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Initial assessment of mammals' population in biodiversity monitoring plots at Haut-Sassandra Classified Forest, Central-West of Côte d'Ivoire

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Abstract

The present study took place at Haut-Sassandra Classified Forest (HSCF), in biodiversity monitoring plots with different treatments depending on the intensity of human activities. Its main objectives are to identify the different species of mammals present in the plots according to the treatments and assess their conservation status. The methodology consisted first on conducting surveys among neighboring populations and then on carrying out pedestrian surveys in the forest. At the end of these surveys, 27 species of mammals were identified, including five (5) confirmed by pedestrian surveys from direct and indirect observations. If species of high conservation value among the 27 species cited during the surveys were identified, only one species among the five (5) confirmed arouses interest at the national level because its status of fully protected. Mammals confirmed in the field are much more present in plots of low human activity intensity. These results demonstrate both the ecological potential of the HSCF and the scale of the threats it faces through human activities such as poaching and the exploitation of non-timber forest products. It should be mentioned, however, that beyond these threats, there is real hope for the re-colonization of HSCF by mammals if agricultural activities cease.

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Introduction

Tropical forests contains more than half of the world's biological diversity (Koné *et al.*, 2014) with several species of mammals. Côte d'Ivoire, located in this tropical zone, has a rich and diverse fauna due to the diversity of its ecosystem. Unfortunately, this wildlife diversity is subject to various anthropogenic pressures. Logging, forest clearing for agriculture, urbanization and bush fires are, among others, the factors that threaten this diversity (Béné *et al.*, 2015). In fact, Ivorian forest cover, which was estimated to 16 million ha in 1900 decreased to 2.7 million ha in 2015 (Chatelain *et al.*, 2004; Durrieu *et al.*, 2005). Consequently, a large number of animal species are thus endangered due to the destruction of their habitats. The loss of forest habitats some animals depend on let them more and more confined in fragments of forests on ivorian territory (Caspary *et al.*, 2001; Hilson and Nyame, 2006).

Faced with this problem of biodiversity conservation, Côte d'Ivoire has created a network of protected areas as well as classified forests, in order to fight against this loss of its biodiversity. In addition to these actions, hunting has been banned since 1974. Despite this management policy, the forest cover continues to decline, poaching is still legion, leading to the disappearance of several species of fauna (Lauginie, 2007). In addition to the anthropogenic pressures already existing in protected areas, the politico-military crises experienced by the country (2002-2011) have worsened the loss of biodiversity. These successive crises have led to massive infiltration of protected areas located in CNO zones (Center-North-West) (Kouakou *et al.*, 2015). This is the case of the Haut-Sassandra Classified Forest (HSCF) which sheltered an exceptional fauna wealth with nearly 400 chimpanzees and a large number of elephants in 1991. It was one of the best preserved classified forests in Côte d'Ivoire until 2002. Unfortunately, the FCHS lost 10 years later, 80% of its forest cover which represented the natural habitats of the fauna thus causing the disappearance of a large part of its biodiversity (PNUE, 2015). In order to contribute to the restoration of this forest, a project to monitor the

reconstitution of biodiversity was initiated in 2016 by the Interdisciplinary Research Group in Landscape Ecology and Environment (GRIEPE) of the Jean Lorougnon Guédé University in collaboration with SODEFOR. Thus, several studies have been carried out in this forest (Assalé *et al.*, 2016; Barima *et al.*, 2016; Zanh *et al.*, 2016; Kouman, 2018). But these works only focused on floristic diversity. However, several scientific studies have shown the role of fauna on the ecological level with, among other things, the dispersal of seeds and the pollination of flowering plants (Pierre, 2003). Considering the importance of wildlife in forest regeneration, an assessment of mammalian fauna in the plots in relation to the intensity of human activities was necessary. The main objective of this study is to provide a preliminary database on mammals in the monitoring plots in order to better understand the process of recolonization of the Haut-Sassandra Classified Forest by the fauna.

Materials and methods

Study area

The study took place at Haut-Sassandra Classified Forest (HSCF), located in the Center-West of Côte d'Ivoire, between 6 ° 52 ' - 7 ° 24' North and 6 ° 59 ' - 7 ° 10' West (Fig. 1). Delimited and classified in 1974, HSCF covers an area of 102,400 ha (SODEFOR, 2014). The region is situated in a two-season climate. A raining season from March to October and a dry season from November to February. The average annual rainfall varies from 1,200 mm to 1,600 mm with an average temperature of 26 °C (www.Tutienpo.net. Accessed December 20, 2018). Its vegetation is a dense semi-deciduous forest.

Data collection

The biodiversity monitoring plots located to the South-East of the HSCF and four neighboring villages (Kouassikro, Domangbeu, Monokozi and Goréa) are concerned by this study. In these different localities, the methodology applied consisted first of interviews with farmers and hunters, then in pedestrian inventories of mammalian fauna in the biodiversity monitoring plots.

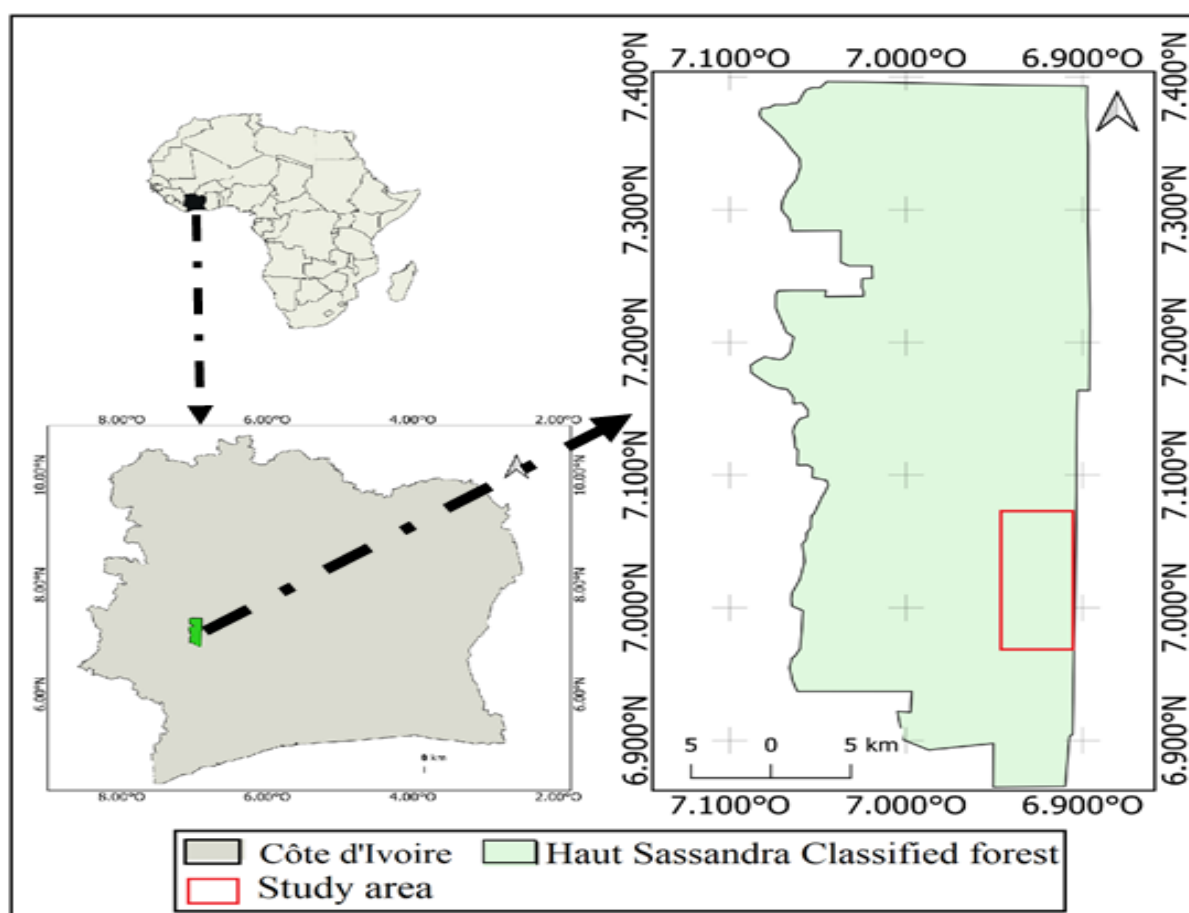


Fig. 1. Location of Haut-Sassandra Classified Forest.

Surveys in villages

This method consisted in collecting from certain populations living close to the classified forest, information on the fauna that has existed and on that supposed to still be present in the study area. For this, people of 24 years old and over who have knowledge on wildlife have been interviewed. The respondents were farmers or hunters. A questionnaire was submitted to them individually.

Pedestrian surveys

After the surveys in villages, pedestrian surveys were made to confirm information collected from the respondents using the line transect method. These surveys took place in four types of plots with different treatments:

- Treatment 1: cocoa farm maintained and harvested;
- Treatment 2: cocoa farm not maintained but harvested;
- Treatment 3: cocoa farm maintained and not harvested;

Treatment 4: forest relic.

These treatments were repeated three times (Fig. 2). The linear transect method consisted on walking slowly and silently at a speed of about 0.5 to 1 km / h along a north-south oriented transect and passing through the middle of the 50 m x 50 m plot while looking for signs of the presence of mammals (Fig. 3). When following linear transects, no deviations are allowed. Whenever an indice of the presence of a mammal is observed, nature of the indice and number are registered, the species is identified and the geographical coordinates noted.

Data analyses

Species identification is based on knowledge of the mammalian fauna of the region and also using Kingdon's Illustrated Guide for African Mammals (Kingdon, 1997). The specific frequencies based on indices of the presence of mammals were calculated. Conservation status has been determined at three

levels. First at the local level, depending on the abundance that interviewed persons attribute to the species they cite. Then, at the national level according to the three appendices which classify the species

according to their level of protection and finally at the international level, the IUCN Red List (IUCN, 2018) of threatened species with the different classification categories was used.

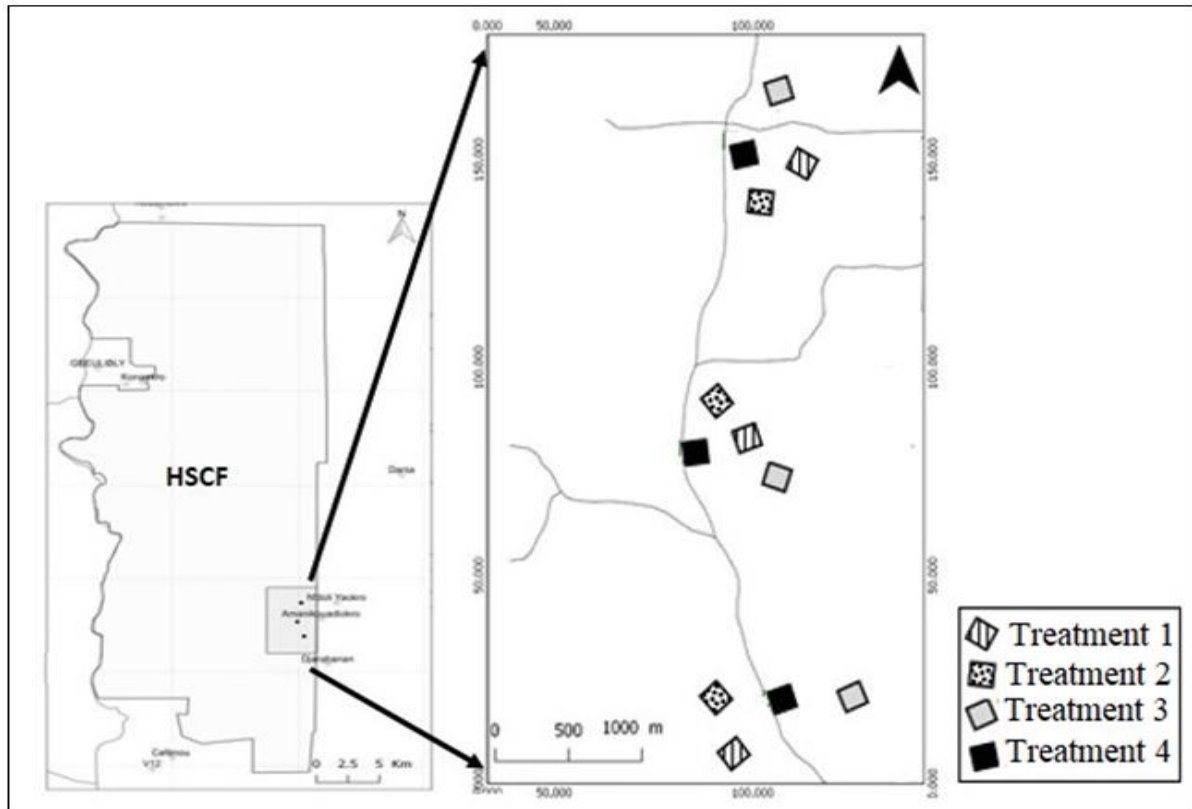


Fig. 2. Location of biodiversity monitoring plot at HSCF.

Results

Specific diversity of mammals according to the surveys in villages

Twenty-seven species of mammals belonging to nine (9) orders which are: Artiodactyla, Primates, Rodentia, Carnivora, Proboscidea, Pholidota, Lagomorpha, chyroptera and Hyracoidea have been reported during surveys. The 27 species have been cited at different rate by the 20 persons that have been interviewed (Table 1).

Specific diversity of mammals according to pedestrian survey in plots with different treatments

Pedestrian surveys in the plots permitted to collect 141 indices of the presence of mammals belonging to five (5) species of mammals grouped into two (2) Orders: Rodentia and Cetartiodactyla. The order of Rodentia (93%; N = 131) is the most common, followed by the

order of Cetartiodactyla (7%; N = 10). Specifically, *Funisciurus pyrropus* is the most frequent species (48%; N = 68) followed by *Euxerus erythropus* (43.3%; N = 61), *Tragelaphus scriptus* (5.7%; N = 8), *Tryonomys swinderianus* (1.4%; N = 2) and *Syncerus caffer* (1.4%; N = 2).

Two (2) of the five (5) species (*Euxerus erythropus* and *Funisciurus pyrropus*) are found in all treatments. *Tryonomys swinderianus* is observed in treatments 2 (Farm not maintained but harvested) and 3 (Farm not maintained and not harvested). *Tragelaphus scriptus* is present in treatments 1 (Farm maintained and harvested) and 2. *Syncerus caffer* is observed only in treatment 3. Four (4) of the five (5) species are found treatments 3 and 2, three (3) are reported in treatment 1 and two species are present in treatment 4 (forest relic).

Table 1. Mammals species cited by persons interviewed in villages.

Order	Common Name	Scientific Name	Citation rate (%)
Cetartiodactyla	Maxwell's Duiker	<i>Cephalophus maxwelli</i>	55
	Black Duiker	<i>Cephalophus niger</i>	60
	Bay Duiker	<i>Cephalophus dorsalis</i>	40
	Bush Pig	<i>Potamochoerus porcus</i>	75
	Cape Buffalo	<i>Syncerus caffer</i>	95
	Bushbuck	<i>Tragelaphus scriptus</i>	100
	Royal Antelope	<i>Neotragus pygmaeus</i>	80
Primates	Spot Nosed Monkey	<i>Cercopithecus petaurista</i>	65
	West African Chimpanzee	<i>Pan troglodytes verus</i>	85
	Black and White Colobus	<i>Colobus polykomos</i>	45
	Campbell's Monkey	<i>Cercopithecus campbelli</i>	25
	West African Red Colobus	<i>Piliocolobus badius</i>	60
Carnivora	African Civet	<i>Civettictis civetta</i>	55
	Brown Mongoose	<i>Crossarchus obscurus</i>	60
	Leopard	<i>Panthera pardus</i>	45
Rodentia	Greater Cane Rat	<i>Trynomys swinderianus</i>	100
	Mouse	<i>Mus sp</i>	25
	Beecroft's Flying Squirrel	<i>Anomalurus beecrofti</i>	75
	Striped Ground Squirrel	<i>Euxerus erythropus</i>	100
	Fire-footed Rope Squirrel	<i>Funisciurus pyrropus</i>	100
	African Brush-tailed Porcupine	<i>Atherurus africanus</i>	70
	Crested Porcupine	<i>Hystrix cristata</i>	70
Proboscidea	African Elephant	<i>Loxodonta africana</i>	95
Pholidota	Tree Pangolin	<i>Phataginus tricuspis</i>	35
Largomorpha	Scrub hare	<i>Lepus saxatilis</i>	70
Hyracoidea	Southern Tree Hyrax	<i>Dendrohyrax arboreus</i>	60
Chiroptera	Hammer Headed Bat	<i>Hypsignathus monstrosus</i>	80

Citation rate: percentage of persons who cited the species.

Treatment 3 contained the highest number of mammalian indices (34.04%; N = 48). Treatments 2, 4 and 1 follow in decreasing order with respectively N = 38 (26.95%), N = 35 (24.82%) and N = 20 (14.18%) (Table 2).

Conservation status of mammals at HSCF

According to surveys, at local level, some species are common in the region while others have virtually disappeared. Of the 27 mammals encountered, four

(4) species are very abundant. Then follow 10 species which are abundant and Nine (9) species classified as rare. Four species qualified as very rare are species that are no longer found in the study area (Table 3). At the national level, seven (7) of the 27 of mammal species are listed in Annex I (fully protected species), five (5) species in Annex II (partially protected species) and the fifteen (15) other species in Annex III (wild species whose hunting is authorized for users) (Table 3).

Table 2. Mammals species observed in plots according to the treatments.

Order	Common Name	Scientific Name	Indices in plots by treatment			
			T1	T2	T3	T4
Rodentia	Striped Ground Squirrel	<i>Euxerus erythropus</i>	10	13	18	20
	Fire-footed Rope Squirrel	<i>Funisciurus pyrropus</i>	8	18	27	15
	Greater Cane Rat	<i>Trynomys swinderianus</i>	0	1	1	0
Cetartiodactyla	Bushbuck	<i>Tragelaphus scriptus</i>	2	6	0	0
	Cape Buffalo	<i>Syncerus caffer</i>			2	
Total = 141			20	38	48	35
Abundance (%)			14.18	26.95	34.04	24.82

T1 = cocoa farm maintained and harvested; T2 = cocoa farm not maintained but harvested;

T3 = cocoa farm maintained and not harvested; T4 = forest relic.

According to the IUCN Red List, among the mammals present at HSCF, 20 species are classified in the category of Least Concern (LC), four (4) species are vulnerable (VU), two (2) endangered species (EN) and one (1) critically endangered species (Table 3).

Discussion

Results of surveys in neighboring villages and those of pedestrian surveys on fauna permitted to draw up the list of mammals in the biodiversity monitoring plots at HSCF. The number of species reported by villagers interviewed is much higher than the result of pedestrian surveys. Indeed, out of a total of 27 species grouped into nine (9) orders of mammals that would have existed in the forest before the politico-military crises, 23 species are still present and among them only five (5) species have been confirmed by the pedestrian surveys. These five (5) species are grouped

into two (2) orders Rodentia and Artiodactyla. This diversity of mammals identified by surveys is almost identical to that obtained by Assui (2018) in the Mont Péko National Park with 28 species grouped into seven (7) orders. Since the two protected areas are located close to each other, they suffered the same anthropogenic impacts during politico-military crises.

However, the results of the present study are below to those of Apkatou *et al.* (2018) in the classified forests of Mabi and Yaya in the South-East of Côte d'Ivoire with 52 species grouped into seven (7) orders and those of Yaokokore-Beibro *et al.* (2010) in the North of Côte d'Ivoire in the classified forest of Badénou in Korhogo with 45 species grouped into nine (9) orders. This could be explained by the loss of control of the HSCF by the official manager, SODEFOR, during politico-military crises.

Table 3. Different conservation status of mammals at HSCF.

Order	Common Name	Scientific Name	Local Status	National Status	International status
Cetartiodactyla	Maxwell's Duiker	<i>Cephalophus maxwelli</i>	-	AIII	LC
	Black Duiker	<i>Cephalophus niger</i>	-	AII	LC
	Bay Duiker	<i>Cephalophus dorsalis</i>	-	AI	LC
	Bush Pig	<i>Potamochoerus porcus</i>	-	AIII	LC
	Cape Buffalo	<i>Syncerus caffer</i>	+	AI	LC
	Bushbuck	<i>Tragelaphus scriptus</i>	++	AIII	LC
	Royal Antelope	<i>Neotragus pygmaeus</i>	-	AIII	LC
Primates	Spot Nosed Monkey	<i>Cercopithecus petaurista</i>	+	AII	VU
	West African Chimpanzee	<i>Pan troglodytes verus</i>	--	AI	CR
	Black and White Colobus	<i>Colobus polykomos</i>	-	AI	VU
	Campbell's Monkey	<i>Cercopithecus campbelli</i>	+	AII	LC
	West African Red Colobus	<i>Piliocolobus badius</i>	-	AII	EN
Carnivora	African Civet	<i>Civettictis civetta</i>	+	AIII	LC
	Brown Mongoose	<i>Crossarchus obscurus</i>	+	AIII	LC
	Leopard	<i>Panthera pardus</i>	--	AI	EN
Rodentia	Greater Cane Rat	<i>Tryonomys swinderianus</i>	++	AIII	LC
	Mouse	<i>Mus sp</i>	+	AIII	LC
	Beecroft's Flying Squirrel	<i>Anomalurus beecrofti</i>	+	AIII	LC
	Striped Ground Squirrel	<i>Euxerus erythropus</i>	++	AIII	LC
	Fire-footed Rope Squirrel	<i>Funisciurus pyrrhopus</i>	++	AIII	LC
	African Brush-tailed Porcupine	<i>Atherurus africanus</i>	-	AIII	LC
	Crested Porcupine	<i>Hystrix cristata</i>	-	AIII	LC
Proboscidea	African Elephant	<i>Loxodonta africana</i>	--	AI	VU
Pholidota	Tree Pangolin	<i>Phataginus tricuspis</i>	--	AI	VU
Largomorpha	Scrub hare	<i>Lepus saxatilis</i>	+	AIII	LC
Hyracoidea	Southern Tree Hyrax	<i>Dendrohyrax arboreus</i>	+	AII	LC
Chyroptera	Hammer Headed Bat	<i>Hypsignathus monstrosus</i>	+	AIII	LC

Very rare; - Rare; + Abundant; ++Very abundant; AI: Annex I, AII: Annex II, AIII: Annex III

Least Concern (LC), Vulnerable (VU), Endangered (EN), Critically Endangered (CR).

This situation has favored a massive infiltration of the population into the HSCF to carry out agricultural activities (cocoa farms) and illegal hunting (PNUE, 2015), thus by destroying the habitat of these animals they compromise their survival and cause their disappearance.

The five (5) species identified during the pedestrian surveys were obtained from 141 signs of presence in the different treatments. As expected, the indices of mammals' presence are more important in the plots with less human activities. Thus, treatments 3 (Farm not maintained and not harvested) and 2 (Farm not maintained and harvested) have more signs of mammals' presence than treatment 1 (Farm

maintained and harvested). However, treatment 4 (Forest Relic) supposed to be without human activities and therefore may have more indices of mammals' presence did not show the expected result.

There is less evidence of the presence of mammals this treatment than in treatments 2 and 3. This is explained by the fact that the forest relics are small in size and are found near roads. They are therefore disturbed by the noise of the trucks. In addition, they are also places of supply to populations with all kinds of wood products, thus pushing animals to join farms with areas of refuge. This same behavior has been observed in cocoa agroforests in the forest-savanna contact zone in Côte d'Ivoire by Béné *et al.* (2018).

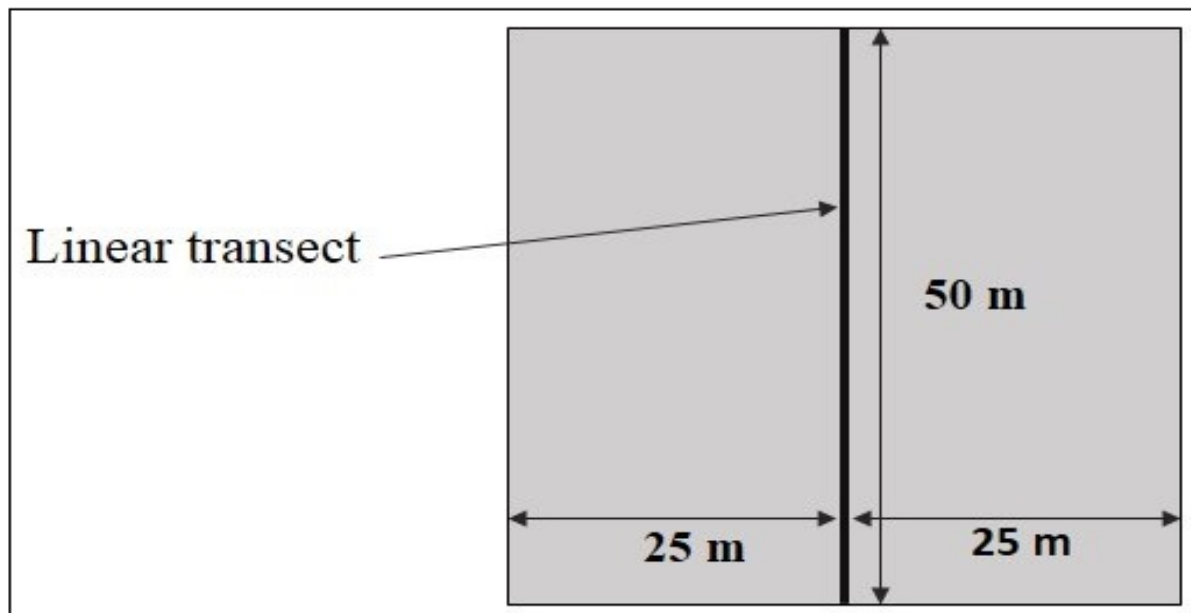


Fig. 3. Linear transect in a biodiversity monitoring plot.

In addition, the work reveals that the 27 species of mammals likely to be encountered in the HSCF belong to different categories of conservation status whether at the local, national or international level. According to local assessment, the 27 species of mammals cited are: "Very abundant" (4), "Abundant" (10), "Rare" (9) and "Very rare" (4). At the national level, of the 27 species of mammals, seven (7) belong to Annex I, five (5) to Annex II and 15 to Annex III. According to the international assessment, 20 of the 27 mammal species are in the "Least Concern" category, four (4) are "Vulnerable", two (2) are

"Endangered" and one (1) "Critically Endangered". The five (5) species of mammals confirmed by the pedestrian surveys are all in the category "Abundant" at the local level and of "Least Concern" at the international level. But at the national level, four (4) species belong to Annex III and one (1) to Annex I of fully protected species.

The five species are not found at the same rate in the different treatments. *Euxerus erythropus* and *Funisciurus pyrropus* are found in all treatments. They are small mammals that adapt to all

environments, even the most disturbed. *Tryonomys swinderianus*, a medium-sized mammal, is observed in treatments 2 and 3 where the reduction in human activities favors the emergence of a refuge area. *Tragelaphus scriptus*, a large species mammal, but commensal to humans, is present in treatments 1 and 2 where there is a higher level of human activity. *Syncerus caffer*, a large mammal, is only seen in treatment 3 with no human activities.

It should therefore be noted that plantations with less human presence are the most used by animals, especially those with a large size. This raises the hope of recolonization of these areas by animals if they are freed from their current illegal occupations. Indeed, Vounserbo (2011), in the wildlife corridors of Hunting Zones of Interest 1 and 4, has shown that wildlife that is threatened migrates to less anthropized areas.

Also, the presence of species of high conservation value on the list of species reported and the confirmation of the Cape Buffalo species "fully protected" at the national level, in this forest allows to say that it has a relatively high wildlife potential. However, the fact that no indices of "Vulnerable", "Endangered", "Critically Endangered", "Rare" and "Very rare" species cited was observed reflects the very high level of degradation of HSCF. In fact, the reduction and destruction of habitats is a major cause of the scarcity of species. This situation is corroborated by the work of Sangaré *et al.* (2009) who show that the HSCF before infiltration still hosted species of high conservation value such as the Tree Pangolin, the West African Chimpanzee and the West African Red Colobus. As HSCF is highly anthropized, the confirmed species, generally of low conservation value, are mammals which certainly have a very high capacity for adaptation.

Conclusion

This study in the biodiversity monitoring plots indicated that, beyond the important impacts of human activities, HSCF has a relatively large specific wildlife diversity. In fact, the surveys revealed 27 species of mammals of which five were confirmed by

pedestrian surveys. The large number of mammals, in the study area in general, and their abundance in unmaintained and unharvested farm in particular, are a good indicator of a possible recolonization of the forest by the fauna in the absence of human activities. We therefore recommend the end of agricultural activities in the forest in order to facilitate the development of wildlife.

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