REPORT ON THE POPULATION SURVEY AND MONITORING OF CHIMPANZEES IN SAPO NATIONAL PARK, LIBERIA (JUNE – DECEMBER 2009)

WCF/FDA

April 2010

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SUMMARY

A chimpanzee and elephant survey was conducted in the Sapo National Park (Liberia) from June to December 2009. The current report is written by the Wild Chimpanzee Foundation (WCF) and presents the data relative to the chimpanzee survey. The content of this report results from a successful collaboration between the WCF and the CITES programme for Monitoring the Illegal Killing of Elephants (MIKE) and the Forest Development Authority (FDA) of Liberia throughout the duration of the project.

In accordance with IUCN Primate Specialist Group standards, the survey of chimpanzees consisted of counts of chimpanzee sleeping nests on transects and estimates of nests mean lifetime derived from a decay study. A systematic design was used for the survey; 44 line transects, each one kilometre in length, were effectively walked during transects counts. In total, 178 chimpanzee nests were observed during transect walks and 295 fresh nests were marked for the decay study.

The encounter rate of all activities (feeding sites, vocalisations, nests) of chimpanzee in the park was 5.07 signs per km. However, the density of nests was 99.49 nests per sq km and the estimate of chimpanzee density was 0.864 individuals per sq km. In this study, the mean nest lifetime was estimated at 100.69 days. Using these estimates and chimpanzee nests production rate (1.14 nests per day) in the Taï National Park, we estimated the population of chimpanzees in the Sapo National Park, excluding mining areas, to be 1079 individuals with a 20.99% CV and confidence intervals ranging from 713 to 1633. The results of a multivariable analysis indicated that the proximity of villages and human activities in the park were the variables the most likely to influence the distribution of chimpanzees in Sapo National Park.

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1. INTRODUCTION

Sapo National Park (SNP) is one of the last remaining blocs of tropical rainforest in West Africa. Previous surveys of elephants and chimpanzees have been conducted in this park but several years ago (Barnes and Dunn, 2002; Nisbett and Agoramoothy 1990). The lack of updated information on the population of these two keystone species makes conservation planning and management decisions difficult. It has therefore been a priority for the WCF, GRASP, the CITES-MIKE and the FDA to survey elephant and chimpanzee populations in the SNP.

In 2009, the Wild Chimpanzee Foundation (WCF) and the CITES programme for the Monitoring of Illegal Killing of Elephants (MIKE) in collaboration with Forestry Development Authority of Liberia (FDA) gathered sufficient funding to undertake a survey of elephants and chimpanzee in the Sapo National Park. The overall long-term aim of this survey was to enhance the survival of the West African chimpanzee and forest elephant subspecies by assessing their status in the Sapo National Park and improving the relevant management strategies.

The present report aims at presenting information relative to the Western African subspecies of chimpanzee (*Pan troglodytes verus*) collected by the Wild Chimpanzee Foundation and the aforementioned institutions during the survey in the Sapo National Park. Although data on the population size and distribution of the two species were collected by all the institutions, the main objective for the WCF was to contribute to the lasting protection of viable chimpanzee populations in their original forested habitat.

For that, the specific objectives of the WCF were to:

1. Estimate the density, abundance and spatial distribution of chimpanzees in Sapo National Park in compliance with approved survey standards.
2. Identify threats and other factors influencing the distribution and density of chimpanzees in Sapo NP and to understand their inter-relationships.
3. Make a contribution to the updating of the management plan for Sapo NP to help ensure the long-term survival of chimpanzees and their habitats.
4. Reinforce the capacity of Sapo National Park staff in population monitoring techniques for chimpanzees with a view to maintain a long-term monitoring programme, and to enhance the capacity of Liberia's national officers to collect and process data in accordance with IUCN Primate Specialist Group standards.
5. Gain the support of the local population for the conservation of the Sapo National Park by including them in the survey activities and providing income.

6. Provide a model of collaboration between different organizations in surveying multiple flagship species by harmonizing methodologies, eliminating duplication of effort and minimizing costs.

To reach these objectives, the overall project field work consisted of a pilot study including the training phase of local managers, a decay study of chimpanzee nests and data collection on predefined transects.

2. METHODS

2.1. Study area

The field data were collected in the Sapo National Park (SNP). It is the first national park in Liberia, and it is largely located in Sinoe County in the south-eastern corner of the country (**Figure 1**). This park is a fragment of lowland rainforest of the Upper Guinean Forest ecosystem which covers about 1,500 sq km including the current extension areas. It falls between latitudes N 5-6°and longitudes W 8-9° and is one of the most intact forest ecosystems of Liberia. The boundary of the park is buffered by a belt of community forest and the northern zone is largely characterised by a hilly terrain.

Figure 1: Map of Liberia showing the counties and the location of Sapo National Park

Rainfall is bimodal with peaks in June- July and September- October. Replete in biodiversity, the mammal fauna at SNP includes the West African chimpanzee (*Pan troglodytes verus*), forest elephant subspecies (*Loxodonta africana cyclotis*) and other endangered species such as the pigmy hippopotamus (*Hexaprotodon liberiensis*) Jentink's

duiker (*Cephalophus jentinki*), Red colobus (*Procolobus [Piliocolobus] badius)* and Diana monkeys (*Cercopithecus diana diana).*

Despite the efforts of the government and the FDA who manages SNP with the support of international NGO's such as Conservation International (CI), Fauna and Flora International (FFI); the park is still threatened by illegal settlers engaged in illicit gold mining and hunting (Freeman, T. and Blamah, G., Pers. Comm.).

2.2.Collaboration, training of local people and capacity building of FDA staff

Collaboration between the WCF and the IUCN program MIKE started, before travelling to Monrovia (Liberia), by communication via emails to standardize the methodological issues of the survey of both species. The project was then officially launched on June 2nd 2009 with a meeting held in Monrovia. It was an opportunity for both the WCF and MIKE to present the objectives of the project to Liberian local conservation authorities and NGOs (FDA, CI, FFI etc.) and to discuss logistical problems or other issues that may contribute to the success of the project.

In addition to that, staff members of both the WCF and MIKE with the help of FDA purchased all local materials in Monrovia and Greenville. The two experts for the chimpanzee survey from the WCF (Paul K. N'Goran and Célestin Y. Kouakou) and the two experts for elephant survey from the IUCN/MIKE and WWF travelled to Jalay's Town (Park headquarters) in order to coordinate a theoretical and practical training workshop to form the field teams. Before the training, Mr. Theo Freeman (FDA) introduced staff members of both the WCF and MIKE to local resident communities of the SNP especially those in Jalay's Town and Juarzon.

In harmony with FDA and resident communities, a total of 18 people were chosen in order to train and form the survey teams (**Appendix 1**)**.** Among them 11 were FDA personnel and 7 local inhabitants. A survey manual describing the relative nest age classes and the precise methods for surveying chimpanzees was developed by the Wild Chimpanzee Foundation experts. During the training workshop that took place in Juarzon, a copy of the manual was given to each of the participants. The manual served as a guide allowing participants to better understand the training workshop and all other steps of the survey in the Sapo National Park. During the workshop, the participants were taught about:

- Navigation using compass, GPS and Maps
- Line transect method
- How to avoid obstacles on transects

- The retrospective nest decay experiment
- Identification and classification of chimpanzee nests
- Basic forest ecology and vegetation type description.

Subsequently, the FDA officers were taught about the use of the software MapSource for the management and the supervision of the field missions, as well as data entry requirements for future analyses. Overall the workshop was very successful with all participants very motivated to carry out the work and to be involved in the project.

2.3. Field survey

The training workshop was followed by the pilot study and the search of fresh nests of chimpanzees in the SNP for the decay study.

2.3.1. Pilot study and chimpanzee nest decay study

We undertook the pilot study of the project in the Sapo National Park from June 8th to July 2nd. Previous to this, a collaborative design for the study was created, taking into account the need to survey for both chimpanzees and elephants. Survey of chimpanzees consisted of looking for chimpanzee nests on lines of least resistance (with minimum cuttings) known as the reconnaissance surveys transect method (Peres 1999; Walsh and White 1999; Kühl 2008). The two species were surveyed on the same transects. Details of the pilot study methodology can be found in the intermediate report. During the pilot phase, at least one WCF-MIKE staff member was present in the field during the different missions to supervise the three teams and reinforce the practical knowledge of team members. Indeed, as far as the WCF was concerned, the pilot phase was designed to:

- Identify and contribute to the capacity building of the Liberia wildlife staff in WCF standards that follow the IUCN Primate Specialist Group standards and in MIKE survey standards;
- Obtain an estimate of encounter rates of chimpanzee nests (number of nest groups/km or number of nests/km), then to ascertain the optimum sample size of transects (number and length) to be distributed to adequately sample the population of chimpanzees;
- Predict the logistical constraints likely to occur during the main survey
- Plan the steps to comprehensively and simultaneously survey chimpanzee and elephant populations in Sapo NP. Two elephant experts from CITES MIKE and WWF and two chimpanzee experts from WCF undertook the pilot survey with eighteen field officers in Sapo.

To estimate the decay rate of nests or mean life time of chimpanzee nests in the Sapo National Park, we marked 6 batches of fresh nests at regular intervals between June 2009 and October 2009, these nests were then revisited to know whether they were still considered present or not (Laing et al. 2003). To avoid any bias in decay time estimates, the three teams investigated different areas and/or habitats of the park likely to experience different ecological factors. Searches of freshly built nests were made during 5 to 7 days of field missions. For each fresh nest observed, an identification code was written on the tree and on a coloured tape that was attached to the nearest stick below the nest. Then, by recording the geographical information about the location of each nest (GPS coordinates), we were able to relocate all nests and to check upon the decay stage at revisits. In total 295 nests were marked before counts on transects and 285 were revisited. We started revisits after 17 transects out of 44 had been sampled; the datasheets (**Appendix 2**) were filled in for further analyses.

2.3.2. Survey design and chimpanzee nest counts on line transects

Following the results of the pilot study and field constraints, we found it was appropriate to use a systematic design for surveying chimpanzees and elephants in the Sapo National Park. To ensure that each location in the area had the same probability of being sampled, we used ArcGis 9.2 and set up systematically spaced and parallel transects with each transect being one (1) kilometer each in length (**Figure 2**). Transects were orientated (East-West) in order to cross the drainage line of major rivers such as the Sinoe river; many rivers of the Park flow approximately in north-south direction.

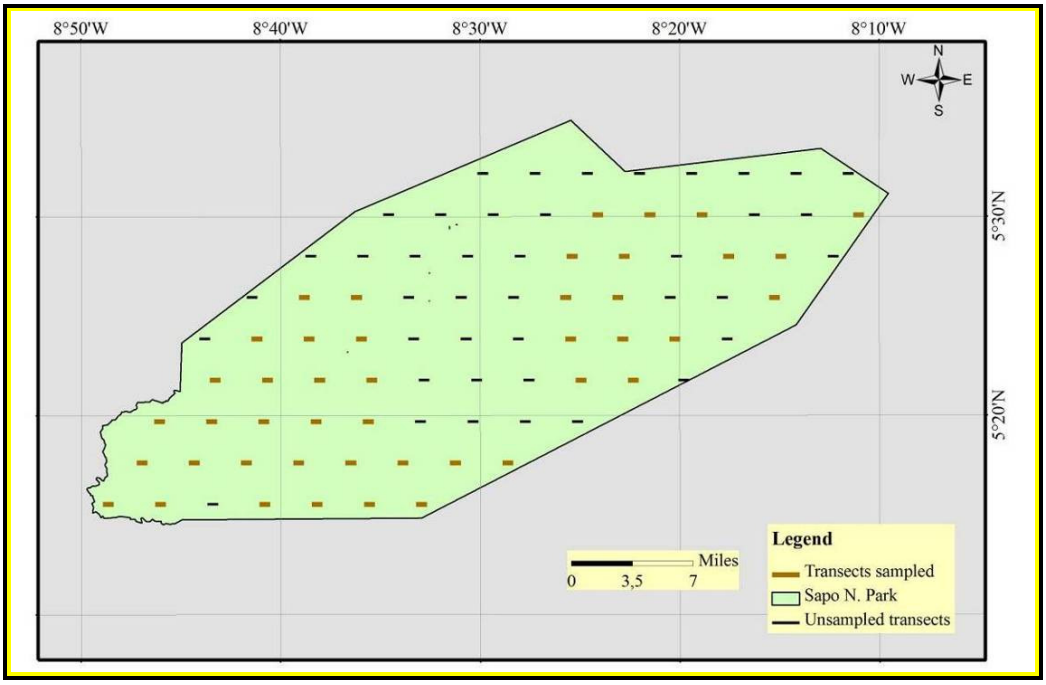

Figure 2: Survey design used for surveying chimpanzees in Sapo National Park

Due to the poor visibility in forested habitats such as the Sapo NP and the cryptic behaviour and low densities of the targeted species, surveys of chimpanzees relied on counts of sleeping nests to estimate chimpanzee population status in the Sapo National Park (Marchesi et al. 1995; Plumptre and Reynolds 1996). We conducted nest counts on line transects using distance sampling methodology (Buckland et al. 2001; Kouakou et al. 2009). Starting points of line transects were located in the field by using a map; a Garmin GPSMAP 60Cx (Global Positioning System) receiver containing all transect locations and a compass. Based on ground information or field observations during the pilot phase, mining activities were known to occur in the park and the locations were known. Therefore, we did not survey transects located in the suspected mining areas for security reasons and also because chimpanzees were unlikely to occur there.

To collect data when walking along line transects, each team was composed of six people. Among them four walked strictly on the line transect collecting data on habitat type, the presence of chimpanzees (nests, feeding sites or vocalisations), elephants and other large mammals. The two other observers walked at five meters maximum away from the line (on the left and right), specifically searching for chimpanzee nests on the line and next to the line. This particular disposition of observers on the transect aims at ascertaining the maximum detection of nests on the transect line as required for distance sampling data analysis. The length of transects was precisely measured with a hip chain. Team members looked for nests following standard nest count techniques along line transects, based on distance sampling methods. The following notes were recorded in the datasheet (**Appendix 3**) each time a chimpanzee nest was observed:

- the distance walked along the transect, measured with the hip chain;
- the perpendicular distance from the line to the nest of chimpanzee (location underneath the nest), measured with the measuring tape,
- coordinates of nest-group using the GPS;
- chimpanzee nest decay stages or relative age classes (Kouakou et al. 2009; Marchesi et al. 1995),
- height of nests above ground estimated per five meter intervals of distances, for example 5-10 meters high;
- Nesting tree species when known (either the vernacular name or scientific name).

In addition to searching for chimpanzee presence signs, we also recorded human aggression signs, ecological factors (habitat type) and other threatened and/or endemic fauna species in the park (**Appendix 4**).

2.4. Data analysis

2.4.1. Chimpanzee population status analysis

To estimate the population size of chimpanzees in the Sapo National Park (SNP), the densities of nests along transects, the mean lifetime of nests and the nest production rate were the necessary covariates to be estimated. Given that no habituated chimpanzees exist in SNP, for our conversions, we used the value of nest production rates estimated by Kouakou et al. (2009) in the Taï National Park, the closest park to Sapo with habituated chimpanzee communities. The mean lifetime of nests in the SNP was estimated by analyzing the decay study data. For all chimpanzee nests, we defined the response variable CD (Code Decay) to be **1** if a nest was judged not to have decayed at the time of the revisit or **0** otherwise. We followed Laing et al. (2003), and we fitted a logistic regression model to the decay study data. We included only **age** as a covariate, and the analyses were performed using the software R to estimate the parameters by using the **Markov regression models for time series**, and we calculated the mean lifetime in Excel.

To estimate densities of nests at SNP, we used nest count data recorded along line transects and performed analysis with the software Distance 5.0 commonly used for distance sampling data analysis. We followed Buckland et al. (2001) to estimate nest densities as follows:

$$\hat{D}n = \frac{n}{2wL\hat{P}_a}$$

Where $\hat{D}n$ is the estimated nest density; n is the number of nests detected in the surveyed area a with $a = 2wL$; L being the total length of transect lines or survey effort and w the distance from the transect line beyond which no nests were detected; $\hat{P}_a$ the probability that a randomly chosen nest within the surveyed area a is detected. We grouped perpendicular distances and we discarded the largest 5% of these observations in all analyses to facilitate model-fitting to the data. We tested several models of detection function and we selected the model with the lowest AIC (Akaike Information Criterion) (Buckland et al. 2001).

2.4.2. Factors affecting chimpanzee population and spatial distribution

To estimate the spatial distribution of chimpanzees in the Sapo National Park, we used chimpanzee presence signs especially sleeping nests and feeding site locations and performed spatial analysis in ArcGis. We specifically interpolated the encounter rate of the presence signs recorded for each transect with the Inverse Distance Weighted (IDW) option.

To know the key factors that explain the distribution of chimpanzee in the SNP, we performed General Linear Models (GLM) on the distribution of nests and all other signs on

transects. We extracted spatial covariates by using ArcGis 9.2 and Excel software, and we found the following variables:

- OFL: Open forest length on line transects (Ecological factor: primary forest);
- DVT: Distance to villages and towns (Human pressure around the park);
- WAT: Water lines (Ecological factor: encounter points of creeks, streams and rivers)
- HUM: Human illegal activities on transects (Human pressure in the park)
- DMZ: Distance to mining zones (Human pressure: Permanent activities in the park).

In total, we got 32 models by all combinations with the 5 covariates. We fitted chimpanzee nests and all chimpanzee signs recorded on transects to all models by using the negative binomial function. We then sorted all AIC that were smaller than AICs of null models. The assumption for the null model is a homogeneous distribution of chimpanzee signs across the park. All variables included in the best models (models with the smallest AIC) are supposed to explain the density and the spatial distribution of chimpanzee signs in Sapo National Park.

3. RESULTS

3.1 Pilot study

During the pilot study, a total of 77.6 km of survey transects were walked by the three teams, each supervised by at least one of the chimpanzee or elephant experts. We observed 216 chimpanzee nests and a total of 15 poaching signs excluding poacher's cuttings and trails. The results of the pilot study indicated that 27 km were enough to achieve a CV of 20% for surveying chimpanzees in the Sapo National Park. Details about the pilot study can be found in the intermediate report prepared by the WCF-MIKE team.

3.2 General results: Synthesis of all fauna data recorded on transect

Table 1: Synthesis of direct and indirect observations of elephants and other large mammals

Species	**Direct observations**	**Indirect observations**
Chimpanzee (*Pan troglodytes verus*)	0	223
African Elephant *(Loxodonta africana)*	0	131
Diana monkey (*Cercopithecus diana*)	0	09
Red Colobus *(Procolobus badius)*	01	03
Mangabey monkey (*Cercocebus atys*)	01	03
Lesser white-nosed Monkey *(Cercopithecus petaurista)*	01	02
Mona Monkey *(Cercopithecus mona)*	00	03
Western Black and White colobus (*Colobus polykomos*)	00	02
Olive colobus monkey *(Procolobus verus)*	00	02
Pygmy hippopotamus *(Hexaprotodon liberiensis)*	00	02
Zebra duiker *(Cephalophus zebra)*	00	06
Jentink's duiker *(Cephalophus jentinki)*	00	05
Small duikers	01	36
TOTAL	**04**	**427**

*NB:*For monkeys, observations of groups were shown and only vocalizations were reported here as indirect observations. Indirect observations reported for duikers and elephants consisted only of dung.

Recorded fauna data consisted mostly of indirect observations dominated by duikers, chimpanzee and elephants signs (**Table 1**). Due to the nature of the survey, we did not pay attention to other signs of fauna in the park.

3.3 Chimpanzee population status in Sapo National Park

- **Densities, distribution and decay time of chimpanzee nests in Sapo National Park**

In total, 178 nests were observed along the 44 line transects surveyed (**Table 2**). Consequently, the encounter rates of chimpanzee nests in the Sapo National Park were 4.045 nests per kilometer walked. We found at least one nest on 31/44 transects (70.45%).

Table 2: Synthesis of observations of chimpanzee presence on transects

Chimpanzee presence sign	Total observed	Encounter rates (observations/km)
Chimpanzees seen	0	0
Chimpanzees heard	05	0.114
Chimpanzee nests	178	4.045
Chimpanzee feeding sites	40	0.278
TOTAL	**223**	**5.068**

During transect counts, the teams heard different groups of chimpanzees five times, and the teams reported 40 feeding sites. Among the candidates' models during analysis in Distance 5.0, the half-normal model with cosine as adjustment term was chosen. The AIC of that model was 573.04. The results from the analysis using Distance 5.0 are given in **Table 3**.

Table 3: Parameter estimates of chimpanzee nests in the Sapo National Park

Parameters	Point estimate	Percentage coefficient of variation	95% Confidence Interval
Nest densities Dn (nest/km²)	99.49	19.83	[67.10 – 147.49]
Nest abundance (nests)	124 170	19.83	[83 753 – 18 4090]
Nest detection probability (P)	0.57	6.46	[0.50 – 0.64]
Effective Strip Width (ESW)	19.47	6.46	[17.50 – 22.57]

Our results indicated that the density of chimpanzee nests (Dn) were 100 nests per sq kilometer. When excluding the areas not surveyed from the total size of the Sapo National Park (1549.94 sq km), we were able to estimate that 124 170 nests of chimpanzee were present in the park during the study period. Furthermore the nests of chimpanzees were not

equally distributed in the different vegetation types we identified. As such, we found 121 nests in the open (primary) forest, 30 nests in the swamp habitats, 22 in the disturbed forest areas and 5 nests were found in the swamp habitats dominated by raffia trees.

The distribution of chimpanzee nests throughout the park is indicated by **figure** 3. Nests of chimpanzees can be found in different areas of the Sapo National Park. However, the results indicated a spatial heterogeneity in the distribution of chimpanzee nests. They were more likely to be found in the eastern, south-eastern and north-western areas of the park; and at the period of the survey, chimpanzees may build nests in some mining areas of the park. In total, 295 nests were marked for the decay study and 285 nests were revisited. However ten of them (only 3.39%) were not revisited due to field constraints or were not relocated because the flag (mark) could not be seen. During revisits, we found that 84 nests had completely decayed or disappeared while 201 nests were still present. When applying the method of Laing et al. (2003), we found that the mean lifetime of chimpanzee nests in the Sapo National Park was 100.69 days.

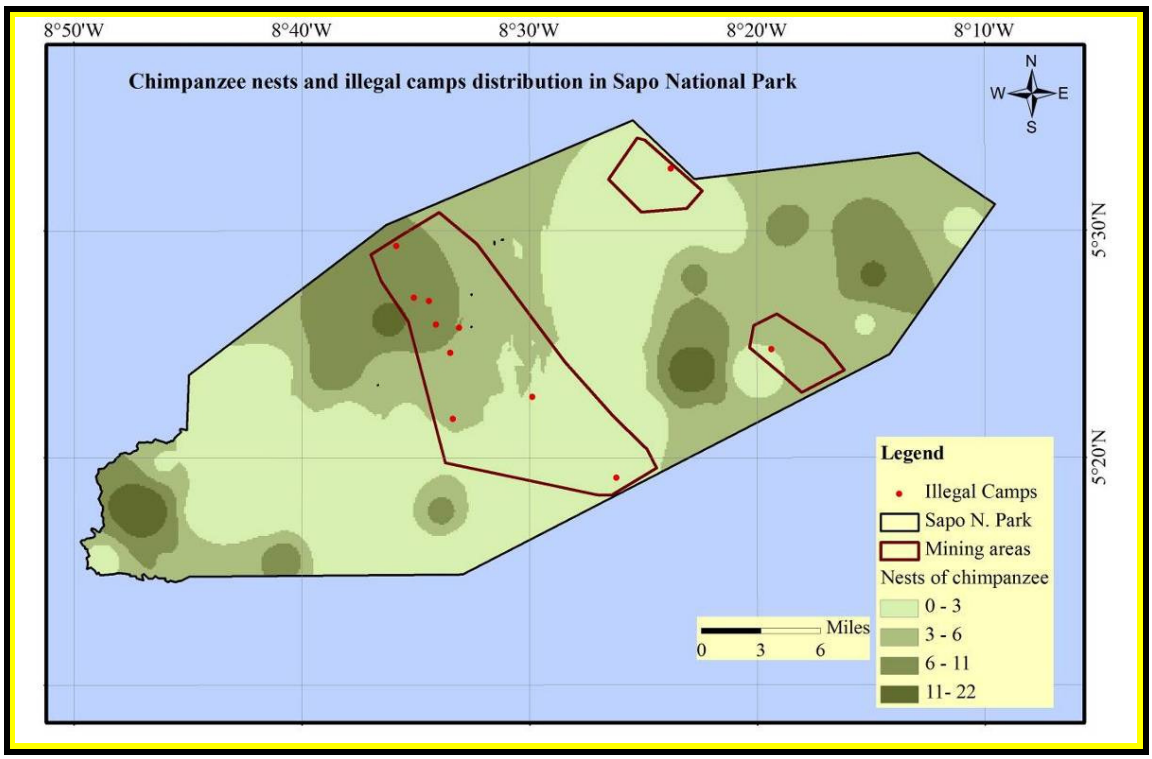

Figure 3: Chimpanzee nests distribution in Sapo National Park

- **Densities, abundance and spatial distribution of chimpanzee populations in Sapo National Park**

When using the aforementioned mean lifetime of nests in the Sapo National Park and the nest production rate of chimpanzees in the Taï National Park (1.143 nests per chimpanzee per day), our analysis in Distance 5.0 indicated that the density of chimpanzees in the Sapo

National Park was 0.864 individuals per sq kilometer (**Table 4**). However, to estimate the abundance of chimpanzees in SNP, we considered two situations: the abundance excluding the mining areas that were not surveyed (**Figure 3**) and the abundance of chimpanzee when extrapolating the densities from the areas surveyed to the whole park. In each of the cases the point estimate (mean estimate) of chimpanzees was beyond one thousand.

Table 4: Density and abundance of chimpanzee in Sapo National Park

Parameters	Point estimate	Percentage coefficient of variation	95% Confidence Interval
Chimpanzee densities Dc (indiv./km²)	0.864	20.99	0.571 – 1.308
Chimpanzee abundance (indiv.): Entire park [a]	1340	20.99	885 - 2028
Chimpanzee abundance (indiv.): Excluding mining areas [b]	1079	20.99	713 – 1633

[a] Chimpanzee abundance estimated without excluding the mining areas that were not surveyed (the estimates from the areas surveyed were extrapolated to the entire Park of size 1549, 49 sq kilometers)
[b] Chimpanzee abundance estimated by excluding the mining areas that were not surveyed (the total area size of the park excluding the mining zones was 1248.11 sq kilometers).

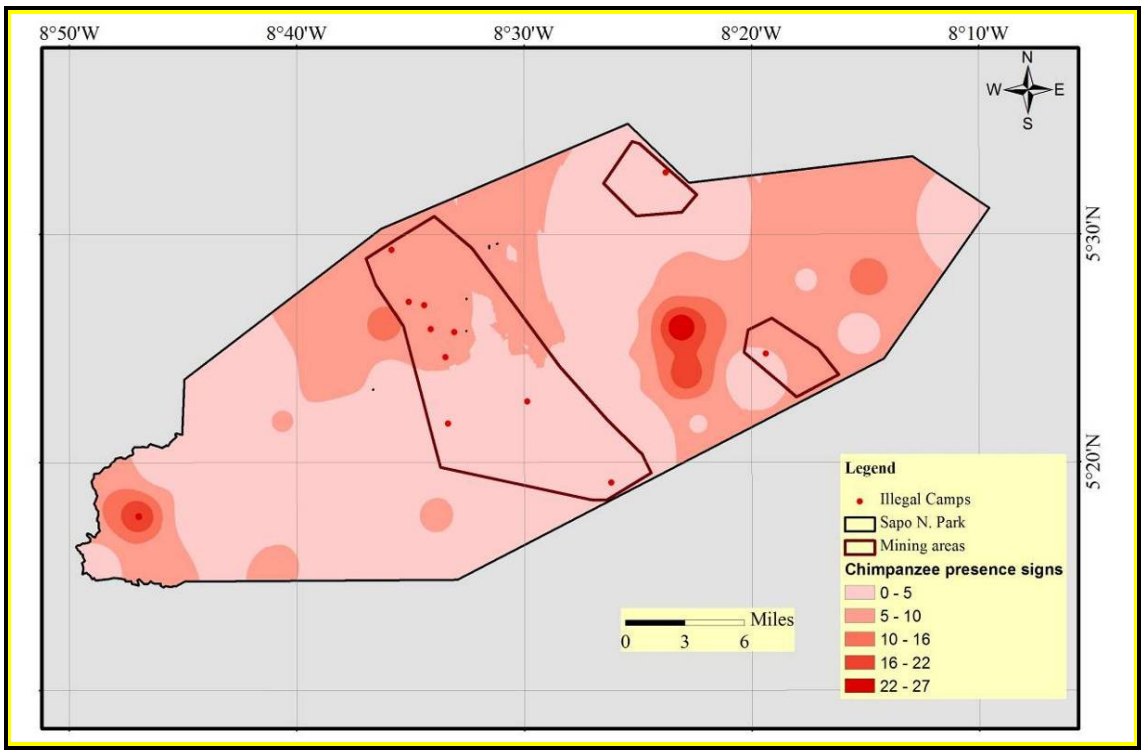

Figure 4: Spatial distribution of chimpanzee in Sapo National Park and location of illegal mining camps

In **Figure 4**, we indicated the distribution of chimpanzees in the whole park shown by interpolation analysis using the locations of nests feeding sites and other presence signs of chimpanzees.

The distribution of all chimpanzee presence signs was similar to the distribution of nests shown in **Figure 3**. Although chimpanzees are unlikely to occur in the mining area situated in the northern area of the park, the interpolation results indicated that we may find chimpanzees in other locations situated in the mining areas. From **Figure 4,** three distinct areas can be distinguished as occupied by chimpanzee communities in the Sapo National Park: the eastern, the south-eastern and the north-western areas of the park. Surprisingly, we found that the central zones of the park were less likely to have high numbers of chimpanzee presence signs.

3.4 Threats or factors influencing the distribution and density of chimpanzees in Sapo National Park

Based on field observations, we found illegal activities to occur in the SNP. Indeed, evidence of illegal activities was indicated by direct observations of poachers, camps of poachers, gun shots heard, snare settings observed, used cartridges and other illegal human activities.

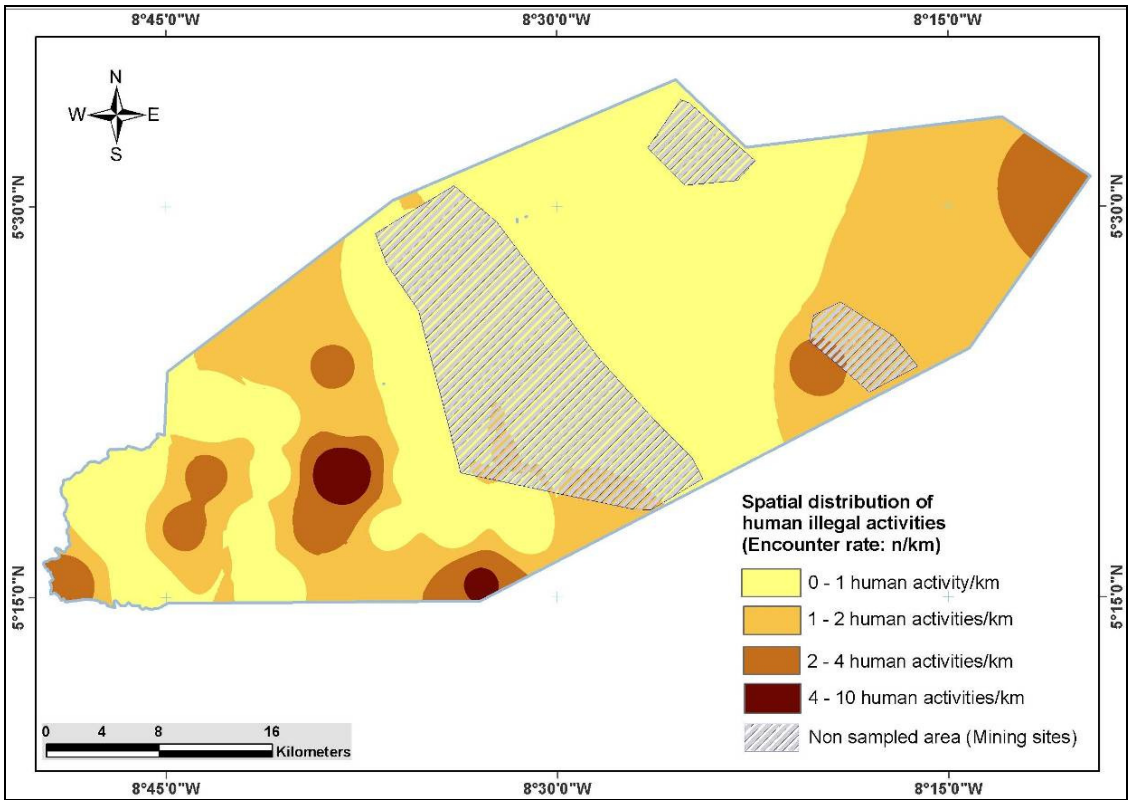

Figure 5 : Spatial distribution of human illegal activities in Sapo National Park

In total, the encounter rates of all these illegal activities during line transect surveys was about 1.2 signs per kilometer walked (**Table 5**).

Table 5: Human activities or illegal signs encountered on transects

Human signs encountered	Total observed	Encounter rates (Signs/Km)
Poachers	07	0.159
Poacher trails	04	0.091
Ranger trails	01	0.023
Cartridges	02	0.045
Gun shots	03	0.068
Snares	01	0.023
Other human activities	38	0.864
TOTAL	**56**	**1.273**

These reported encounter rates excluded the mining activities because line transects situated in the mining zones were not walked for security reasons. However, we wanted to emphasize that the teams had evidence of mining activities in the Sapo NP by hearing and seeing humans, and observing large trails in close proximity to the areas shown in **Figure 5** as mining zones**.**

Figure 6: Poachers' camp observed in Sapo National Park

More specifically the field teams saw 7 poachers, heard gun shots on three occasions when walking transects and found two camps (**Table 5**). Two large camps were also observed by one of the teams when walking between transects (**Figure 6**). Furthermore, during a week

field mission for the decay study in October 2009, a team heard gun shots, saw 19 snares settings and 9 used cartridges.

Prior to the spatial analysis aiming at determining the variables that influenced the distribution of chimpanzees in the SNP, we tested the spatial autocorrelation (Moran's I) to avoid violating the assumptions of data independence. We found that Moran's Index I was -0.04 and -0.03 respectively for nests and all signs of chimpanzee. These results indicated that at the scale of the entire survey area, chimpanzee sleeping nests and other presence signs were randomly distributed.

The covariate human illegal activities (HUM) in the park was the most likely to influence the distribution of chimpanzee nests. In addition to that factor, the distance to villages and towns was also likely to influence the occurrence of chimpanzees at a given location in the park. When comparing AICs of models better than the null ones, we can see that there is no statistical difference in between models since there is no difference higher than 2 (**Table 6**). Chimpanzee occurrence in Sapo National Park is random; the density and the spatial distribution is not highly influenced by any factor, but human pressure around the park and human activities (mainly poaching signs) appear to be potential factors that will negatively affect the chimpanzee density (**Table 6**).

Table 6: Results of the modeling process with the 5 factors (covariates)

Chimpanzee presence signs	*Model's parameters*			*Coefficients*					
	Models	**AIC**	**AICw**	**Intercept**	**OFL**	**DVT**	**WAT**	**HUM**	**DMZ**
Nests	**HUM**	222.3	0.158	1.33	0	0	0	**-0.38**	0
	Null Model	223.6	0.083	1.40	0	0	0	0	0
All Signs	**DVT + HUM**	239.8	0.105	1.53	0	**0.35**	0	**-0.28**	0
	DVT	240.2	0.088	1.58	0	**0.36**	0	0	0
	HUM	240.4	0.079	1.58	0	0	0	**-0.29**	0
	Null Model	240.8	0.062	1.63	0	0	0	0	0

OFL: Open forest length on line transects (Ecological factor: primary forest)
DVT: Distance to villages and towns (Human pressure around the park)
WAT: Water lines (Ecological factor: encounter points of creeks, streams and rivers)
HUM: Human illegal activities on transects (Human pressure in the park)
DMZ: Distance to mining zones (Human pressure: Permanent activities in the park)

3.5 Capacity building of Sapo National Park staff and contribution to the long-term survival of chimpanzees and their habitat

When carrying out this project, local villagers as well as FDA officers were trained and participated in data collection. In total 18 people of both categories were trained (**Appendix 1**) before the pilot study and before the main survey started. Their capacity was reinforced in:

- Navigation process in a forested habitat using a compass, GPS and Maps
- Indirect sign (nests or dung) sampling during line transect surveys
- The retrospective dung and nest decay experiment
- Identification and classification of chimpanzee nests and elephant dung piles
- Basic forest ecology and vegetation type description.

During the missions for the decay study and the main survey, FDA officers were enabled to supervise teams for data collection. In addition to that, two FDA officers were trained in data entry and preliminary analysis before the decay study began. They were taught how to enter all data as well as how to manipulate and organize the data in an Excel. They were also initiated on how to use GIS programs such as Map Source. Specifically they were trained on how to download and to upload data from/to the GPS devices and to produce maps of the data collected.

3.6 Collaboration between WCF and IUCN/MIKE

The collaboration was very successful and was beneficial to both implementing organizations. They saved time and money by combining two different species in one survey project. When analyzing all expenditures for field data collection (materials, mission fees for field teams, car rental and fuel for vehicles, etc.), we noticed that this represented about 50% of all the costs involved in the project implementation. Consequently, at least 50% of the project's costs were shared between the two organizations; so 25% of the project's total budget could be saved by both the WCF and the IUCN/MIKE program. Almost all materials purchased were used by both the WCF and the IUCN/MIKE program. The same field team members were used by the two organizations, and this allowed the project to use more teams for the survey which in turn also saved time.

4.DISCUSSION

The survey reported here has updated the population status of western chimpanzees (*Pan troglodytes verus*) in the Sapo National Park and contributed to the capacity building of Liberian wildlife staff in the methods of surveys and monitoring of chimpanzees and other large mammals.

Densities and abundance of chimpanzees in Sapo NP

Based on sufficient data collected over six months of field work and following the standards of the Primates Specialist Group of the IUCN (International Union for Nature Conservation), we found that the density of chimpanzees in the Sapo National Park was 0.864 individuals per sq kilometre. Prior to the main survey, we conducted a pilot study to know the required sample size or transect length needed to effectively carry out the survey; we conducted a decay study and estimated for the first time the nest mean lifetime of chimpanzees to be 100.69 days in the Sapo National Park. The decay time of nests observed at Sapo was quite similar to the recent estimate from Taï (91.22 days) (Kouakou et al. 2009). Moreover, the use of nest production rates (1.143 nests per chimpanzee per day) from the nearby Taï National Park, Cote d'Ivoire, may have further limited bias in the mentioned chimpanzee density estimate.. Using these conversion factors, the density of chimpanzees in the Sapo is relatively higher than recent estimates from the Taï NP where Campbell et al. (2008) and N'Goran et al. (2007, 2008) have reported that only about 500 weaned chimpanzees, hence half of the population estimated for Sapo, may still survive. Furthermore, our estimate of chimpanzee density (0,864 chimpanzees per square kilometre) did not, lie between the confidence limits estimated by Anderson et al. (1983) at the same site. Surprisingly, it was higher than the upper limits (0.77 chimpanzees per square kilometre) of the estimate of the above mentioned authors, which could imply that the population size of chimpanzees at Sapo might have increased over the past 25 years. From our study, one can be confident (95% of chance) that the current population size of chimpanzees in the Sapo NP lies between 850 and 1300. However for a precise estimate and considering a point estimate, it may be more reliable to refer to the value of 1037 weaned chimpanzees; the total number of chimpanzees in Sapo National Park could be about 1218 individuals when adding the proportion (17.5%) of juveniles as estimated by Plumptre and Reynolds (1996). This estimate only takes into account the areas that were effectively surveyed. It is unlikely that the same chimpanzee density estimates can be extrapolated to the mining areas: However, once the security for these zones can be assured, it would be advisable to survey these remaining areas to effectively include these zones in the overall abundance and density estimates for Sapo NP.

Our survey relied upon the counts of nests left by chimpanzees rather than direct sightings of the animals themselves. Therefore, sources of error may have been introduced with the estimates of nest decay time, nest production rate and the encounter rates of nests or detection of nests by trained team members. However, our results indicate that the SNP is one of the few tropical rainforest sites left in the world that contains a population of Western African chimpanzee (*Pan troglodytes verus*) large enough to have the potential for long term viability.

The spatial distribution of chimpanzees in the Sapo National Park and threats to the survival of their population

The spatial heterogeneity in the distribution of chimpanzee presence in the Sapo NP indicated by interpolation shows that some areas in the park may be more suitable for their survival than others. However, the spatial modelling results indicated that chimpanzees may occur everywhere in the park with the same chance and that the range of chimpanzees was not restricted to a specific area of the park; even in some zones of the mining areas, chimpanzees may have ranged there at the time of the survey. However, mining activities imply habitat destruction and contamination of soil and water by residuals of chemicals used during these operations. Moreover, permanent settlements inside the park result in illegal agricultural and hunting activities and other related dangers for the fauna, such as disease transmission. It therefore appears urgent to stop the activities of the illegal miners within Sapo National Park in order to protect the chimpanzees and other fauna and flora of the park. We therefore encourage and fully support the recent decision of the government and the Forest Development Authority to evict all illegal hunters and miners from Sapo NP (Isonpon 2010) in the coming months.

.Poaching, not only organised by illegal settlers within the park, has to be considered a major threat to the fauna in Sapo National Park. Analysis confirmed that human activities and mainly poaching seemed to influence chimpanzee density and distribution. In addition to that, increased human pressure and unsustainable land use practices around the park will need to be considered to effectively protect chimpanzees and other fauna inside the park..

In the short term, to better guide surveillance and sensitization efforts in and around the park, the managers may refer to the spatial distribution maps shown in **Figures 3, 4**. For instance, patrols should be especially reinforced inside or in the boundaries of areas of higher encounter rates of chimpanzee activities to effectively manage the population of chimpanzees in Sapo. Moreover, patrols should also concentrate on areas of highest anthropogenic threats (**Figure 5**.)

Surveys of elephants and chimpanzees in Sapo National Park: a model of collaboration for reducing effort and minimizing costs

In this study, chimpanzee survey experts from the Wild Chimpanzee Foundation with elephant survey experts from the IUCN-MIKE had trained together FDA staff and local villagers. The trainees were divided into three teams and each team simultaneously collected survey data of both elephants and chimpanzees on the same transect. Consequently, we have reduced the costs for obtaining information about the population status of both species and have increased know-how in the trainees as well as the trainers on how to survey two important flagship species. The institutional collaboration between the WCF, MIKE and FDA proved very successful as all steps of the project as well as obstacles were discussed and resolved together, resulting in a completed and complimentary survey of chimpanzee and elephant populations. We encourage such collaborations for surveying the same species or other species in other sites for effective conservation purposes.

CONCLUSION

This study has updated the population status of chimpanzees in Sapo National Park which may currently contain one of the largest populations of *Pan troglody verus* in forested habitats of West Africa. However, chimpanzees in Sapo are highly threatened by illegal settlements and mining as well as poaching activities inside park borders.Political decisions are to be taken and adequate conservation measures to be implemented to protect the biodiversity of this park, particularly the very important chimpanzee population and other threatened species including elephants.

ACKNOWLEDGEMENTS

We would like to thank USFWS/GACF and USFWS/AfECF for the financial support they provided. Thanks are due to all the partners for the logistics, the workforce and administrative support necessary to carry out this project. We wish to thank Mr. Massalatchi Sani and Mr. Yaw Boafo from the IUCN-MIKE for facilitating collaboration. Thanks to Mr. Nandjui Awo from the WWF-Tai project and Joel Gamys from Conservation International who helped us by participating in the training phase and in the field data collection. We would also like to express our gratitude to the Government of Liberia who gave authorization to do this project. We especially thank the Managing Director of Liberia Forestry Development Authority, Mr. Moses D. Wogbeh and his predecessor Mr John Woods for allowing the study to be undertaken. Thanks to Mr Theo Freeman, Mr Morris Kamara, Mr. Blamah Goll and Mr. Konnie for their personal implications in the team member selection, logistics and field mission organization. We also thank Conservation International Liberia for their administrative support. Our gratitude goes to FFI (Fauna and Flora International Liberia) officers especially to Mr Michael Abedi- Lartey who supported us with useful information and made vehicles available for us whenever it was possible. We acknowledge all the local villagers who accepted to participate in the data collection phase. Thanks to the housekeeper Elisabeth and Ojuku who took care of us in Jalay's town and Juarzon. Particular thank to Mr. Edward Dahn, Robert Nyamah, Fayiah and Joseph who safely drove us throughout the project.

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APPENDIX

Appendix 1: List of field team members including experts

Trainees and Trainers	Position (Profession)	Original working area
1. N'Goran K. Paul	Expert WCF	WCF (Abidjan, RCI)
2. Kouakou Y. Célestin	Expert WCF	WCF (Abidjan, RCI)
3. Yaw Boafo	Expert UICN-MIKE	IUCN-MIKE (Ouagadougou, RBF)
4. Nandjui Awo	Expert for Elephant	WWF-Tai project (Soubré, RCI)
5. Blamah S. Goll	FDA Park warden	Zone 1 (Sapo)
6. Korvah Vanyamah	FDA Bilogist	East Nimba Nature reserve
7. Lassana Curley	FDA Bilogist	Lake Piso Muttiple use
8. Samuel M. Frieman	FDA Ranger	Zone 2 (Sapo)
9. Jerry D. Johnson	FDA Ranger	Zone 3 (Sapo)
10. Maxwell Congein	FDA Ranger	Zone (Sapo)
11. Jefferson Kannah	FDA Ranger	Zone 1 (Sapo)
12. Sargbeh Flahn	FDA Ranger	Zone 2 (Sapo)
13. Nathaniel Naklen	FDA Ranger	Zone 3 (Sapo)
14. David Tarlue	FDA Ranger	Zone 1(Sapo)
15. Abonoco Tarpeh	FDA Ranger	Zone 2 (Sapo)
16. Augustine Nimeley	Auxiliary from local villages	Zone 1 (Sapo)
17. Isaiah Jayswen	Auxiliary from local villages	Zone 3 (Sapo)
18. George Worjloh	Auxiliary from local villages	Zone 2 (Sapo)
19. Milton Tarnewon	Auxiliary from local villages	Zone 2 (Sapo)
20. Laswson Wesseh	Auxiliary from local villages	Zone 2 (Sapo)
21. Jerome Tarley	Auxiliary from local villages	Zone 2 (Sapo)
22. Touray Pardeah	Auxiliary from local villages	Zone 2 (Sapo)

Appendix 2: Elephant dung-pile/ Chimp nest decay rate monitoring datasheet (revisits)

Sheet number: Date: Location (Stratum):
Team members: Reporter:

Time	Dung/ Nest ID number	Revisit information							
		Wpt Nb	Longitude	Latitude	Date of finding	Date of revisit	Absent /Present	Decay stage	Remarks

Appendix 3: Elephant / Chimpanzee survey datasheet in Sapo National Park

Sheet number: Date: Location (Stratum): Transect name:
Team: Reporter: Start time: End time:

Distance from start (m)	Time of the day (hh:mn)	Vegetation type	Information about the detection					Geographical position (UTM: Waypoint/Longitude/Latitude)				General remarks (Tree species, etc.)
			Detection details: Code of observation (2)	Number of objects detected	Decay stage	Perp. Distance (m)	Boli diameter / Nest height	Wpt Nb	Longitude	Latitude	Altitude	

Appendix 4: List of animals, animal activities, human activities and ecological factors to be recorded

Animals	
Name/Description	**Code**
Chimpanzee:	Chimp
Elephant:	Elef
Red Colobus:	Badius
Diana Monkey:	Diana
Mona Campbelli Monkey:	Mona
Yellow backed Duiker:	Yello back
Jentink Duiker:	Jentink
Bongo	Bongo
Buffallo	Buff
Maxwell Duiker	Max D

Ecological factors/Vegetation	
Name/Description	**Code**
Rivers and streams:	River
Swampy forest:	Swamp F
Raphia Swamp:	Raphia S
Open forest (primary):	Open Forest
Secondary forest (disturbed):	Dist Forest
Bush (cut forest):	Bush
Fruiting trees spots	Fruit spot

Transect	
Name/Description	**Code**
Begining of the transect:	Start
End of the transect:	End
Rest time	Rest

Animal's activities	
Name/Description	**Code**
Chimpanzee nests:	Chimp Nest
Nuts cracking or feeding sites:	Chimp Feed
Chimpanzee screaming and drumming:	Chimp Cry
Elephant dung:	Elef Dung
Red Colobus vocalisation:	Badius Cry
Diana Monkey vocalisation:	Diana Cry
Mona vocalisation:	Mona Cry
Yellow back Duiker	Yello dung
Jentinks duiker dung	Jentink Dung
Small Duiker's dung: (All other duikers)	SD dung
Bongo dung	Bongo dung
Buffalo dung	Buffalo dung

Illegal activities	
Name/Description	**Code**
Poachers:	Poacher
Poaching camps:	P Camp
Gun shots:	Shots
Snares:	Snare
Spent cartridges	Cartridge
Old Farms:	Farm
Other human activities:	Hum Act