CURRENT CONSERVATION STATUS OF LARGE MAMMALS IN SIME DARBY OIL PALM CONCESSION IN   LIBERIA

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Abstract

The forest ecosystem of Liberia is part from the Upper Guinea Eco-region, and harbors an exceptional biodiversity in a rich mosaic of habitats serving as refuge for numerous endemic species. Unfortunately, many of these forests have been lost rapidly over the past decades, and the remaining are under various forms of anthropogenic pressure, subsistence farming, and large-scale industrial agriculture and mining. As part of a broader survey to generate information for conservation management strategies in the Gross Concession Area in preparation for its oil palm and rubber plantations in western Liberia, Sime Darby (Liberia) Inc., commissioned surveys on large mammals species in 2011. Through a combination of hunter interviews and foot surveys, we documented evidence of 46 and 32, respectively, of large mammals in the area. Fourteen of the confirmed species are fully protected at national level and three are partially protected. At the international level, 15 species are of conservation concern, including Zebra and Jentink's duiker, Diana monkey, Sooty mangabey, Olive colobus, Elephant and Leopard.

Key words: large mammal, conservation status, biodiversity, threatened species, Liberia.

1. Introduction

Three large blocks of equatorial forest exist in the world. These are situated in South America, in Southeast Asia and in Africa. In Africa, the forest block is divided into two sub-blocks separated by the Dahomey Gap: the Guinean Block of West Africa and the Congolese Block of Central Africa. There is no doubt that the Guinean Block is the most directly threatened. This block covers The Upper Guinea forest block, stretching from Guinea, through Sierra Leone, Liberia, Ivory Coast, Ghana to Togo, constitutes one of the very high priority conservation tropical biodiversity hotspots in the world. Due to a combination of anthropogenic factors, it is also one of the most threatened. Currently, the Liberian portion is considered the most important, since it contains the most extensive and relatively intact remaining of the original forest block (Vershuren, 1983).

Liberia is the only West African country thought to have been totally covered in tropical rainforest before the influence of human settlement. Currently, this forest is estimated to cover about 49% of the total landmass of the country. The importance of the Guinean Forests of West Africa (GFWA) ecosystem resulted in its designation by Conservation International (CI, 2007) as one of the world's 35 Hotspots, areas of highest biodiversity richness under the greatest threat. Due to its status as retaining the most intact remaining forest in the hotspot, Liberia's forests are considered the top priority for conservation in West Africa.

However, the once continuous tracts of forests in Liberia, which represent the main sizeable intact forest blocks within the Upper Guinea Forest Region, are now isolated from each other, into two fragmented blocks. There is evergreen forest block in the southeast and a semi-deciduous block in the north-western portions of the country, separated by a distinct transitional zone of disturbed forest vegetation mostly along the Nimba-Monrovia corridor. This division of the Liberian forest blocks is largely due to shifting cultivation and human settlements, which is also compounded by fragmentation from logging and road infrastructure activities. Therefore, Liberia's biodiversity is under severe threat with rapid loss and decimation of species and habitats that are jeopardizing future development of the country. Biodiversity loss in Liberia is of regional concern because Liberia still holds the last remaining two blocks of the Upper Guinea Forest Ecosystem of West Africa. As we well know, most of the biodiversity in this region is held by the forest. So, further significant loss of biodiversity in Liberia would have adverse consequences for conservation of biodiversity in West Africa.

Environmental and social impact assessments have become a prerequisite to the launching of most important development projects in tropical countries, and biological assessments are increasingly becoming a major component of such studies. In addition, as a consequence of massive protests throughout the world, environmental issues are increasingly taken into consideration in the planning and implementation of development projects. The Forestry Development Authority (FDA), created in 1976 to manage Liberia's forest fauna and flora, has actively sought the cooperation of the International Union for Conservation of Nature and Natural Resources (IUCN) and the World Wildlife Fund (WWF) in achieving its mandate.

As part of land management planning for its oil palm and rubber plantation concession in western Liberia, Sime Darby Plantations (Liberia) Incorporated (hereafter called Sime Darby) commissioned an Environmental and Social Assessment (ESA) through Fauna & Flora International (FFI) in November-December 2011. The objective was to characterize the environmental and social conservation baseline of the company's Gross Concession Area (GCA) in order to provide an informed basis for assessment of the expected impacts of its development activities, as required by Liberian and international law.

The status of large mammal populations in tropical forests is viewed as particularly important in the EIAs. Large mammals, notably primates, are particularly sensitive to habitat disturbance (Koné, 2004; Bene *et al.*, 2009) and are invaluable indicators of the conservation status of natural habitats. This study aims at assessing the current status of the large mammals at four sites (concession Block E, Block F, Block G and Block H) in the Gross Concession Area of Sime Darby.

2. Global objectives

This study aimed to document the diversity and conservation status of large mammals of the GCA, and highlight measures for their long term conservation under an intensive industrial agricultural development.

3. Specific objectives

We sought to address the following specific objectives:
 i.   Identify and document the large Mammal communities of the study area
 ii. Appropriately describe the current status of large Mammal species with attention to species that are of global conservation significance (species listed on the IUCN Red List of Threatened Species) as well as species protected by national legislation.

4. Methods

4-1- Location of the study zone

Liberia lies at the southwest corner of West Africa, bordered by Sierra Leone to the northwest, Guinea to the northeast, and Côte d'Ivoire to the east. The landscape is dominated by generally flat coastal plains, rising to rolling plateaus and low mountains in the northeast, highest of which is the Nimba range in North Nimba County. Liberia's climate is tropical, with the wet season lasting from approximately April until October. Rainfall varies from about 4080mm at Buchanan on the Coast, to 1918mm at Yekepa.

Bong County is situated roughly at the geographic center of Liberia. The County is drained by six principal rivers and a number of small streams. It is part of the high forest belt, which can be divided into an evergreen rain forest zone and the moist semi-deciduous forest zone. The evergreen forest receives an annual rainfall of 80 inches and consists of species that do not have a marked period of leaf fall. The tallest trees reach 200 feet. The semi-deciduous forest is a transition to the deciduous forest type found in the Ivory Coast.

The densely forested Gbarpolu County occupies an area of approximately 1,263 square miles, and is located in the western region of Liberia. The County has two main mountain ranges, Kpo and Fanyea, and three main river systems. Gbarpolu contains significant portions of the Upper Guinea Forest. Most of this forest is deciduous and mountain in nature, covering all three main forest classes: class 3.1–forest with small agricultural; class 3.2–open dense forest; and class 3.3–closed dense forest.

The concession of Sime Darby covers four counties (Gbarpolu, Bomi, Bong and Grand Cape Mount) see figure 1. Initially, with a total concession area of 311,817 ha the Gbarpolu County with 51% housed the major portion, then Bong and Bomi with 18% each, and finally Grand Cape Mount with 13%. The boundaries of this concession have been revised downward from 311,817 ha to 116,634 ha. This study concern four blocks (F, G and H in Gbarpolu County and block E in Bong County).
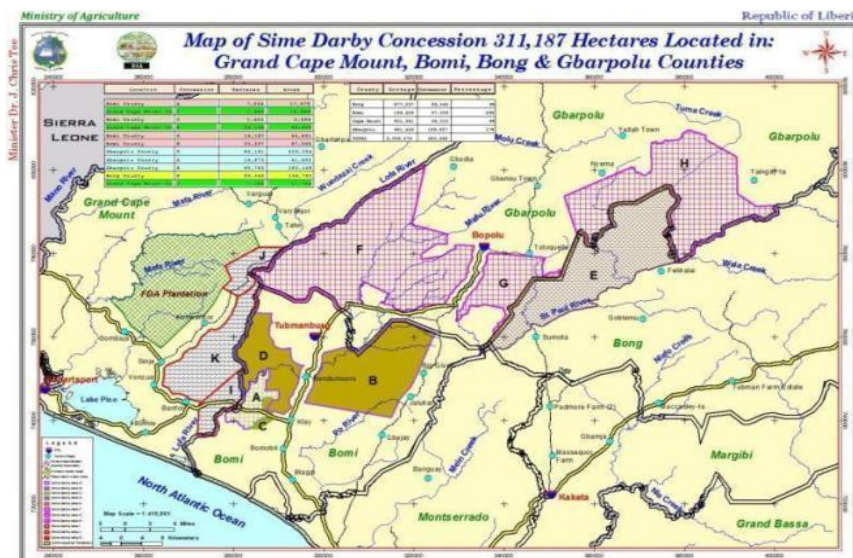

Figure 1. Sime Darby concession location in the four counties

4-2- Sampling

The choice of a survey area in a block was guided by vegetation cover assessment as a proxy for probable habitat suitability (figure 2) and hunter interviews in neighboring communities. The vegetation of block E was mainly forest with open canopy; block F was a forest with high and closed canopy; block G was a forest with open canopy and block H a young forest and farm bush forest. We adopted the following approach in this study : (1) initial town interviews of experienced hunter-informants to obtain general information on animal species that occur in the area, their distribution and population trends; (2) walking in the targeted forest block(s) of potential conservation interest to observe evidence of wildlife, by using mainly hunter trail. Three persons composed one team. One team was composed during the first day and two teams for the other days. In each team one person was concentrated on primate's evidence and the two other members on ground evidence of animal presence. When a sign of evidence is seen, we record the date, the time; the type of the observation, count the number, determine the species when possible and record the GPS coordinate.
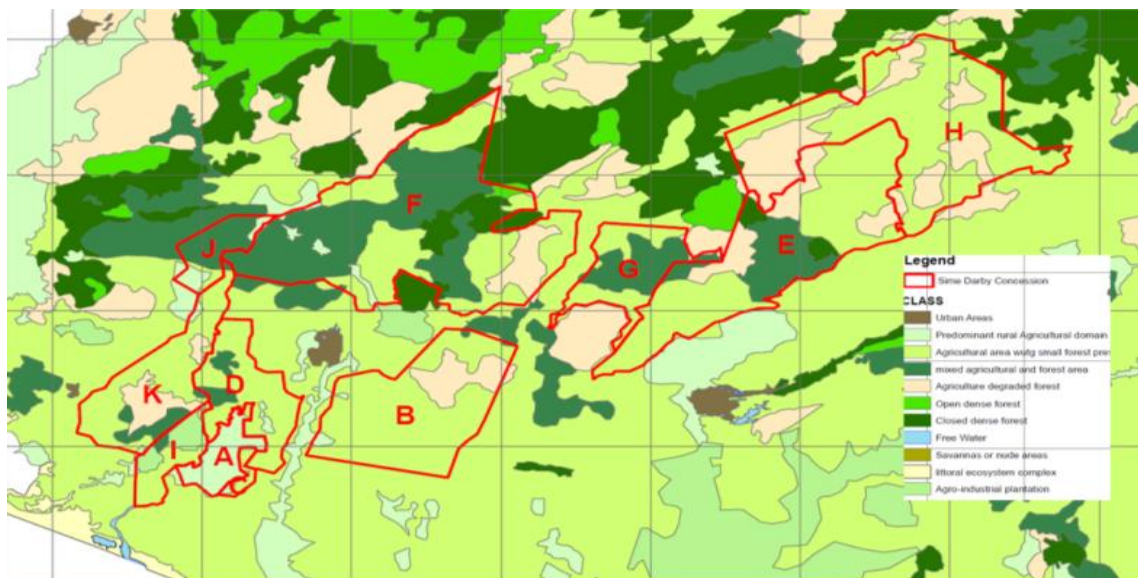

Figure 2. Vegetation covers of Sime Darby different blocks

4-3- Analysis

Species identification was made based on our own knowledge of the area's fauna, and backed up with the Kingdon Field Guide to African mammals (Kingdom, 2007). We calculated the frequencies of specific encounters of different indices of presence. We used the national (Liberia) conservation status of the new "an act adopting the national wildlife conservation and protected area management law of Liberia" and the following tags (table 1) are used the IUCN and the Red List of Threatened Species 2008 to determine each species' conservation status.

Table 1. IUCN Red list of threatened Species Categories

Abbreviation	Signification	Definition
EX	Extinct	No reasonable doubt that the last individual has died.
EW	Extinct in the wild	Known only to survive in captivity or as a naturalized population well outside its previous range.
CR	Critically Endangered	The species is in imminent risk of extinction in the wild.
EN	Endangered	The species is facing an extremely high risk of extinction in the wild.
VU	Vulnerable	The species is facing a high risk of extinction in the wild.
NT	Near Threatened	The species does not meet any of the criteria that would categorize it as risking extinction but it is likely to do so in the future.
LC	Least Concern	There are no current identifiable risks to the species
LR/cd	Lower Risk/conservation Dependent	Species which were the focus of conservation program and may have moved into a higher risk category if that program was discontinued.
LR/nt	Lower Risk/near Threatened	Species which are close to being classified as Vulnerable but are not the subject of conservation program
LR/lc	Lower Risk/least Concern	Species for which there are no identifiable risks

5. Results

5-1- Presence and encounter rates of large mammals in the four blocks

According to the literature review, 65 large mammal species are likely to live in the study area. Surveys of hunters have identified 46 species of large mammals. Then, the field study confirmed 32 species (table 2). A total of 438 observations of large Mammals signs were made during a total time of 63 hours survey. This gives a frequency of 7 observation / hour. And 33 of these observations are direct sign and represents 8% of all observations that are been made against 405 indirect observations (92%). Direct observations showed a frequency of 0.5 obs/h and were composed of

40% (seen), 30% (call) and 22% of the combination seen/call. The indirect observations have a frequency of 6.4 obs/h and consisted mainly of foot print (75%), feeding site (9%), trail/foot print (7%), trail (4%) and dung (4%).

Table 2. Large Mammal species confirmed in Sime Darby gross concession area

	Large Mammal Species according to literature review		**Species in Sime Darby Gross Concession**	
Order	**Scientific name**	**English name**	**Conf. hunters**	**Conf. field survey**
Artiodactyla	*Cephalophus dorsalis*	Bay duiker	X	X
	Tragelaphus scriptus	Bushbuck	X	X
	Cephalophus maxwelli	Maxwell's duiker	X	X
	Boocercus euryceros	Bongo	X	
	Cephalophus zebra	Zebra duiker	X	X
	Cephalophus jentinki	Jentink's duiker	X	X
	Cephalophus ogilbyi	Ogilby's duiker	X	X
	Cephalophus silvicultor	Yellow-backed duiker	X	X
	Cephalophus niger	Black duiker	X	X
	Hyemoschus aquaticus	Water chevrotain	X	X
	Potamochoerus porcus	Red river hog	X	X
	Hylochoerus meinertzhageni	Giant hog	X	
	Hippopotamus amphibius	Hippopotamus	X	
	Hexaprotodon liberiensis	Pygmy hippopotamus		
	Syncerus caffer	African buffalo	X	X
	Neotragus pygmaeus	Royal antelope		
Carnivora	*Crossarchus obscurus*	Cusimanse	X	X
	Herpestes sanguinea	Slender mongoose	X	X
	Herpestes ichneumon	Ichneumon mongoose		
	Mungos gambianus	Gambian mongoose		
	Atilax paludinosus	Marsh mongoose		
	Genetta tigrina	Blotched genet	X	
	Poiana leightoni	west African linsang		
	Felis aurata	Golden cat		
	Panthera pardus	Leopard	X	X
	Mellivora capensis	Ratel	X	
	Aonyx capensis	African clawless otter		
	Lutra maculicollis	Spot-necked otter	X	X
	Nandinia binotata	African palm civet	X	X
	Genetta sp	Genet	X	X
	Civettictis civetta	African civet	X	X
Pholidota	*Phataginus tricuspis*	Tree pangolin	X	X
	Uromanis tetradactyla	Long-tailed pangolin	X	
	Smutsia gigantea	Giant pangolin	X	
	Dendrohyrax dorsalis	Western tree hyrax	X	
Primates	*Galagoides demidovii*	Demidoff's Galago	X	
	Galagoides thomasi	Thomas' Galago		

Perodicticus potto	Bosman's potto	X		
Cercocebus atys atys	Sooty mangabey	X	X	
Chlorocebus aethiops sabaeus	Green Monkey			
Cercopithecus diana diana	Diana monkey	X	X	
Cercopithecus nictitans stampfii	Stampfi's putty-nosed monkey			
Procolobus verus	Olive colobus	X	X	
Procolobus badius badius	Western red colobus			
Colobus polykomos	Western black-and-white colobus	X		
Cercopithecus petaurista b.	Lesser spot-nose	X	X	
Cercopithecus m. campbelli	Campbell's monkey	X	X	
Pan troglodytes verus	Western chimpanzee	X		
Rodentia *Anomalurus derbianus*	Lord Derby's anomalure			
Anomalurus peli	Pel's anomalure			
Anomalurus beecrofti	Beecroft's anomalure	X	X	
Hystrix cristata	Crested porcupine	X	X	
Atherurus africanus africanus	brush-tailed porcupine	X	X	
Thryonomys swinderianus	marsh cane rat	X	X	
Cricetomys emini	Giant pouched rats	X		
Cricetomys gambianus	Giant pouched rats	X	X	
Euxerus erythropus	Striped ground squirrel	X	X	
Protoxerus stangeri	African giant squirrel	X	X	
Heliosciurus rufobrachium	Red-legged sun squirrel	X		
Funisciurus pyrropus	Fired-footed rope squirrel			
Paraxerus poensis	green squirrel			
Heliosciurus gambianus punctatus	Gambian sun squirrel			
Protoxerus aubinnii	Slender-tailed squirrel			
Epixerus ebi	Western palm squirrel			
Probiscidae *Loxodonta africana*	Elephant	X	X	
TOTAL		**65**	**46**	**32**

5-2- Confirmed large mammal species in the four blocks conservation status

We observe that in all of the blocks, 14 out of the 32 Mammal species confirmed are fully protected at national level and three are partially protected. At the international level, a total of 15 (47%) species are of conservation concern according to IUCN Red List of Threatened Species constituted of two Vulnerable Artiodactyla (Zebra and Jentink's duikers), one Vulnerable Primate (Diana monkey) and one Vulnerable Proboscidea (Elephant) (table 3).

Also, five (5) species on this list are Near Threatened (NT) with two Primates (Sooty mangabey and Olive colobus), one Pholidota (Tree pangolin) and two Carnivora (Leopard and African palm civet). In the same list, six others Artiodactyla are listed as Low Risk and Near Threatened or Conservation Dependent: Maxwell's duiker (LR/nt), Black duiker (LR/nt), Bay duiker (LR/nt), Ogilby's duiker (LR/nt), Yellow-backed duiker (LR/nt), African buffalo (LR/cd).

Table 3. Sime Darby gross concession large mammal species conservation status

Order	English name	Scientific name	National status	IUCN Red List
Artiodactyla	Maxwell's duiker	*Cephalophus maxwelli*	Not listed	LR/nt
	Black duiker	*Cephalophus niger*	Not listed	LR/nt
	Bay duiker	*Cephalophus dorsalis*	Not listed	LR/nt
	Bushbuck	*Tragelaphus scriptus*	Not listed	LR/lc

	African buffalo	*Syncerus caffer*	Fully protected	LR/cd
	Red river hog	*Potamochoerus porcus*	Fully protected	LR/lc
	Zebra duiker	*Cephalophus zebra*	Fully protected	VU
	Ogilby's duiker	*Cephalophus ogilbyi*	Fully protected	LR/nt
	Yellow-backed duiker	*Cephalophus silvicultor*	Fully protected	LR/nt
	Jentink's duiker	*Cephalophus jentinki*	Fully protected	VU
	Water chevrotain	*Hiemoschus aquaticus*	Fully protected	LC
Primates	Sooty mangabey	*Cercocebus atys atys*	Fully protected	NT
	Campbell's monkey	*Cercopithecus m. campbelli*	Fully protected	LC
	Lesser spot-nose	*Cercopithecus petaurista b.*	Fully protected	LC
	Olive colobus	*Procolobus verus*	Not listed	NT
	Diana monkey	*Cercopithecus diana diana*	Fully protected	VU
Probiscidae	Elephant	*Loxodonta africana*	Fully protected	VU
	brush-tailed porcupine	*Atherurus africanus africanus*	Not listed	LC
	Giant pouched rats	*Cricetomys sp*	Not listed	LC
	African giant squirrel	*Protoxerus stangeri*	Not listed	LC
Rodentia	marsh cane rat	*Thryonomys swinderianus*	Not listed	LC
	Striped ground squirrel	*Euxerus erythropus*	Not listed	LR/lc
	Beecroft's anomalure	*Anomalurus beecrofti*	Not listed	LC
	Crested porcupine	*Hystrix cristata*	Not listed	LC
Pholidota	Tree pangolin	*Phataginus tricuspis*	Fully protected	NT
	African civet	*Civettictis civetta*	Partially protected	LR/lc
	Leopard	*Panthera pardus*	Fully protected	NT
	African palm civet	*Nandinia binotata*	Partially protected	NT
Carnivora	Spot-necked otter	*Lutra maculicollis*	Not listed	LC
	Slender mongoose	*Herpestes sanguinea*	Not listed	LC
	Cusimanse	*Crossarchus obscurus*	Not listed	LC
	Genet	*Genetta sp*	Partially protected	LC

5-3- Encounter rates of large mammal species confirmed in the four blocks

During the survey, whatever the method of confirmation of large Mammal species (direct or indirect) in the field, they belong to 6 orders (Artiodactyla, Primates, Proboscidea, Rodentia, Pholodota and Carnivora). The majority of present signs belongs to the order Artiodactyla with 73%, then the Rodentia (11%), Carnivora (6%) and Proboscidea (4%) and finally the order of Pholidota with 1% (Figure 3).
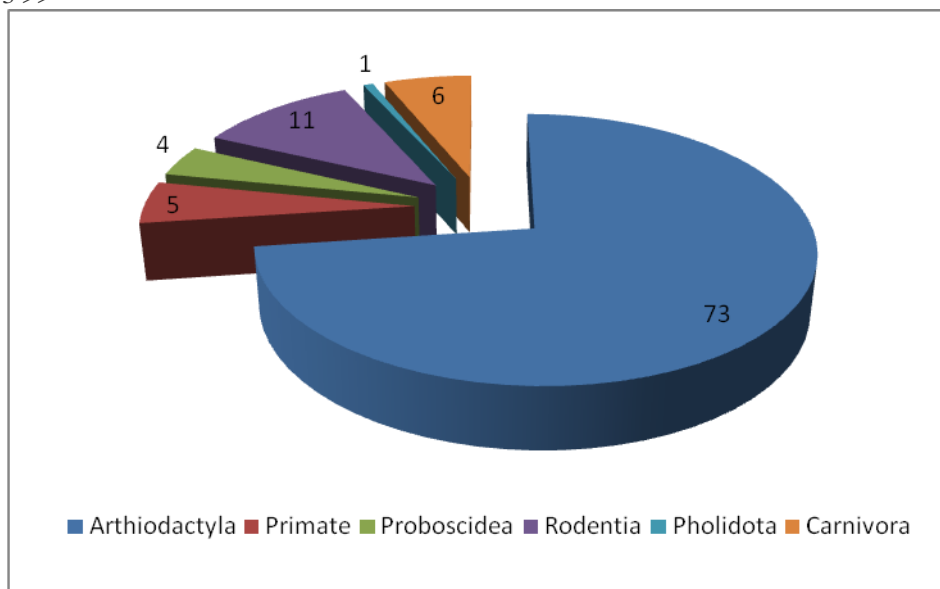
<< Figure 3 >>

Figure 3. Frequency of the different large Mammal orders confirmed in the Sime Darby concession

The order Artiodactyla is dominated by the Maxwell's duiker and Black duiker, then the Bay duiker, the bushbuck, the African buffalo and the Red river hog. The others Zebra, Ogilby's, Yellow-backed, Jentink's duikers and the Water chevrotain are encountered at lower rate. Primates are represented by Sooty mangabey, Campbell's monkey, Lesser spoted-nosed monkey and Olive colobus. Only one group of Diana monkey was encountered during the survey. The Proboscidea are represented by the Elephant. The Rodentia are dominated by the Brush-tailed porcupine, the Giant pouched rats and the African giant squirrel. Concerning Carnivora, the Cusimanse is the most encountered while the Pholidota is represented by the Tree pangolin (table 4).

Table 4. Encounter rate and frequency of encounter per hour in the four blocks

Order	English name	Scientific name	Observation	Encounter rate	Observ/hour
	Maxwell's duiker	*Cephalophus maxwelli*	103	0.235	1.63
	Black duiker	*Cephalophus niger*	96	0.219	1.52
	Bay duiker	*Cephalophus dorsalis*	41	0.094	0.65
	Bushbuck	*Tragelaphus scriptus*	25	0.57	0.40
	African buffalo	*Syncerus caffer*	22	0.050	0.35
Artiodactyla	Red river hog	*Potamochoerus porcus*	15	0.034	0.24
	Zebra duiker	*Cephalophus zebra*	8	0.018	0.13
	Ogilby's duiker	*Cephalophus ogilbyi*	4	0.009	0.06
	Yellow-backed duiker	*Cephalophus silvicultor*	3	0.007	0.05
	Jentink's duiker	*Cephalophus jentinki*	1	0.002	0.02
	Water chevrotain	*Hiemoschus aquaticus*	1	0.002	0.02
	Sooty mangabey	*Cercocebus atys atys*	8	0.018	0.13
Primates	Campbell's monkey	*Cercopithecus m. campbelli*	7	0.016	0.11
	Lesser spot-nose	*Cercopithecus petaurista b.*	5	0.011	0.08

	Olive colobus	*Procolobus verus*	2	0.005	0.03
	Diana monkey	*Cercopithecus diana*	1	0.002	0.02
Probiscidae	Elephant	*Loxodonta africana*	17	0.039	0.27
	brush-tailed porcupine	*Atherurus africanus africanus*	32	0.073	0.51
	Giant pouched rats	*Cricetomys sp*	8	0.018	0.13
	African giant squirrel	*Protoxerus stangeri*	4	0.009	0.06
Rodentia	marsh cane rat	*Thryonomys swinderianus*	2	0.005	0.03
	Striped ground squirrel	*Euxerus erythropus*	2	0.005	0.03
	Beecroft's anomalure	*Anomalurus beecrofti*	1	0.002	0.02
	Crested porcupine	*Hystrix cristata*	1	0.002	0.02
Pholidota	Tree pangolin	*Phataginus tricuspis*	2	0.005	0.03
	African civet	*Civettictis civetta*	2	0.005	0.03
	Leopard	*Panthera pardus*	1	0.002	0.02
	African palm civet	*Nandinia binotata*	1	0.002	0.02
Carnivora	Spot-necked otter	*Lutra maculicollis*	3	0.007	0.05
	Slender mongoose	*Herpestes sanguinea*	1	0.002	0.02
	Cusimanse	*Crossarchus obscurus*	17	0.039	0.27
	Genet	*Genetta sp*	2	0.005	0.03
TOTAL		**32**	**438**	**1.000**	**6.95**

6. Discussion

The diversity and frequency of large mammals recorded during the present survey is high compared to results from other surveys in Guinea, Côte d'Ivoire, and Ghana (Struhsaker and Bakarr, 1999; Barrie and Kante, 2004; Herbinger and Tounkara, 2004; Sanderson and Trolle, 2005; Barrie and Aalangdong, 2005). Despite of the relative shortness of this survey, we found many species of conservation concern in an appreciable numbers, among which were three Primates (*Cercocebus atys atys*, *Cercopithecus Diana diana* and *Procolobus verus*) and six other large Mammal species (*Cephalophus jentinki, C. niger, C. silvicultor, C. dorsalis, C. maxwelli* and *Panthera pardus*). Even if we did not confirm the presence of the Chimpanzee (*Pan troglodytes verus)* during the field survey, all the hunters interviewed have mentioned it presence in all the study area. This offers hope for the future of large Mammal species in Liberia.

However, the blocks in which these species live is intended to be transformed into oil palm plantation in a few time and their long-term survival become problematic. These forests and it fauna are already threatened by human actions including commercial logging, traditional mining, agricultural activities and hunting activity. Current distribution patterns of most large mammals and observed human activities in other areas in Liberia reflect these increasing pressures. Logging occurs in many countries in West Africa and has been cited as the primary cause of habitat destruction in Sierra Leone (Bakarr *et al*., 2001). Before the war, Liberia was a major source of timber and this has caused, and will continue to cause, forest fragmentation and the subsequent loss of large Mammals. The Liberian civil conflict also negatively impacted upon large Mammals as most of the forests were abandoned by government authorities and plundered by rebels engaged in illegal mining and logging. Secondary impacts of resource extraction such as roads and trails are equally destructive to the forest. Logging roads create easy access for hunters (and others) into areas that were otherwise not penetrable (Sayer *et al.,* 1992; Wilkie *et al*., 1992; Oates, 1999).

Local communities cause additional habitat degradation by establishing farms and hunting when road make the deeper forest accessible. The roads and trails fragment the forest reducing the area for wildlife. Collateral damage from logged trees was extensive and many untargeted trees had been damaged. The companies' workers often support

themselves and their families on bushmeat, consume trees for fuel wood and clear areas to plant crops. In addition, the increase in human population due to implementation of a company is accelerating the conversion of remaining forest habitats into human-dominated settlements and agricultural landscapes.

As the human population grows, bushmeat markets develop and the targets are mainly large mammals (Ungulates, Primates, Carnivores and some Rodents). Species most preferred by hunters include antelopes, forest pigs, and primates, while smaller species like the Cane Rat *Thryonomys swinderianus* and Giant Rat *Cricetomys spp.* are taken opportunistically (Eves and Bakarr, 2001). One of the consequences is the scarcity of some Primates species in much of West Africa as a result of unregulated exploitation, habitat loss and the increasing demand for bushmeat (Davies, 1987; McGraw, 1998; Grubb *et al.,* 1998; Davies and Hoffmann, 2002; Bene *et al.*, 2009; Gonedele-Bi *et al.*, 2009). Populations of forest-dependent animals have been reduced to such low levels that a number of them can no longer be considered viable. Large mammals are become the first to be eliminated from forest areas. As in most other countries in West and Central Africa, people in Liberia have always hunted and relied on bushmeat to provide them with protein (Anstey, 1991; Bene and Dufour, 2011).

The bushmeat trade is a lucrative business in Liberia, as in other parts of Africa (Oates, 1986; Barrie and Kante, 2004; Sanderson and Trolle, 2005; Barrie and Aalandong, 2005; Bene and Dufour, 2011). The apparent extinction of Miss Waldron's Red Colobus *Piliocolobus badius waldroni* has been attributed to hunting and the demand for bushmeat (Oates *et al.*, 2000). West African Chimpanzees are the most threatened of the three subspecies mainly due to habitat loss, high hunting pressure and the pet trade (Kormos and Boesch, 2003). The lack of law enforcement is often a major problem, but the "an act adopting the national wildlife conservation and protected area management law of Liberia" will solve many of these problems if it properly applied.

Biological Diversity involves every facet of our lives. Economic development, health and well being, cultural and social benefits, which are the foundations of sustainable development, all depend on biological diversity. Activities of man over the centuries have re-shaped the diversity of species, genes and ecosystems, to the extent that it is generally agreed that the earth has lost tremendous amount of biological diversity over time. For Liberia, biological diversity has declined significantly over the years, and the country has lost many species, while most of its ecosystems have been degraded significantly (BIOPA report, 2009).

In addition, there has been very slow progress in the establishment of protected areas in Liberia. No protected area has been seen around the study zone. The first protected area of the country, Sapo National Park, was proclaimed in 1983, and two additional areas (Mount Nimba Nature Reserve and East Nimba National Park) were declared by the Government in October, 2003. Conservation of Biodiversity in Liberia is increasingly hampered by several threats to the very biodiversity. The threat to Liberia's biodiversity is due to several factors, such as the absence of some basic data. The threats include also population pressure, especially due to the movement of displaced people and refugees, who use biological resources for food, shelter and energy. The method of farming (shifting cultivation), poaching and hunting, in association with unregulated timber extraction continue to threaten biodiversity. Other threats include soil erosion, mining, firewood gathering, charcoal production, invasive species, inappropriate use of agrochemicals, ignorance, lack of or insufficient public education and awareness.

The Liberian government should, through the FDA, require mining or farm companies more actions in favor of biodiversity conservation in general and large mammal in particular. In terms of this specific study area, special measures such as creating in the concession of Sime Darby a space for the conservation of wildlife of conservation concern, should be required. Corridor could be created and managed to allow a species to survive by joining surrounding protected or community forest. Awareness campaigns among local populations should be initiated for a participatory conservation of these species.

7. Acknowledgement

8. References

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