Wild Chimpanzee Foundation®

Biomonitoring in the Proposed Grebo National Park, Liberia

REPORT ON PHASE 1 IN THE PROPOSED GREBO NATIONAL PARK
(February-July 2014)

Prepared by Wild Chimpanzee Foundation

In collaboration with Forestry Development Authority, Liberia

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KOUAKOU Yao Célestin
DOWD Dervla
TWEH Clement
ZORO GONE BI Irie Berenger
VERGNES Virginie
NORMAND Emmanuelle
BOESCH Christophe
Wild Chimpanzee Foundation
liberia@wildchimps.org
Tel: +231(0) 880 533 495

Executive summary
A- Generalities and methods of biomonitoring program
This report presents results from the biomonitoring program in 2014 in the Proposed Grebo National Park (PGNP), undertaken by survey team members from the Forestry Development Authority (FDA) and local communities. They were supervised by two specialists from the Wild Chimpanzee Foundation (WCF) during the data collection period from February 21st until July 13th 2014. 242.7 km of line transects were walked in PGNP to collect data relating to signs of presence of large mammals and aggression on flora and fauna, which was analysed to establish the diversity and abundance of these species. The design of the data collection was changed this year to allow for a more intense survey with groups of transects being more densely distributed, giving more accurate estimates of distribution and populations.

B- Abundance and spatial distribution of large mammals in Proposed Grebo National Park (PGNP)
Two types of information were recorded: direct observations of large mammals and other animals and their indirect observations (dung, footprints, vocalizations, feeding sites and sleeping nests for chimpanzee...). The diversity of large mammal observations, encounter rates of their signs of presence, as well as their distribution are compared for the three years of the survey, and revealed a stable population of chimpanzees (247 individuals +/-) but a decreasing trend in monkeys and duikers. The northern horn in Grebo appears to be particularly an important habitat for endangered and vulnerable species and should therefore be included in PGNP. Wildlife is noticeably lower in abundance along the border with Côte d'Ivoire and the community owned land (known as native reserves).

C-Threats to wildlife of the PGNP
Hunting remains a threat to the entire PGNP and appears to be increasing in comparison with previous years. Moreover, habitat degradation in 2014 has worsened due to the increase in the harvesting of chewing sticks, which are exported to Ghana through Côte d'Ivoire. Camps of Ghanaians, sett in the park, were encountered along the Cavalla River along with piles of sticks to be exported. Active mining sites are found in the community-land area of the Bilibo community, and hunting here is also high, as it is along the border too.

D-Conclusion and Recommendations
Though PGPN still harbours exceptional biodiversity, threats to its survival remain rife. Hunting pressure is high and FDA needs to increase its law enforcement efforts there and continue to raise awareness in the local communities. Efforts on a cross-border scale must be initiated in collaboration with Ivorian authorities to stop the chewing stick trade, alongside preventing Ivoirians and other foreigners from hunting in the park. The legality of the mining in Bilibo needs to be clarified with the Ministry of Mines and prospections of new sites stopped within PGNP. The re-delimitation of the park to avoid community-land is also important and should be performed in conjunction with local communities and authorities.

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LIST OF ACRONYMS

CV: Coefficient of variation
FDA: Forestry Development Authority
GNF: Grebo National Forest
IUCN: International Union for the Conservation of Nature
PGNP: Proposed Grebo National Park
TGSFC: Taï-Grebo-Sapo Forest Complex
TNP: Taï National Park
UTM: Universal Transverse Mercator
WCF: Wild Chimpanzee Foundation

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1. INTRODUCTION

As part of the Liberian Government's Protected Area Network Strategy, the Wild Chimpanzee Foundation (WCF) is working in close collaboration with the Forestry Development Authority (FDA) to create the Grebo National Park in southwest Liberia. The Proposed Grebo National Park (PGNP) is located in the heart of the Taï-Grebo-Sapo Forest Complex (TGSFC), a transboundary biodiversity hotspot, shared with neighbouring Côte d'Ivoire.

To contribute to the creation, management and conservation of the proposed park, WCF and FDA led the first phase of biomonitoring across the newly designed park. Previous surveys were in 2012 and 2013, in the Grebo National Forest and the original Proposed Grebo National Park. These surveys provided baseline data on the presence of wildlife and anthropogenic threats. In 2014, the design was improved to increase the data collection effort, thereby improving spatial distribution and abundance estimates of both wildlife and anthropogenic activities. As such, the 2014 survey, reported here, is the **first phase of biomonitoring for the new Grebo National Park, providing BASELINE data for the park within these new limits**. Nonetheless, data from 2014 were compared with previous similar surveys in 2012 and 2013 to provide an idea of the evolution the populations of wildlife in the PGNP over the course of 3 years. In future surveys the current design should be sued to be able to make direct comparisons on an annual basis. Further data collection was planned in the corridor areas running through the logging concession "FMC F", and the community forest area linking FMC to Sapo National Park, though this was cut short due to the Ebola crisis in the country. This data collection will be completed in 2015, when field work resumes, prior to the 2nd phase of biomonitoring in the Proposed Grebo National Park.

This report presents the methodology used, the new design of the Proposed Grebo National Park, agreed on by FDA and WCF, as well as the major results of the first phase of biomonitoring, which was undertaken from February 2014 to July 2014. Results include spatial distribution of large mammals (including chimpanzees and elephants), anthropogenic threats and a population estimate on chimpanzees in PGNP. We conclude with various recommendations to continue long-term conservation and sustainable management in PGNP and the Taï-Grebo-Sapo Forest Complex.

2. METHODS

2.1. Study area

2.1.1.   History of PGNP

The Proposed Grebo National Park (PGNP) is located in a forest previously known as Grebo National Forest (GNF). GNF was created in the 1950's as part of FDA's mandate to protect the forest estate of Liberia. As a national forest, natural resource extraction was permitted (through logging activities, for example) but hunting was not allowed. Figure 1 shows areas of overlap between PGNP and GNF, as well as PGNP and previously non-protected land (known as *native reserve*). The diagram clearly shows that the original Grebo National Forest (black diagonal lined area) was split into two distinct fragments: a small isolated patch in the south that juts out towards Côte d'Ivoire (circled in red in Figure 1) and the main bulk of the forest extending from River Gee County up into Grand Gedeh County. This leaves an area between the two tracts of forest which represents the native reserve of the people of Glaro district, River Gee (on Figure 1 it corresponds to the area between both fragments of GNF, without diagonal lines crossing it). This area of native reserve was previously unprotected

when GNF existed, but is now included within the boundaries of PGNP. Another smaller native reserve is found in the northwest in Grand Gedeh (circled in blue in Figure 1), which belongs to the Bilibo community but is currently also found within the proposed boundaries of the PGNP.
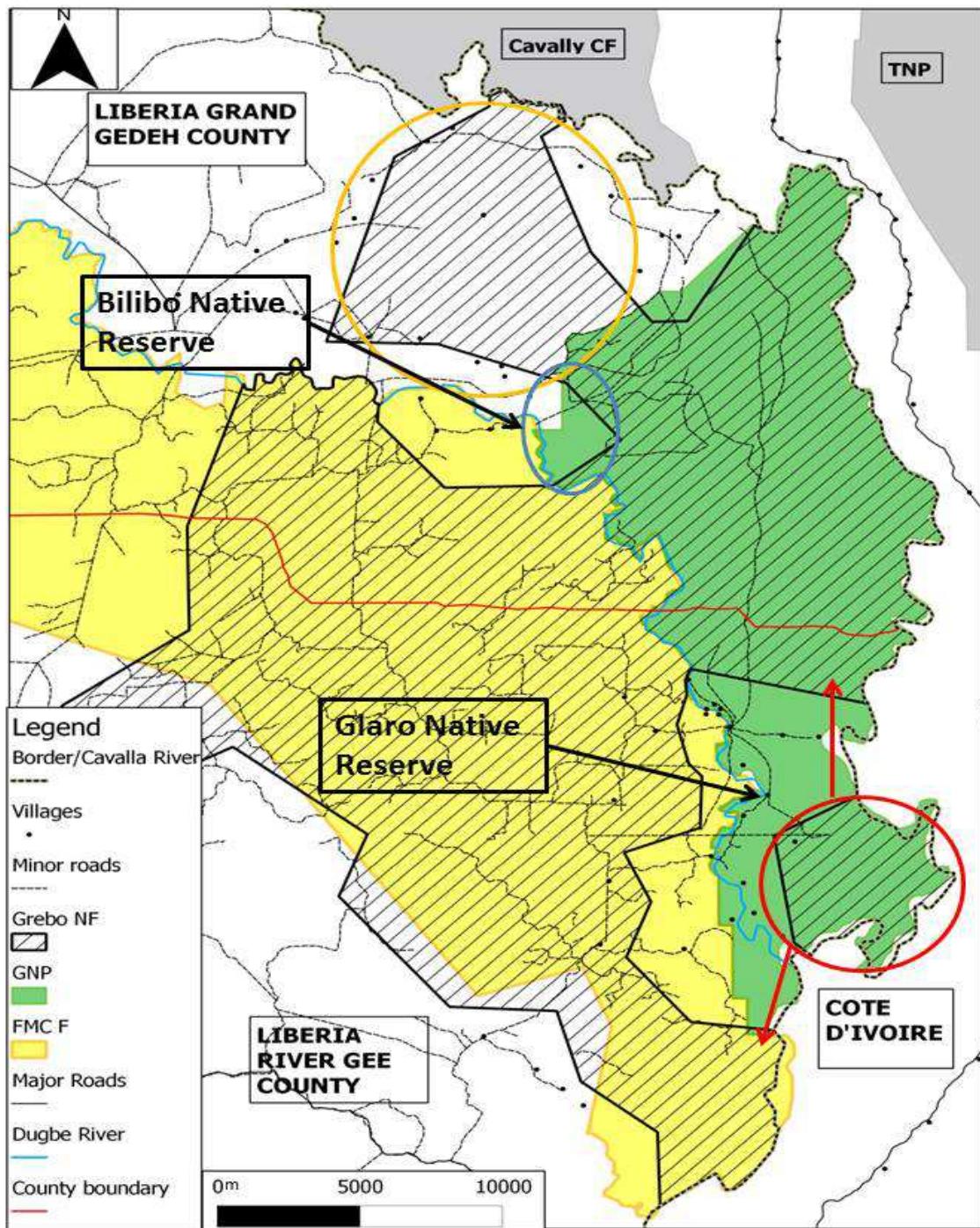
Figure 1: Diagram showing the location of the PGNP in relation to the GNF. The area of black diagonal lines represents the original Grebo National Forest (GNF), demarcated in the 1950s. The yellow area represents the logging concession FMC F created in 2003. The green area represents the current boundaries of Proposed Grebo National Park (PGNP). PGNP also includes an area of previously unprotected forest, depicted with just green and no black diagonal lines.

In 2003, a new law was created to establish a protected area network in Liberia, based on FDA's pledge to protect 30% of their forest cover for conservation purposes. As part of this pledge, it was proposed to create "Grebo National Park" (depicted in green in Figure 1) that runs along the border with Côte d'Ivoire, with the Cavalla River acting as the boundary of PGNP to the east, and the Dugbeh river acting as the boundary to the west. The remaining parts of the GNF were then attributed to a major logging concession, known as FMC F, where heavy logging had occurred in the past. As shown in Figure 1, the boundary of both FMC F and PGNP do not align exactly with the GNF. For example, the original proposed GNP area overlaps with the Native reserve of the Glaro people, as does FMC F. Additionally; the "horn" of the GNF (circled in orange in Figure 1) was omitted from both. The original size of the PGNP was 97,140 hectares, in comparison with 260,326 hectares for the GNF.

In light of the above and results of previous surveys led by WCF and FDA in GNF in 2012, discussed further in the report, WCF and FDA agreed that the form of the PGNP should be revised. Due to the known importance of the "horn" in terms of wildlife, and also in terms of acting as a natural corridor between Liberia and the Cavally Classified Forest in Côte d'Ivoire, it was agreed in October 2014 that it should now be allocated to PNGP. The study area covered for the first phase of biomonitoring in the PGNP thus includes the horn and is named as the "new PGNP" in the report for clarity.

However, the main issue is where PGNP overlaps with the native reserve of the Glaro people in River Gee, and the Bilibo community in the north (circled in blue in figure 1). Previous discussions with FDA and local communities led to the agreement that the isolated patch (of the GNF), surrounded by the Cavalla river and the Glaro Native Reserve, could remain part of PGNP by creating protected corridor areas leading north and south (red arrows in figure 1) thereby ensuring connectivity and protection. Such corridors would then be considered as part of PGNP. Results from the current study would then help to refine the limits of PGNP, in which as little community land as possible is incorporated in the park.

2.1.2. The PGNP today

We conducted the study in the new Proposed Grebo National Park (PGNP) located in southeast Liberia in Grand Gedeh and River Gee counties. The new PGNP is a wet evergreen forest contiguous with the Cavally Classified Forest (CCF) and very close to Taï National Park (TNP), both situated in Côte d'Ivoire. It lies in the heart of the Taï-Grebo-Sapo Forest Complex, the largest remaining forest bloc of the Upper Guinean Forest Ecosystem, a biodiversity hotspot. The new PGNP covers 126,900 hectares and is one of the key areas for transboundary conservation initiatives between Côte d'Ivoire and Liberia. Several big mammal species inhabit the GNF 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).
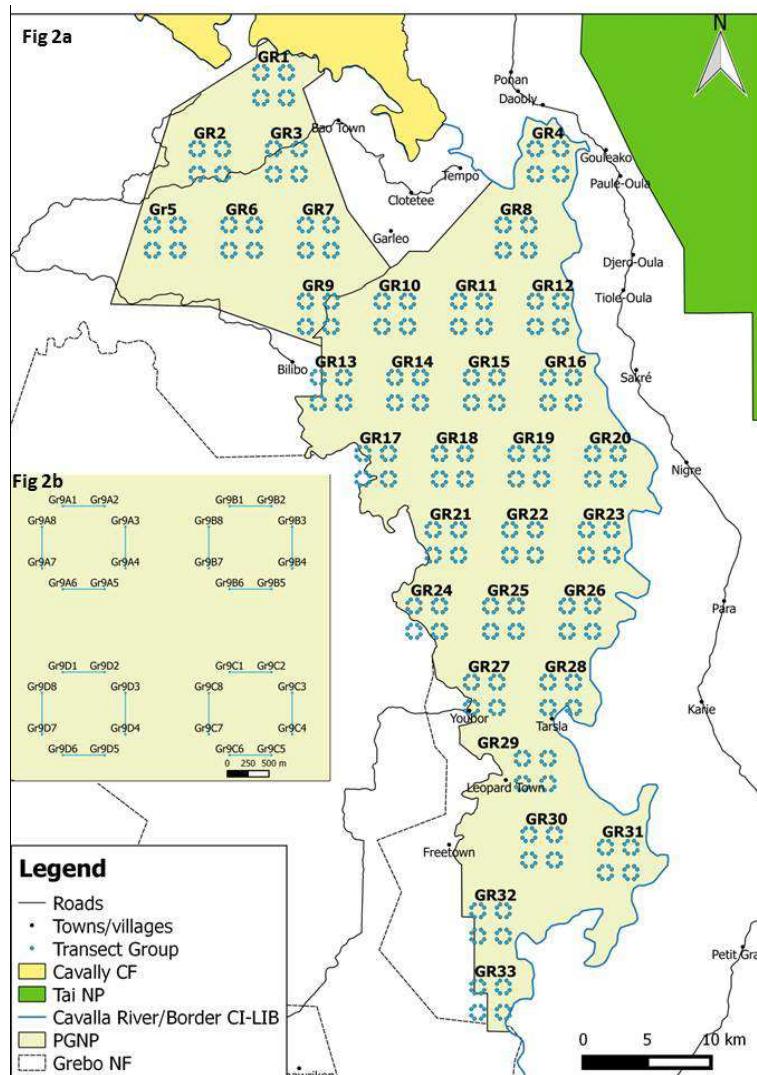
Figure 2: Location of the Proposed Park in the Grebo National Forest (2a) and the detail of the survey design (2b).

2.2. Chimpanzee and other large mammals survey design

To allow for robust analysis, we used a systematic survey design covering the entire new Proposed Grebo National Park (PGNP). The design for this study allowed for an increased sampling effort in comparison to surveys conducted in 2012 and 2013. This survey design will be used for all subsequent large mammal surveys in the PGNP. As such, the survey can be considered the **1ˢᵗ phase of biomonitoring** within the newly agreed upon boundaries for Grebo National Park.

The design follows IUCN standards for transect surveys for great apes (Kühl et al., 2008), in which the whole of the new PGNP 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). To improve the precision of the estimation of wildlife abundance and spatial distribution, the number of groups of transects was increased from 8 in 2013 to 33 today in 2014 (Figure 2a).

The groups of transects, composed of four transects each, were regularly spaced to allow for accurate estimates of abundance as well as accurate estimates of spatial distribution of animal species (Norton-Griffiths 1978; Plumptre, 2000, Buckland et al., 2001). Each transect is composed of 4 segments of 500m each, meaning a total length 2km per transect and 8 km per group. For clarity we provided details of the group of transects Gr9 in Figure 2b (above) with Gr9A, Gr9B, Gr9C and Gr9D being the 4 transects of the group. Overall, the targeted sampling effort in PGNP for the 2014 survey was 264 km. An increase in the sampling effort allows for more precise estimations, which is important for any conservation management strategy.

As mentioned above, in 2013, the WCF and FDA agreed to include the horn of Grebo in the PGNP (see Figure 1 orange circle). Note, the transects of Gr27, Gr28, Gr29, Gr32, Gr33 are located within the original PGNP, but in the area that corresponds to the Glaro native reserve (Figure 1). Gr13 is also located within the original PGNP, but in an area that was previously unprotected, used by the Bilibo community (Figure 1). Data from this study will help identify final boundary lines for PGNP to minimize impacts on local communities and their land use, whilst increasing protection for local wildlife.

2.3. Field data collection along line transects and local capacity building

Data were collected from February 21ᵗʰ until July 13ᵗʰ 2014 by three teams supervised by individuals from the Wild Chimpanzee Foundation (Clement Tweh and Zoro Goné Bi Irié Berenger) alongside individuals from FDA (Charles Tweh and Trokon Grames). Most team members have extensive experience in data collection and team supervision, having participated in previous surveys led by WCF/FDA in PGNP and also a nationwide chimpanzee and large mammal survey in Liberia. Each team consisted of six Liberians, either staff members/auxiliaries of the FDA, or local community members. Details of team members for the 2014 survey are listed in Appendix 1. All team members participated in a training workshop in February 2014 in Freetown, River Gee, to further build their capacity in data collection and survey methodology. Training included animal identification, tracking signs, GPS training, reading of UTM coordinates, and how to measure perpendicular distances, fill in data sheets, and walk along the transects etc…

During transect surveys, four individuals walked strictly on the straight transect line following a direction given by a GPS (Global Positioning System) and two others walked on either side of the transects. All team members collected data on habitat type, the presence of chimpanzees (nests, feeding sites or vocalisations), elephants and other large mammals. To determine the density of chimpanzees in the study area, perpendicular distances of a nest to the transect line are recorded (details of nest counts on line transects using distance sampling methodology are described elsewhere by Buckland et al. (2001) and Kouakou et al. (2009)). For other species, both direct and indirect signs were collected following the same method. In addition to searching for presence signs of chimpanzee and other large mammals, signs of anthropogenic activities were also recorded, as well as ecological factors (habitat type). The detailed methodology is available upon request.

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 efforts and estimations of animals' population sizes and spatial distribution using the programs Distance 6.0 and Arc Gis 9.2/Quantum GIS 2.4.

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. Due to the difference in survey design in 2014 compared to 2012 and 2013, encounter rates of all observations of species presence signs calculated for the whole of the new PGNP, which now includes the horn of Grebo, were **not** compared with previous years. However, encounter rates of direct and indirect observations of chimpanzees, elephants, bovids, monkeys and hunting in 2014 were also calculated using only the data on the transects inside the original design of the PGNP used in 2012 and 2013, and were subsequently compared with these 2012 and 2013 encounter rates.

2.4.2. Chimpanzee population status analysis

To estimate the population size of chimpanzees in PGNP, 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 PGNP, for our conversions, we used the value of nest production (1.14 days) and decay rates (84.38 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 Proposed Grebo National Park

To estimate the spatial distribution of chimpanzees and other large mammals as well as anthropogenic activities in the proposed park, we used presence signs assigned to each species, and all anthropogenic activities, and performed spatial analysis in ArcGIS 9.2. 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. Due to the difference in survey effort and difference in area surveyed, it was not possible to compare spatial distribution of large mammals and anthropogenic threats with previous surveys (WCF/FDA, 2012, 2013), though previous reports can be referred to at the head office of the FDA in Monrovia, or at the website: www.wildchimps.org.

3. RESULTS

3.1.   Survey effort and review of observations along line transects

In 2014, the three teams walked a total of **242.728 km** of line transects, representing **91.94%** of the theoretical survey effort targeted (L= 264km). The main reason for not completing the total target effort was due to large obstacles such as watercourses, valleys and "sacred forests" of the local communities for which the survey teams were not given permission from the communities to enter. For example, Dugbeh River could not be crossed and so transect Gr24D could not be sampled. The survey effort of 2014 still remains largely higher (almost 5 times greater) than the 51.5 km walked during the 2013 survey, and as such we cannot make comparisons in terms of spatial distribution of wildlife or anthropogenic threats.

In total, **4,468** observations confirming the presence of wild animals in PGNP were recorded (both direct and indirect). 79.01% (i.e. 3,550) of observations were of mammals, 17.7% (791) were of birds and the rest were other species. Figure 3 summaries the number of observations made with **more than 30 species encountered.** Note that signs of bovids, primates and Suidae were the most common of mammals, whilst signs of elephants, rodents, pygmy hippopotamus, water chevrotain and giant pangolin were relatively rare. Observations recorded on carnivores were also relatively low, with only 70 recorded. They represented the presence of: the leopard, Liberian mongoose, African civet and the Padrine genet. Concerning threats to the wildlife in PGNP, we recorded **1,472** signs of human activities, of which 843 were poaching signs and 233 were paths or tracks made by humans, and 329 were signs of habitat disturbance (cut trees, farms, mining sites, etc).
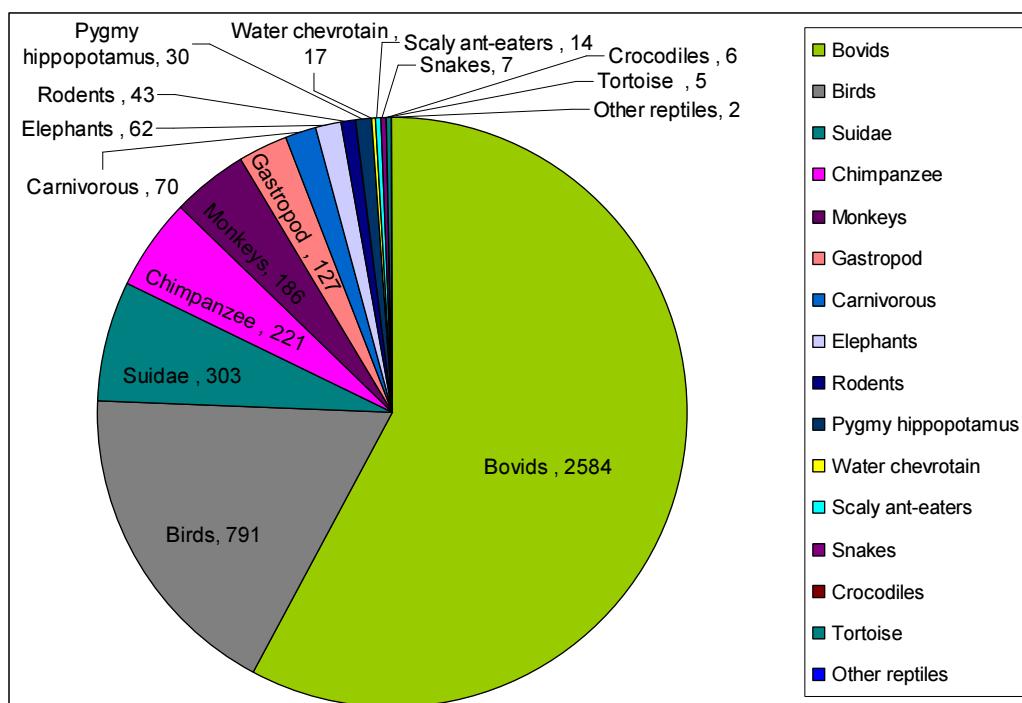
Figure 3: Numbers of all direct and indirect observations of animals along line transects during the 2014 survey in the PGNP.

Globally, we found a high array of biodiversity in the new PGNP. A variety of large mammals (including also strictly medium size mammals) were found to be present in the

PGNP, with more than two species observed per kilometre walked (Figure 4). Both the horn of the PGNP (4a) and the central area (4b) are shown to be important for harbouring high levels of biodiversity. Areas showing relatively low diversity correspond to the periphery along the Côte d'Ivoire border and in the south near the vicinity of villages of Glaro district.
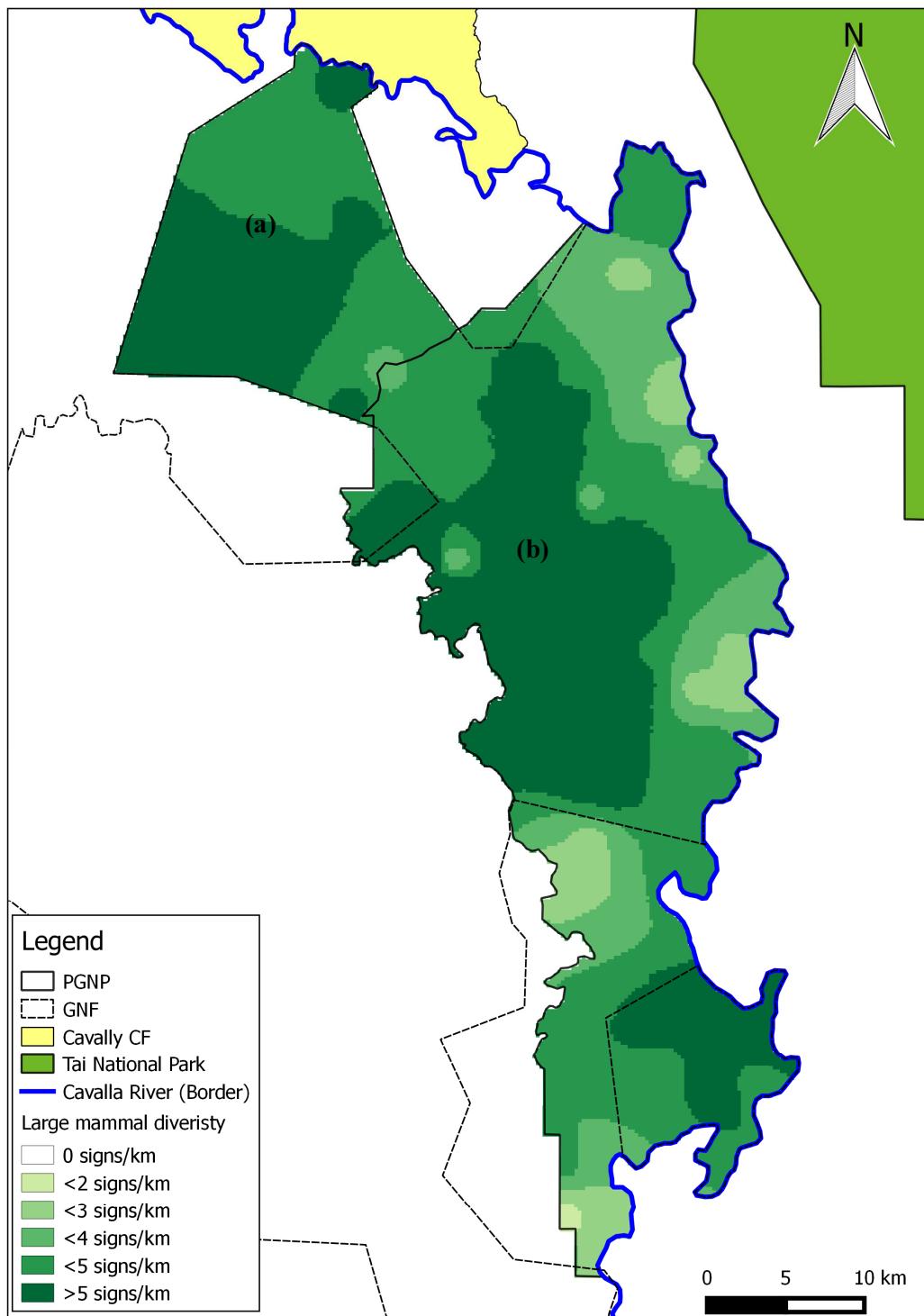
Figure 4: Spatial distribution of large mammal diversity observed in 2014. (a) and (b) indicate the two areas with the highest large mammal diversity.

<u>The spatial distribution of the four endangered large mammal species</u>, i.e. chimpanzees, red colobus, Jentink duiker and Liberian mongoose observed during the 2014 survey is indicated in Figure 5. It is possible to encounter endangered large mammals at almost any location of the PGNP, though they were mainly encountered in the horn of the proposed park (5a) and the central areas (5b), as well is in the isolated patch of the current PGNP (5c).
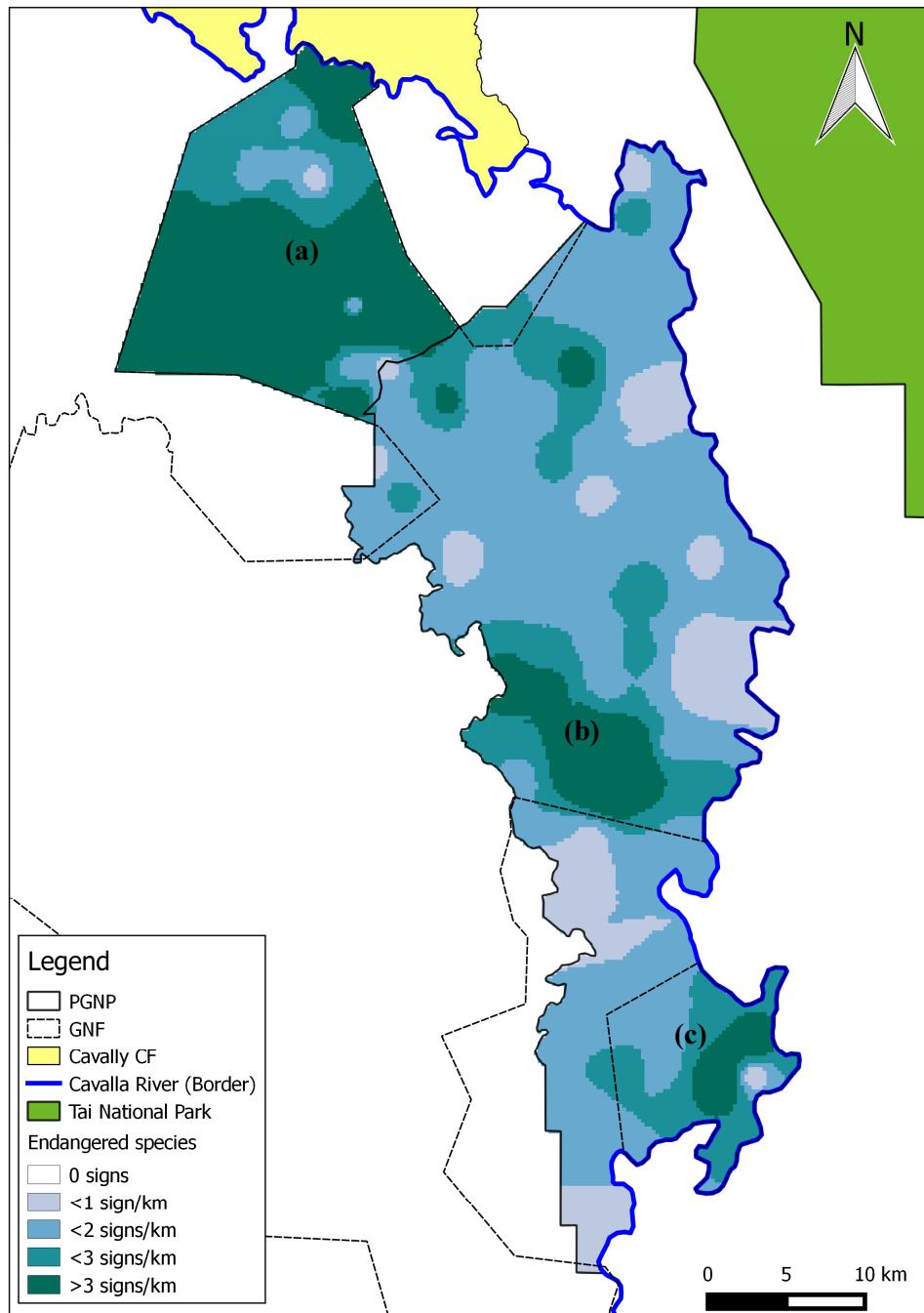
Figure 5: The spatial distribution of the endangered species observed in 2014. (a), (b) and (c) indicate the 3 main areas of higher abundance of 4 large endangered mammals (chimpanzee, red colobus, Jentink's duiker and pygmy hippopotamus) in PGNP in 2014

<u>For vulnerable species</u> (Figure 6); the African forest elephant, the Diana monkey, the zebra duiker and the black and white colobus , we found relatively higher encounter rates of their signs of presence in the central areas of the PGNP (6a), though they were also relatively highly encountered in the horn (6b) where more than one sign per kilometre was observed. Overall, endangered and vulnerable species were rarely observed in the vicinity of villages.
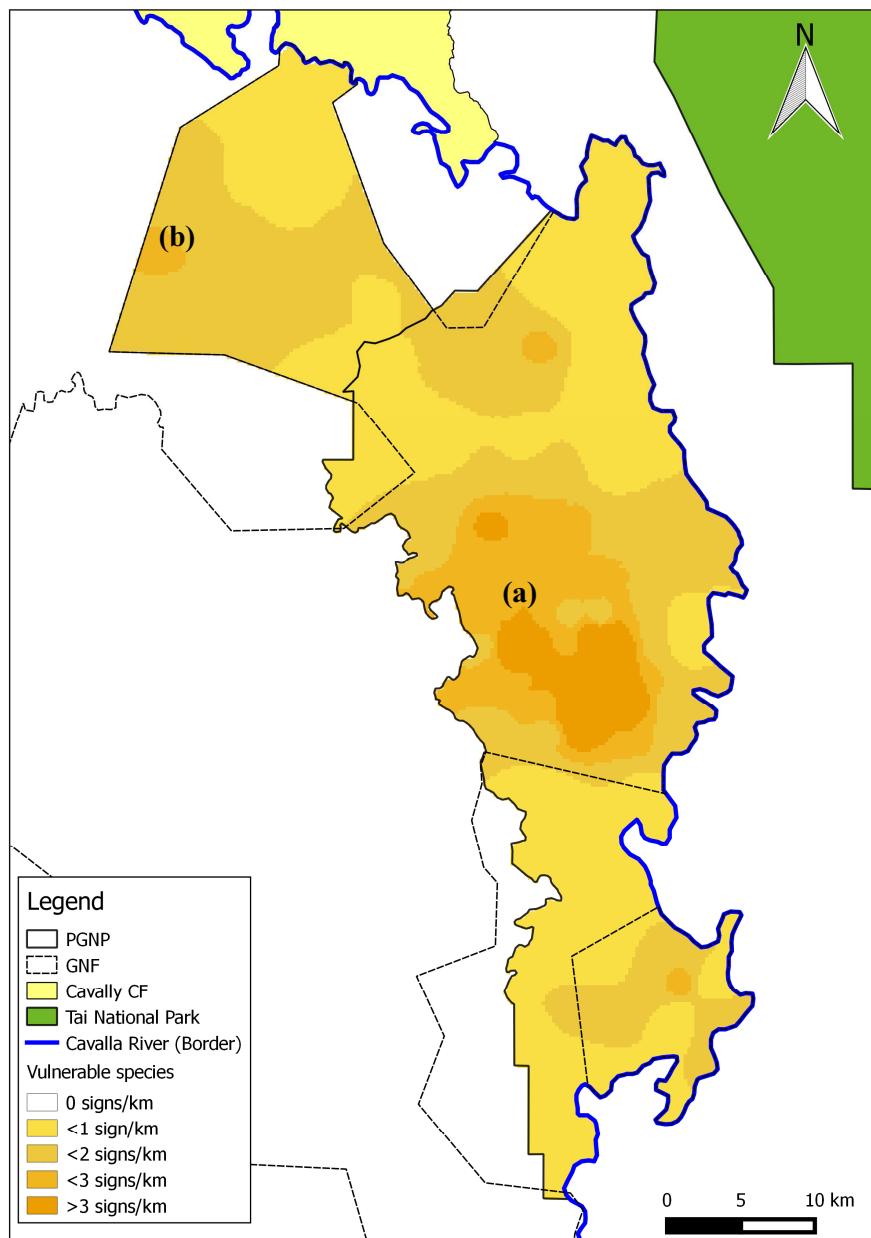
**Figure 6:** The spatial distribution of the vulnerable species observed in 2014. (a) = central area of highest abundance and (b) = horn of Grebo with relatively higher abundance of 4 vulnerable species; elephant, Diana monkey, zebra duiker and black and white colobus.

3.2. Bovid population

Encounter rates of bovids (including both direct and indirect observations) were relatively high in the PGNP (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): Maxwell's duiker (2), black-backed duiker (5), black duiker (2), and Ogilby's duiker (7). The small sample size (n < 60) did not allow for a population estimate calculation. The comparison of signs of presence of bovids from 2012 to 2014 shown in Table 2 indicates no clear evolution. 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.

Table 1: Observations and encounter rates of direct and indirect observations for bovids in new PGNP in 2014

Type of observation	Observations new PGNP	Encounter rates (N/km)
Direct	16	0.07
Dung	817	3.37
Footprint/track	1,750	7.21
TOTAL	2,583	10.64

Table 2: Comparison of encounter rates of all signs of presence of bovids in old PGNP surveyed area

Year	Encounter rates (N/km) old PNGP
2012	9.98
2013	6.38
2014	8.82

Concerning the spatial distribution of bovids (Figure 7), they occur in all areas of the park, though are more abundant in the horn of the new PGNP (7a), the Bilibo native reserve (7b) and the centre (7c). The northern horn of the park has the highest number of observations of bovids and in some areas one can encounter more than 20 signs per km walked. The southern part of the PGNP appears to have a much lower abundance.
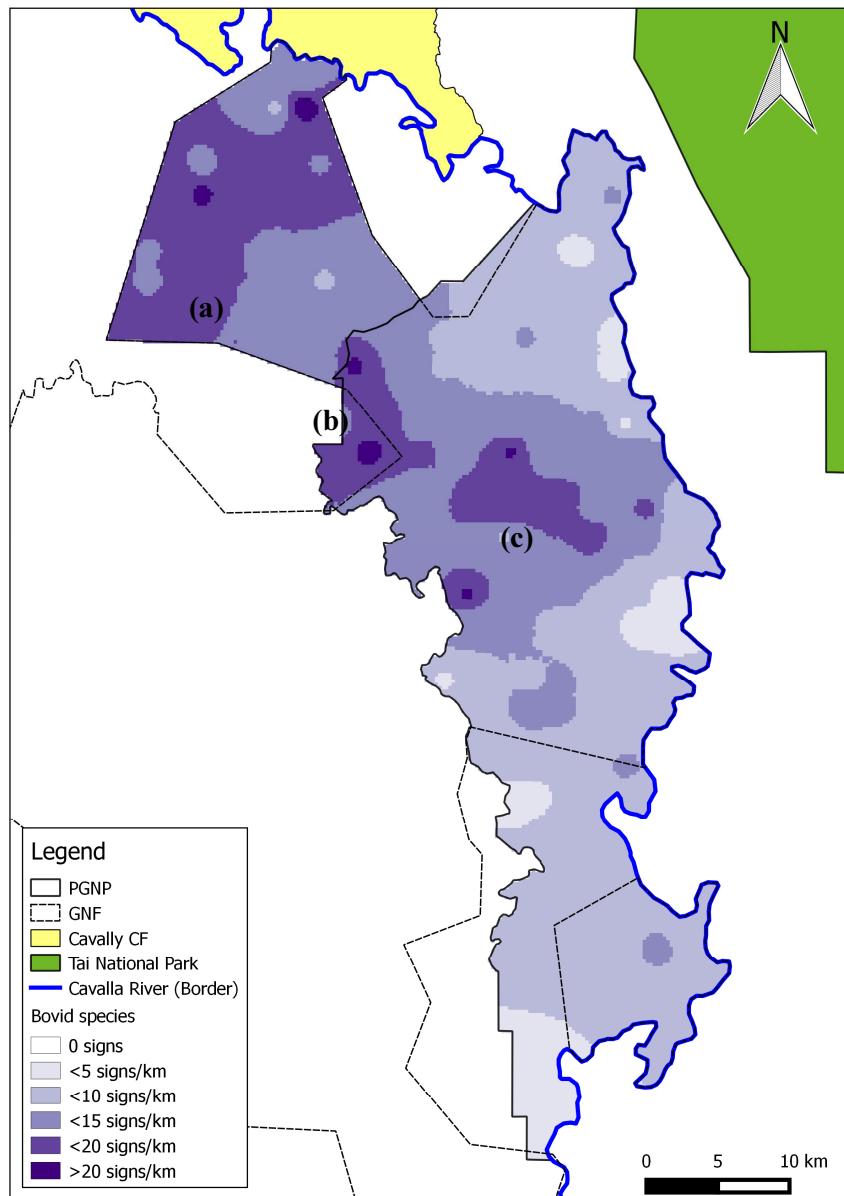
Figure 7: Spatial distribution of bovids in the PGNP in 2014. (a), (b), (c) indicate 3 areas of relatively high abundance of bovids in the PGNP in 2014

3.3. Primate population

In total, eight different primate species were observed directly and/or indirectly during the 2014 survey (Table 3). Presence signs of the Western chimpanzee were the most observed among primates species, which was also the case in 2012 and 2013. Evidence of chimpanzee presence was confirmed by their sleeping nests, dung, nut cracking sites, and by their vocalizations. An estimation of chimpanzee populations was possible, as this is done using only indirect signs (sleeping nests and dung). See page 16 and Table 5 for the density and abundance calculation for chimpanzees. Chimpanzees appear to be highly threatened considering the survey in the old PGNP, as the encounter rate of indirect observations decreased by 28% for chimpanzees between 2012 and 2014 (Table 4).

As for monkeys, there is a threefold increase in the encounter rate between 2012 and 2014. Should this positive trend be confirmed in the 2015 survey, this would be excellent news for the monkey populations. Unfortunately, the limited number of direct observations along transects did not allow for estimations of the monkey population. In 2014, a total of 51 direct observations of monkeys were made, in a total of 19 groups. No observations, neither direct nor indirect of the putty-nosed monkey were made.

Table 3: Observations and encounter rates for primates in 2014 in the new PGNP surveyed area

Primate species	Observations in new PGNP 2014			Encounter rates of all signs of groups of monkeys (N/km)
	Direct observation of **individual**	Indirect observations of **groups** (heard)	Direct observations of **groups** (seen)	**2014**
Diana monkey (*Cercopithecus diana*)	4	63	3	**0.27**
Red colobus monkey (*Procolobus badius*)	23	14	4	**0.07**
Mona monkey (*Cercopithecus mona*)	2	17	2	**0.08**
Western Black-and-white Colobus monkey (*Colobus polykomos)*	7	16	3	**0.08**
Sooty mangabey (*Cercocebus atys*)	0	9	0	**0.04**
Lesser spot-nosed monkey (*Cercopithecus petaurista*)	11	8	5	**0.05**
Olive colobus monkey (*Procolobus verus*)	4	7	2	**0.04**
Total of Monkeys	**51**	**134**	**19**	**0.63**

	Direct observation of individuals	Indirect observations	Encounter rates of all signs of chimpanzees (N/km)
Chimpanzee (*Pan troglodytes verus*)	0	221	**0.91**

Table 4: Comparison of encounter rates of all signs of monkey groups and chimpanzees signs in the old PGNP surveyed area

	Encounter rates (N/km) old PNGP	
Year	**Monkeys groups**	**Chimpanzees**
2012	0.20	0.92
2013	0.54	0.99
2014	0.63	0.66

Across the park, indirect and direct observations of monkeys groups are detected in most areas, with slightly higher encounter rates in the northeast horn (a) and the centre of the PGNP (b) (Figure 8).
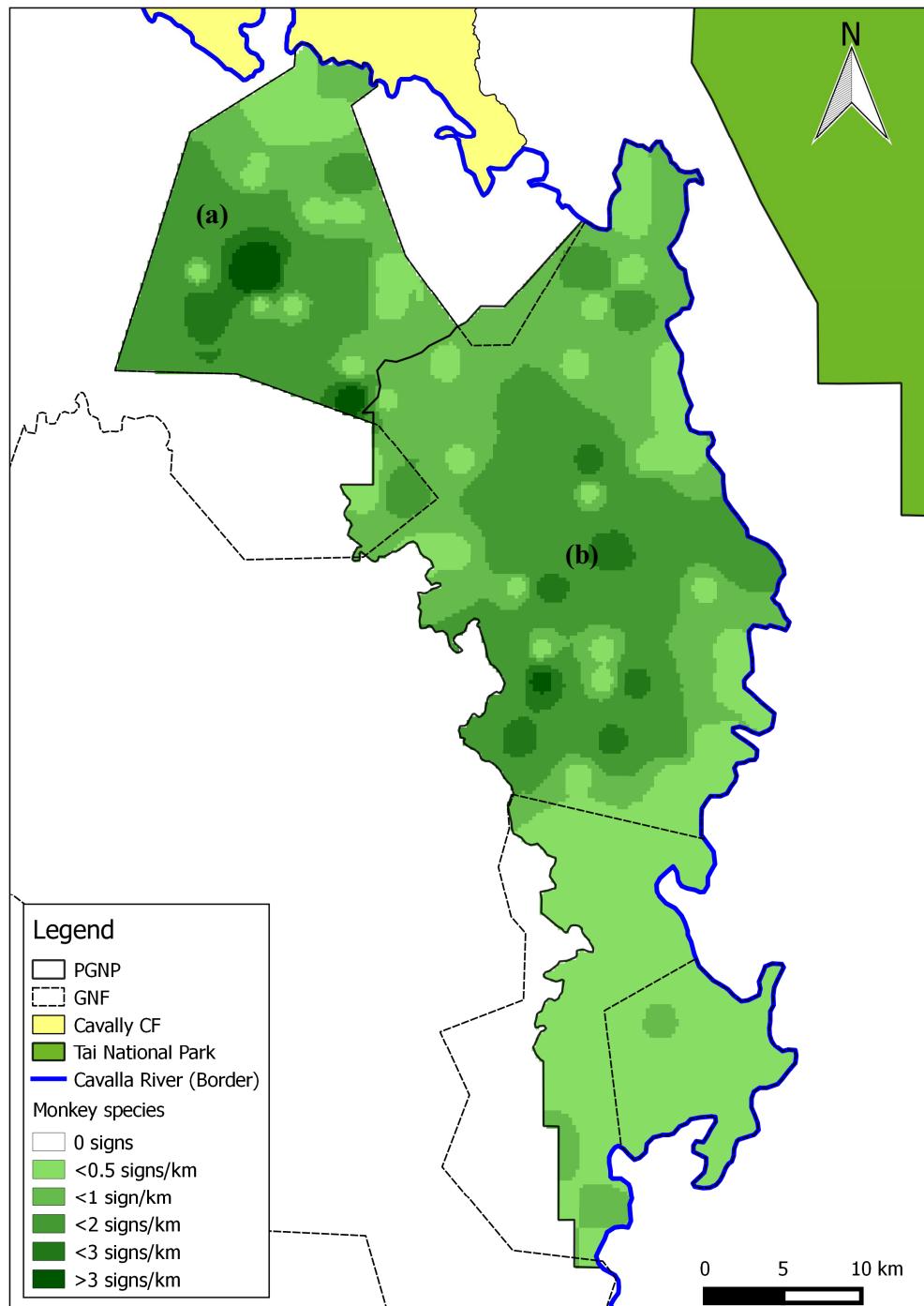

Figure 8: Spatial distribution of monkeys in PGNP in 2014, (a) and (b) representing the areas of relatively high abundance of monkeys

Figure 9 presents the distribution of chimpanzees found mainly towards the southern centre of the PGNP (a), in the area around the sacred forest of Leopard Town community, in Glaro, River Gee. They are also present in the south (b) (in the area of forest that was originally isolated from the original Grebo National Forest), and in the horn (c). Importantly, they were observed in the north of the horn, along the Cavalla River, which corresponds to a natural corridor with the Cavally Classified Forest in Côte d'Ivoire (d).
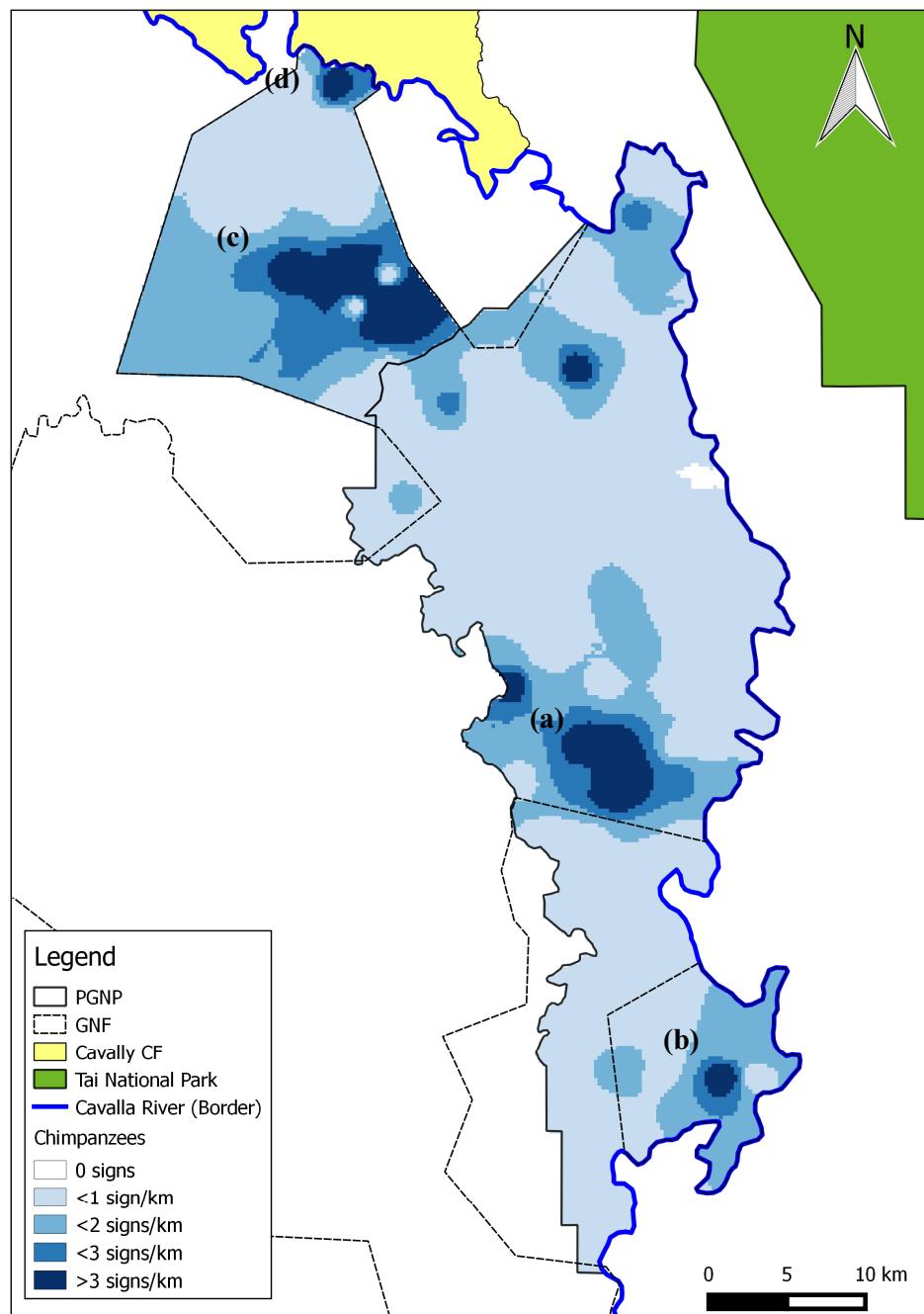

Figure 9: Spatial distribution of chimpanzees signs of presence observed in 2014. (a), (b), (c) and (d) indicate areas of relatively high abundance of chimpanzees in the PGNP in 2014, and (d) indicates a natural corridor linking PGPN to Cavally Classified Forest in Côte d'Ivoire.

Density and abundance of chimpanzees:

Among the 221 indirect signs of chimpanzees observed, 189 sleeping nests were detected directly from the line. This quantity of observations was large enough 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 5 for 2014.

Table 5: Population estimates of chimpanzees in the Proposed Grebo National Park

Population parameters	Point Estimate	Coefficient of variation	95% Confidence Interval
Densities of chimpanzees (ind./km²)	0.161	24.15%	0.101 – 0.257
Abundance of chimpanzees (weaned ind.)	204	24.15%	128 – 327
Chimpanzee abundance (total ind.)*	**247**	**24. 15%**	**155 – 396**

* The total number of chimpanzees in PGNP was estimated to be 247 individuals, considering that 17.5% of the individuals of a population are juveniles (as estimated by Plumptre and Reynolds, 1996).

The calculations demonstrated that the density of chimpanzee nests in PGNP was 16 nests per km² (CV=23%) during the study period. Using conversion factors, we estimated 0.161 weaned chimpanzees per km². Consequently, their population size was 204 weaned individuals and a total population of 247 including juveniles/infants (Plumptre *et al*. 1996).

3.4. Other mammal species

In addition to bovids and primates, signs of presence of other large mammal species were detected during the survey (Table 6). Only the Liberian mongoose was observed directly. All other presence of mammals was confirmed by indirect observations (tracks, feeding sites and dung). The signs of presence of the red river hog were the most often encountered with 1.11 signs detected per kilometre walked.

Table 6: Observations on other large mammal signs in the new PGNP in 2014

Family	Species	Observations in 2014					Encounter rates (N/km)
		Dung	Feeding site	Track	Trail	Total	2014
Suidae	Red river hog (*Potamochoerus porcus*)	4	197	68	0	269	1.11
Elephantidae	Elephant (*Loxodonta africana cyclotis*)	33	0	7	22	62	0.26
Suidae	Giant forest hog (*Hyloc. meinertzhageni*)	1	27	6	0	34	0.14
Herpestidae	Liberian mongoose* (*Liberiictis kuhni*)	3	23	3	0	32	0.13
Hippopotamidae	Pygmy hippopotamus (*Hexaprotodon liberiensis*)	12	0	18	0	30	0.12
Tragulidae	Water Chevrotain (*Hyemoschus aquaticus*)	0	0	17	0	17	0.07
Felidae	Golden cat (*Felis aurata*)	4	0	11	0	15	0.06
Manidae	Giant pangolin (*Manis gigantea*)	0	2	11	0	13	0.05
Felidae	Leopard (*Panthera pardus*)	0	0	2	0	2	0.01
Manidae	African civet (*Civettictis civetta*)	0	0	0	0	0	0
Procaviidae	Tree hyrax (*Dendrohyrax dorsalis*)	0	0	0	0	0	0
Manidae	Tree pangolin (*Phataginus tricuspis*)	0	0	0	0	0	0
Manidae	African palm civet (*Nandinia binotata*)	0	0	0	0	0	0
Total		**57**	**249**	**143**	**22**	**471**	**1.95**

* Three (3) direct observations were made of Liberian mongoose but not of any of the other species

The spatial distribution of the signs of presence of African forest elephants in 2014 shows their presence in the southern centre of the park (Figure 10). This was also the case in 2012 and 2013 (see WCF/FDA, 2012, 2013).
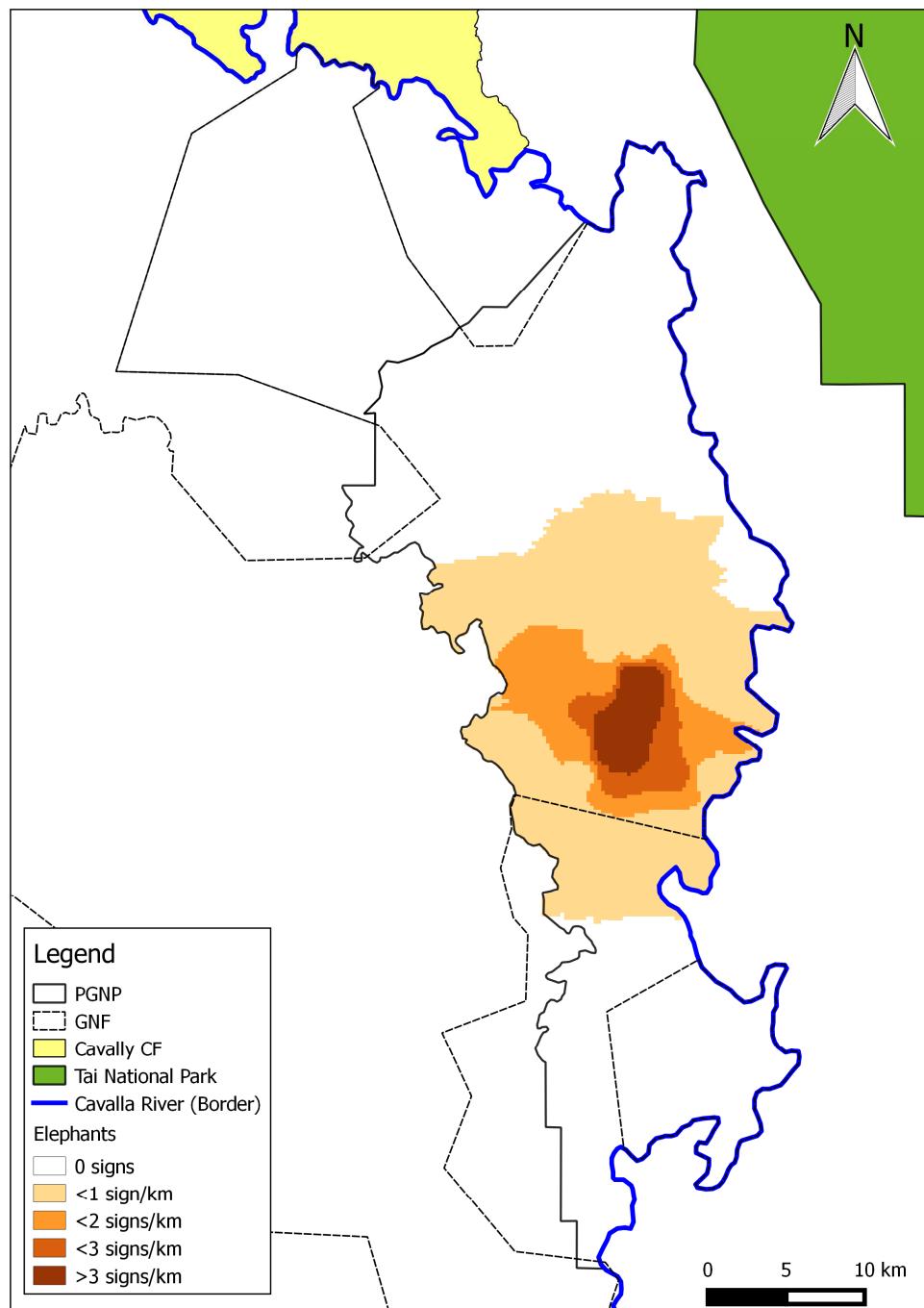

Figure 10: Spatial distribution of elephants in 2014 for the new PGNP.

For the pygmy hippopotamus, signs of presence were observed in most areas of the park, though were notably absent in the north (a) and more frequent in the southern areas (b) (Figure 11).
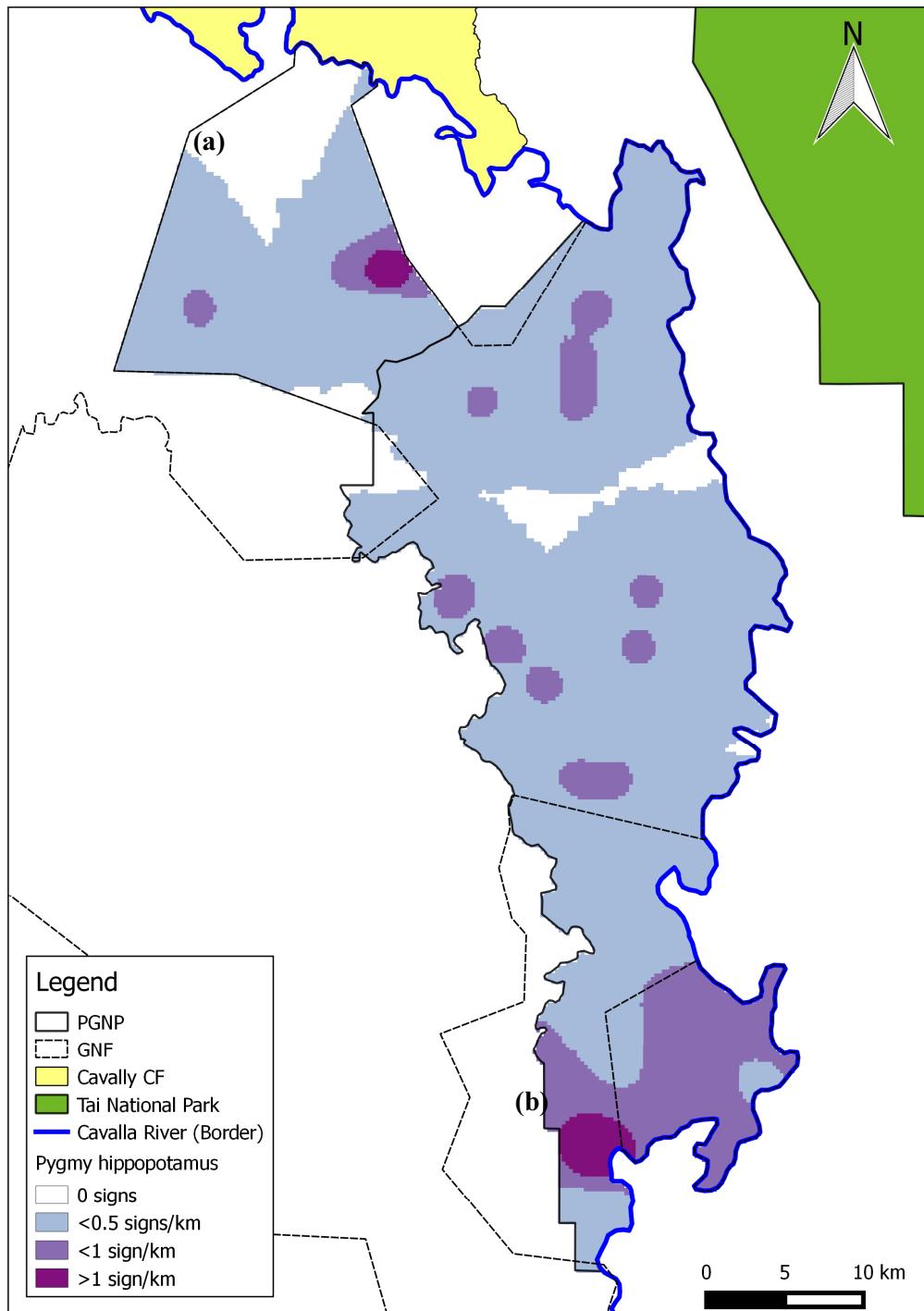

Figure 11: Spatial distribution of the signs of presence of pygmy hippopotamus in 2014 for the PGNP. (a) indicates an area with no sign of pygmy hippopotamuses whereas (b) indicates an area with highest level of signs.

3.5. Threats or factors influencing the distribution and density of chimpanzees and other large mammals in the new PGNP

We observed threats to wildlife across the entire PGNP 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 chewing stick harvesting (
Table 7). The encounter rates of signs of aggression on fauna were twice as great as those on flora. Poacher trails were the most abundant signs of encounters with 2.87 signs per kilometer walked. Survey team members regularly heard gun shots during the survey period, though only nine shots were heard along transects and therefore included in our analysis. When comparing encounter rates in the old PGNP survey area in 2012, 2013 and 2014, there is an increasing trend of hunting signs (Table 8) across the park (nearly doubled in 2 years). Regarding habitat disturbance, 68% (311 signs) of aggression signs on flora were related to the harvesting of chewing sticks in PNPG (
Table 7).

Table 7: Human activities or illegal signs encountered on transects in the new PGNP in 2014

Type of human activity	Observation	Number of observations	Encounter rate (N/km) PGPN 2014
Aggression on fauna (hunting)	Poacher Trail	696	2.87
	Human Path	132	0.54
	Empty Gun Shell	123	0.51
	Object (old batteries, sneakers, cup...)	15	0.06
	Gunshot heard	9	0.04
	Snare (trap)	7	0.03
	Voices (heard)* or people seen	2	0.01
	Settlements/camps	5	0.02
	TOTAL	**989**	**4.07**
Agression on flora (habitat disturbance)	Logging activities*	102	0.42
	Pit sawing	1	0.00
	Chewing stick (cutting tree, extraction of roots…)	311	1.28
	Honey extraction	2	0.01
	Direct observation of humans	19	0.08
	Farming activities	13	0.05
	Mining activities	9	0.04
	TOTAL	**457**	**1.88**

Table 8: Comparison of encounter rates of hunting signs in the original GNP surveyed area

Year	Encounter rates (N/km) OLD PNGP
2012	1.76
2013	2.45
2014	3.38

The spatial distribution of signs of hunting activities is indicated in Figure 12. Hunting signs can be encountered across the park, with a higher abundance towards the north near the known mining area of Bilibo Community (a); along the border with Côte d'Ivoire (b), and in the southern isolated patch of the current PGNP (c).
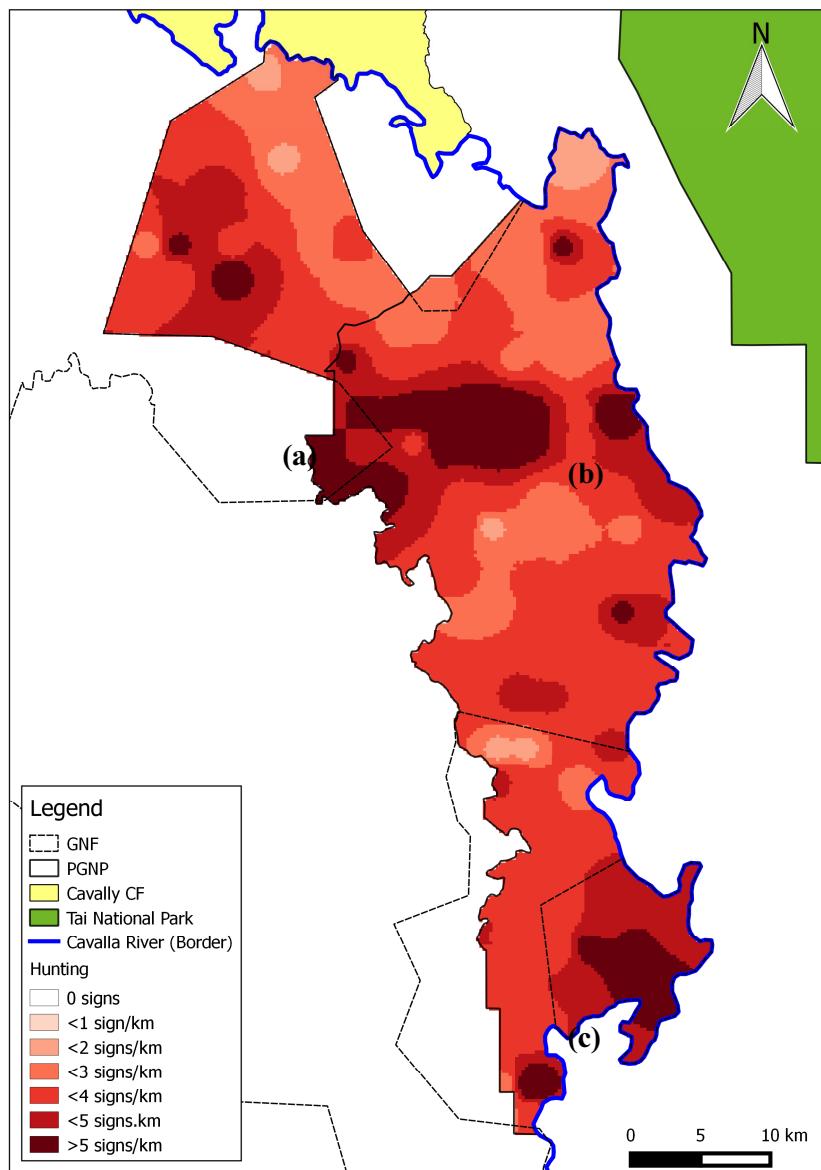

Figure 12: Spatial distribution of hunting in PGNP in 2014. (a), (b), and (c) indicate areas under greatest threat from hunting activities.

Signs of aggression on flora covered the entire new PGNP in 2014 (Figure 13). In 2014, the eastern side of the park that runs along the border with Côte d'Ivoire is particularly threatened by habitat disturbance, due to the harvesting of chewing-sticks.

A total of 13 farmed areas and 9 mining sites were observed inside the current PGNP. Plotting the locations of these observations shows that the majority of farms and mines are located outside of the original Grebo National Forest in the community-land (Figure 13). All mining sites were located in the Bilibo community-land (Figure 13), though prospection sites were observed inside the current PGNP (figure 13). Farms in River Gee were generally located inside the native-reserve near the villages, whereas chewing-stick harvesting sites and camps in River Gee were located inside the current PGNP along the border with Côte d'Ivoire (figure 13).
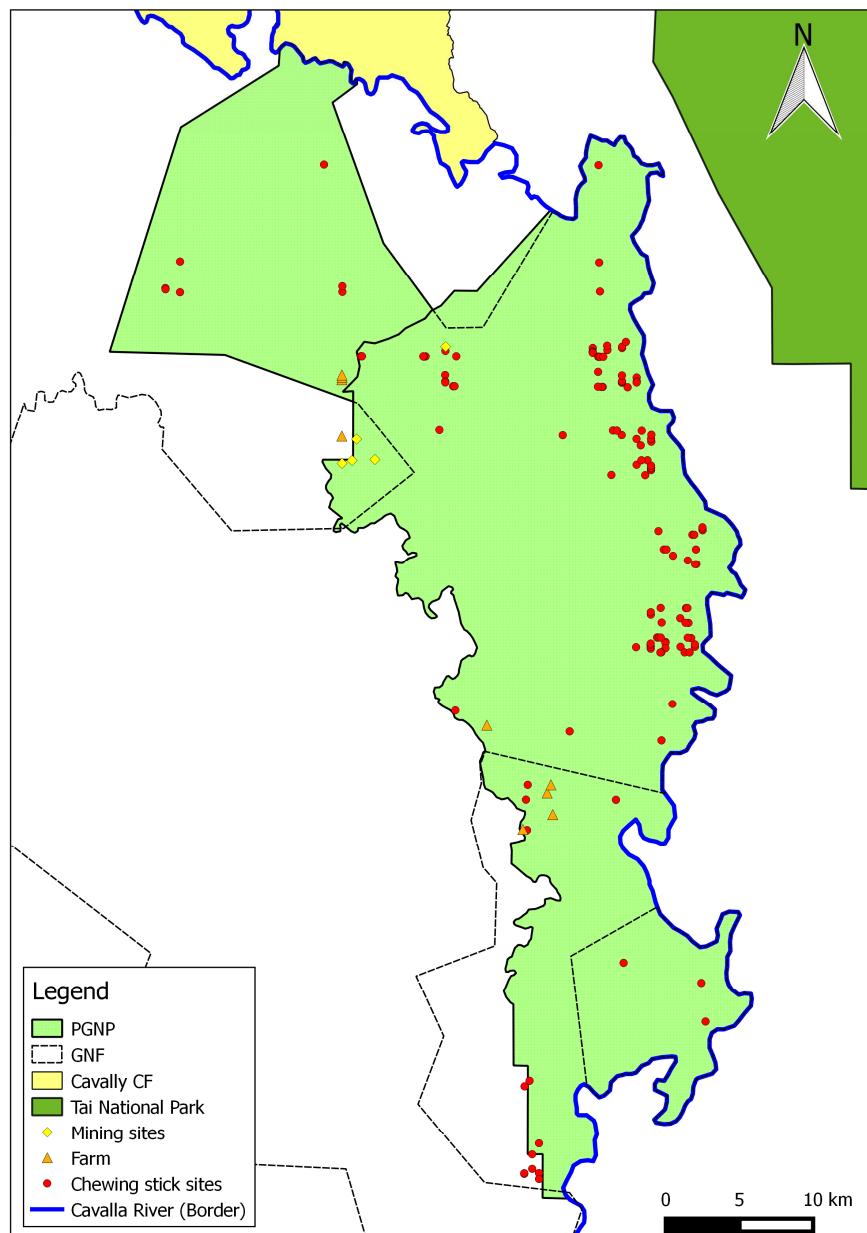

Figure 13: Locations of farms, mines and chewing-stick harvesting sites in PGNP in 2014

4. DISCUSSION

The 2014 survey provides important results for the overall management of the PGNP. A deepened understanding of the population status of large and medium size mammals and the threats to those animals is well documented with 242.728 km of line transects covered by experienced Liberian wildlife surveyors (at least two years of experience in the study area and in survey methodology).

The increase in survey effort allowed for more precise spatial distributions and encounter rate calculations, though direct comparisons between previous surveys and the 1st phase of biomonitoring in the new PGNP (the results of which are described in the current report), should only be made tentatively, due to the change of survey design and sampling effort. The survey in 2012, covered the entire Grebo National Forest, whilst the survey in 2013 covered only 51.5 km of the Proposed Grebo National Park (see Appendix 2 for previous survey areas and designs), delimited by the Protected Area Network Strategy of Liberia. As mentioned before, the new boundaries of the PGNP, used for this 2014 survey, include parts of the Grebo National Forest that had previously been investigated as preliminary phases for a biomonitoring program. The increased survey effort of this 1st official of biomonitoring phase improved spatial distribution and abundance estimates of both wildlife and anthropogenic activities (Buckland et al. 2001; Nomani, 2012). However, 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 the low densities of large and medium size mammals in the PGNP, and an extreme elusive behaviour to escape human observers limits direct detections. Note that for the coming phases, abundance and density can be estimated with the same survey design by combining observations from successive surveys and by making a post-stratification analysis in the software Distance.

Regarding chimpanzees in PGNP, the abundance estimates precision of CV = 24.15% (mean estimate was 204 weaned individuals) is reliable enough, and the population size has remained stable in the study area, as the 95% confidence intervals of this first phase estimates overlap with the one from the 2013 preliminary biomonitoring phase. Though this is reassuring, the increase of anthropogenic threats within the PGNP is worrying and could cause major decreases in chimpanzee and other wildlife populations, if no imminent action is taken.

The diversity of large mammals from the study area has been confirmed with 21 species among the 28 species reported by Hoke *et al.* (2007). The difference is likely to be due to the exclusion of nocturnal species (e.g. Demidoff's galago and the Western tree hyrax) and/or the fact that Hoke et al., surveyed the entire GNF (a larger survey area) and/or could be due to a lack of capacity in field teams to identify all species confidently. For example, the putty-nosed monkey was not observed in 2012, 2013 and 2014, yet this species is present in Taï National park and the Cavally Classified Forest in Côte d'Ivoire, all part of the same forest block. This may also be due to very low densities, which may increase the probability of missing observations (Gu and Swihart, 2004). Nonetheless, increased training in animal identification should be done at the beginning of the next phase.

The diversity of large mammals of conservation importance in the PGNP is confirmed with the presence of eight primate species including the Western chimpanzee, the African forest elephant, the pygmy hippopotamus, the leopard etc. This diversity reaffirms the importance of the creation of the national park and its role within the Taï-Grebo-Sapo Forest Complex.

The spatial distribution maps for endangered and vulnerable species clearly demonstrate the necessity of maintaining the proposed corridor (horn area) to the Cavally Classified Forest in Côte d'Ivoire. Relatively high encounter rates of endangered species, bovids and vulnerable species, are found in that area. Interestingly, signs of chimpanzees were found right on the tip of the horn, next to the Cavalla River. In 2010, chimpanzees were found to be present in this area in the Cavally Classified Forest (WCF, 2010). Further studies should be led to confirm their presence in 2015, and to monitor the crossing of the corridor in this area by both chimpanzees and other wildlife.

<u>Hunting remains a great threat to the wildlife throughout PGNP</u> and appears to be increasing. Though the transboundary bushmeat markets have been closed down this year by FDA, hunting pressure is still high. High hunting along the border indicates that possibly Ivorians are also hunting within the PGNP, as well as the Ghanaians settled in the park for chewing-stick harvesting. Hunting is also high near Bilibo community, where active mining sites are present. An effort to stop hunting through intense patrols by FDA rangers is needed imminently.

Other anthropogenic activities in the PGNP with known negative impacts on wildlife include <u>farming, mining and growing instances of chewing-stick cutting activity</u> which is particularly developed in the northern areas along the Cavalla River, probably to facilitate the border trade. Indeed, such activities may lead to a decline in vegetated surface, soil erosion and alter interactions among organisms which ultimately lead to the decline of biological diversity and abundance (Morris, 2010; Musa and Jiya, 2011).

<u>One of the most significant findings</u> this year from biomonitoring is the hundreds of observations of chewing-stick harvesting. Further investigations made by the teams in the field showed that the chewing-sticks are being harvested by groups of Ghanaians, who export the chewing sticks (*Garcinia Spp*) to Ghana via Côte d'Ivoire. Local communities received payments from the harvesters to settle in the forest, while FDA also received payments for permits for harvesting. However, the permits did not state the locations of the harvesting and as such, the Ghanaians settled in the protected area right along the border with Côte d'Ivoire. In July 2014, FDA cancelled all permits due to observations made during the biomonitoring data collection. Additionally, <u>mining is occurring within the PGNP</u>, in the community area of Bilibo. Though the active sites are outside the original limits of the GNF, new prospection sites are found further inside the forest. Efforts should be enforced by all authorities to ensure the trade is control and stopped within the PGNP.

The location of the new PGNP along the border means that <u>threats are also coming from Côte d'Ivoire</u>, requiring communication and collaboration with Ivorian authorities. Discussions with communities in both Grand Gedeh and River Gee around PGNP showed that Liberian and Ivorian farmers are developing cocoa and rubber farms both in and around the forest, putting further pressure on the park. Moreover, all produce is then exported to Côte d'Ivoire, as the communities say that there is no transport or means to export the produce to a city in Liberia. In addition to the farmed produce, chewing-sticks and also bushmeat are being brought over illegally to and sold in Côte d'Ivoire. The Cavalla River, acting as boundary for the PGNP, has become a way of easily accessing the forest for communities living on the other side of the border. With no ranger posts or patrols along the river/border, the lack of control and law enforcement has meant people are not only encroaching within the park, but also using the natural resources, degrading the habitat and hunting the wildlife (wildlife is relatively less abundant along the Cavalla River). Information concerning these issues must

be shared with the authorities in Grand Gedeh and River Gee, as well as with the Ministry of Agriculture, Ministry of Lands, Mines and Energy, as well as with the Bureau of Naturalization and Immigration. Potentially, a task force could be created to deal with these cross-border issues, to reduce the impact on PGNP.

In general, encounter rates of animals were higher in the central and northern areas of the PGNP. This is not surprising as the majority of the southern area corresponds to the Native Reserve of the Glaro people, where just under 2,000 people reside. Farming is high in these areas, and therefore wildlife is less likely to be abundant. This should be taken into account for the re-delimitation of the Grebo National Park Boundary lines. The native reserve of the Glaro people area is relatively degraded in forest cover (see satellite images 2009 in Appendix 2) and therefore can be removed from the PGNP, though forest areas along the Cavalla river that link the isolated patch to GNF should be included in the new park boundaries (see Figure 1). A final proposition of a new delimitation of the PGNP should therefore be discussed with FDA, local authorities and local communities as soon as possible. Results from land-use studies to be done in 2015 will help to propose more refined limits for the PGNP. Our results showed that communities in River Gee generally respect the original boundaries of the GNF, with very few farms observed in the south within the GNF boundaries.

Globally, our initial understanding of the population dynamics of large mammals and threats from human activities within the new PGNP is well clarified from this study. Most importantly, it confirms the high potential of the new PGNP for the biodiversity of Taï-Grebo-Sapo and it requires immediate recommendations (see next section) for both the Liberian government through the Forestry Development Authority and international donors to improve its management and conservation.

5.   CONCLUSION AND RECOMMENDATIONS

The first official phase of biomonitoring reported here has confirmed the rich diversity of large mammal species, including endangered, endemic and vulnerable species, inhabiting the Proposed Grebo National Park. 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 247 individuals (range 155-396; CV=24.15%). Attention and immediate action is, however, needed from the Liberian government, conservation NGO's and international donors to significantly reduce the threats faced by this area so rich in biodiversity. .

The creation of Grebo National Park is vital to ensure integrity of the Taï-Grebo-Sapo Forest Complex. Many of the threats that weigh upon the park are cross-border in nature and should thus be handled accordingly. Recommendations on local, national, and international scales are provided below:

i)   Using the results of the biomonitoring survey and ecoguard patrols (WCF 2014), a new proposition for the PGNP boundary lines should be made. A land-use survey in the corridor areas in River Gee should then be led to refine the boundary lines and to demarcate them on the ground. A workshop with FDA, WCF, local authorities and local communities, should be organised to validate the boundary lines together, and the demarcation process in the field should be performed by a joint team (FDA, WCF, local community members).

ii)   FDA should carry out urgent law enforcement patrols within the park. Such patrols could be joined by Immigration officers, Police, and even the

Emergency Response Unit (ERU). A clear message from the Liberia authorities is needed to ensure that the chewing-stick trade is stopped immediately. Patrols should first target the camps along the border.

iii) FDA should send an official communication to the Ministry of Forests and Water in Côte d'Ivoire to state that export of bushmeat and chewing-sticks has been banned by the FDA and that all permits have been annulled. Transboundary meetings between FDA and Liberian Immigration with Water and Forest Agents and Ivorian Immigration should be held to develop better coordination and communication with key state institutions working along the countries' border.

iv) Ranger posts along the border, in the park, and on the other side of the park should be built. A permanent presence of rangers is needed to stop hunting inside the park, as well as other illegal activities. Ranger posts should also be placed at known crossing points to stop the trade of bushmeat and chewing sticks.

v) 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 park, as well as to ensure the communities understand the implications of carrying out illegal activities within PGNP. 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.

vi) External funds supporting the creation of the park should be made available as soon as possible. PGNP lacks core operational funds, material resources and human resources to function correctly. Results from 2014 show that the park is under more pressure than ever before, and the presence of FDA in the communities and in the park is needed now to stop this increasing trend. Studies in neighbouring Ivory Coast have shown how lack of funds in protected areas has led to a 50% decrease in wildlife in just one year (Kuhl et al, *in Prep*).

vii) Biomonitoring should be implemented annually to monitor the populations of wildlife and the anthropogenic threats. WCF should continue to work with FDA directly and continue to build the capacity of rangers to collect and manage data. Extra training in 2015 on species identification should be done to improve the skills of the data collectors in the field. Data collected on birds and reptiles could potentially be removed from the data collection process to reduce time spent on the transects and allow the teams to concentrate their efforts on observations of large mammals.

viii) Camera trap studies in the horn of the PGNP along the Cavalla River, in the natural corridor with Cavally Classified Forest, should be done to try and observe if the corridor is used by the chimpanzee populations and other wildlife populations.

ix) Certain transects in this data collection phase passed nearby to towns such as Youbor and Freetown in the Native Reserves. Clearly, the idea of collecting biomonitoring data in these areas is a waste of resources. It is suggested that in the next phase of data collection, the transects that fall in these areas are discarded from the protocol.

x) Map the Leopard town Community Sacred forest and study if and how it can or should be included in the Grebo National Park.

ACKNOWLEDGMENTS

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APPENDICES

Appendix 1

List of field team members including experts -

| NAME	TEAM POSITION
Zoro Berenger	WCF Supervisor
Clement Tweh	FDA/WCF Supervisor
Amstrong Saylee	FDA Biomonitoring Team A member
Akkon Amos Odee	FDA Biomonitoring Team A member
John Kaso	FDA Biomonitoring Team A member
Turay Paideah	FDA Biomonitoring Team A Volunteer
Lewis Monu	FDA Biomonitoring Team A Volunteer
Josephus Nyeneken	FDA Biomonitoring Team B member
Lester Cheapoo	FDA Biomonitoring Team B member
Stephen Teah	FDA Biomonitoring Team B member
Shad Nebo	FDA Biomonitoring Team B Volunteer
John Miaply	FDA Biomonitoring Team B Volunteer
Napoleon Cheneken	FDA Biomonitoring Team C member
Polasky Yoh	FDA Biomonitoring Team C member
Eric Kayo	FDA Biomonitoring Team C member
Junior Augunstine Nimely	FDA Biomonitoring Team C Volunteer
Roty Gbayea	FDA Biomonitoring Team C Volunteer

Appendix 2
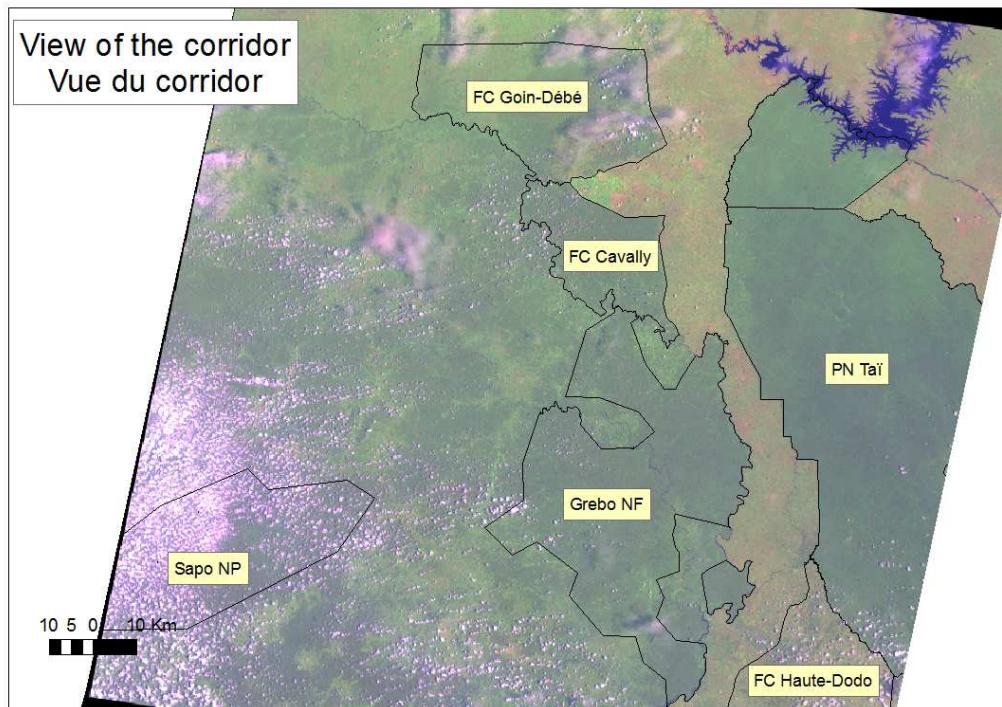
Figure 14: Satellite image of the TGSFC in 2009.
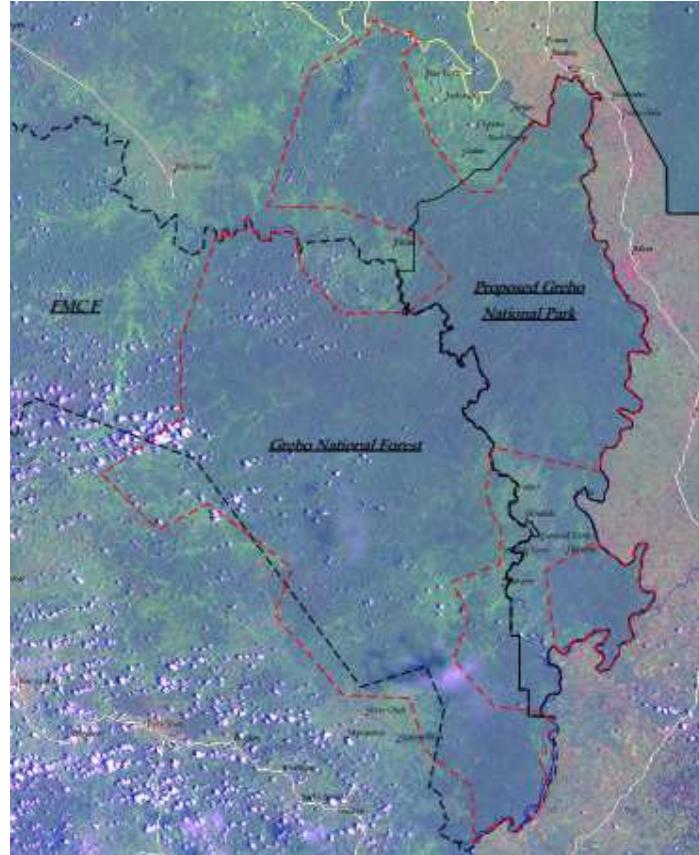
Figure 15: Close up on Grebo Forest Cover