Wild Chimpanzee Foundation®

FINAL REPORT:
Survey of Wildlife and Anthropogenic threats in the Grebo-Sapo Corridor, South-eastern Liberia

(May-July 2015)

Prepared by Wild Chimpanzee Foundation
In collaboration with Forestry Development Authority, Liberia

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Executive summary

A- Generalities and Survey Methodology

In 2013, a corridor linking Proposed Grebo-Krahn National Park(PGKNP) with the Sapo National Park (SNP) was identified, under the Taï-Grebo-Sapo Transboundary Corridor Initiative, a scheme led by the Governments of Côte d'Ivoire and Liberia. The corridor runs through a major logging concession (FMC 'F') and community land (Putu and Chedepo Districts of Grand Gedeh and River Gee counties respectively). To evaluate the feasibility and potential impact of creating the corridor, a survey was led to measure the presence of both wildlife and anthropogenic threats inside the corridor. The survey would also provide a first idea of the potential boundary lines of the corridor. Supervised by trained WCF staff and FDA rangers, 3 teams of trained FDA rangers, auxiliaries and community members walked **103.17 km** across two systematic transect designs (1 for the concession, 1 for the community land) between the **28th of May 2015 and the 15th of July 2015**. Data was collected on the presence of large mammal and anthropogenic activities. Data was collected following IUCN Standards for Great Ape Surveys (Kühl et al., 2008).

B- Abundance and spatial distribution of large mammals in the Grebo-Sapo Corridor (GSCor)

Data was analysed to determine the encounter rates for each species and the spatial distribution of target species (chimpanzees, monkeys, duikers, etc.). A **population estimate of chimpanzees** in the survey area of FMC-F was also calculated and provided the current estimate of **688 individuals.** Surprising levels of biodiversity were discovered in both FMC-F and the community corridor with signs of **7 species of monkey** found in both FMC-F and the community corridor.

C-Threats to wildlife of the GSCor

The data collected on anthropogenic activities was treated in the same way as the wildlife data. **Signs of hunting were found in both survey areas** at levels which are likely to be having an impact on wildlife in the proposed corridor, higher than in the Proposed Grebo-Krahn National Park. Encounter rates of activities leading to deforestation were surprisingly low for a logging concession and community land, which is a positive result. The largest threat to wildlife in the surveyed areas is hunting activity which fuels the bush meat trade. Note that **a large mining camp is located in the FMC F corridor** and it appears that the consumption of bushmeat there is extremely high.

D-Conclusion and Recommendations

A corridor between PGKNP and SNP has been presented based on the results of this report. It is vital that all affected stakeholders meet to discuss the boundary lines of the corridor and the management strategies needed to maintain it. Given that the corridor falls in three different types of land-use (National Forest, logging concession and community forest) the creation of a successful corridor will be a complex and delicate process.

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LIST OF ACRONYMS

CV: Coefficient of variation
FDA: Forestry Development Authority
FFI: Fauna and Flora International
FMC F: Forest Management Contract F
GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit
GNF: Grebo National Forest
GSCor: Grebo-Sapo Corridor
IUCN: International Union for the Conservation of Nature
KfW: Kreditanstalt für Wiederaufbau
PA: Protected Area
PGKNP: Proposed Grebo-Krahn National Park
SNP: Sapo National Park
TGSFC: Taï-Grebo-Sapo Forest Complex
TNP: Taï National Park
UNEP-GRASP: United Nations Environment Program-Great Ape Survival Partnership
UTM: Universal Transverse Mercator
WCF: Wild Chimpanzee Foundation

1. INTRODUCTION

In 2009, a Transboundary Corridor Initiative for the Taï-Grebo-Sapo Forest Complex (TGSFC) was launched by the Governments of Liberia and Côte d'Ivoire with support from the Wild Chimpanzee Foundation (WCF) and the Great Ape Survival Partnership of the United Nations Environmental Program (GRASP-UNEP). A steering committee has been set up to lead the process of managing the complex together, with representatives from the Forestry Development Authority of Liberia (FDA), the Office Ivoirien des Parcs et Réserves (OIPR) and the Société de Développement des Forêts (SODEFOR) of Côte d'Ivoire, as well as partners from the Mano River Union (MRU), WCF, UNEP-GRASP, Fauna and Flora International (FFI) and the German Cooperation (GIZ/Kfw). Under this initiative, a corridor linking Proposed Grebo-Krahn National Park (PGKNP) to Sapo National Park (SNP) was identified, running through a logging concession (FMC 'F') and community land (Putu and Chedepo Districts, Grand Gedeh and River Gee Counties, respectively).

To evaluate the feasibility and assess the potential of creating a corridor between these two protected areas (PAs) to protect the forest cover and integrity of the TGSFC, a survey on the wildlife and anthropogenic threats was completed by the Forestry Development Authority and the Wild Chimpanzee Foundation. The survey provides baseline data for which comparisons can be made in the future, and also provides quantitative estimates of abundance, density and spatial distribution of both wildlife and anthropogenic threats. It also provides a proposed boundary line for the corridor and provides recommendations on its creation, future management and conservation and how it can contribute to the protection and management of the TGSFC. Data was collected between the 28th of May 2015 and the 15th of July 2015 by three teams composed of trained individuals from the FDA, the WCF and local communities.

2. METHODS

2.1. Study area

2.1.1. History of Taï-Grebo-Sapo Forest Complex Transboundary Initiative

Since 2009, the Governments of Côte d'Ivoire and Liberia have been working towards a transboundary collaboration for the Taï-Grebo-Sapo Forest Complex (TGSFC), which spans across the border of both countries and forms part of the world's 34 biodiversity hotspot. This region is extremely important for the conservation of numerous endangered and endemic species, such as the West-African chimpanzee, the red colobus, the pygmy hippopotamus, various exotic species of duikers, and the Liberian mongoose.

Overall, this remarkable tropical forest habitat harbors over 1,200 species of flora (300 of which are endemic), over 230 bird species, 145 mammal species, and countless other rare and endemic species. The TGSFC represents the largest contiguous bloc of tropical rainforest within the Upper Guinean Forest Ecosystem. In Côte d'Ivoire, it consists of Taï National Park (UNESCO World Heritage Site and Biosphere reserve), and three adjacent classified forests (Cavally, Goin-Débé, Haute-Dodo). In Liberia, it consists of Sapo National Park, Proposed Grebo-Krahn National Park and a large logging concession, known as FMC F, run by Eurologging Ltd (Figure 1). The main objective of this collaboration is to determine how to effectively manage

the different forest fragments while encouraging the development or the maintenance of connectivity. To do so, various corridors were identified to either protect natural connectivity or to create connectivity between the different protected areas, both across the countries' border and within their national boundaries. A steering committee meeting is held annually to monitor progress of the initiative and to push forward urgent actions, such as studying the feasibility of the identified potential corridors.

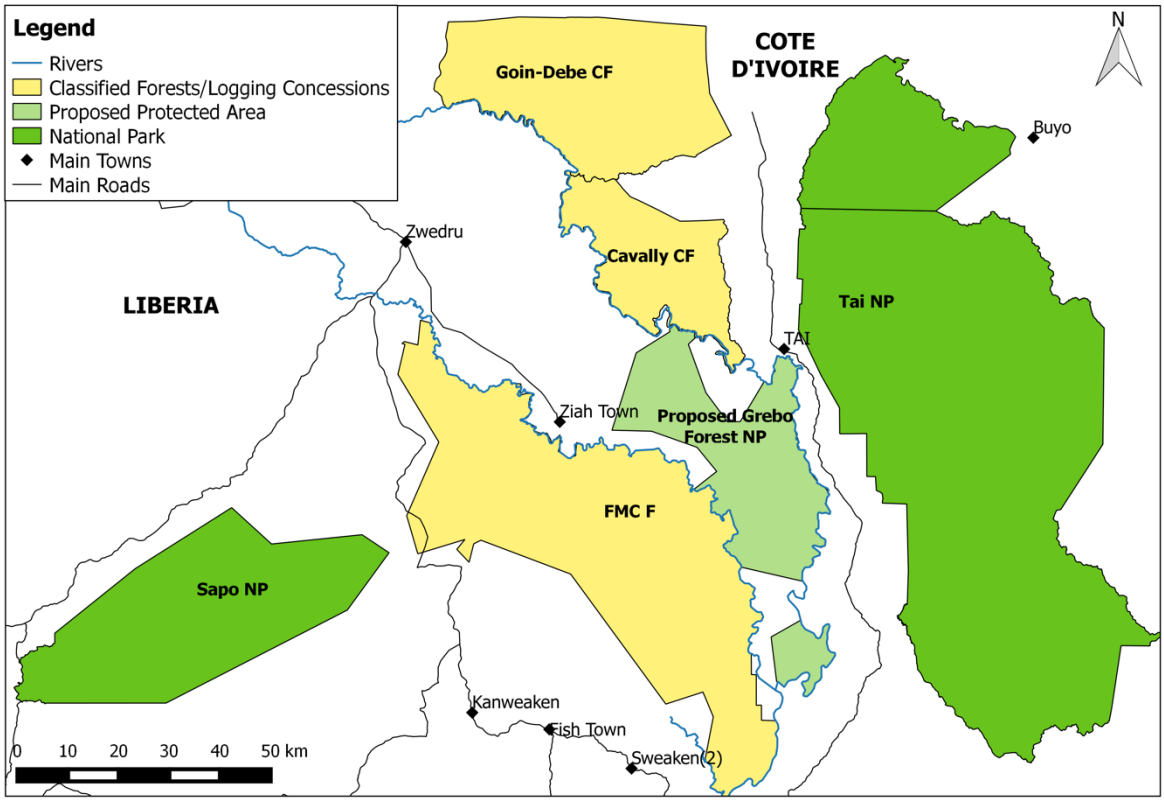

Figure 1 Diagram showing the Protected Areas and concessions that make up the TGSFC

2.1.2. The Grebo-Sapo Corridor

Within Liberia, the largest corridor needed is one that would link the Sapo National Park to the Proposed Grebo-Krahn National Park. An area was chosen by FDA that links the two in the shortest distance possible while potentially protecting as much forest and wildlife habitat as possible (Figure 2). The identified corridor covers land that is both inside a large logging concession (FMC F, run by Euro Logging Liberia-ELL) and community land in Putu and Chedepo Districts, in Grand Gedeh and River Gee Counties respectively. A general area of approximately 26,000 hectares has been included in the potential corridor, though this will be refined based on the results of the present and future surveys. Preliminary discussions between FDA and ELL have addressed the possibility of ELL returning the land in the proposed corridor that currently overlaps with FMC F. The creation of a forest landscape corridor will have to be further discussed with the communities from both districts, though it is understood that both have applied for community forest licenses, though it is unclear at this stage if they have applied for commercial use or conservation use of their forest.

The corridor is located in a wet evergreen forest and is recognised as a priority hotspot for conservation (Kormos and Boesch, 2003, Tweh et al, 2014, Junker et al 2015). Several big mammal species are thought to inhabit the Grebo-Sapo Corridor (GSCor) including the West African chimpanzee *(Pan troglodytes verus*), the forest elephant subspecies *(Loxodonta africana cyclotis*) and other endangered species such as the pygmy hippopotamus *(Hexaprotodon liberiensis)*, Jentink's duiker *(Cephalophus jentinki),* red colobus monkey *(Procolobus [Piliocolobus] badius)* and Diana monkeys *(Cercopithecus diana diana*) (see IUCN red data list 2012).

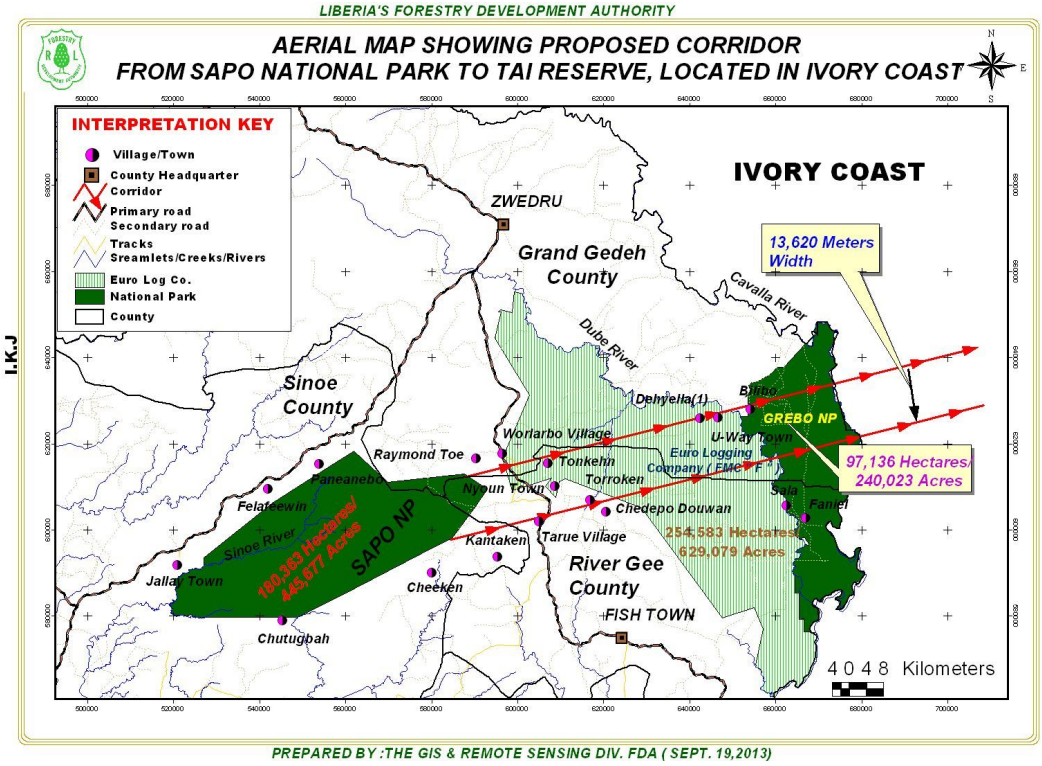

Figure 2 Grebo-Sapo Corridor identified by FDA

2.2. Survey design

To allow for robust analysis, we used two systematic survey designs, specific to the two different areas within the corridor (FMC F and the community land). We suggest that the same survey design be used for future surveys within the Grebo-Sapo Corridor (GSCor) to allow for comparison, unless a more intense survey is needed. The design follows IUCN standards for transect surveys for great apes (Kühl et al., 2008), in which the whole of the identified corridor is covered using a systematic arrangement of transects. Such a spatial arrangement of survey transects is known to be effective for unbiased studies of the distribution and densities of large wild mammals in tropical forests (Norton-Griffiths 1978; Plumptre, 2000; Buckland et al, 2001). Figure 3 shows the design in both FMC F and the community land.

In FMC F, 10 groups of 4 transects are spaced out evenly across the target area, separated by 10km (Figure 3). Each of the 4 transects are composed of 4 sections of 500 m each, meaning a total of 2km per transect and 8km per group and thus a total potential of 80km overall of sampling effort. For clarity, Figure 4 shows the details of one group of transects. In the community land, due to the reduced size, 15 2km straight line transects were spaced evenly

across the target area, meaning a total potential of 30km overall of sampling effort (Figure 3). The overall target sample for the GSCor was 110km. Data from this survey will be able to show where wildlife is present and where the threats are located within the identified corridor. Data can also be used to help define the boundary lines of the corridor.

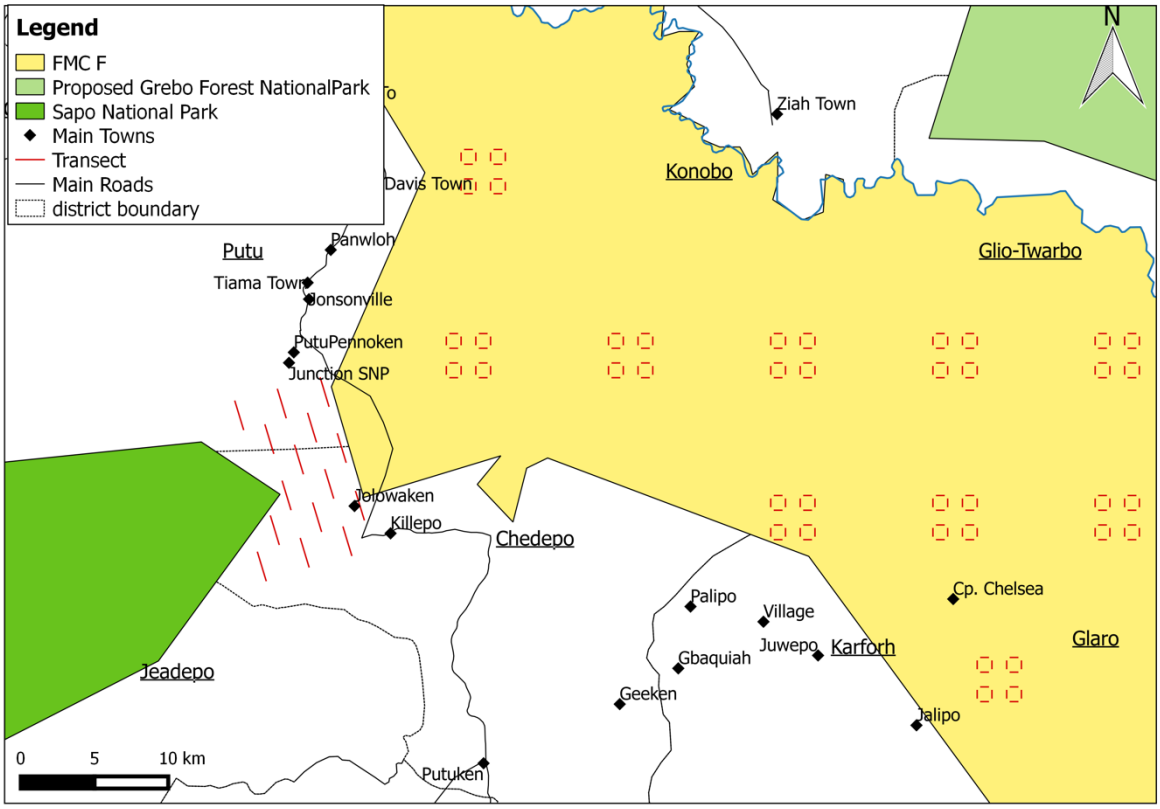

Figure 3 Survey design for Grebo-Sapo Corridor

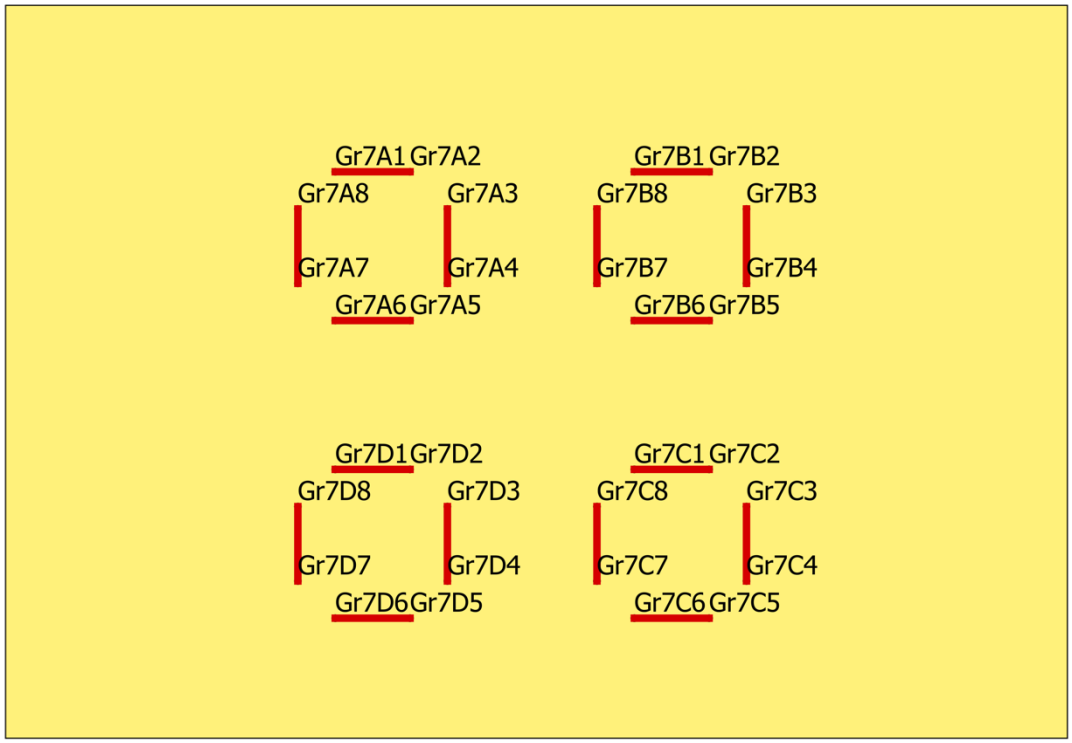

Figure 4 Close up of an example of a group of transects in the FMC F part of the Grebo-Sapo Corridor

2.3. Data collection along line transects and local capacity building

Data were collected from 28th of May 2015 until the 15th of July 2015 by three teams supervised by individuals from the Wild Chimpanzee Foundation (Zoro Goné Bi Irié Berenger and Jimmy Parker) alongside rangers from FDA (Clement Tweh). Prior to the corridor survey, the three teams had recently completed a full biomonitoring survey of the Proposed Grebo-Krahn National Park and thus did not require re-training. A training workshop was held in February 2015, prior to the aforementioned biomonitoring program, during which teams learned about survey methodology, species identification, use of GPS and other equipment, etc. Most team members have extensive experience in data collection and team supervision, having participated in previous surveys led by WCF/FDA in PGKNP and also a nationwide chimpanzee and large mammal survey in Liberia. Each team consisted of six Liberians, either FDA auxiliaries or local community members. Names and positions of the team are listed in Appendix 1.

Along transects, the teams were requested to collect data on all signs of large mammal (and some small mammal) presence, based on the WCF species identification guidebook; as well as data on all signs of anthropogenic activity. Using a GPS unit and a compass, the teams followed the target transect, with four members walking on the transect and two walking 5m to each side. For each observation, the UTM coordinates were taken. Observations included all direct observations of wildlife and anthropogenic activities and indirect observations such as dung, tracks, calls and nests (for chimpanzees). Details of nest counts on line transects using distance sampling methodology are described elsewhere by Buckland et al. (2001) and Kouakou et al. (2009. Perpendicular distances were recorded for chimpanzee nests, to be able to determine their density. Each team member was given a specific role. Detailed information on this is available from the WCF.

2.4. Data analysis

The collected data were saved and organized in an Excel file using mainly the following options: filter, sort, pivot table and pivot chart. Globally, analysis consisted of calculations of survey effort, encounter rates, estimations of animals' population sizes and spatial distribution using the programs Excel, Distance 6.0 and Quantum GIS 2.6.

2.4.1. Survey effort and encounter rates of species

Survey effort was calculated by summing the total distance effectively walked by team members along each transect during data collection. Encounter rates of species were calculated by dividing the number of all observations of species presence signs (vocalization, dung, footprint, feeding signs and sleeping nests for chimpanzee) by the distance walked during the survey. Encounter rates can be used to compare with data from future surveys to follow the trends of population increase or decrease.

2.4.2. Chimpanzee population status analysis

To estimate the population size of chimpanzees in the Grebo-Sapo Corridor, the density of nests along transects was calculated using the Distance 6.0 program (Buckland 2001; Kühl et al. 2008**;** Plumptre, 1996). Nest density was converted to chimpanzee density using the mean lifetime of nests and the nest production rate following the methodology described by Kouakou et al. (2009). Given that no habituated chimpanzee group exists in the GSCor, for our conversions, we used the value of nest production (1.14 days) and decay rates (91.22 days) estimated from Taï NP, due to the proximity and similarity of habitat conditions to the study area (Kouakou et al. 2009).

2.4.3. Spatial distribution and population dynamics of large mammals and their threats in the Grebo-Sapo Cor

To estimate the spatial distribution of chimpanzees and other large mammals as well as anthropogenic activities in the target corridor, we used presence signs assigned to each species, and all anthropogenic activities, and performed spatial analysis in ArcGIS. We used the Inverse Distance Weighted (IDW) option from the spatial analysis tools to estimate abundance and encounter rates of the distribution of animal presence and anthropogenic activities in the entire study area, including un-sampled locations (Li and Heap 2008). When the numbers of observations were few (less than 30) and did not allow for reliable spatial interpolation, we plotted locations of observations. Spatial distribution calculations will assist in defining the potential boundaries of the corridor.

3. RESULTS

3.1. Survey effort and review of observations along line transects

In 2015, in FMC-F, three teams walked a total of **77.18 km** of line transects, representing **96.5%** of the theoretical survey effort targeted (L= 80km). The main reason for not completing the total target effort was due to large obstacles such as watercourses and valleys. Given that this is the first year that this survey has been completed, no comparisons with any previous data sets can be made.

In total, **1,324** observations confirming the presence of wild animals in FMC-F were recorded (both direct and indirect). 80.1% (i.e. 1,066) of observations were of mammals, 18.1% (239) were of birds and the rest were other species. Figure 5 summarizes the number of observations made with **more than 50 species encountered.** Note that signs of bovids and chimpanzees were the most common of mammals, whilst signs of pygmy hippopotamus, water chevrotain and scaly ant eaters were relatively rare. Concerning threats to the wildlife in the GSCor, we recorded **291** signs of human activities, of which 238 were poaching signs and 53 were signs of habitat disturbance (cut trees, farms, mining sites, etc.).

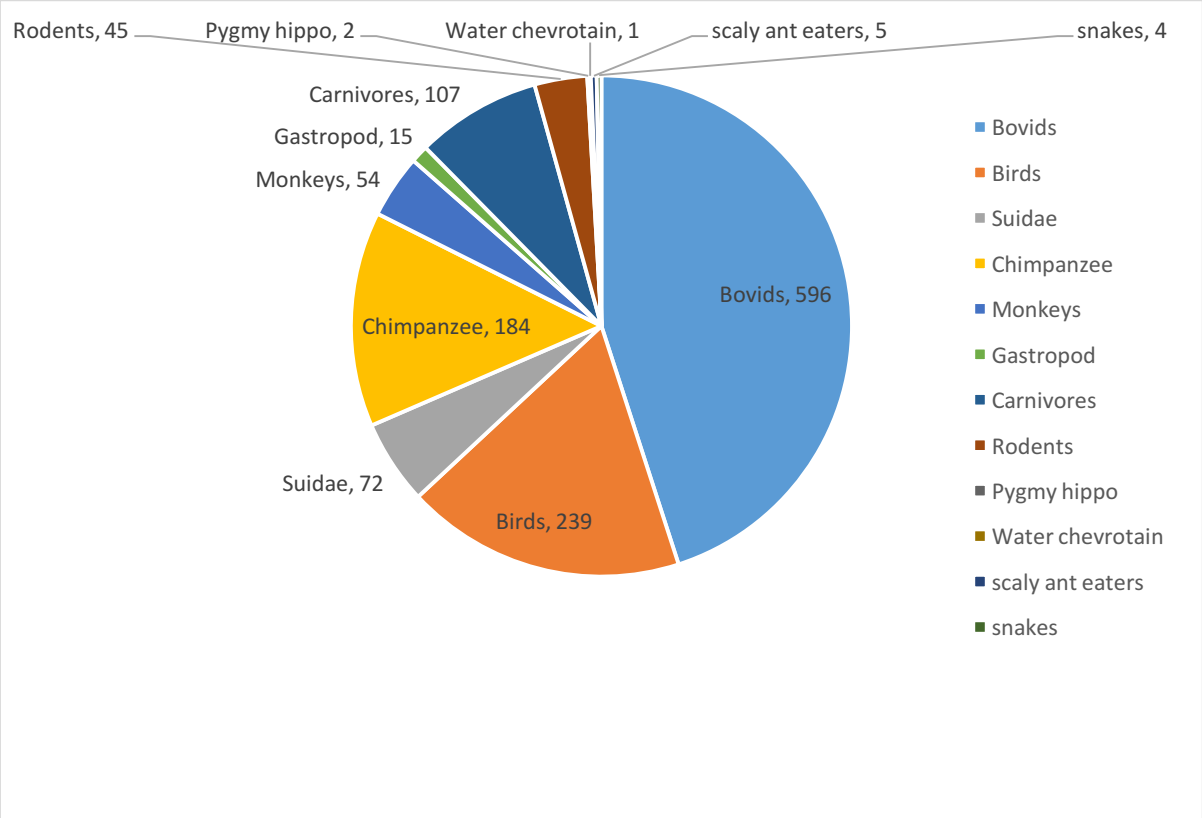

Figure 5 Numbers of all direct and indirect observations of animals along line transects during the 2015 survey in FMC-F

In 2015, in the community corridor, three teams walked a total of **26km** of line transects, representing **86.7%** of the theoretical survey effort targeted (L= 30km). Given that this is the first year that this survey has been completed, no comparisons with any previous data sets can be made. In total, **313** observations confirming the presence of wild animals in the community corridor were recorded (both direct and indirect). 66.5% (i.e. 208) of observations were of mammals, 33.2% (104) were of birds and the rest were other species. Figure 6 summarizes the number of observations made with **39 species encountered.** Note that signs of bovids and birds were the most common of mammals, whilst signs of scaly ant eaters, reptiles and rodents were relatively rare. Concerning threats to the wildlife in the community corridor, we recorded **114** signs of human activities, of which 92 were poaching signs and 22 were signs of habitat disturbance (cut trees, farms, mining sites, etc.).

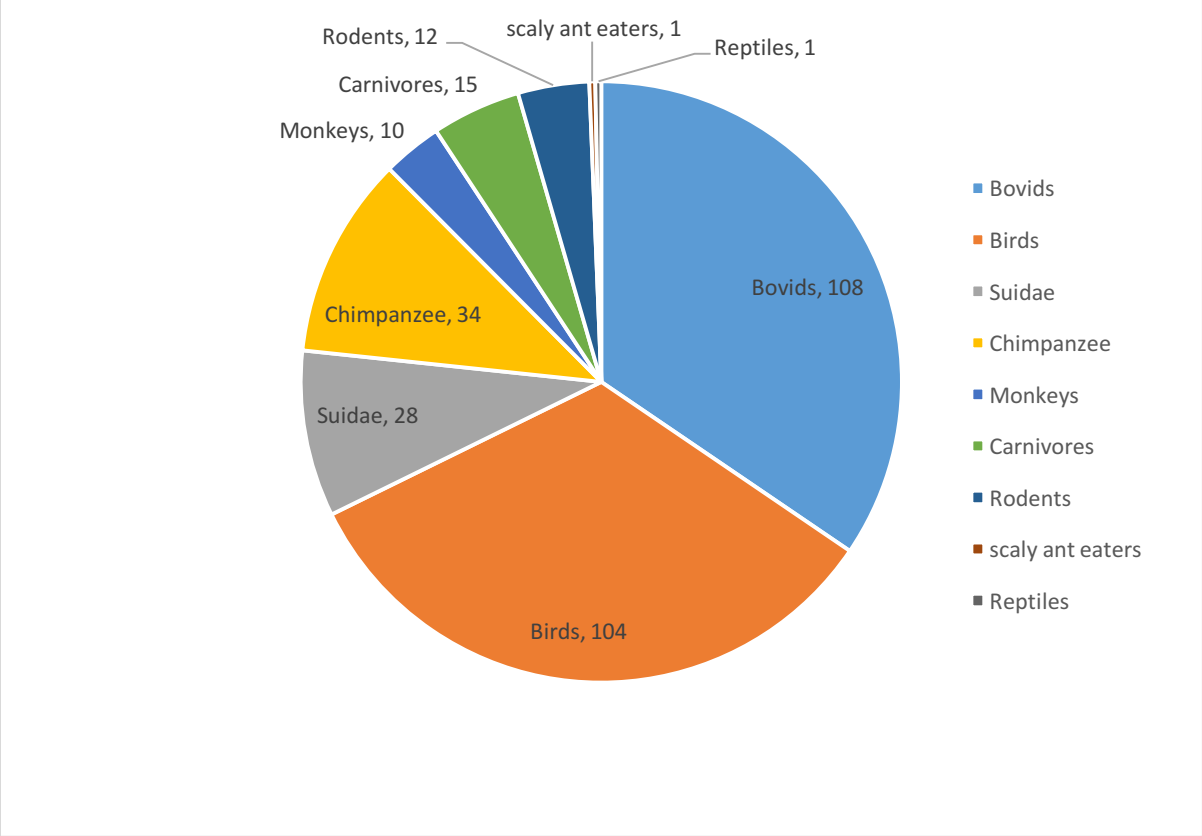

Figure 6 Numbers of all direct and indirect observations of animals along line transects during the 2015 survey in the community corridor

Concerning the spatial distribution of large mammals in FMC-F and the community corridor, large mammals are present throughout both areas, showing a high array of biodiversity in both a logging concession and a community corridor. Two areas in FMC-F (Figure 7b and c) show high signs of presence of large mammals (>22 signs/km). In the community corridor area, one region, located next to the border with Sapo National Park (Figure 7a), showed high signs of presence of large mammal species.

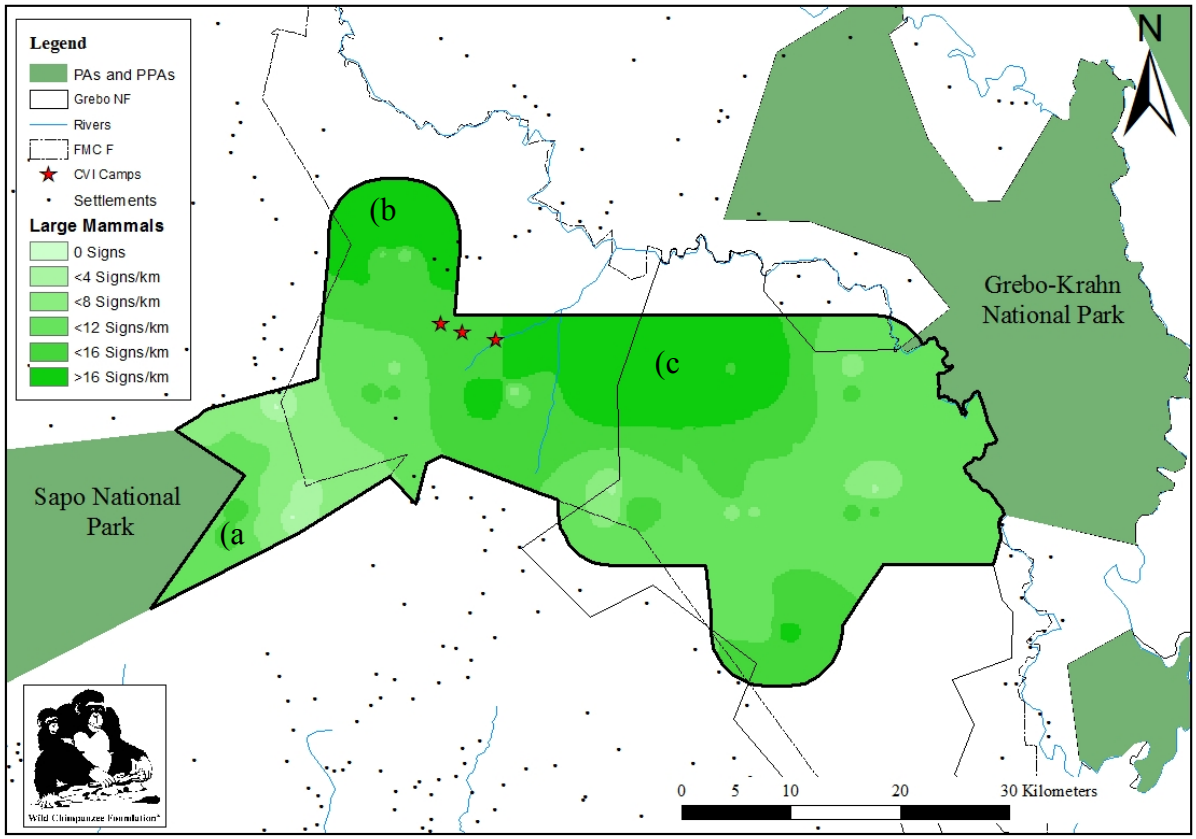

Figure 7 Spatial distribution map of large mammal signs found during the biomonitoring survey in FMC-F and the community corridor. (a), (b) and (c) represent areas of high large mammal signs.

The spatial distribution of the four endangered large mammal species, i.e. chimpanzees, red colobus, Jentink's duiker and pygmy hippopotamus observed during biomonitoring surveys is indicated in Figure 8. It is possible to find endangered species throughout the two survey areas in FMC-F and the community corridor. High concentrations of signs of endangered species were found in two areas in FMC-F (Figure 8-b and c) and one area in the community corridor (Figure 8-a).

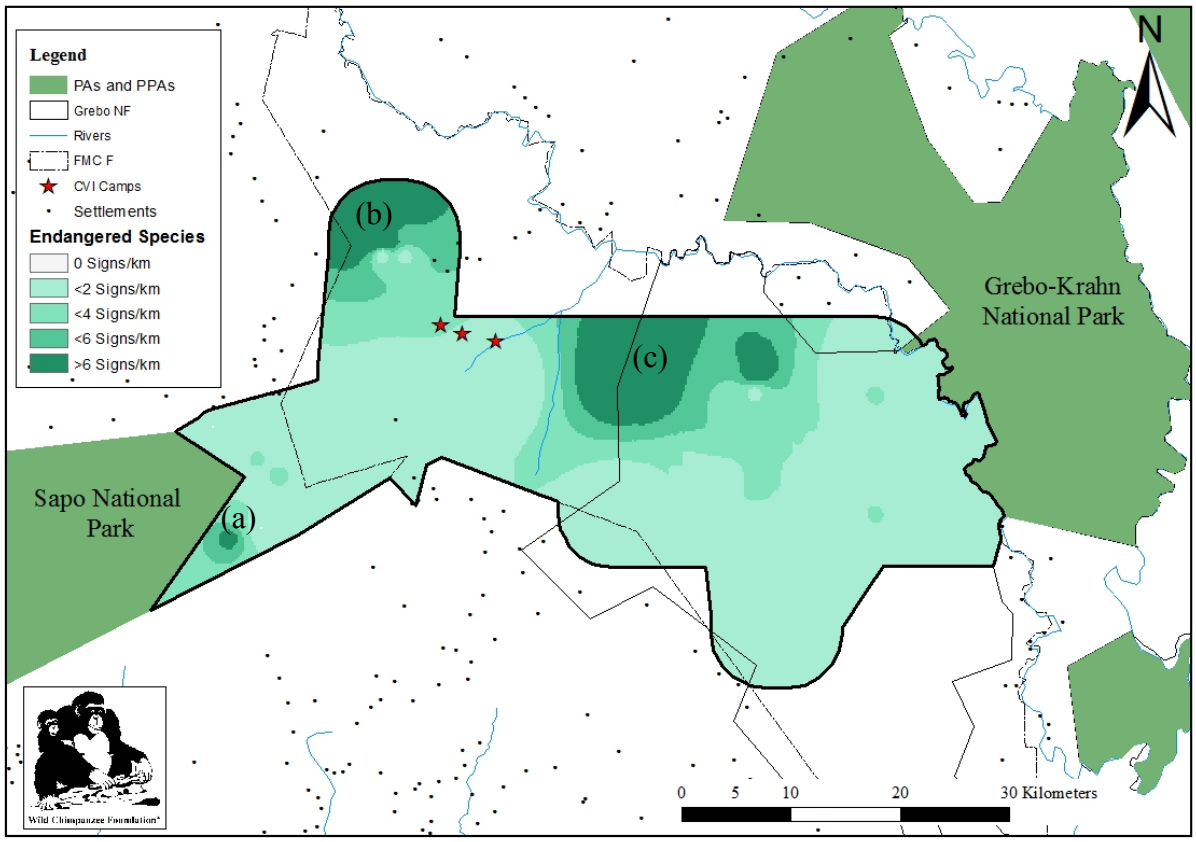

Figure 8 Spatial distribution map of endangered species signs found during the biomonitoring survey in FMC-F and the community corridor. (a), (b) and (c) represent areas of high endangered species signs.

For vulnerable species: forest elephant, black and white colobus, diana monkey, Liberian mongoose and zebra duiker, the distribution of these animals within the two areas surveyed is more restricted (Figure 9). Much of the surveyed area displays less than two signs per kilometer for vulnerable species. One area in FMC-F, close to PGKNP displays more than two signs per kilometer for vulnerable species (Figure 9a).

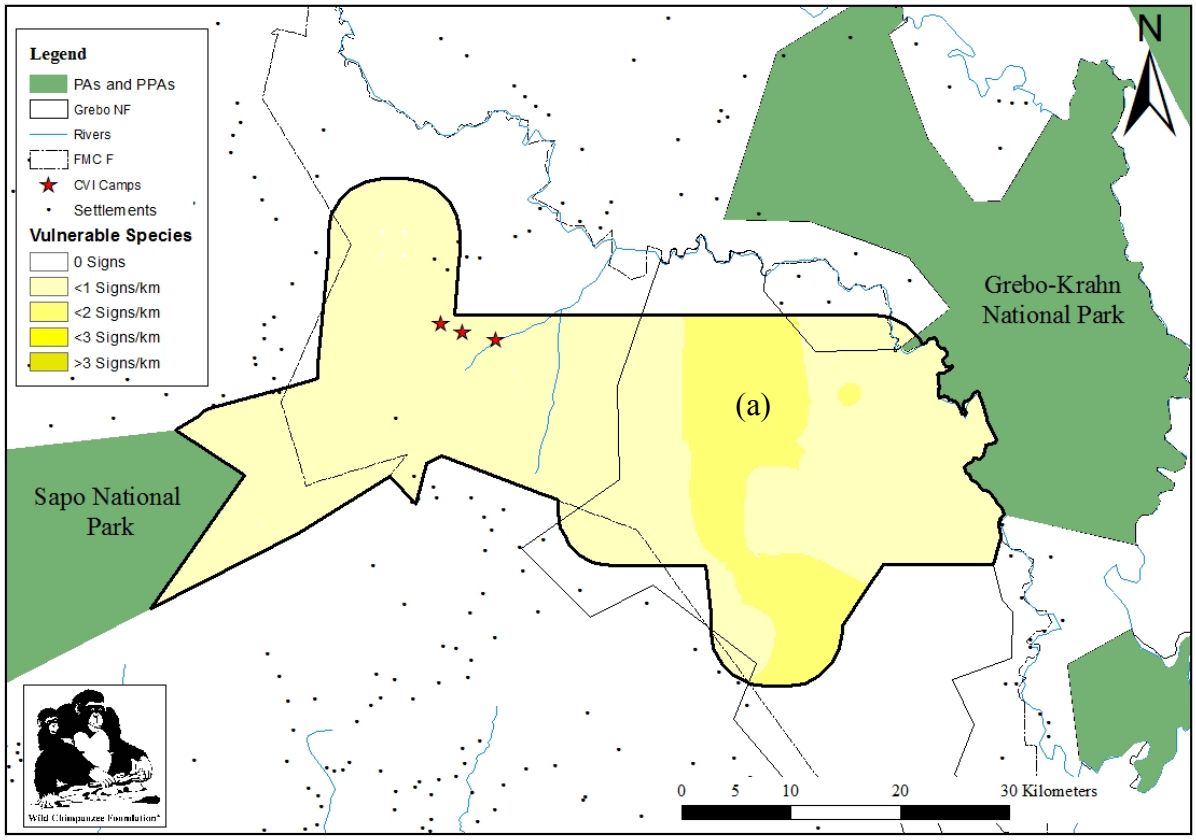

Figure 9 Spatial distribution map of vulnerable species signs found during the biomonitoring survey in FMC-F and the community corridor. (a) represents an area of higher vulnerable species signs.

3.2. Bovid population

Encounter rates of bovids (including both direct and indirect observations) were relatively high in FMC-F (Table 1). Few individuals were observed directly and therefore we can only confirm the presence of certain species (number of direct observation is in brackets): bay duiker (3) and royal antelope (1). The small sample size ($n < 60$) did not allow for a population estimate calculation. For encounter rates of indirect observations (dung and tracks), all bovid observations were grouped together, as it is difficult to differentiate between species using only such observations. Although direct observations were low (only four), the overall encounter rate for bovids in FMC-F (8.16 signs/km) compares favourably with that of the results in PGKNP for 2015 (9.14 signs/km).

Encounter rates of bovids (including both direct and indirect observations) were relatively low in the community corridor (Table 1). Few individuals were observed directly and therefore we can only confirm the presence of certain species (number of direct observation is in brackets):

bay duiker (1) and Maxwell's duiker (1). The small sample size (n < 60) did not allow for a population estimate calculation. The overall encounter rate for bovids in the community corridor was also fairly low (4.15 signs/km) when compared to the results in FMC-F and PGKNP (8.16 and 9.14 signs/km respectively) in 2015.

Table 1 Observations and encounter rates of bovid species within FMC-F and the community corridor

	FMC-F		Community Corridor	
Type of Observation	**Observations**	**Encounter Rates (N/km)**	**Observations**	**Encounter Rates (N/km)**
Direct	4	0.05	2	0.08
Dung	242	3.14	19	0.73
Footprint/Track	384	4.98	87	3.35
TOTAL	**630**	**8.16**	**108**	**4.15**

Concerning the distribution of bovid species over both survey areas, bovids are found throughout FMC-F and the community corridor (Figure 10). One area in FMC-F (Figure 10a) shows signs of bovids that are more than 10 signs per kilometre and this is in the centre of the survey area in FMC-F.

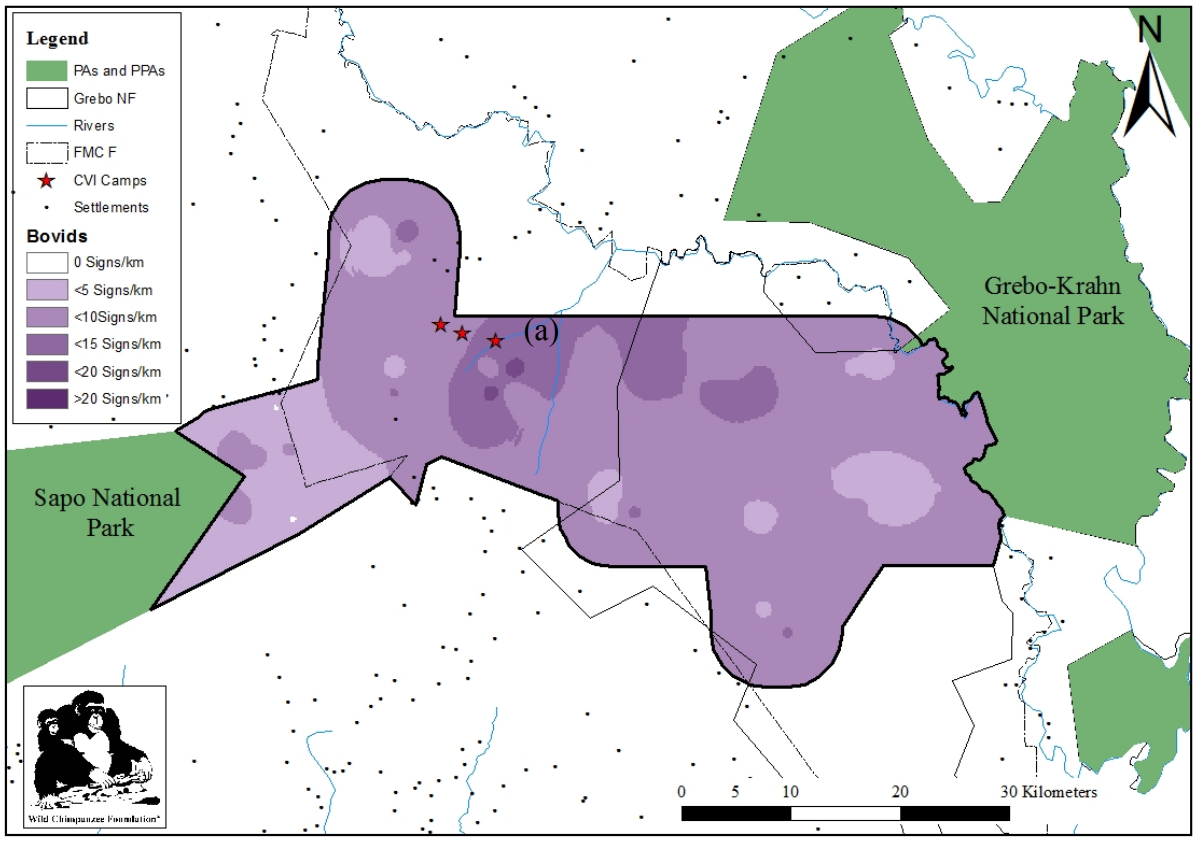

Figure 10 Spatial distribution map of bovid signs found during the biomonitoring survey in FMC-F and the community corridor. (a) represents an area of higher bovid signs.

3.3. Primate population

In total four different monkey species (chimpanzees are discussed further below) were observed directly during the biomonitoring survey in FMC-F, compared to the seven species directly observed in PGKNP in 2015. Indirect signs of 7 different species were also heard during biomonitoring in FMC-F (Table 2). For the overall encounter rate of monkeys within FMC-F the figure of 0.69 signs/km compares well with the figure from PGKNP (0.65 signs/km). Only one species of monkey was observed directly during data collection in the community corridor (*Cercopithecus mona*) whilst indirect signs (vocalizations) of seven different monkey species were heard, however the encounter rate of monkey species in the community corridor was much lower than in FMC-F (0.38 compared to 0.69 signs/km).

Table 2 Numbers of observations and encounter rates of monkey species in FMC-F and the community corridor during biomonitoring.

	FMC-F				Community Corridor			
Primate Species	**Direct Observations of individuals**	**Indirect observations of groups (heard)**	**Direct Observations of groups (seen)**	**Encounter Rates (N/km) of all groups of monkeys**	**Direct Observations of individuals**	**Indirect observations of groups (heard)**	**Direct Observations of groups (seen)**	**Encounter Rates (N/km) of all groups of monkeys**
Diana monkey (*Cercopithecus diana*)	12	20	4	**0.31**	0	3	0	**0.12**
Red colobus monkey (*Procolobus badius*)	36	4	4	**0.10**	0	1	0	**0.04**
Mona monkey (*Cercopithecus mona*)	0	4	0	**0.05**	4	1	1	**0.08**
Western Black-and-white Colobus monkey (*Colobus polykomos*)	0	5	0	**0.06**	0	1	0	**0.04**
Sooty mangabey (*Cercocebus atys*)	0	6	0	**0.08**	0	2	0	**0.08**
Lesser spot-nosed monkey (*Cercopithecus petaurista*)	5	2	2	**0.05**	0	1	0	**0.04**
Olive colobus monkey (*Procolobus verus*)	5	1	1	**0.03**	0	0	0	**0.00**
Total for monkeys	**58**	**42**	**11**	**0.69**	**4**	**9**	**1**	**0.38**

The spatial distribution of signs of monkey species in FMC-F and the community corridor is displayed in Figure 11. In FMC-F, increased signs of monkey presence are found in the eastern region of the survey area (Figure 11b and c) near to PGKNP. In the community corridor area, one patch where signs of monkey presence are greater is found right next to the border with Sapo National Park (Figure 11a).

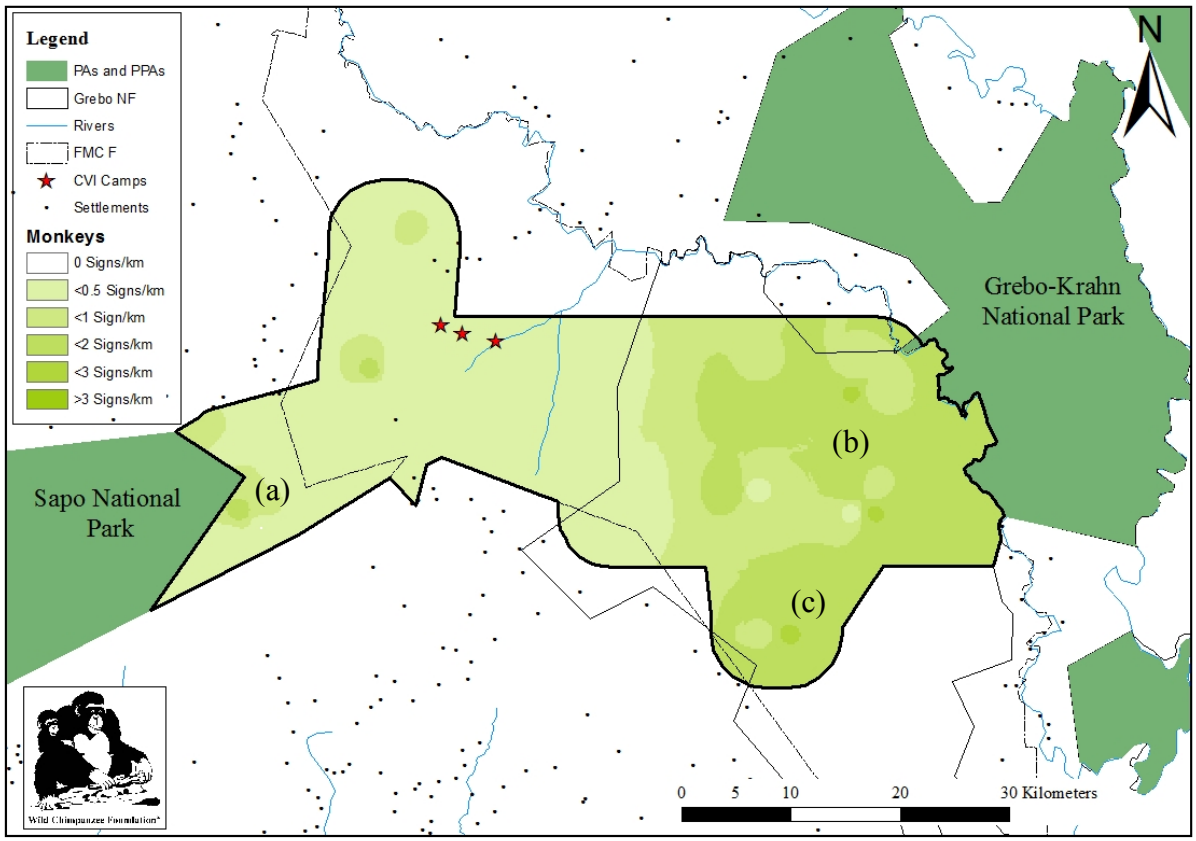

Figure 11 Spatial distribution map of monkey signs found during the biomonitoring survey in FMC-F and the community corridor. (a), (b) and (c) represent areas of higher monkey signs.

When chimpanzee observations are taken into account, no direct signs of chimpanzees were observed during biomonitoring data collection in FMC-F or the community corridor. The number of indirect observations (nests, nut-cracking sites, vocalizations, drumming, dung and footprints) totaled 184 observations, giving an encounter rate of 2.38 signs/km (Table 3). This encounter rate is more than double that of the chimpanzee encounter rate discovered in PGKNP during biomonitoring in 2015 (1.01 signs/km). The overall encounter rate for chimpanzees in the community corridor was 1.31 signs/km with a total of 34 indirect observations (Table 3), which was lower than in FMC-F, but still more than in the PGKNP.

Table 3 Observations and encounter rates for chimpanzee signs in FMC-F and the community corridor

Species	Area	Direct observations of individuals	Indirect observations	Encounter rate of all signs of chimpanzees (N/km)
Chimpanzee (*Pan troglodytes verus*)	FMC-F	0	184	**2.38**
	Community Corridor	0	34	**1.31**

Signs of chimpanzees were found throughout both FMC-F and the community corridor and their spatial distribution is displayed in Figure 12. Large areas of FMC-F display high concentrations of chimpanzee signs of over 3 signs/km (Figure 12b and c). Whist two zones in the community corridor also display results of over 3 signs/km (Figure 12a), in close proximity to the SNP. These results show that chimpanzees are found throughout the community corridor and in FMC-F.

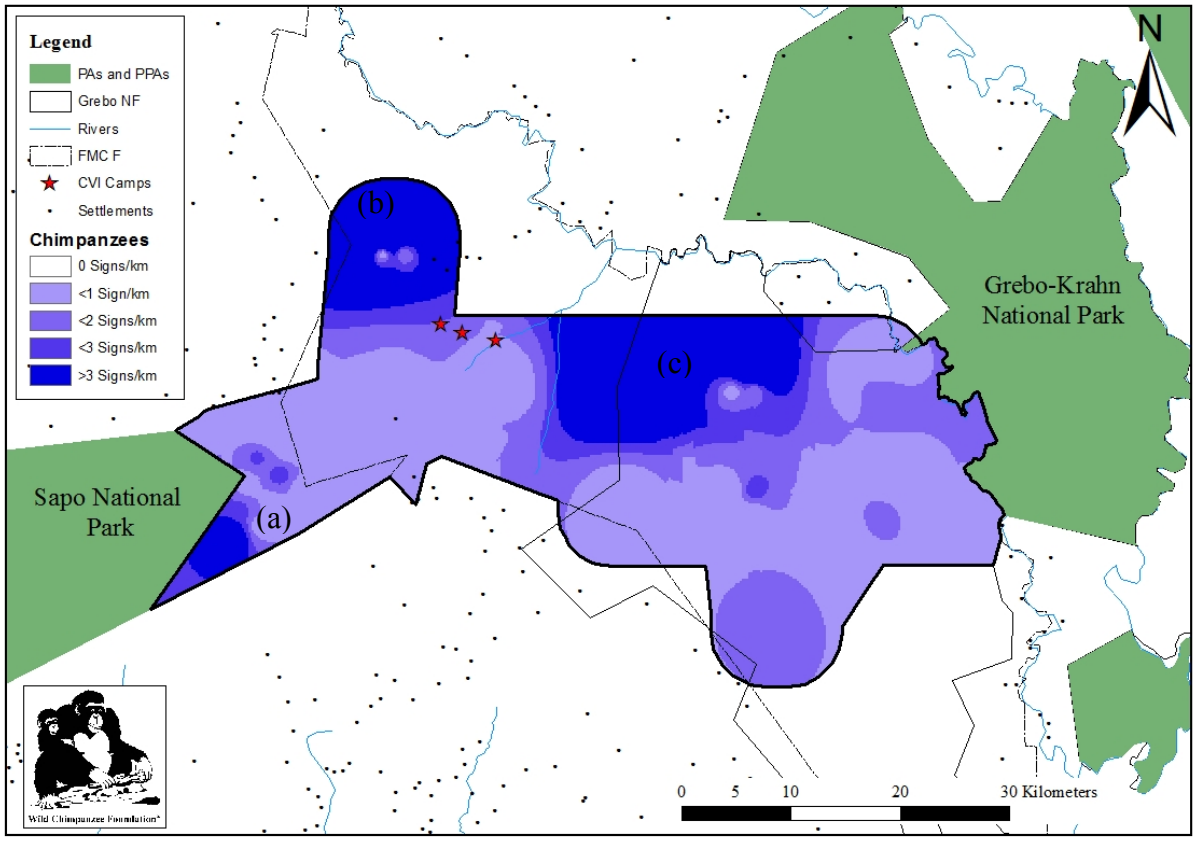

Figure 12 Spatial distribution map of chimpanzee signs found during the biomonitoring survey in FMC-F and the community corridor. (a), (b) and (c) represent areas of higher chimpanzee signs.

Density and abundance of chimpanzees:

A population estimate of chimpanzees was only possible in the FMC F part of the GSCor, as more than 60 nests were observed (154 nests in total) which is necessary to reliably estimate the population density of chimpanzees in the study area. The results from the analysis using the software Distance 6.0 are given in Table 4 for 2015.

Table 4 Population estimates of chimpanzees in the study area of FMC-F

Population parameters	Point Estimate	Coefficient of variation	95% Confidence Interval
Densities of chimpanzees (ind./km²)	0.401	33.69%	0.208-0.773
Abundance of chimpanzees (weaned ind.)	568	33.69%	294-1096
Chimpanzee abundance (total ind.)*	**688**	**33.69%**	**356-1328**

* The total number of chimpanzees in the survey area was estimated to be 688 individuals, considering that 17.5% of the individuals of a population are juveniles (as estimated by Plumptre and Reynolds, 1996).

Using conversion factors, we estimated 0.401 weaned chimpanzees per km². Consequently, their population size was 568 weaned individuals and a total population of 688 including juveniles/infants, though with a large CV of 33.69%. This means that future survey efforts should be increased to improve robustness of the data and result in a better precision on the estimation of chimpanzee numbers.

3.4. Other mammal species

In addition to bovids and primates, signs of presence of other large mammal species were detected during the survey in FMC-F (

Table 5). No direct observations of other large mammals were made in FMC-F. Therefore, all presence of mammals was confirmed by indirect observations (tracks, feeding sites and dung). The overall encounter rate of other large mammals in FMC-F was calculated as 2.73 signs/km.

Table 5 Observations on other large mammal signs in FMC-F in 2015

Other Large mammal Species							
Family	**Species**	**Observations**					**Encounter Rate (N/km)**
		Dung	**Feeding Site**	**Track**	**Trail**	**TOTAL**	
Mustelidae	African Clawless Otter (*Aonyx capensis*)	0	0	3	0	3	**0.04**
Hystricidae	Brush-tailed porcupine (*Atherurus africanus*), Crested porcupine (*Hystrix cristata*)	1	14	7	4	26	**0.34**
Viverridae	African civet (*Civettictis civetta*)	4	0	0	0	4	**0.05**
Herpestidae	Cusimanse (*Crossarchus obscurus*), Liberian mongoose (*Liberiictus kuhni*), Marsh mongoose (*Atilax paludinosis*)	0	96	2	0	98	**1.27**
Felidae	Golden cat (*Felis aurata*)	0	0	2	0	2	**0.03**
Suidae	Giant hog (*Hyloc. meinertzhageni*), Red river hog (Potamochoerus porcus)	1	55	16	0	72	**0.93**
Manidae	Giant pangolin (*Smutsia gigantia*), Long-tailed pangolin (*Uromanis tetradactyla*)	0	4	1	0	5	**0.07**
Cricetomyinae	Giant pouched rat (*Cricetomys emini*)	0	0	1	0	1	**0.01**

TOTAL	6	169	32	4	211	2.73

In the community corridor, only one direct observation of other large mammal species was made and that was of the flying squirrel (Table 6). In total, indirect signs of ten other large mammal species were detected in the community corridor. The overall encounter rate for other large mammal species in the community corridor was calculated to be 1.85 signs/km, a lower figure than that found in FMC-F (2.73 signs/km).

Table 6 Observations on other large mammal signs in the community corridor in 2015

Other Large mammal Species								
Family	**Species**	**Observations**						**Encounter Rate(N/km)**
		Direct Observation	**Dung**	**Feeding Site**	**Track**	**Trail**	**TOTAL**	
Viverridae	African palm civet (*Nandinia binotata*), African civet (*Civettictis civetta*)	0	1	0	2	0	3	**0.12**
Hystricidae	Brush-tailed porcupine (*Atherurus africanus*), Crested porcupine (*Hystrix cristata*)	0	0	1	0	2	3	**0.12**
Herpestidae	Cusimanse (*Crossarchus obscurus*), Marsh mongoose (*Atilax paludinosis*)	0	0	10	2	0	12	**0.46**
Anomaluridae	Flying squirrel (*Anomalurus peli*)	1	0	0	0	0	1	**0.04**
Suidae	Giant hog (*Hyloc. meinertzhageni*), Red river hog (Potamochoerus porcus)	0	0	20	8	0	28	**1.08**
Manidae	Giant pangolin (*Smutsia gigantia*)	0	0	1	0	0	1	**0.04**
TOTAL		**1**	**1**	**32**	**12**	**2**	**48**	**1.85**

3.5. Threats or factors influencing the distribution and density of chimpanzees and other large mammals in FMC-F and the community corridor

We observed threats to wildlife across both survey areas in FMC-F and the community corridor, through signs of aggression on fauna and flora. Evidence of fauna aggression (hunting) was indicated by direct and indirect observations, including poachers heard, gun shots heard, poacher trails, snares, and used cartridges. Observations of signs of aggression on flora (habitat disturbance) included farming, logging and pit-sawing (Table 7). The encounter rates of signs of aggression on fauna are greater in both FMC-F and the community corridor than those on flora. Poacher trails were the most abundant signs of encounters with 2.10 signs per kilometer walked in FMC-F and 1.88 signs/km in the community corridor. Survey team members regularly heard gun shots during the survey period, three shots were heard in FMC-F and five in the community corridor. Signs of aggression against flora were surprisingly low in FMC-F (a logging concession) with 0.69 signs/km (Table 7), the most readily seen sign of habitat disturbance were logging roads (0.26 signs/km). Signs of aggression against fauna in the community corridor were higher in the community corridor with 0.85 signs/km (Table 7), the most regularly encountered sign of habitat disturbance was the presence of farms in the community corridor (0.31 signs/km).

Table 7 Human activities or illegal signs encountered on transects in FMC-F

Observations		FMC-F		Community Corridor	
Type of human activity	**Observation**	**Number of observations**	**Encounter rate (N/km)**	**Number of observations**	**Encounter rate (N/km)**
Aggression against fauna (hunting)	Carcass (elephant)	1	0.01	0	0
	Direct Observations	0	0	2	0.08
	Shotgun shells	35	0.45	4	0.15
	Human paths	25	0.32	27	1.04
	Object (items left by poachers)	2	0.03	1	0.04
	Poacher Trail	162	2.10	49	1.88
	Gunshot heard	3	0.04	5	0.19
	Traps	10	0.13	4	0.15
	TOTAL	**238**	**3.08**	**92**	**3.54**
Aggression against flora (habitat disturbance)	Cut down trees	5	0.06	1	0.04
	Observation of people (loggers)	1	0.01	2	0.08
	Farm	1	0.01	8	0.31
	Prospection hole (mining)	2	0.03	2	0.08
	Hamlet	0	0	1	0.04
	Human path	8	0.10	2	0.08
	Pit-Sawing Site	0	0	3	0.12
	Signs of logging	10	0.13	0	0
	Logging road	20	0.26	2	0.08
	Mine/gold washing site	6	0.08	1	0.04
	TOTAL	**53**	**0.69**	**22**	**0.85**

The spatial distribution of hunting signs in FMC-F and the community corridor is displayed in Figure 13. In FMC-F there are two very small areas which show no signs of hunting, whilst areas of more concentrated hunting activity are found in two areas in FMC-F (Figure 13a and b). In the community corridor there are also certain areas, close to the boundary with Sapo National Park where higher numbers of hunting signs were discovered.

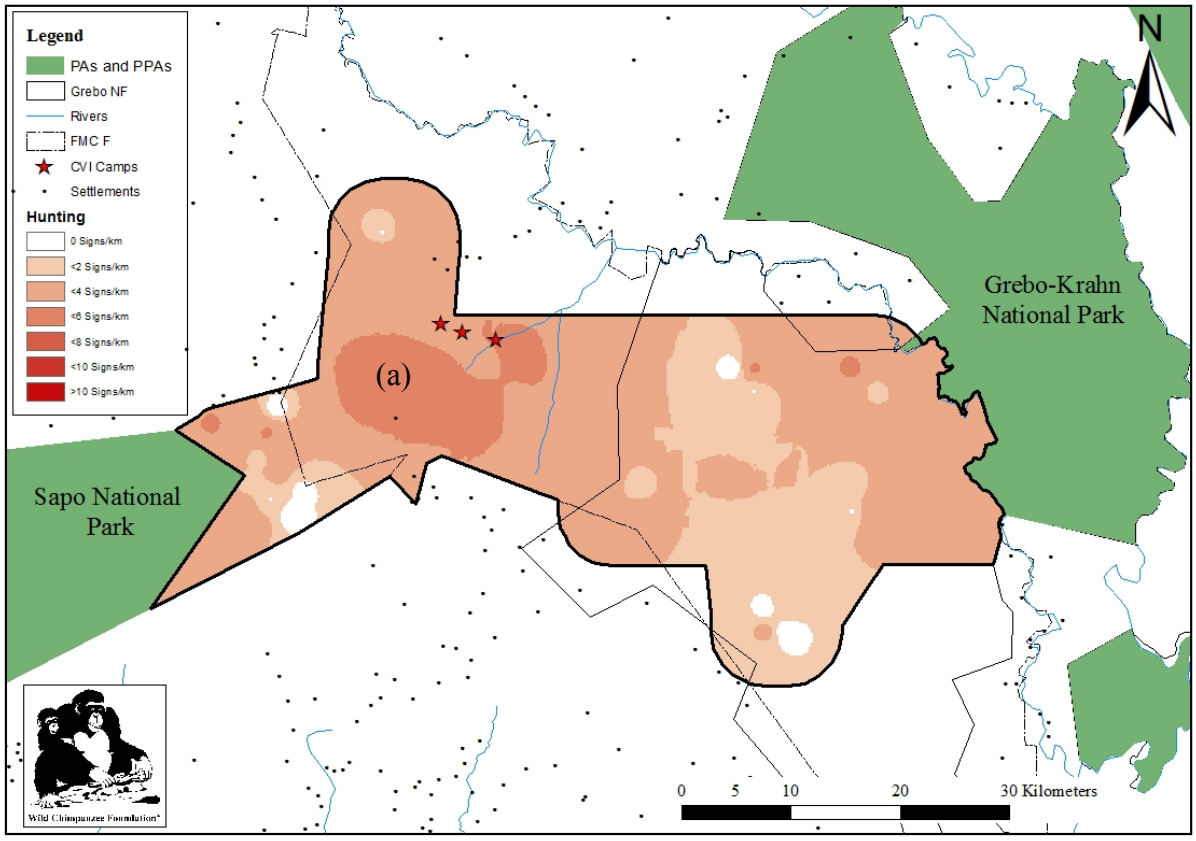

Figure 13 Spatial distribution map of hunting signs found during the biomonitoring survey in FMC-F and the community corridor. (a) represents an area of higher hunting signs.

4. DISCUSSION

The 2015 GSCor survey provides important results for the creation of a landscape corridor which incorporates wildlife presence between Proposed Grebo-Krahn National Park and Sapo National Park. The results from the survey has produced some interesting results for the level of biodiversity encountered within FMC-F and the community corridor. There were many signs of endangered and vulnerable species encountered, showing that even in areas that lack the level of protection that a national park has, there is still a wealth of wildlife, though it is under considerable threat from hunting. Even so, the relatively high survey effort has not attained the required sample size ($n > 60$ or at least 40) for reliable density estimates of bovids and monkeys (Buckland et al. 2001). This suggests that low densities of large and medium sized mammals in the both FMC-F and the community corridor, and extreme elusive behaviour to escape human observers limits direct detections. Regarding chimpanzees, sufficient signs of chimpanzees were discovered in FMC-F to provide a population estimate in the region of FMC-F that was sampled.

Regarding chimpanzees in FMC F, the abundance estimates precision of CV = 33.69% (mean estimate was 688 individuals), suggests that the survey effort is too low and that these results should be treated with caution. In future surveys, the survey effort should be increased in order to produce a more reliable population estimate. At the same, it is clear that there is a significant population of chimpanzees within FMC-F which need to be protected. The encounter rate of 2.38 signs/km is much larger than the encounter rate found in PGKNP (1.01 signs/km) as well as the population estimate being much higher (688 individuals in FMC-F compared to 298 individuals in PGKNP). These results show that swift action must be taken to secure the corridor area linking PGKNP to SNP in order to protect the wildlife present in FMC-F.

A high diversity of large mammal species has been confirmed in both surveyed areas, with signs of 19 large mammal species being detected in the community corridor and 22 species within FMC-F. This figure is lower than the 29 species detected within PGKNP during data collection in 2015, but this is to be expected as the survey in PGKNP was much more intense and covered 249km of transects, compared to 77km in FMC-F and 26km in the community corridor. Even so, these figures are encouraging for the presence of large mammals in a forest concession and in community lands. The only other study into the presence/absence of large mammals in Grebo National Forest, confirmed the presence of 27 large mammal species (Hoke *et al.* 2007), though this included a small area of the FMC F and the majority of the PGKNP.

The spatial distribution maps for both endangered and vulnerable species clearly display the presence of species of conservation importance throughout both survey areas in both FMC-F and the community corridor. Higher signs of monkeys and vulnerable species are found nearer to the Dugbe River which borders the Proposed Grebo-Krahn National Park. Whereas high signs of endangered species, chimpanzees and bovids are found in the centre of the sample area

in FMC-F. In the community corridor, most signs of wildlife were found on the border with Sapo National park in the southern area of the sample region, suggesting the importance of protecting this area.

Hunting activity is a major issue within both FMC-F and the community corridors with encounter rates of 3.08 and 3.54 signs/km respectively, both of these figures are higher than the encounter rate for hunting in PGKNP in 2015 (2.39 signs/km). Hunting signs are highest, near the mining camps of CVI (shown in Figure 14 below) in FMC-F and near to the border with Sapo National Park in the community corridor, generally nearer communities and roads. Once the corridor boundaries and status are finalised, regular patrols in the area will need to be conducted by FDA to limit the impact of hunting activity within the corridor. Hunting also appears to be less abundant in parts of the forest that correspond to the original Grebo National Forest, suggesting communities respected this area as a no-go area.

Much more surprising, were the results for aggression against flora, in FMC-F, an active logging concession, encounter rates for logging activities totalled 0.2 signs/km, though it is understood Eurlogging are not logging there at the moment. Nonetheless, this should be investigated by FDA to discover if Eurologging are complying with their agreement with the Liberian Government. In the community corridor, signs of aggression against flora were also very low (0.85 signs/km) which is nearly half of the value discovered in PGKNP (1.52 signs/km) for 2015. This suggests that activities such as farming and pit-sawing are not taking place at a large scale in the community corridor. One thing to note is that in both areas (FMC-F and the community corridor), activities relating to chewing-sticks have not yet reached this area, suggesting the patrols performed by FDA have prevented the spread of the chewing stick trade further west in Liberia. However, recent reports from local communities suggest that the chewing stick trade is now taking place in FMC F, either because people are beginning to respect the PGKNP, or because there is now a lack of chewing sticks in PGKNP.

Globally, our initial understanding of the population dynamics of large mammals and threats from human activities within the proposed corridor area is well clarified from this study. Most importantly, it confirms the high potential of the corridor for the biodiversity of Taï-Grebo-Sapo and it requires immediate recommendations for both the Liberian Government through the Forestry Development Authority and international donors to initiate this large scale and complex corridor.

We propose a corridor based on the results of the survey data collection in FMC-F and the community corridor which can be found in Figure 14 below. The proposed corridor is planned to incorporate as much of Grebo National Forest as possible, as this area (although granted as a logging concession) remains as government land, though will still require consultations with communities and negotiations with the logging company. As shown, the corridor passes through three distinct areas: FMC-F, Grebo National Forest (within FMC-F) and community lands. The shortest length for the corridor (most direct route from the boundary of the PGKNP to the SNP) is 68km, whiles the longest route is 78km. The corridor has been designed to avoid settlements as much as possible and, in its current state, only incorporates one village called Tonkehn (of which very little is known). Another area which has affected the design of the

corridor is the CVI mining camp (red stars on the map). This area is home to approximately 15,000 miners, working under artisanal mining permits. However, it appears that this is not necessarily the case, with reports of earth-moving machinery being used to extract gold.

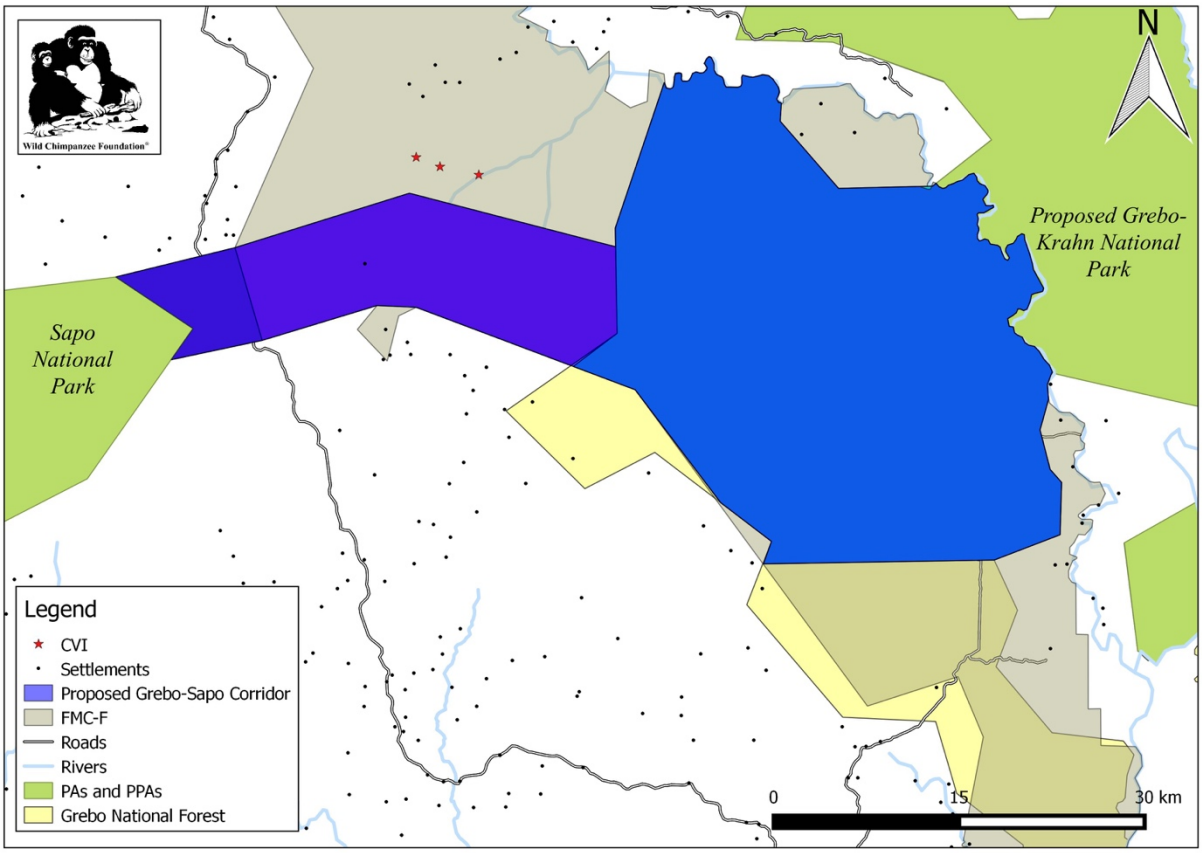

Figure 14 Map showing the proposed corridor linking PGKNP and SNP which runs through FMC-F and community land (corridor shown in blue).

Figure 15 shows which areas of the corridor correspond to each type of land use, while Table 8 shows the area in hectares of each of the areas of the corridor. The total size of the corridor is 136,187 hectares, which is a substantial size, which will need to be discussed further with all involved stakeholders.

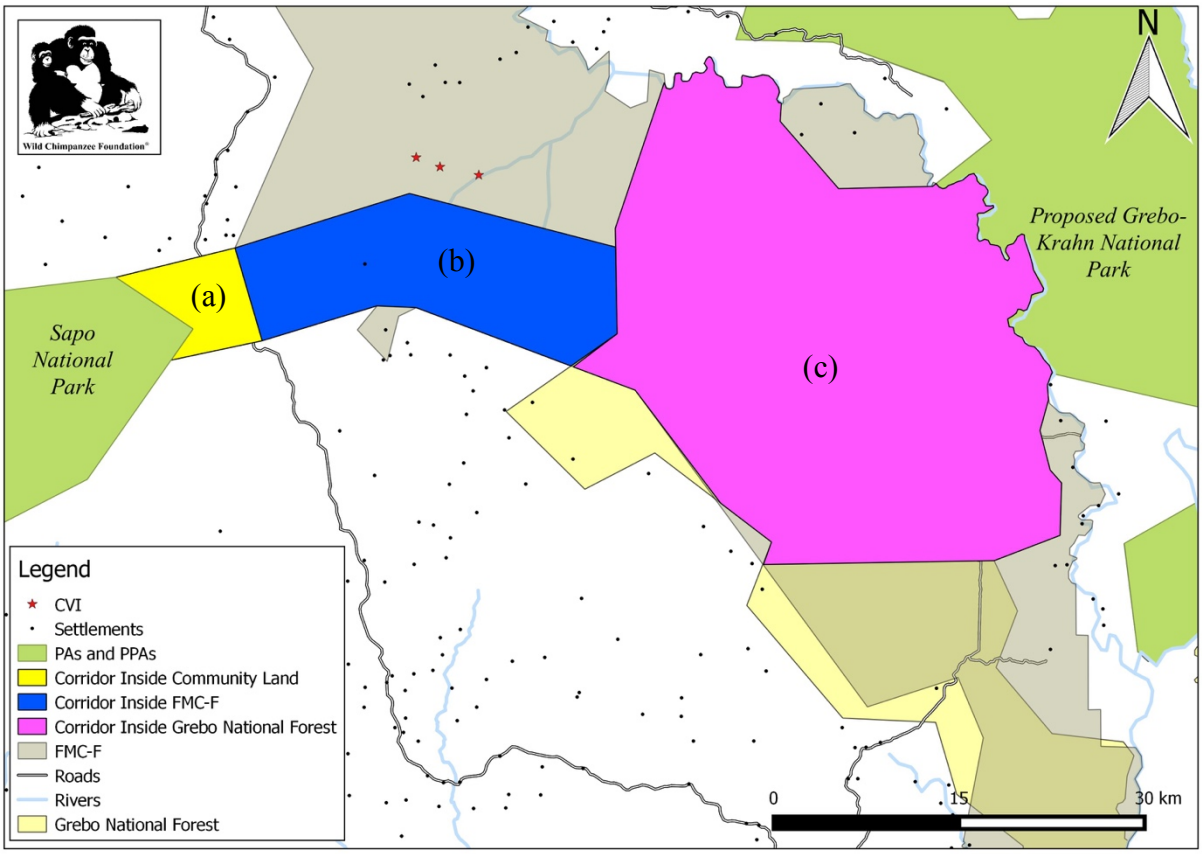

Figure 15 Map showing the status of the land on which the community corridor falls: (a) is community land, (b) is in the concession FMC-F and (c) falls within Grebo National Forest.

Table 8 Table showing the area (in hectares) of land taken up by the corridor dependent on the status of the land.

Where Proposed Corridor Falls	Area (ha)
Community Land	5,553
FMC-F	26,917
Grebo National Forest (within FMC-F)	103,717
TOTAL	**136,187**

5. CONCLUSION AND RECOMMENDATIONS

The first wildlife survey in the Grebo-Sapo corridor area has confirmed the rich diversity of large mammal species, including endangered, endemic and vulnerable species, inhabiting the proposed corridor. The presence of eight primate species has been confirmed, among which the population estimates of the Western chimpanzee is known with a total mean abundance of 688 individuals (range 356-1328; CV=33.69%). Attention and immediate action is, however, needed from the Liberian Government, conservation NGOs and international donors to ensure that the corridor is created, maintained and well managed.

The creation of the Grebo-Sapo corridor is vital to ensure the connectivity of the Taï-Grebo-Sapo Forest Complex. Recommendations on local, national, and international scales are provided below:

i. **A workshop should be organised to discuss the findings in this report:** All relevant stakeholders (WCF, FFI, CI, SCNL, GIZ and KFW), government bodies and ministries (FDA, MLME, EPA) and affected companies in the private sector (Eurologging and Putu) should be brought together to discuss the boundaries of the corridor, management strategies and the way forward to create the corridor. Other things to be discussed should surround the future plans of Putu and Eurologging in terms of their concessions and MLME's strategy for managing CVI mining camp.

ii. **FDA should investigate Eurologging activities:** Given the surprising results surrounding levels of logging within FMC-F, FDA should look into Eurologging's proposed activity in the affected area of FMC-F. The findings should be shared with stakeholders.

iii. **A comprehensive awareness program should be developed by FDA and WCF:** Villages should be regularly visited to ensure a presence in the communities to allow for discussions with the population on the creation of the corridor. The passing of the new Wildlife Act in Liberia should be presented to the communities. Copies could be distributed to all communities. Radio programs highlighting the new regulations should be formulated and broadcasted on local radio stations. A recce mission to fully map communities and estimate population numbers potentially affected by the corridor is also needed, in particular Tonkehn.

iv. **Management strategies for each area of the corridor should be formulated:** Stakeholders should begin to formulate ideas on how to manage different areas of the corridor. Given the fact that the majority of the corridor currently falls within the Grebo National Forest boundaries, what status should this area of the forest receive? How do we manage the area within the Eurologging concession FMC-F and how should communities be approached regarding the use of over 11,000 hectares of their land within the corridor?

v. **FDA should work with the Ministry of Lands, Mines and Energy in relation to CVI:** There is a need for the FDA to coordinate with the Ministry of Lands, Mines and Energy to establish the legality of these operations and to plan on how to manage such

a large population in a key biodiversity area. A study should be completed to evaluate the impact of the mines and the local inhabitants have on the local forest and wildlife, namely due to the suggested high consumption of bushmeat.

ACKNOWLEDGMENTS

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APPENDICES

Appendix 1

List of field team members including experts

NAME	POSITION
Zoro Berenger	WCF Supervisor
Jimmy Parker	WCF Supervisor
Clement Tweh	FDA/WCF Supervisor
Fredrick Wonday	FDA Biomonitoring Team A member
Stephen Teah	FDA Biomonitoring Team A member
Lindsey Rue	FDA Biomonitoring Team A member
Sunnyboy Bando	FDA Biomonitoring Team A member
John Miaplay	FDA Biomonitoring Team A Volunteer
Lewis Monu	FDA Biomonitoring Team A Volunteer
Christopher Doe	FDA Biomonitoring Team B member
Junny George	FDA Biomonitoring Team B member
Williams Wonday	FDA Biomonitoring Team B member
Anthony Farley	FDA Biomonitoring Team B member
Tulay Padeah	FDA Biomonitoring Team B Volunteer
Milton Kuloe	FDA Biomonitoring Team B Volunteer
Charles N. Teah	FDA Biomonitoring Team C member
Isaiah Zoway	FDA Biomonitoring Team C member
Samuel Sayndee	FDA Biomonitoring Team C member
Amstrong J. Saylee	FDA Biomonitoring Team C member
John Z. Kaso	FDA Biomonitoring Team C Volunteer
Amos Wenjor	FDA Biomonitoring Team C Volunteer