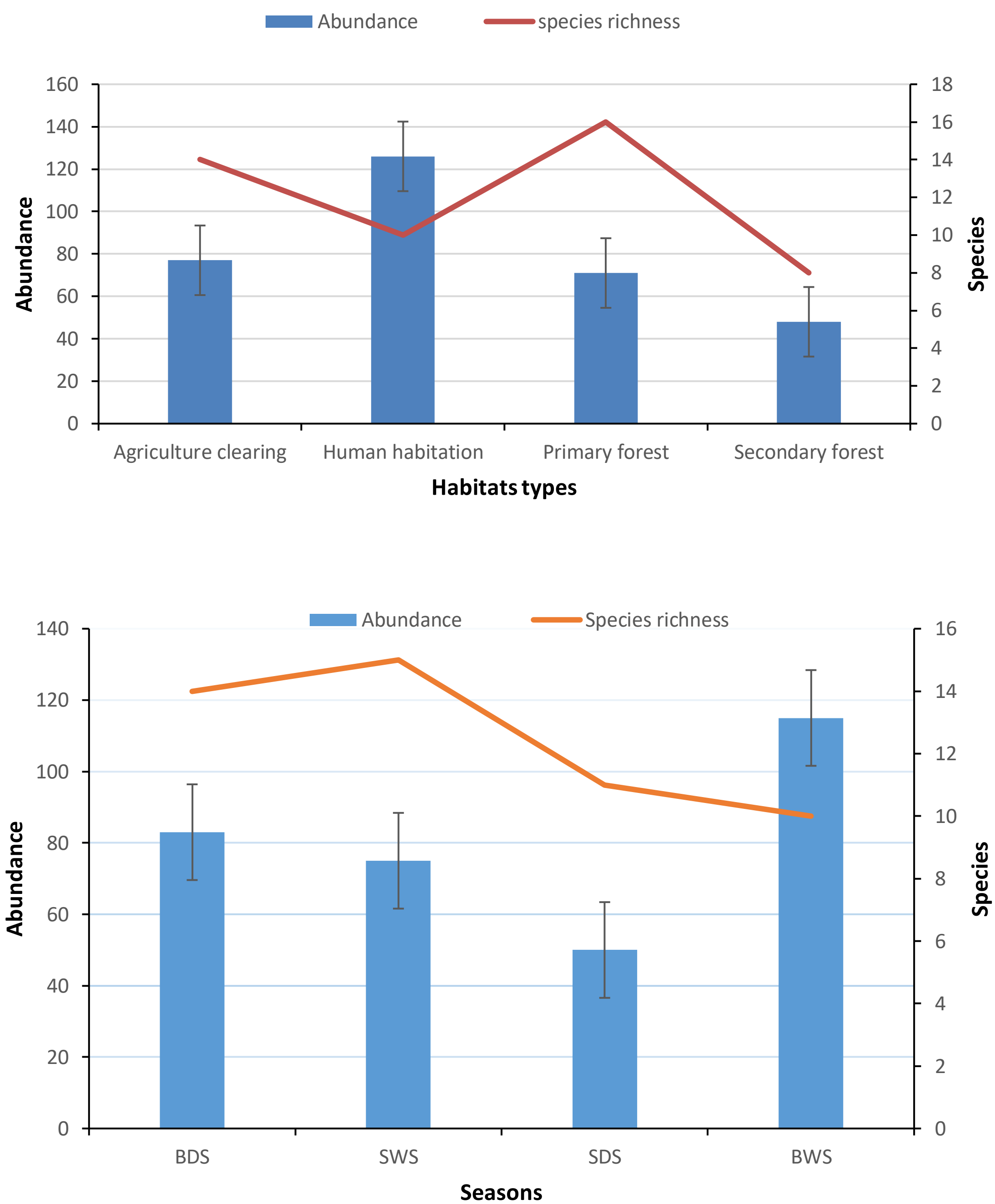

Figure 5: *Spatial and seasonal diversity activity patterns. BDS: Bigger Dry Season, SWS: Small Wet Season, SDS: Small Dry Season, BWS: Bigger Wet Season*

Table 3: *Spatial niche overlap (Pianka's index o) between bat species in Dja Biosphere Reserve. Seed species codes in table 1.*

Species	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
a	1	0,80	0,63	0,92	0,38	0,38	0,13	0,46	0,73	0,38	0,76	0,73	0,51	0,84	0,38	0,80	0,76	0,76	0,76	0,55	0,76	0,71	0,38	0,38
b		1	0,08	0,53	0,12	0,12	0,35	0,21	0,50	0,12	0,93	0,39	0	0,64	0,12	0,42	0,93	0,93	0,93	0,01	0,93	0,26	0,12	0,12
c			1	0,87	0,71	0,71	0	0,70	0,63	0,71	0	0,66	0,71	0,70	0,71	0,63	0	0	0	0,79	0	0,83	0,71	0,71
d				1	0,55	0,55	0,12	0,60	0,79	0,55	0,46	0,81	0,70	0,88	0,55	0,82	0,46	0,46	0,46	0,75	0,46	0,87	0,55	0,55
e					1	1	0	0,99	0,15	1	0	0,04	0	0,42	1	0	0	0	0	0,12	0	0,26	1	1
f						1	0	0,99	0,15	1	0	0,04	0	0,42	1	0	0	0	0	0,12	0	0,26	1	1
g							1	0	0,59	0	0	0,04	0	0,57	0	0	0	0	0	0	0	0,26	0	0
h								1	0,18	1	0,01	0,06	0	0,46	1	0,04	0,10	0,10	0,10	0,12	0,1	0,27	0,10	0,1
i									1	0,15	0,3	1	0,74	0,94	0,15	0,79	0,30	0,30	0,30	0,75	0,30	0,91	0,15	0,15
j										1	0	0,04	0	0,42	1	0	0	0	0	0,12	0	0,26	1	1
k											1	0,28	0	0,42	0	0,45	1	1	1	0	1	0,15	0	0
l												1	0,90	0,84	0,04	0,92	0,28	0,28	0,28	0,89	0,28	0,96	0,04	0,04
m													1	0,57	0	0,89	0	0	0	0,99	0	0,92	0	0
n														1	0,42	0,70	0,42	0,42	0,42	0,61	0,42	0,84	0,42	0,42
o															1	0	0	0	0	0,12	0	0,26	1	1
p																1	0,45	0,45	0,45	0,89	0,45	0,89	0	0
q																	1	1	1	0	1	0,15	0	0
r																		1	1	0	1	0,15	0	0
s																			1	0	1	0,15	0	0
t																				1	0	0,94	0,12	0,12
u																					1	0,15	0	0
v																						1	0,26	0,26
w																							1	1
x																								1

Awareness campaign in local populations
An awareness campaign was carried at 12 villages near capture sites. It consisted of explaining to local populations the morphology, physiology and ecological importance of bats using a live specimen. At the end of the explanation, populations were allowed to ask questions in order to clarify any doubts.

Figure 6. *Explaining to children of Alat-makay village, the anatomy of bat and important role bats play in an ecosystem.*

Future plans as follow-up to this project

1. More sampling sessions to have enough data to predict potential range shifts for southern Cameroon bat distribution – past, present and future.
2. Working with local populations in the Dja Biosphere Reserve and authorities of forest and fauna department to spread information on the ecological importance of bats, and to control local threats.
3. Scientific papers to be published in peer-reviewed journals.

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Appendix: Most commons bat species in the Dja Biosphere Reserve.

Epomops franqueti

Roussettus aegyptiacus

Megaloglossus woermanni

Doryrhina cyclops

Roosting cave containing *Hipposideros ruber* in the forest

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