LARGE MAMMAL
RAPID BIODIVERSITY ASSESSMENT

in the Wonegizi REDD+ Project Site

prepared for Fauna and Flora International
by

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EXECUTIVE SUMMARY

A large mammal survey was carried out in Wonegizi from 21.11.-10.12.19 under FFI's Wonegizi REDD+ Project in order to provide baseline data against which biodiversity objectives may be monitored, as well as to inform the project on the connectivity between Ziama, Wonegizi and Wologizi PPAs for large mammals to understand how such species are moving through the landscape and to provide recommendations for the establishment and management of wildlife corridors.

The survey focused on 31 medium to large sized mammal species with an emphasis on indicator species of global conservation concern. A combination of data collection methods was used, including desk review, interview surveys, reconnaissance surveys, HCV-species targeted surveys, as well as Forest Elephant and Pygmy Hippo dung sample collection. Field surveys were carried out in two different study areas, one in central Wonegizi and one in the northern part of the PPA. For the corridor assessment potential sites were identified per satellite imagery and evaluated in the field through local information and ground-truthing of forest cover, connectivity, extent of human impact and forest degradation.

The resident large mammal fauna of Wonegizi consists of 24 species, including the Western Chimpanzee, seven monkey species, the Forest Elephant, Pygmy Hippo, Leopard, African Golden Cat, Bongo, Bushbuck, five duiker species, the Water Chevrotain, Red River Hog, Giant Ground Pangolin, Black-bellied and White-bellied Pangolin. Another four species, i.e. the Putty-nosed Monkey, Green Monkey, Forest Buffalo and Zebra Duiker might be present as well, but uncommon, i.e. either occur only occasionally and localized, or being very rare if not already extinct today. The forest profile of Wonegizi generally is dominated by small to medium sized trees and largely lacks a contiguous closed high canopy, hence it is not the most suitable habitat for "High Forest"-dependent species such as the Red Colobus Monkey, King Colobus and Diana Monkey, which appear to be rare and restricted to specific areas in Wonegizi. The Jentink's Duiker, another High Forest species, is absent from Wonegizi.

Most often encountered was the Maxwell's Duiker with 2,52 signs/km, closely followed by the Black Duiker with 2,21 signs/km. Other frequent species were the Yellow-Backed Duiker (1,93 signs/km), Bay Duiker (1,77 signs/km), Forest Elephant (1,23 signs/km) and the Red River Hog (1,01 signs/km), while the encounter rates of the remaining species were less than one sign per kilometer. Compared to some other forest sites in Liberia, species abundances in Wonegizi in general were higher, especially that of the Yellow-Backed Duiker. The overall higher abundances in Wonegizi are mostly caused by much higher encounter rates in the northern study area compared to central Wonegizi, which was traced back to the progressive isolation of the northern forest stretch, resulting in limited dispersal options, as well as probably better conservation practices and thus enhanced protection of animals species in northern Wonegizi.

Key habitats for the Pygmy Hippo are the Lawa River in the north, Yanwolo Creek and its distributaries in central Wonegizi and, according to interview information, the transboundary creek between Wonegizi and Ziama in the southeast. Forest Elephants occur only in central and northern Wonegizi, with the latter representing a key habitat, where elephants are found in higher abundances and year-round, while the central parts contain important migration

routes and crucial seasonal habitats. The Forest Elephants of Wonegizi appear to roam mainly in and around Wonegizi PPA and into Ziama, but not so much into Wologizi PPA (anymore). In the past there were several locations where elephants used to cross the main car road between Wonegizi and Wologizi, but today only one spot, located between Kotee and Balakpalazu, is left where this still happens. In general elephants were reported to come closer to human settlements and farms around the crop harvesting time in the second half of the rainy season, and a number of communities complained about crop raiding and Human-Elephant-Conflicts. Inhabitants of those settlements that are located along the main car road between Wonegizi and Wologizi said that elephants come from both sides, and this obviously is also the time of the year when movements between the two PPAs are still taking place. Instead of a major, regular migration however it seems that only a few individuals occasionally cross the main car road between the two PPAs. Chimpanzees were found in both study areas with higher abundances in the north. Local people further mentioned an alleged Chimpanzee hotspot in the hilly area in the central transboundary region of Wonegizi and Ziama, and also said that they show a more widespread distribution in the dry season than in the rainy season. Observations during the field survey indicated that Chimpanzees in Wonegizi use the same sleeping nests more than one time.

The two main threats for large mammals in Wonegizi are hunting and increasing forest loss and fragmentation, mostly due to the recent demarcation of the PA's final boundary line. The former is of particular concern in the southern part, where according to local information and amended by field observations, commercial hunting is taking place, which needs to be followed up and addressed by FDA as soon as possible. Habitat loss, on the other hand, is especially problematic in the north, where it sooner or later will lead to a total isolation of the northernmost forest stretch from the rest of Wonegizi.

The corridor assessment identified five potential sites for the maintenance and restoration of the forest connectivity between Ziama, Wonegizi and Wologizi, i.e. one transboundary corridor between Wonegizi and Ziama in the north, two corridors within Wonegizi to (re-) connect Wonegizi's northernmost forest fragment with the rest of the PPA, as well as two potential wildlife corridor sites between Wonegizi and Wologizi. Conservation measures should first of all focus on the connectivity within Wonegizi and between Wonegizi and Ziama, respectively, which is crucial to prevent the total isolation of the northern forest block and – in contrast to that of Wonegizi-Wologizi – has not been completely interrupted yet, but is already at stake and requires immediate action to stop further destruction and loss of the potential wildlife corridors. The reconnection of Wonegizi with Wologizi will be a more challenging long-term operation, which from a conservation perspective though is considered an essential measure in order to support a thriving biodiversity in Liberia's northern landscape too.

At the end of the report, several recommendations for conservation management of Wonegizi are given.

ACKNOWLEDGEMENTS

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ACRONYMS

ELRECO:	Elephant Research and Conservation
FDA:	Forestry Development Authority
FFI:	Fauna and Flora International
HCV:	High Conservation Value
IUCN:	International Union for the Conservation of Nature
PA:	Protected Area
PPA:	Proposed Protected Area

1. Background

The Norwegian Government is funding the project Driving REDD+ consensus through national policy implementation, for the period June 2016 to December 2020, which is being implemented by Fauna & Flora International among others in Liberia.

The project is principally relevant to following NICFI (Norad's International Climate and Forest Initiative) 2016-2020 funding themes, as detailed in the project document: 'Promoting International Consensus on REDD+' and 'Securing Indigenous and Other Forest-dependent Populations' Rights and Interests', whilst also contributing to 'Improved Transparency, Governance and Legality'.

In Liberia the Theory of Change focusses on supporting the Government of Liberia to make REDD+ operational at national level, as a mechanism to drive reductions in deforestation nationally and to contribute to both the national and international REDD+ consensus, and in so doing also demonstrating early REDD+ implementation success on the ground. Ultimately conservation of Liberia's remaining Upper Guinean forest, with the full and equitable participation of local stakeholders, is the desired goal.

The overarching aim of the project is promoting international consensus on REDD+. A core element of the project's strategy to achieve this aim, is through design and implementation of an operational project that serves to inform national and international policy. Therefore, in Liberia, a REDD+ pilot project is being implemented in the North West of the country, in the Wonegizi landscape, as part of and alongside wider efforts to inform the overarching REDD+ Framework in Liberia and empower Liberian stakeholders to strengthen their engagement in the development of international REDD+.

The Wonegizi REDD+ Project required a rapid assessment of large mammal diversity focusing on threatened and/or keystone and flagship species such as Forest Elephant, Pygmy Hippo, large Ungulates, Primates and Leopard. The main objectives of the survey were to:

- collect large mammal baseline data to augment existing information against which biodiversity objectives of the project may be monitored
- collect data on the connectivity between Wonegizi (from the border with Ziama through Wonegizi) and Wologizi PPAs for large mammals to understand how such species are moving through the landscape and provide recommendations for the establishment and management of wildlife corridors

The work further included the training of field assistants in rapid assessment and large mammal survey techniques to contribute to FFI's overall capacity building programme.

2. Methodology

2.1 Study Area

The Wonegizi REDD+ site, one of Liberia's Proposed Protected Areas (PPA), is located in Zorzor District, Lofa County in northwestern Liberia, bordering the Republic of Guinea (Figure 1). It comprises approximately 380 km² and, situated between the Ziama Man and Biosphere Reserve in Guinea and the Wologizi PPA in Liberia, represents an important link in the overall connectivity of the Liberian northern forest belt. The land cover of the PPA consists mostly of mature forest (Figure 2), which however along the margins as well as around the settlements along Lawa River in the northern part of the PPA has already been converted into farmland (see light pink areas of Wonegizi in Figure 1; Figure 3).

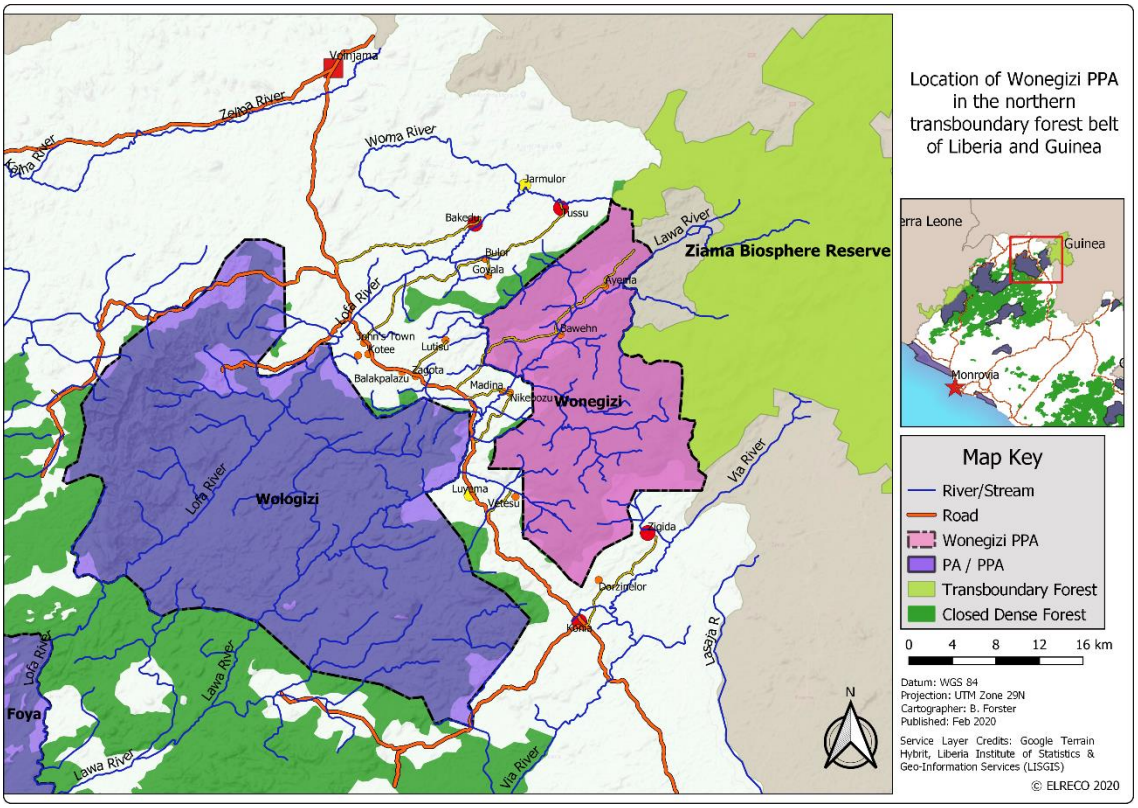


Figure 1. Location of Wonegizi PPA in the northern transboundary forest belt of Liberia and Guinea

Figure 2. Forest profile of Wonegizi PPA

Figure 3. Farmland within Wonegizi PPA

Administratively, Wonegizi PPA is divided into three management zones, i.e. Zone 1 covering the southern part, Zone 2 the central part and Zone 3 the northern part. A detailed description of Wonegizi's characteristic features had been given in previous REDD+ project reports (e.g. OSINUBI et al. 2013; BARCA 2018). The gazettement process designating Wonegizi PPA a Protected Area started in November 2016 with the pre-flagging; in 2019 the final determination of the boundary line began and at the time of the survey was still underway.

2.2 Data collection methods

The rapid assessment was carried out by a field team comprising eight persons, i.e. two team leaders from ELRECO, four field assistants from FFI/FDA and two students/graduates, from 21.11.-10.12.19 (details see Annex 1). The survey focused on large mammal species with an emphasis on species of global conservation importance (as indicated by IUCN Red List status; IUCN 2019) and indicator species, which - based on global/regional distribution, habitat type and previous surveys in the region - could be expected to be present in the area (e.g. KINGDON 2003; BARRIE et al. 2007; OSINUBI et al. 2013; BARCA 2018; IUCN 2019). Indicator species are species that due to their biology and habitat requirements are particularly suitable pointers for habitat type, ecological integrity, forest intactness and disturbance etc. For example, predators such as leopards depend on a sufficient amount of prey, duikers are both vulnerable to snare and gun hunting, certain primate species depend on high, closed primary forests, while others easily cope with disturbed secondary forest or farmbush. There is no explicit scientific definition of "large mammals" *per se*, but in a common understanding the term obviously is associated with traits such as body size, weight, reproduction rate etc., with varying thresholds depending on the aim of research (e.g. a weight between 3 – 20 kg as lower threshold; CARDILLO et al. 2005; MORRISON et al. 2007; KURTIS et al. 2010).

This survey concentrated on 31 medium to large sized mammals including the Forest Elephant, Pygmy Hippo, Primates, Carnivores, Ungulates, Pangolins and the Aardvark. The species list is attached in Annex 2. The following data collection methods were used:

- Desk Review
- Focus Group Interviews
- Reconnaissance Surveys ("Recces")
- Dung Sample Collection
- Additional records of any relevant ad-hoc observation during field work

2.2.1 Desk Review

Most recent studies including large mammal data from Wonegizi relevant for this survey were a Biodiversity Survey Report from 2013 (OSINUBI et al. 2013) and the Wonegizi High Conservation Value Summary from 2018 (BARCA 2018). In June 2019 FDA with support of FFI started a regular biomonitoring program, which was consulted for this study as well.

2.2.2 Focus Group Interviews

The main objective of the interview surveys was to quickly obtain some basic information on the large mammal fauna in the study area, such as species presence, relative abundance, distribution and trends. The interviews further helped to identify common vernacular names and check if the key informants all use the same name for the same animal species (this was of particular importance for correct species identification together with local trackers in the field), and facilitated the selection of suitable study sites for the reconnaissance surveys.

Interviews were carried out in two communities, i.e. in Vetesu at the southwestern border and Goyala in the northern part of Wonegizi (see Figure 1), to obtain as much information on the entire study area as possible. The focus groups comprised between ten and 15 community members, mainly long-resident (ex-) hunters, since they were expected to have a good knowledge of the wildlife and the forest areas. The list of interviewees is attached in Annex 1. Pictures of the target species were shown to the focus group members to determine whether they knew the different animals and to record the commonly used name (Figure 4). If the focus group recognized the shown species, several questions on its presence, distribution, relative abundance and trends were asked, before moving on to the next species.

Figure 4. Focus Group Interview in Goyala

In addition to the wildlife data the team also collected some general socioeconomic data on the community's population size, livelihood, forest types and use of natural resources. The questionnaires are attached in Annex 3.

2.2.3 Reconnaissance Surveys

Reconnaissance Surveys ("recces") are a widely applied standard sampling technique for rapid biodiversity assessments in African Rainforests (e.g. WHITE & EDWARDS 2000; KÜHL et

al. 2008; MAISELS & ABA'A 2011). The basic principle of recces is to follow a compass bearing taking the path of least resistance, i.e. using pre-existing trails whenever possible, and when necessary cut a way through the forest vegetation (WALSH & WHITE 1999). "Guided" recce walks should deviate no more than 40° from the predetermined direction; they are considered more informative and produce a more accurate, representative data set than "travel" recces, which can deviate by any degree. In this assessment we used guided recces. The design of the recce lines, i.e. their location, direction and length, depends on several factors such as the study site's topography and terrain, forest density, barriers (mountains, big rivers), number of teams, and therefore needs to be adapted to the specific conditions in the field.

The Reconnaissance Surveys in Wonegizi were carried out in two different areas, i.e. Area 1 in the central part (Zone 2), and Area 2 in the northern part (Zone 3) of the PPA (Figure 5). Area 1 was accessed from Vetesu and one camp was set in the center. In Area 2 two camp sites were used, i.e. entering from Goyala a first camp was established in the western part of Area 2, and after completing the surveys in that area the team moved northeast to a second camp, and finally left the PPA out to Tussu (Figure 5 and Annex 1). Data were collected by two teams, each comprising one Team Leader, two Field Assistants, one student and two to three local trackers. The layout of the recce lines was mostly following the "Star Formation", though in some cases the "Cloverleaf" was applied (Figure 5). In the "Star Formation" the lines run from a central point (= the camp site) straight to the main cardinal directions (north, south, west, east, northeast, southeast, northwest, southwest), while in the "Cloverleaf" recces also start from the center point, but teams try to go a circle back to the camp. The advantage of the "Cloverleaf" is that data collection can take place throughout the whole walk and therefore increase the sample size, while in the "Star" teams have to return to the camp the same way, so data recording has to stop at the outer most point of the recce line, in order to avoid double counts of the same signs on the way back. The disadvantage of the "Cloverleaf", however, especially in unknown terrain is that it is difficult for the teams to estimate the time they will need for going back to the camp, so the "Star" is preferable for safety and effectiveness. There was no pre-determined length of the recce lines, but the teams just went as far as possible with regard to a reasonable time management. Distances covered varied between 1,60 and 4,30 km per recce line, depending on the topography, penetrability of the vegetation, natural barriers, as well as the type and frequency of observations (which had an influence on the time required for data recording).

In total 16 recce lines were surveyed, six in Area 1 and ten in Area 2, covering a total distance of 45,70 km, with 18,70 km in Area 1 and 27 km in Area 2. Each line was surveyed once during a day-survey. In case the lines started directly from the camp site, a minimum distance of 150 m away from the camp was kept before starting with data recording in order to (i) account for possible negative impacts of the camping site (noise, smoke etc.) on the presence of wildlife in the nearby area, and (ii) to avoid overlaps with the survey area of neighbouring recce lines. A GPS was used for navigation. Data recording included all direct and indirect signs of the mammal focus species, signs of human impact, type and age of signs, number of individuals, habitat type, GPS coordinates and elevation (see datasheet Annex 4). To avoid recording the same animal repeatedly, a minimum distance between signs of the same species

was kept before recording this species again. The minimum distance was not fixed but dependent on different criteria such as the animal species (assuming that certain species have larger home ranges than others and thus a bigger distance had to be kept), topography, direction of the animal's movement relative to the recce line, as well as the evaluation of the local trackers, but in general lay between 100 m to several hundred meters. Secondly, in case more than one sign of the same animal was found at a given location (e.g. footprints and dung of a Maxwell's Duiker) the species was only recorded once and additional signs, if relevant, noted in the "Notes" column.

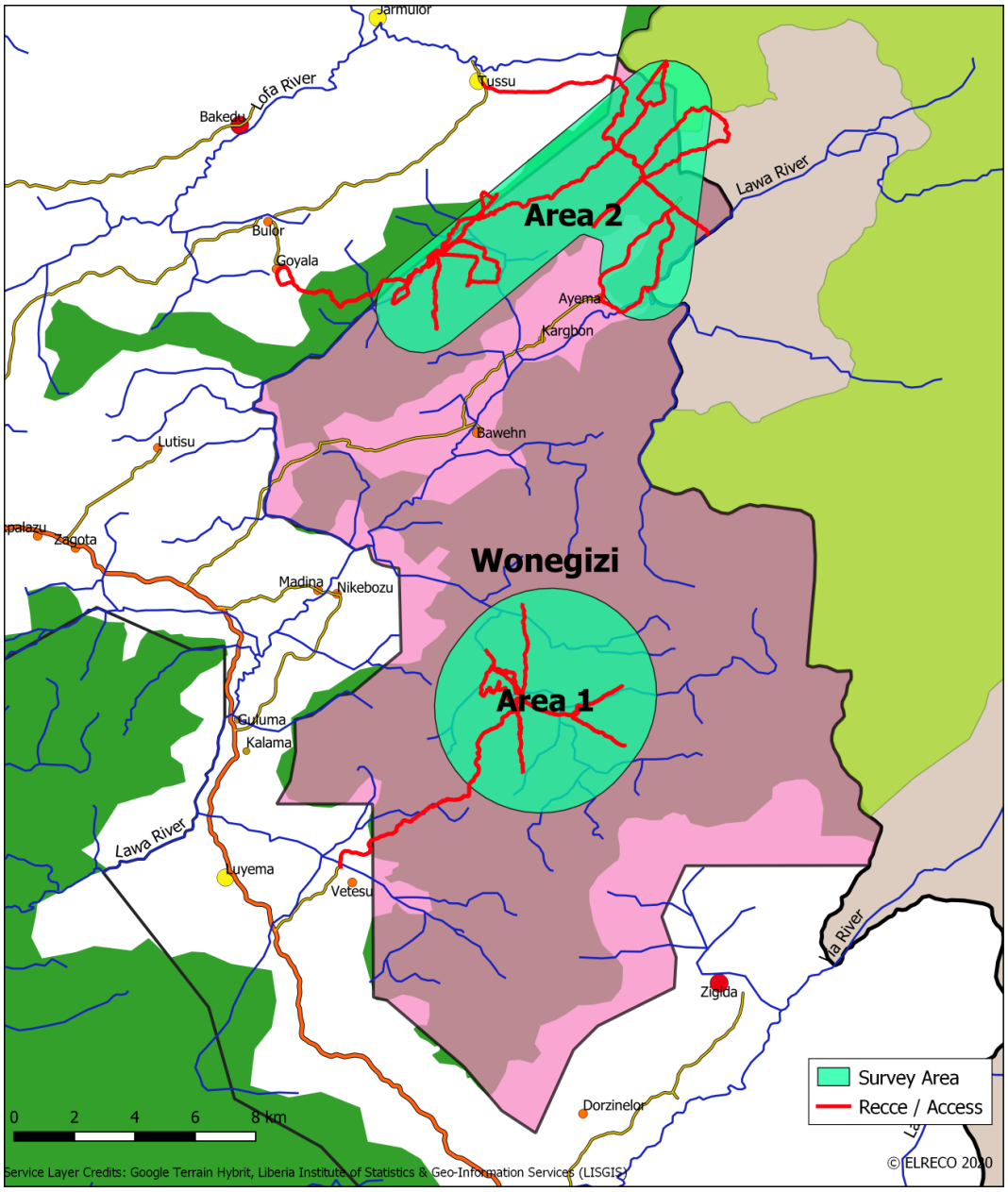


Figure 5. Study Areas Large Mammal Survey Wonegizi

In addition to the Reconnaissance Surveys several targeted surveys were carried out focusing on "High Conservation Value" (HCV) species that according to the interviews should be present in the forest, but might not necessarily be captured by the standard recce design. This applied mainly to the Pygmy Hippo (due to its dependence on larger water bodies) and the

Chimpanzee. Further, in the northeastern part of Area 2, specific corridor surveys were conducted (see section 2.3). Apart from the systematic data collection during the Reconnaissance, HCV and Corridor Surveys, the teams recorded all relevant ad hoc data (by GPS and/or hand-written notes) whenever encountered throughout the whole field survey. By moving to/from/between camp sites, walking to the starting point of recce lines or on their way back from recce end points etc., the field teams spent additional time and covered a considerable amount of distance in the forest outside of the regular data collection periods. Taking all these distances into account (Reconnaissance Surveys, HCV Surveys, Corridor Surveys, Moving in/out/back to camp sites etc.) the total survey effort, i.e. the distance that was walked in the forest throughout the Large Mammal Survey was 94,70 km (Table 1).

Table 1. Survey Effort Large Mammal Survey Wonegizi.

Date	Area	Survey Method	Bearing	Survey Code	Distance (km)
25.11.19	1	Recce	North	WN01A	3,70
25.11.19	1	Recce	South	WN01B	3,20
26.11.19	1	Recce	60°	WN02A	2,50
26.11.19	1	Recce	120°	WN02B	2,50
27.11.19	1	Recce	315°	WN03A	2,50
27.11.19	1	PH Survey Yanwolo River	Yanwolo	WN03B	4,30
01.12.19	2	Recce + Chimpanzee Survey	East	WN04A	2,20
01.12.19	2	Recce	South	WN04B	3,20
02.12.19	2	Recce	45°	WN05A	3,20
02.12.19	2	Recce	220°	WN05B	3,40
04.12.19	2	Recce + Corridor Survey	40°	WN06A	2,90
04.12.19	2	Recce	130°	WN06B	3,60
05.12.19	2	Recce + Corridor Survey	215°	WN07A	1,60
05.12.19	2	Recce + Corridor Survey	South	WN07B	2,10
06.12.19	2	Recce	225°	WN08A	2,80
06.12.19	2	Recce	285°	WN08B	2,00

Summary Large Mammal Survey Effort (km)	Area 1	Area 2	Total
Distance Recces	18,70	27,00	45,70
Total Survey Distance	40,30	54,40	94,70

2.2.4 Dung Sampling Protocol

Dung Samples for genetic analysis were supposed to be collected from the Pygmy Hippopotamus, following FFI's Dung Sampling Collection Protocol, and the Forest Elephant, following ELRECO's Elephant Dung Sampling Protocol that was developed for the nationwide elephant status survey, based on the *Dung Survey Standards for the CITES MIKE Programme*. Both protocols are attached in Annex 5.

2.3 Corridor Survey

The corridor survey comprised several activities. First of all, before the field trip, six potential corridors connecting the forests of Ziama, Wonegizi and Wologizi were identified based on satellite imagery (Figure 6, red circles):

1: Transboundary corridor between Ziama and Wonegizi
NB: Due to time constraints there was no chance for on-the-ground evaluation of the forest connectivity between Ziama and Wonegizi in the central and southern transboundary area, but according to the satellite image it looks still largely intact

2-4: Remaining potential corridors connecting the northern forest stretch of Wonegizi with the rest of the PPA

5-6: Potential sites to restore forest connectivity between Wonegizi and Wologizi PPA

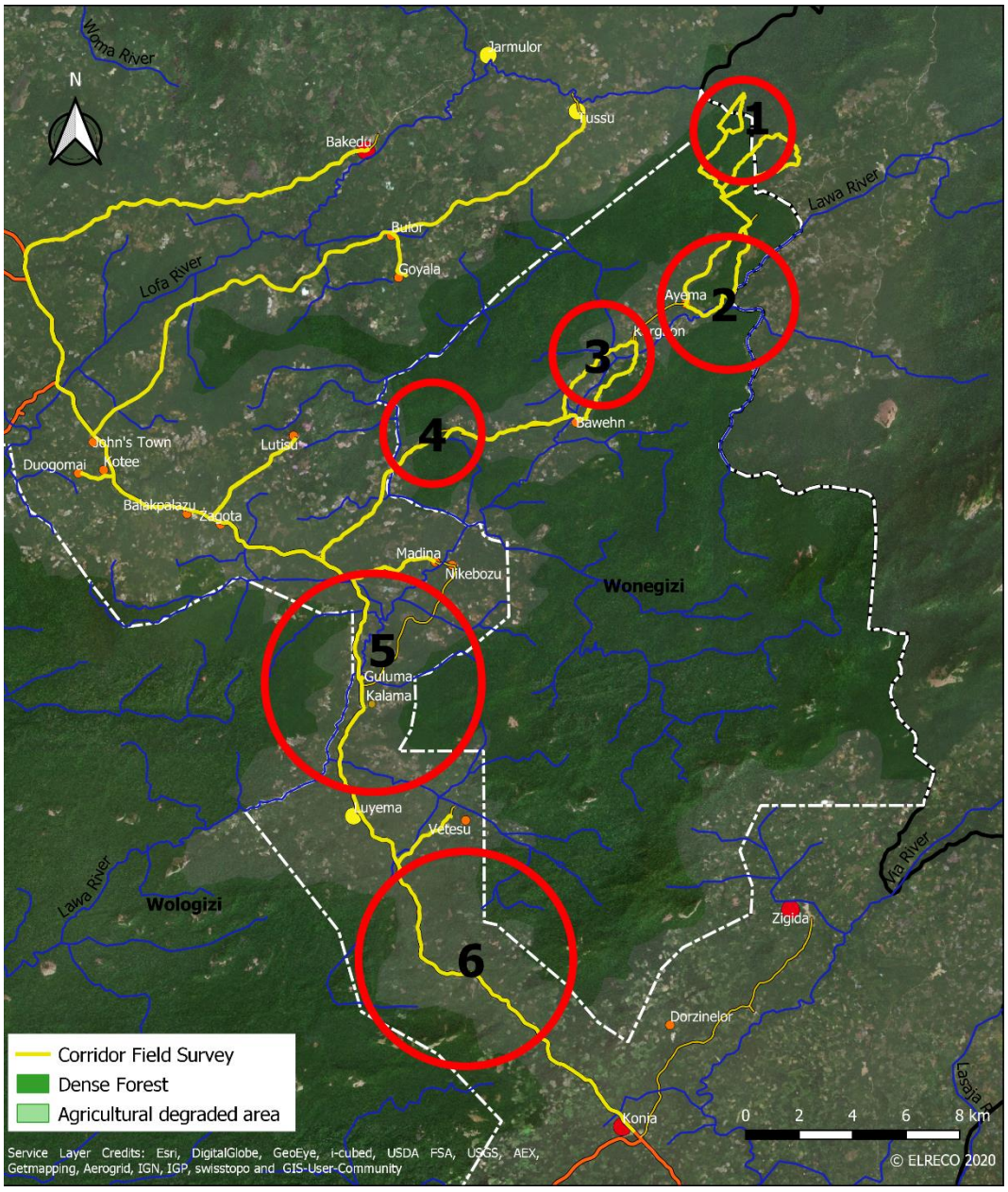


Figure 6. Corridor Survey design

During the field survey, in addition to these six key areas, the field team further assessed potential sites for the dispersal of Pygmy Hippos and Forest Elephants, whose movements do not necessarily require contiguous forest cover, but, in case of the Pygmy Hippo, suitable water bodies/rivers, and in case of the Forest Elephant might depend on traditional migration routes, regardless of vegetation cover. Data gathering in the field included interviews of local people, on-site information of FDA and FFI field staff, ground-truthing of existing vegetation types and search for animal signs, both during the field surveys in Area 2, and particularly through a targeted corridor survey on the last two days of the field trip (see also Annex 1). This specific assessment was done by car and on foot, starting from Tussu, all the way up to Bakedu at Lofa River, then back down south to Konia, with stops and detours to strategic points. The areas that were visited for the corridor survey are indicated in yellow in Figure 6.

2.4 Training of field staff

Before actual field work started, a one-day training course was held for the survey team field assistants on the 22nd of November 2019 at the FFI Office in Zorzor. The training comprised the following topics:

1) Introduction to basic principles of wildlife surveys
2) Interview Surveys
3) Reconnaissance Surveys
4) Pygmy Hippo and Forest Elephant Dung Sampling Protocol

2.5 Data analysis

All data collected in the field were entered into prepared raw data files for further analysis. Computer programs used for editing and analyzing included EXCEL, BASECAMP and QGIS.

Different data sets were used for the analysis of parameters:

- *Presence* of a species was assessed by considering all records collected in the interviews and during field work
- *Relative abundance* was calculated and expressed in two ways: (1) as ordinal ranking (low, medium, high) adapted from the interviews and (2) as *signs per kilometer* based on the recce line data. For this calculation only the distinct signs *seen, heard, footprint, dung* and *chimpanzee nests* were used; other signs such as elephant roads, animal trails, burrows, digging and scratching marks, and feeding sites were discarded from the analysis, either because they could not always be clearly allocated to one specific species (a feeding site or animal trail could have been used by different species) or, especially in the case of the elephant roads, to avoid an overestimation. Elephants repeatedly use the same roads for seasonal migration and thus these roads become permanently visible, even if they have not been used by elephants recently. If used recently then usually footprints or dung can also be found. Secondly, as is the case with all animal trails, it is possible that the recce line crosses the same trail several times.
- *Spatial distribution* of animal species was derived from all the data collected during the field surveys (Recces, HCVs, Ad-hoc observations).

3. Results and Discussion

3.1 Status of large mammal fauna in Wonegizi PPA

3.1.1 General Overview

Table 2 lists the mammal species that were recorded during this survey, and for comparison also shows the results from 2013 (OSINUBI et al.) and 2018 (BARCA). The survey of 2018 however focused mainly on amphibians and trees, and only included opportunistic observations of mammal species.

In total 29 mammal species were recorded to occur in Wonegizi, i.e. all focus species except the Aardvark and the Giant Forest Hog, which according to the locals never appeared in the PPA. The presence of five of the recorded species, however, especially the Jentink's Duiker, and further the Putty-Nosed Monkey, Green Monkey, Forest Buffalo and the Zebra Duiker is debatable; those are marked with an asterisk in Table 2 and will be further discussed below.

Regarding the IUCN conservation status, 15 species are of global conservation concern, i.e. listed either as *Critically Endangered* (one species, the Western Chimpanzee), *Endangered* (six species, the Diana Monkey, Red Colobus, Pygmy Hippo, Jentink's Duiker, Giant Ground Pangolin and the White-bellied Pangolin) or *Vulnerable* (eight species, the Forest Elephant, King Colobus, Olive Colobus, Leopard, African Golden Cat, Zebra Duiker, Ogilby's Duiker and the Black-bellied Pangolin), while the remaining species are considered Near Threatened (six species) or of Least Concern (eight species; IUCN 2019). Regarding the status of the Ogilby's Duiker (*Cephalophus ogilbyi brookei),* the species as a whole is assessed as Least Concern, but the regional subspecies (split by some taxonomists as a separate species, Brooke's Duiker, see GRUBB & GROVES 2001; GRUBB 2005) is Vulnerable.

16 of the 29 species were recorded during field work, i.e. captured by the Reconnaissance and HCV Surveys as well as the ad-hoc data collection, mostly by indirect signs such as footprints and dung, although six species were also directly observed (seen or heard). The presence of the other 13 species in Wonegizi is based on interview information only. These include rare or elusive species such as the Leopard, African Golden Cat and Pangolins, that usually are difficult to find and would require more suitable sampling methods such as Camera Trapping. Considering all available information, such as recent records reported by the interviewees as well as the survey data from 2013 and 2018, respectively, there are strong indications that eight of the 13 species do occur in the PPA: the Red Colobus, Olive Colobus, Diana Monkey, Leopard, African Golden Cat and all three pangolin species. The Diana Monkey however might be very rare or even locally extinct today, since the last record local people remembered in Vetesu (southern Wonegizi) was from 2017, and in Goyala (northern Wonegizi) from 2018 (see also 3.1.2).

Table 2. Large mammal species recorded in Wonegizi.

Year: 2019 this study; 2013 OSINUBI et al.; 2018 BARCA
Type of sign: CT: Camera Trapping; D: Dung; FP: Footprint; FS: Feeding Site; H: Heard; N: Nest; R: Animal Road; S: Seen
I: Interview/Local Information; if last record elder than from 2019 it is indicated in brackets
* The presence of species marked with an asterisk is questionable, further explanation see text

No.	Species	Scientific name	IUCN	2019	2013	2018
Proboscidea						
1	Forest Elephant	*Loxodonta cyclotis*	VU	FP, D, R, I	CT, FP	FP, D, R
Primates						
2	Western Chimpanzee	*Pan troglodytes verus*	CR	H, N, I	CT	
3	Upper Guinea Red Colobus	*Piliocolobus badius*	EN	I	killed (I)	
4	King Colobus	*Colobus polykomos*	VU	H	killed (I)	
5	Olive Colobus	*Procolobus verus*	VU	I	killed (I)	
6	Diana Monkey	*Cercopithecus diana diana*	EN	I (2018)	H	
7	Sooty Mangabey	*Cercocebus atys atys*	NT	H, I	CT, H, FP	
8	Campbell's Monkey	*Cercopithecus campbelli*	LC	S, H, I	CT	
9	Lesser Spot-nosed Monkey	*Cercopithecus petaurista*	LC	H, I	killed (I)	
10	Putty-nosed Monkey *	*Cercopithecus nictitans*	NT	I (2018)		
11	Green Monkey *	*Chlorocebus sabaeus*	LC	I (2015)		
Carnivora						
12	Leopard	*Panthera pardus*	VU	I	maybe (I)	Scratch Marks
13	African Golden Cat	*Caracal aurata*	VU	I		
Cetartiodactyla						
14	Pygmy Hippopotamus	*Choeropsis liberiensis*	EN	FP, I	CT	FP
15	Forest Buffalo *	*Syncerus caffer nanus*	NT	I (2016)		FP
16	Jentink's Duiker *	*Cephalophus jentinki*	EN	Never		FP
17	Yellow-backed Duiker	*Cephalophus silvicultor*	NT	FP, I	CT, FP	FP
18	Bongo	*Tragelaphus eurycerus*	NT	FP, I		FP, D
19	Zebra Duiker *	*Cephalophus zebra*	VU	I (2018)		
20	Ogilby's (Brooke's) Duiker	*Cephalophus ogilbyi brookei*	VU	FP, I	CT, FP	FP
21	Bay Duiker	*Cephalophus dorsalis*	NT	S, FP, D, I	CT, FP	
22	Maxwell's Duiker	*Philantomba maxwellii*	LC	FP, D, I	CT, FP	
23	Black Duiker	*Cephalophus niger*	LC	FP, D, I	CT, FP	
24	Bushbuck	*Tragelaphus scriptus*	LC	FP, D, I	FP	
25	Water Chevrotain	*Hyemoschus aquaticus*	LC	FP, I	FP	H, FP
26	Red River Hog	*Potamochoerus porcus*	LC	FP, D, FS, I	CT, FP	D, FS
Pholidota						
27	Giant Ground Pangolin	*Smutsia gigantea*	EN	I	CT	
28	Black-bellied Pangolin	*Phataginus tetradactyla*	VU	I	CT	
29	White-bellied Pangolin	*Phataginus tricuspis*	EN	I	CT	

The status of the remaining five species in Wonegizi PPA needs to be discussed, as follows:

**Putty-Nosed Monkey*

The interviewees of Vetesu said that this species is occurring in Guinea, but not in their area (southern Wonegizi). In Goyala (northern Wonegizi) the hunters reported of a record from 2018, but stated that this monkey is quite rare and only appears in very low numbers, if at all. Interestingly, their description of the monkey's appearance matched very well the one that was given by local people in the Wologizi survey in 2018 (VOGT & FORSTER 2019a), so it can be assumed that the "mysterious" monkey species reported from Wologizi in fact was the Putty-nosed Monkey. In conclusion, it seems that the Putty-nosed Monkey is probably more common in Guinea and only occasionally enters adjacent forest sites in Liberia, and thus is a rare species in Wonegizi PPA.

**Green Monkey*

Similar information was obtained about the Green Monkey. Both interview communities recognized this species and also knew about its adaptation to Savanna habitats, but it obviously only occurs, in low numbers, in the northern part. In fact, the latest record the interviewees from Goyala remembered dated back to 2015, so it is questionable if the Green Monkey is present in Wonegizi today at all.

**Forest Buffalo*

According to the local information from Goyala, the Forest Buffalo never existed in that part of Wonegizi, while the Vetesu community described it as a rare species and only recalled a footprint from 2016. There was also a footprint record in the 2018 report.

**Jentink's Duiker*

The Jentink's Duiker very likely does not occur in Wonegizi. Both interview communities stated that it has never existed in this region. The 2018 report however mentions a footprint record, but although duiker footprints in general have very distinct, species-specific shapes and usually can be well distinguished by experienced trackers, even those of similar-sized species, there always remains some risk of misidentification. So probably the record of the 2018 survey was confused with another species such as the Yellow-backed Duiker or Bongo.

**Zebra Duiker*

Only the Goyala interview group confirmed the Zebra Duiker's presence in Wonegizi, but it seems to be very rare today. The last record was reported from 2018.

In conclusion, if considering the above described five species as absent or uncommon species, the resident large mammal fauna of Wonegizi consists of 24 species, including the Forest Elephant, Pygmy Hippo, eight diurnal primate species, the Leopard and African Golden Cat, nine ungulates and three pangolin species, whereof 13 are of global conservation concern (one *Critically Endangered*, five *Endangered* and seven *Vulnerable*).

3.1.2 Relative Abundance and Population Trends

Interviews

In the interviews local hunters among others were asked to rate the relative abundance of the mammal species either low, medium or high. Though these data don't allow any conclusion with regard to wildlife densities or population sizes in the respective areas, they reflect how easily hunters come across a species and therefore indicate how common an animal species is. The interviewees further should assess the species' population trend over the past ten years as either increasing, decreasing or stable, and in case of an increasing or decreasing trend explain the possible reason.

Results are presented in Table 3, in addition the global trend evaluated by IUCN is shown in the last column (except for the Forest Elephant which IUCN does not recognize as a distinct species, thus a global trend assessment for this specific population is not available). In case the two interviewed communities differed in their answers, both results are listed in the respective columns, with the first record referring to Vetesu (southern Wonegizi) and the second to Goyala (northern Wonegizi). For example, the King Colobus population was rated as low in numbers and decreasing because of hunting in Vetesu, but high in numbers and increasing because of the PA gazettement process in Goyala (No. 20 in Table 3).

Regarding the relative abundance, 16 animal species were rated equally by the two interview communities, i.e. 14 were assessed as high in numbers, one (the Water Chevrotain) as medium and one (the Diana Monkey) as low (No. 1-16 in Table 3). The 14 high-rated species include the Western Chimpanzee, three monkeys, the African Golden Cat, the Pygmy Hippo, four duikers, the Bushbuck, Red River Hog and the two small pangolin species. The results for the remaining species (No. 17-28) differed between Vetesu and Goyala, with some species being even totally absent from one of the two areas, as already outlined in the previous section. Considering the results per community, Vetesu rated 17 species as high, two as medium and four as low in abundance. Goyala also classified 17 species as high, two as medium and six as low, so the distribution of ranking categories was similar, but applied to different species. For example, the Red Colobus was evaluated as high in numbers in Vetesu but low in Goyala, while the opposite was the case for the King Colobus (No. 19 and 20 in Table 3). Special attention deserves the result of the assessment of the Forest Elephant (No. 17). Elephants are found in the central and particularly northern parts of Wonegizi, but absent in the south (see also next section 3.1.3), hence the interviewees of Vetesu usually do not encounter the species and basically could not say anything about its abundance, except that it must be more than one animal. In contrast, the people from Goyala provided very precise information, thinking that in that part of Wonegizi there roam two or three elephant groups with approximately seven to eight individuals each, as well as some single males.
These latter results (No. 17-28) point to spatial differences both in species diversity and densities in Wonegizi PPA, which will be the topic of section 3.1.3.
Another striking result was the assessment of the Giant Ground Pangolin by the Vetesu interviewees who said that this animal is (still) highly abundant in their forest, which is in contrast to overall indications that this species tends getting rare and locally extinct in Liberia's forests today (e.g. Wologizi, VOGT & FORSTER 2019a).

Table 3. Evaluation of abundance and population trends of large mammals by local hunters in Wonegizi.

Trend: Species' population is ↑ increasing; ↔ stable; ↓ decreasing; PA refers to the Protected Area status gazettement of Wonegizi and related activities. Columns with 2 data sets: Interview result from Vetesu / Goyala

No.	Species	IUCN	Abundance Wonegizi	Trend	
				Wonegizi Past 10 yrs & Reason	Globally (IUCN)
1	Western Chimpanzee	CR	High	↑ low price, PA	↓
2	Sooty Mangabey	NT	High	↑ PA	↓
3	Campbell's Monkey	LC	High	↑ PA	unknown
4	Lesser Spot-nosed Monkey	LC	High	↑ PA	unknown
5	African Golden Cat	VU	High	↑ smart, PA	↓
6	Pygmy Hippopotamus	EN	High	↑ PA	↓
7	Yellow-backed Duiker	NT	High	↑ PA	↓
8	Bay Duiker	NT	High	↑ PA	↓
9	Maxwell's Duiker	LC	High	↑ PA	↓
10	Black Duiker	LC	High	↑ PA	↓
11	Bushbuck	LC	High	↑ PA	↔
12	Red River Hog	LC	High	↑ PA	↓
13	Black-bellied Pangolin	VU	High	↑ PA	↓
14	White-bellied Pangolin	EN	High	↑ PA	↓
15	Water Chevrotain	LC	Medium	↔	↓
16	Diana Monkey	EN	Low	unknown	↓
17	Forest Elephant	VU	more than 1 / 2-3 groups	↓ ↑ Disturbed / PA	not available
18	Leopard	VU	Medium / High	↔	↓
19	Upper Guinea Red Colobus	EN	High / Low	↓ / unknown Hunting	↓
20	King Colobus	VU	Low / High	↓ ↑ Hunting / PA	unknown
21	Ogilby's Duiker	VU	Low / High	↑ PA	↓
22	Giant Ground Pangolin	EN	High / Low	unknown	↓
23	Olive Colobus	VU	High / not here	unknown	↓
24	Bongo	NT	not here / Medium	↑ PA	↓
25	Putty-nosed Monkey	NT	not here / Low	↑ PA	↓
26	Green Monkey	LC	not here / Low	unknown	↔
27	Forest Buffalo	NT	Low / not here	↔	↓
28	Zebra Duiker	VU	not here / Low	unknown	↓

Looking at the assessment of the population trends, it can be noted that there was a high concordance in the communities' rating of species population trends, i.e. independently of each other they stated the same trends for 25 of the 28 evaluated species (89,29%). Only the Forest Elephant, Red Colobus and King Colobus assessment differed, with Vetesu stating a decrease due to increasing human disturbance (Forest Elephant) and hunting (Red Colobus, King Colobus), respectively, while the informants in Goyala said that the Forest Elephant and King Colobus populations increase because of activities such as awareness, law enforcement,

patrols and the general presence of FDA, which come along with the gazettement of Wonegizi as PA, resulting in a better protection of animal species. This was also the main reason stated for all increasing trends, which the interviewees allocated to in total 17 mammal species. In case of the Chimpanzee, the increasing population trend was further explained by the fact that the selling price of Chimpanzee meat is relatively low and therefore they are not much hunted, an interesting statement that however could not be further evaluated in the frame of this rapid assessment. The African Golden Cat was claimed to enter human settlements and among others catch chicken, but because it is a smart animal it cannot be easily hunted, and therefore also gradually increases in numbers. Three species populations, namely that of the Water Chevrotain, Leopard and Forest Buffalo were thought to have remained stable over the past years, and another five could not be further assessed. Globally, almost all species assessed by IUCN show a decreasing population trend, the only exceptions are the Bushbuck and Green Monkey, whose population is indicated as stable for now.

It has to be kept in mind that interview data have their limitations and always bear some uncertainties regarding accuracy and reliability of interviewees, and thus might not reflect realistic facts. In this study some explanations of population trends sounded contradictive, e.g. on the one hand, the PA gazettement and related operations were seen as the main reason that animals are better protected and therefore increasing in numbers, on the other hand a few species are still decreasing because of hunting and human disturbance. This probably reflects a typical situation in a transition process from a "Paper Park" to an actively managed Protected Area - the interviewed communities seemed very much aware of Protected Species, PA laws and regulations, and the need of reducing human impact in the PPA, but certainly the area is not fully protected from illegal activities yet, i.e. for example hunting is still happening (see also Chapter 3.2). This might have put interviewees in a sort of dilemma how to best formulate answers, i.e. trying to find a balance between saying the truth and not revealing everything that is still happening.

In general, the interview data of Wonegizi are remarkable, especially when compared to the data from the Wologizi survey in 2018, where interviewees (also from two communities) attested almost exceptionally decreasing or stable population trends of the large mammal fauna in Wologizi (VOGT & FORSTER 2019a). The only increasing trend that was stated, by one community only, was that of the Diana Monkey. In contrast, at least 17 species were rated as increasing in numbers in Wonegizi. It has to be noted that when it came to the question about population trends over the past ten years (in Wonegizi), the informants sometimes seemed to have difficulties to reflect this time span or were just not able to give an assessment, but felt that populations are (now) starting to recover because of the recent developments in the active management of Wonegizi. I.e. the population trend assessment in Wonegizi probably was not really a reflection of the past but more like a future scenario of what will happen from now on.

Reconnaissance Surveys

15 mammal species were recorded along the recce lines and therefore allowed the calculation of relative abundances, i.e. encounter rates, expressed as signs per kilometer. As explained in Chapter 2.5, only the distinct signs *seen, heard, footprint, dung* and *chimpanzee nests* were used for this analysis.

In total 522 distinct signs were recorded throughout the surveys along the 16 recce lines. The most often encountered species was the Maxwell's Duiker with 115 records, resulting in an encounter rate of 2,52 signs/km, closely followed by the Black Duiker with 2,21 signs/km (Table 4, Figure 7).

Table 4. Relative abundance of mammal species encountered along recce lines, expressed as and ordered by signs/km; in addition the total number of recce lines per species is shown.

Rank	Species / IUCN Status		Signs/ km	Recce Lines
1	Maxwell's Duiker	LC	2,52	16
2	Black Duiker	LC	2,21	16
3	Yellow-backed Duiker	NT	1,93	16
4	Bay Duiker	NT	1,77	16
5	Forest Elephant	VU	1,23	11
6	Red River Hog	LC	1,01	16
7	Western Chimpanzee	CR	0,28	3
8	Bongo	NT	0,13	3
9	Water Chevrotain	LC	0,09	3
10	Ogilby's Duiker	VU	0,07	2
10	Pygmy Hippopotamus	EN	0,07	2
11	Campbell's Monkey	LC	0,04	2
11	Lesser Spot-nosed Monkey	LC	0,04	2
12	Sooty Mangabey	NT	0,02	1
12	Bushbuck	LC	0,02	1

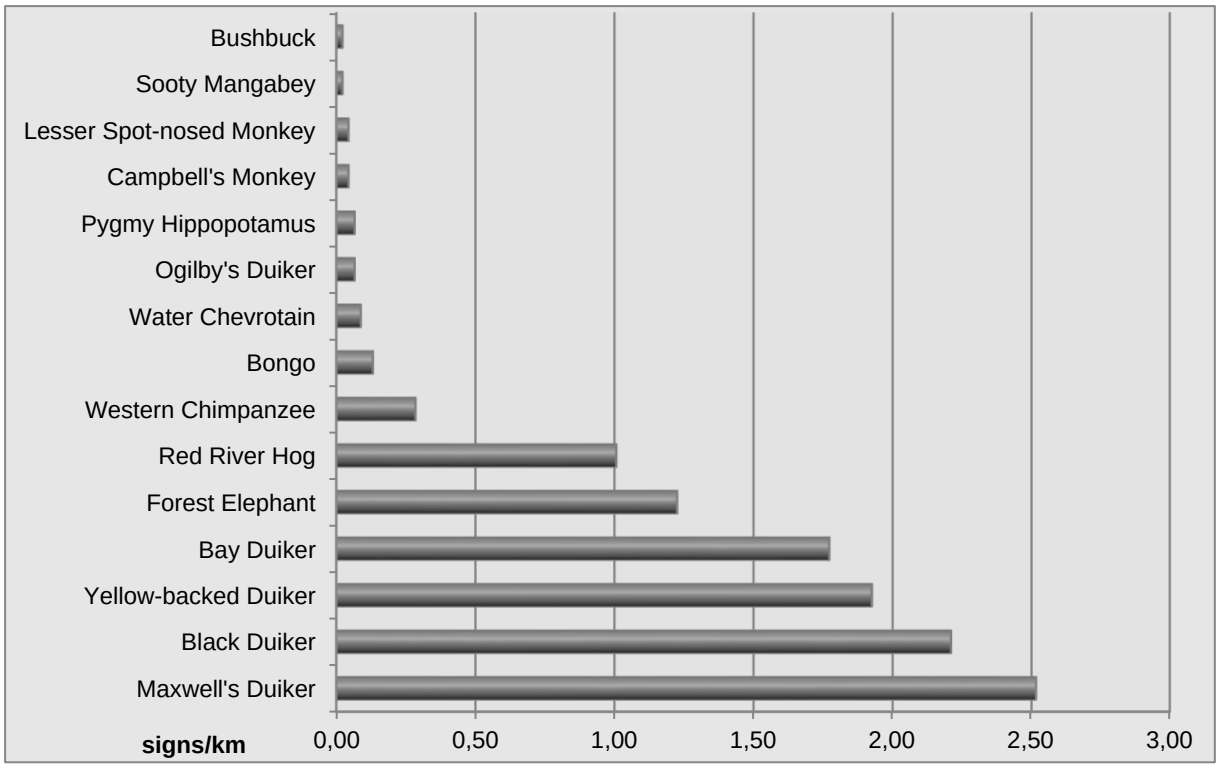


Figure 7. Relative abundances (signs/km) of mammal species recorded by recce surveys in Wonegizi

Third- and fourth-ranking were the Yellow-Backed Duiker and the Bay Duiker with 1,93 signs/km and 1,77 signs/km, respectively. Relatively high encounter rates were further noted of the Forest Elephant (1,23 signs/km, Rank 5) and the Red River Hog (1,01 signs/km, Rank 6). These six top-ranking species were recorded at least three times more often than the remaining species, whose encounter rates were all less than one sign/km. The Western Chimpanzee, Rank 7, was the next frequently found species with 0,28 signs/km, which for better illustration could also be expressed as one sign per 3,57 km, i.e. on average one would need a survey effort of at least 3,57 km to come across a sign of this species. Two species, the Sooty Mangabey and the Bushbuck were only recorded once along the recces, resulting in the lowest encounter rates of 0,02 signs/km.

In general the encounter rates of monkey species were quite low, an observation that was also made in Wologizi (VOGT & FORSTER 2019a). There are several possible explanations for this. On the one hand, the low encounter rates might be linked to the species' behavioural ecology, i.e. as primarily arboreal animals, monkeys do not leave as distinct, easily detectable signs on the ground as do terrestrial species. Further, monkeys might become aware of the survey teams and disappear before the latter notice their presence. On the other hand, the encounter rates could reflect real low densities, probably due to overhunting in the past, since monkeys, besides duikers, are the main target of bushmeat hunting. Last but not least, species like the King Colobus, Red Colobus and the Diana Monkey depend on old growth forest with an intact high canopy, which seems to be largely lacking in Wonegizi, thus the presence of those species could be confined to specific areas (see also 3.1.3). For further clarification it would need a specific primate survey, one of the recommendations that are given at the end of this report.
The low density of Bushbuck signs is very likely owed to the fact that its typical habitat types were not covered much by the survey. The species is naturally absent from extensive areas of closed-canopy forest and known to cope well with human-dominated landscapes (PLUMPTRE & WRONSKI 2013), and usually found in habitat types such forest edges, low bush and farmlands, which were only partially included in Area 2 (see also Figure 5).

The overall encounter rates are also reflected in the total number of recce lines a species was recorded at (Table 4). The four top-ranking species Maxwell's Duiker, Black Duiker, Yellow-backed Duiker and Bay Duiker were found along all 16 lines, as well as was the Red River Hog on Rank 6. Signs of the Forest Elephant, fifth-ranking in terms of relative abundance, however were only encountered along 11 of the 16 lines. Hence the number of recce lines does not only contain information on a species' relative abundance, but also on its spatial distribution, which will be discussed in the next section (3.1.3).

Relative frequencies become more meaningful if placed into a context. Table 5 and Figure 8 show data from other studies in Liberia that, with the exception of the Wologizi survey, are a bit outdated but used similar methods to allow a comparison with the results from Wonegizi:

Sapo National Park: Protected Area in Southeast Liberia; Liberia's first National Park est. in 1983. Data of the long-term biomonitoring program from the period 2007-2009 (VOGT 2011; due to several reasons duiker species were pooled per size/weight-class in that report).

Dugbe:	A gold mining concession area in Southeast Liberia, approximately six kilometers south of Sapo National Park. Large Mammal Survey in 2014 by Vogt & Forster.
Shaw-Boe:	A previously proposed REDD site in Southeast Liberia, approximately 35 km northwest of Sapo National Park. HCV biodiversity assessment in 2012 by Vogt & Forster (VOGT 2013).
Wologizi:	PPA in the Northwestern Forest Block adjacent to Wonegizi (see Figure 1). Rapid large mammal assessment in 2018 (VOGT & FORSTER 2019a).

Since no comparable relative abundance data were available for the Bushbuck, it is not included in Table 5 and Figure 8, respectively.

The comparison of the studies mainly shows the following: First of all, the six most common species in Wonegizi were frequent species in other areas as well. Only the Yellow-backed Duiker is outstanding for Wonegizi, where it was the third most often encountered mammal species, while in other forests it was much rarer. Secondly, Wonegizi has the highest encounter rates of these top-ranking species, i.e. obviously containing higher population densities than the reference sites. However, this was primarily due to strikingly higher abundances in study Area 2, the northern part of Wonegizi, which will be discussed further below (3.1.3).

On the other hand, regarding the lower ranking species, particularly the results of the Ogilby's Duiker differ considerably between Wonegizi and other areas, with an encounter rate of only 0,07 signs/km in Wonegizi, but 0,52 signs/km in Dugbe and similar rates of 0,35 signs/km and 0,31 signs/km in Wologizi and Shaw-Boe, respectively. In fact, the trackers in Wonegizi said that they find it difficult to clearly distinguish signs of the Ogilby's Duiker from that of the resembling Bay Duiker, especially the footprints, which made up 97% of all indirect duiker signs in this survey, only 3% accounted for dung records. Therefore it is possible that the Ogilby's Duiker abundance was underestimated and the Bay Duiker might be overrepresented. A camera trapping survey would be required for further clarification.

Looking at the primates, the above mentioned low encounter rates of monkey species (e.g. Lesser-Spot-nosed Monkey, Campbell's Monkey and Sooty Mangabey) become even more apparent when compared with the results of Shaw-Boe and Sapo National Park. Although among the low-ranking species in those areas as well, their relative abundance was at least 2,5 up to 22 times higher than in Wonegizi. The Chimpanzee showed a more balanced encounter rate across all areas.

The highest encounter rate of the Pygmy Hippo was found in Wologizi (0,28 signs/km), where it was recorded four times more often than in Wonegizi (0,07 signs/km), and at least twice as often than in the other areas. Given it is a water-bound species, the presence of Pygmy Hippos is very much localized, and thus, as in the case of primates, requires species-specific surveys to provide more consolidated data about its population density in a given area.

Table 5. Comparison of relative abundances (signs/km) of mammal species in different forest sites in Liberia (SNP = Sapo National Park), ordered by descending frequencies in Wonegizi.

Rank	Species	Wonegizi	Wologizi	Dugbe	Shaw-Boe	SNP
1	Maxwell's Duiker	2,52	1,89	1,74	1,08	
2	Black Duiker	2,21	1,73	0,83	0,39	
3	Yellow-backed Duiker	1,93	0,87	0,03	0,08	
4	Bay Duiker	1,77	1,70	1,08	1,31	
5	Forest Elephant	1,23	0,73		0,51	0,35
6	Red River Hog	1,01	0,74	0,42	0,28	
7	Western Chimpanzee	0,28	0,20	0,21	0,13	0,27
8	Bongo	0,13	0,04	0,03	0,15	
9	Water Chevrotain	0,09	0,08	0,17	0,33	
10	Ogilby's Duiker	0,07	0,35	0,52	0,31	
10	Pygmy Hippopotamus	0,07	0,28	0,10	0,08	0,12
11	Lesser Spot-nosed Monkey	0,04	0,05	0,03	0,10	0,14
11	Campbell's Monkey	0,04	0,04	0,03	0,10	0,30
12	Sooty Mangabey	0,02	0,05	0,03	0,44	0,19

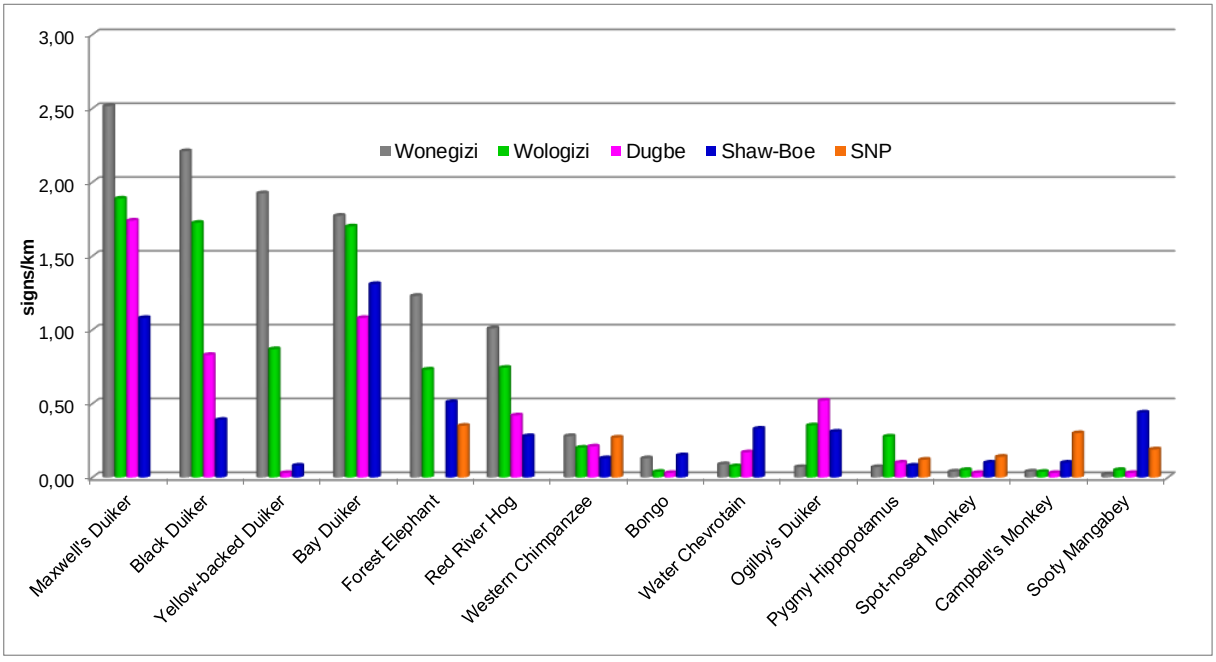


Figure 8. Relative abundances of mammal species in different forest sites in Liberia; corresponding chart of data presented in Table 5

3.1.3 Spatial Distribution

This chapter highlights the spatial distribution of the 16 mammal species that were recorded during the field surveys in Wonegizi, mostly based on the data collected through Recces, HCVs and Ad-hoc observations in Area 1 (central Wonegizi) and Area 2 (northern Wonegizi), and in part amended by relevant data from the interviews and the corridor survey.

Table 6 lists the 16 species ordered by descending overall abundance as presented in the previous chapter. Two data sets are shown per species and area; i.e. one indicating if the species' presence in an area was confirmed during field work (not all species were found along recces but probably by an opportunistic observation), and the second the relative abundance of those species that were detected during the reconnaissance surveys.

Table 6. Mammal species recorded during the field surveys in the two different study sites in Wonegizi.

A1: Area 1 (Central); A2: Area 2 (North); x: presence confirmed; Rel. Abundance = signs/km.

No.	Species	Presence confirmed		Rel. Abundance	
		A1	A2	A1	A2
1	Maxwell's Duiker	x	x	1,93	2,93
2	Black Duiker	x	x	1,44	2,74
3	Yellow-backed Duiker	x	x	1,23	2,41
4	Bay Duiker	x	x	1,55	1,93
5	Forest Elephant	x	x	0,32	1,85
6	Red River Hog	x	x	0,96	1,04
7	Western Chimpanzee	x	x	0	0,48
8	Bongo	x	x	0,21	0,07
9	Water Chevrotain	x	x	0,05	0,11
10	Ogilby's Duiker	x		0,16	0
11	Pygmy Hippopotamus	x	x	0,16	0
12	Lesser Spot-nosed Monkey	x	x	0	0,07
13	Campbell's Monkey	x	x	0	0,07
14	Sooty Mangabey	x		0,05	0
15	Bushbuck		x	0	0,04
16	King Colobus		x	0	0
Total		**14**	**14**	**8,07**	**13,74**

Regarding the species diversity, in both study areas 14 mammal species were recorded, i.e. in Area 1 all except the Bushbuck and the King Colobus, and in Area 2 all except the Ogilby's Duiker and the Sooty Mangabey. The "missing" species do not have to be truly absent from the respective areas, but in general might be rare in Wonegizi (the monkeys and probably also the Ogilby's Duiker) and /or bound to certain habitats (e.g. the Bushbuck and King Colobus). The King Colobus, only recorded once in Area 2 throughout the whole survey, prefers "high forest", i.e. the canopy of primary and mature old growth forest, as do also the Red Colobus Monkey and the Diana Monkey (KINGDON 2003; IUCN 2019), which during field work were not encountered at all. Although the forest in both survey areas in Wonegizi in general seemed largely intact (apart from the degraded margins close to farmland, and settlements in Area 2), it was striking that it does not contain a lot of high trees and more or less lacks a contiguous closed high canopy. According to local information, this is either due to natural

causes such as a rocky soil (Area 1) or to previous logging activities (Area 2, where ATICO was operating in the 1980s). Hence, suitable habitats for these three monkey species might be rare in Wonegizi (which moreover could be the reason for the general absence of the Jentink's Duiker, another "high forest" species). The interviewees and trackers from Vetesu mentioned a "rough and hilly" terrain between Vetesu and Ziggida, i.e. in the south of Wonegizi, where especially the Red Colobus, King Colobus, Olive Colobus and Diana Monkey can be found, as well as another hilly part in the central transboundary area which can be reached within approximately six hours walking distance from Ziggida, and allegedly contains high numbers of chimpanzees (Figure 9). Due to the restricted accessibility for humans these places were reported to remain untroubled by anthropogenic pressure and hence to represent a refugium for animals.

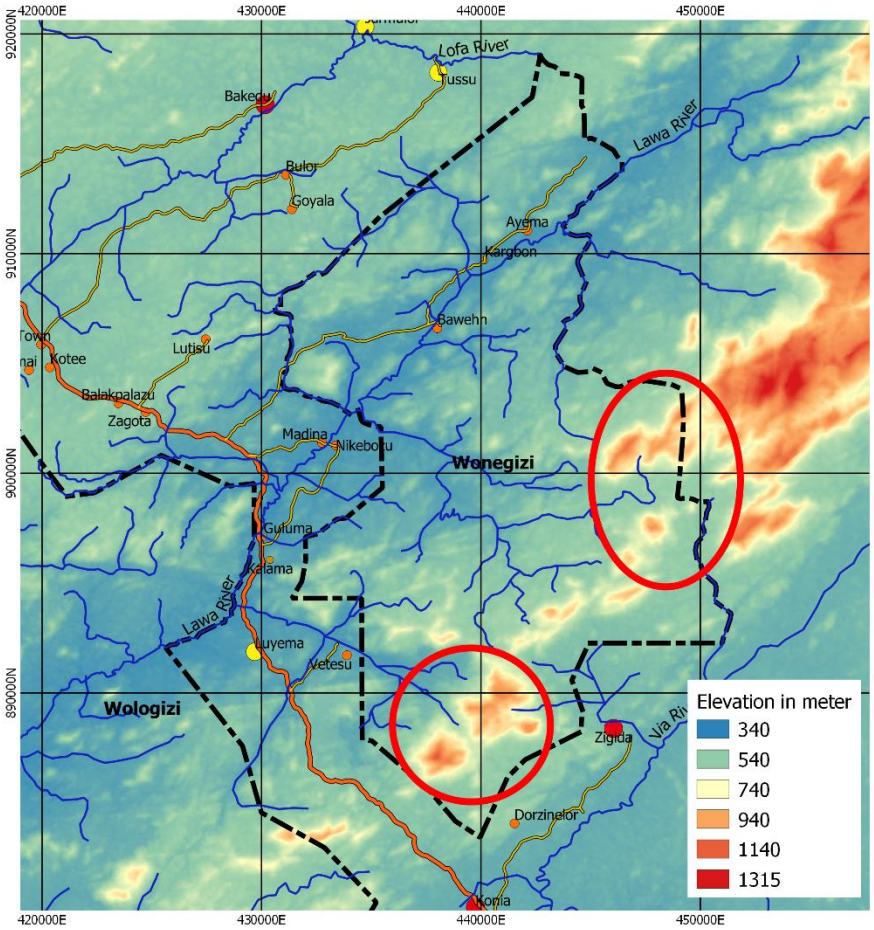


Figure 9. Elevation map of Wonegizi, showing the two hilly areas (red circles) which might serve as potential wildlife refugia

The 2018 HCV Report also points out those areas as potential pristine wildlife habitats, particularly for primates, birds and amphibians; in fact the HCV field team tried to access some parts (unfortunately it is not indicated where exactly), but had to give up because of insurmountable steep cliffs. Because of the limited time it was not possible to further evaluate this interesting information by ground-truthing in this study, so it is highly recommended to investigate these parts of Wonegizi as soon as possible in the near future.

Comparing the two study sites with regard to species abundance, Area 2 (North Wonegizi) was considerably richer than Area 1 (Central Wonegizi) (Table 6, Figure 10). 12 of the 16 species, i.e. all except the Bongo, Ogilby's Duiker, Pygmy Hippo and Sooty Mangabey, were more abundant in Area 2, with in part much higher encounter rates. Only the Bay Duiker, Red River Hog and Water Chevrotain showed a more balanced abundance. The overall encounter rate of all mammal species signs was 13,74 signs/km in Area 2 and 8,07 signs/km in Area 1.

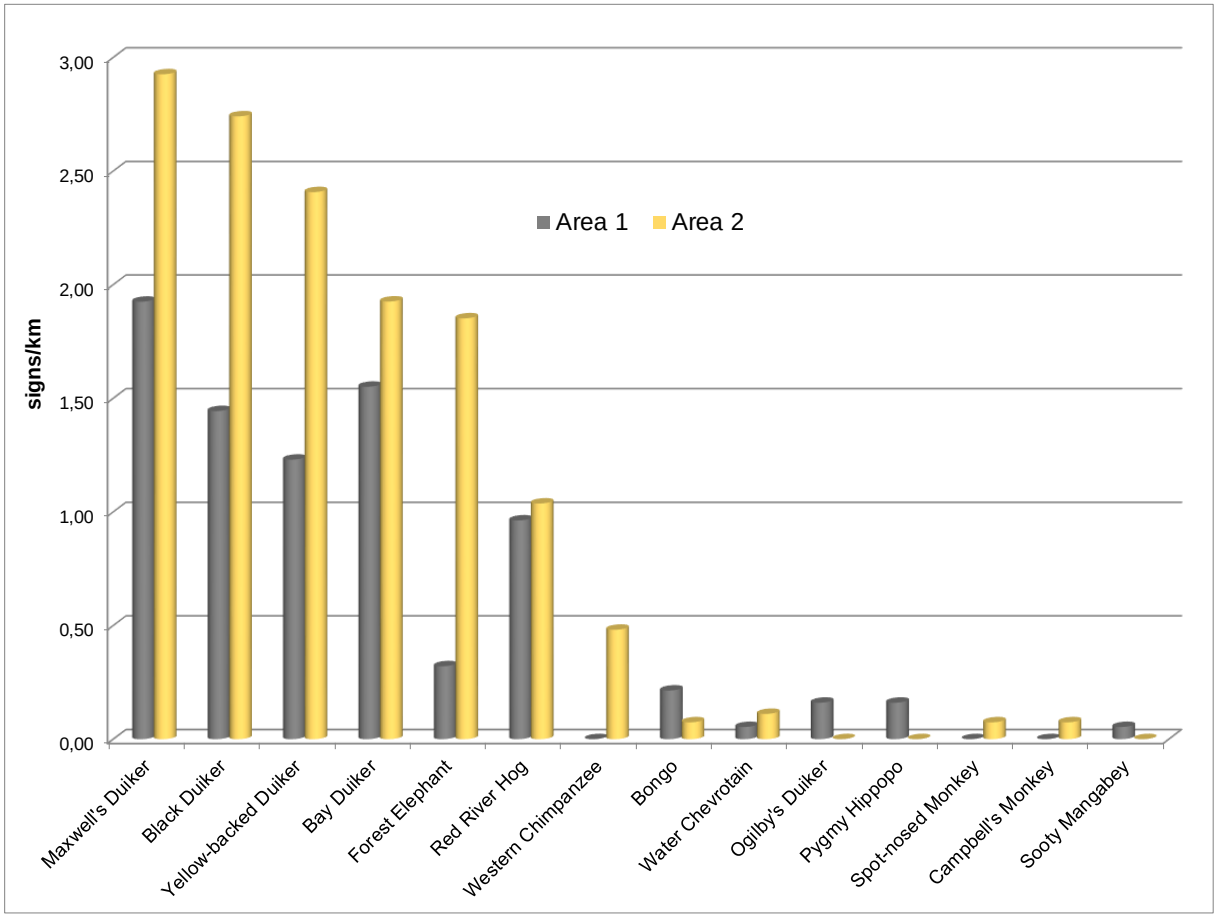


Figure 10. Relative abundances of mammal species per study area in Wonegizi

There are two possible explanations for the difference between the two sites:

(1) Better protection / less hunting in Area 2. According to the local trackers and FDA auxiliaries, commercial hunting is happening in the southern central and southeastern parts of Wonegizi, i.e. the PPA catchment area of the Ziggida communities. It seems to take place mainly in administration Zone 1, but might have a wider impact on the fauna in Zone 2, i.e. central Wonegizi where study Area 1 was located. In contrast, animals were reported to be better protected in northern Wonegizi, among others because "it is a Muslim area and they do not hunt". A lower hunting pressure further would be assumed to result from effective PPA management, such as law enforcement, patrolling and awareness, gradually leading to a change of local people's behavior. However, regular patrols just started recently (law enforcement in December 2018, biomonitoring in June

2019) and, given the relatively long recovery periods of mammal populations[1], thus cannot be the main reason for the higher abundances of mammals in Area 2. In case the higher densities in Area 2 should reflect an increase in animal numbers over the past years due to better protection compared to Area 1, it must be a long-term effect of general better conservation practices in northern Wonegizi. On the other hand, it is also possible that populations did not increase in Area 2 over the past years, but severely decreased due to commercial hunting in the southern part.

(2) Isolation of northern forest stretch of Wonegizi leading to limited wildlife dispersal options and higher population densities. As will be pointed out more detailed in the following chapters (3.2 and 3.3), the area north of Lawa River represents quite an isolated forest fragment of Wonegizi. Due to human settlements and agricultural activities along the Lawa River, the forest connectivity within the PPA is largely interrupted. In the transfrontier area with Guinea, the forest connectivity between Wonegizi PPA and the Ziama Biosphere Reserve is limited to a stretch in the northernmost region of the boundary line. Although not all species depend on forest connectivity to thrive – in fact, some like for example the Bushbuck, Lesser Spot-nosed Monkey and the Black Duiker cope well with secondary growth and anthropogenic altered landscapes – and thus human settlements and farmland do not represent a 100% barrier for animal movements, the extent of forest disruption as well as involved human disturbance definitely will limit dispersal options for wildlife in northern Wonegizi. Hence, compared to the rest of the PPA, species might be more "crowded" in Area 2, resulting in higher encounter rates.

Figures 11 and 15 illustrate the spatial distribution of records of three selected key species, i.e. the Western Chimpanzee, Pygmy Hippopotamus and the Forest Elephant. It has to be noted that these figures do not reflect population densities or numbers of individuals, but the signs that were recorded of the respective species, i.e. theoretically some of the signs could have been left by the same individual or group.

Western Chimpanzee (Figure 11). Chimpanzee signs were found in both areas, with comparatively higher densities in Area 2. In Area 1 there was only one ad-hoc observation of a "Playing Ground" (local dialect), i.e. a fruit feeding site and traces of related signs such as tread down vegetation etc., which according to the local trackers however could be clearly allocated to Chimpanzees. The records in Area 2 included mostly nests (Figure 12), further fresh dung (Figure 13), and on two occasions Chimpanzees were also heard. The number of nests per site varied between one and eight, and there were indications that the Chimpanzees use the same sleeping nest more than once. For example, on at least two occasions the field team found a sleeping site, where Chimpanzees definitely had spent the previous night (indicated by fresh footprints and fresh dung under the nests, as well as by the fact that they were still present in the vicinity when the field team reached the site in the early morning), but

[1] Population growth rates of mammals depend on a lot of factors, i.e. are a very complex topic with only little data available in the literature. Based on those findings (e.g. HONE et al. 2010; VERMEULEN 2017), however, it can be assumed that for medium-large sized mammals it will take at least a few years to double populations. For the Forest Elephant in Central Africa the population doubling time was calculated 58 years, or 38 years if illegal killing would be eliminated (TURKALO et al. 2017).

not all nests (required for the estimated group size that could be retrieved from vocalizations) were fresh but of different decay stages. Reuse of previously made nests is known from other areas as well (GOODALL 1962; overview in HERNANDEZ-AGUILAR et al. 2013).

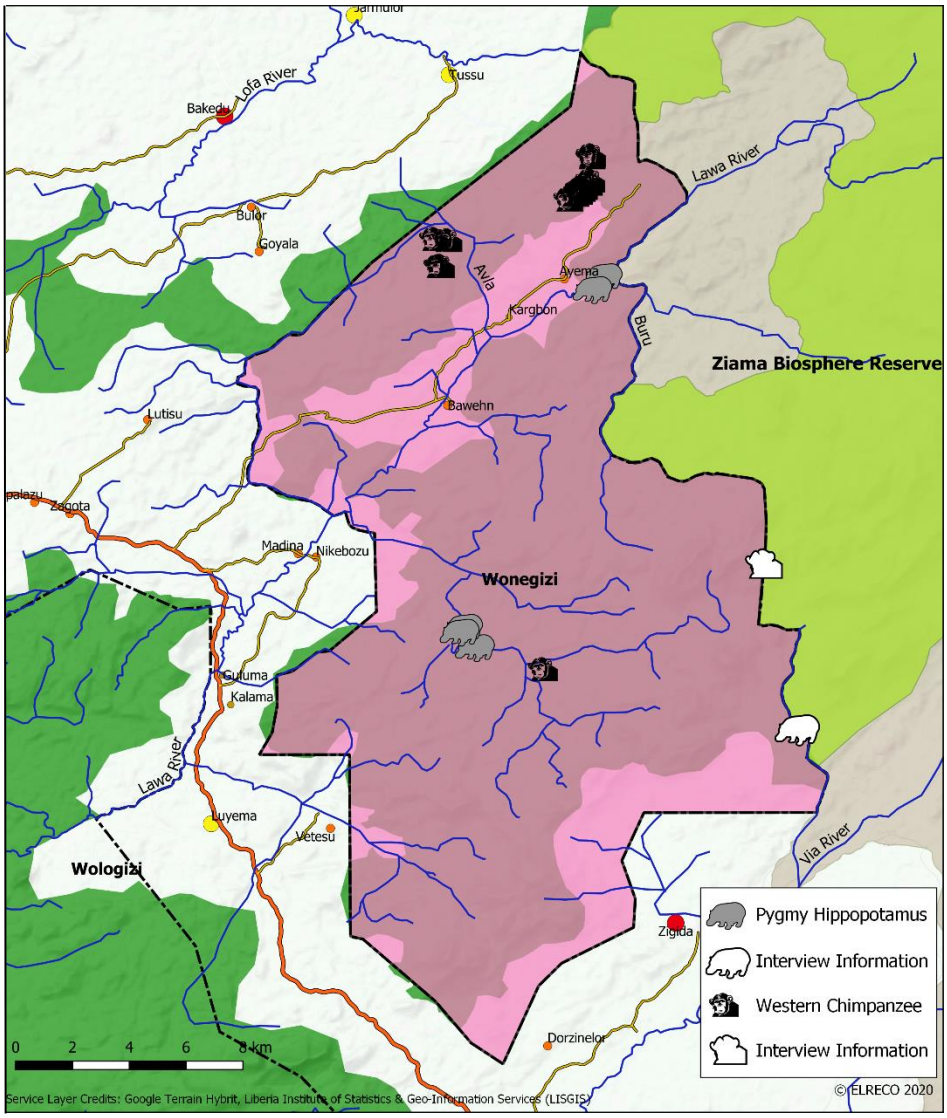


Figure 11. Spatial distribution of Western Chimpanzee records and Pygmy Hippo records across the study sites in Wonegizi

Figure 12. Chimpanzee nest

Figure 13. Chimpanzee fresh dung

No Nut Cracking Sites were found. A reason could be that at time of the survey there was no nut season, but even old Nut Cracking Sites usually can be easily identified by tools like an "anvil and hammer" (e.g. rocks, roots, stones) and broken nut shells, which decay much slower than for example dung or footprint signs.

Additional information from the interviews and trackers: In Vetesu/Area 1 people said that Chimpanzee generally are more spread out in the dry season, while in the rainy season they show a more localized distribution, which might be related to food availability. In Area 1 they apparently can be found particularly in August. In Area 2, local people from Bawehn reported that Chimpanzees from both sides of Lawa River come closer to their town in November and December. As was already mentioned above, the trackers further highlighted the hilly central transboundary area (Figure 9) as a special Chimpanzee retreat site, which is also indicated in Figure 11 by the blank chimpanzee symbol. Habitat-wise the interviewees remarked that Chimpanzees prefer low areas and often are found in valleys, which was supported by the field observations. 50% of the nesting sites were located in swamps, the rest of all signs in old/mature secondary forest habitat. The elevation levels covered by the whole field survey ranged between 380-636 m asl, and Chimpanzee signs were recorded between 443-496 m asl.

Pygmy Hippopotamus (Figure 11). Pygmy Hippo signs were recorded along the Yanwolo creek and its distributaries in Area 1, and at the Lawa River and its confluence with the Buru River (coming from Guinea) in Area 2. Only footprints were found (Figure 14).

Figure 14. Pygmy Hippo footprint at Yanwolo Creek in Area 1 (due to the soft soil it appears a bit oversized)

According to the local information gathered in the interviews and during the corridor assessment, in northern Wonegizi the Lawa River is the most important Pygmy Hippo habitat, where it still occurs in relatively high numbers. It obviously never occurred along the Avla Creek nor its distributaries at the northern boundary line of Wonegizi. Apart from Lawa River in the north and Yanwolo Creek in central Wonegizi, the locals further pointed out the transboundary creek in the southern part of the PPA as a third key area for Pygmy Hippos, which is indicated by the blank Pygmy Hippo symbol in Figure 11.

Forest Elephant (Figure 15). According to the local information, and supported by the field data of this survey as well as the 2013 and 2018 reports, Forest Elephants are only found in north and central Wonegizi, but not in the south, which might be linked to the rough and hilly terrain in the latter part (Figure 9).

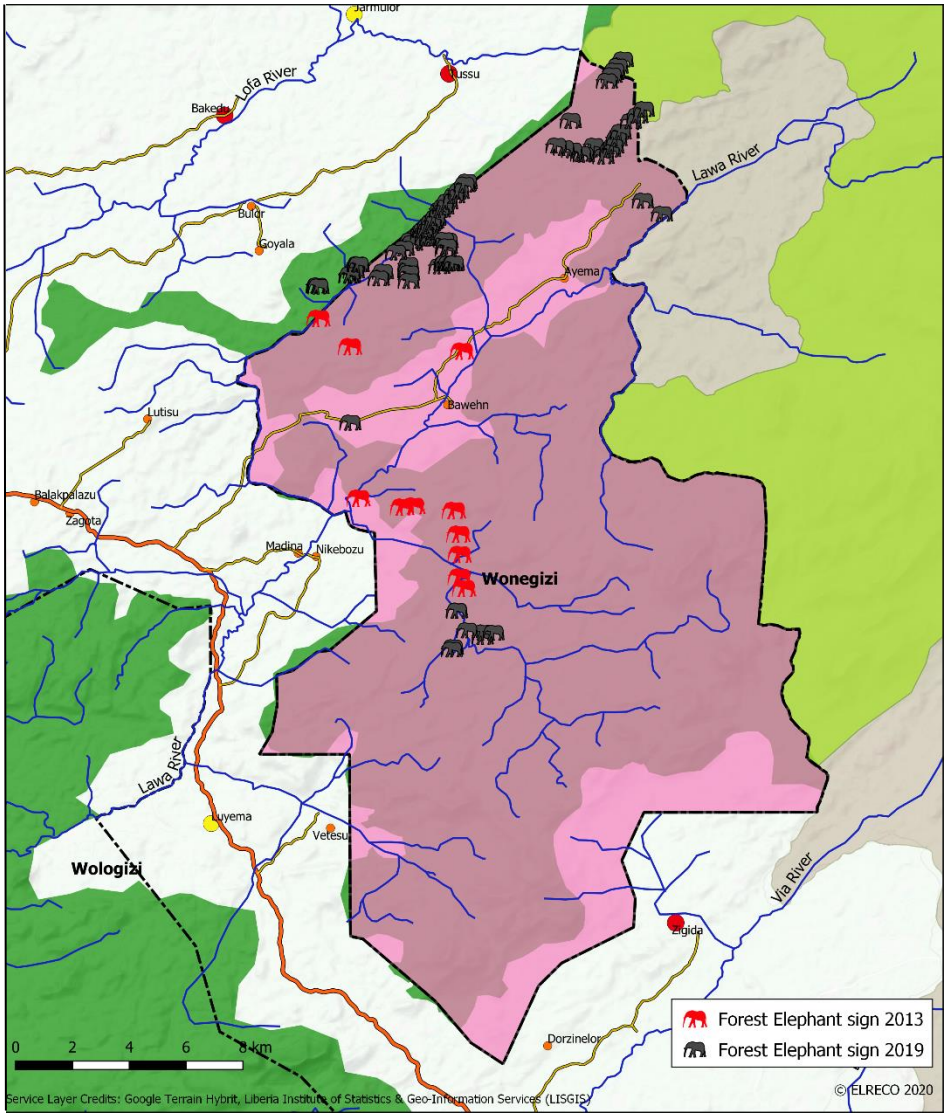


Figure 15. Spatial distribution of Forest Elephant records across the study sites in Wonegizi

While in central Wonegizi elephants seem to occur more temporarily, i.e. mainly during the rainy season, they were reported to be present year-round in the northern part. The trackers and local FDA biomonitoring auxiliaries assume that the northern elephant population consists of two to three groups, of seven or eight individuals each, and a few single bulls. In both study areas fresh (less than one month) and old signs were found, i.e. footprints, dung, roads and other indications such as a river crossing point and feeding signs (Figure 16). The records were taken in a variety of habitat types, including Old Secondary Forest, Swamp, Bend Bush, Riverine Forest and Post-cultural Secondary Growth, at elevation levels ranging from 406-636 m asl. Six dung samples were collected, one in Area 1 and five in Area 2. The fact that Forest Elephants are more abundant in northern Wonegizi, where the encounter rate was nearly six times higher than in Area 1 (1,85 signs/km versus 0,32 signs/km, see Table 6), might arise from several factors such as topography, less human disturbance (see 3.2.1), the presence of Lawa River (the largest water body in Wonegizi), and, to some extent, limited access to other sites in Wonegizi from the surrounding forest areas. From Wologizi, Wonegizi is separated by the main car road, and access from the transboundary Reserve in the east is blocked by the huge mountain ridge in Ziama (Figure 9). The above discussed hypothesis of limited dispersal options due to forest fragmentation might not apply to Forest Elephants, as their movements do not depend on forest connectivity and they also enter farmland and secondary growth. In conclusion, the higher abundance and permanent presence of elephants in the north highlight this area as the key elephant area in Wonegizi, which, however, does not mean that the central parts are less vital for the species, since they contain seasonally important haunts and migration routes. Regarding the movement patterns, the local people said that elephants are more spread out and come closer to human settlements and enter their farms in the rainy season, an observation that was also made in Wologizi and other elephant rage areas (VOGT & FORSTER 2019a, b). Based on all information that was collected during this survey, it appears that the elephants from Wonegizi and Ziama form one cluster population that roams in Wonegizi and the transboundary areas of Ziama, but does not migrate so much into Wologizi (see also Chapter 3.3).

Figure 16. Elephant signs (footprint and feeding site)

3.1.4 Summary of key information on large mammals in Wonegizi PPA

This chapter summarizes some of the key facts presented in the previous chapters.

Primates

Western Chimpanzee

- Chimpanzee signs were found in both survey areas, but with a higher abundance in the northern site of Wonegizi
- Another alleged Chimpanzee hotspot mentioned by the interviewees is the mountainous region in the central transboundary area between Wonegizi and Ziama, ca. six hours walking distance from Ziggida
- Local people further stated that Chimpanzees are more widespread in the dry than in the rainy season
- There were indications of multiple use of the same sleeping nests
- No Nut Cracking Sites were found throughout the whole survey
- There seems to be no hunting taboo, but one interview community reported that Chimpanzees are not much hunted because of the low market price of Chimpanzee meat

Monkeys

- At least seven species were confirmed to be present in Wonegizi: the Red Colobus, King Colobus, Olive Colobus, Diana Monkey, Sooty Mangabey, Campbell's Monkey and Lesser Spot-nosed Monkey
- The High Forest species Red Colobus, King Colobus and Diana Monkey seem to be very rare, most likely due to habitat conditions, as well as hunting
- Two other monkey species, i.e. the Putty-nosed Monkey and the Green Monkey, reported to be known from Guinea, might occasionally also occur in / around Wonegizi
- In general, the encounter rates of monkey species were relatively low. Specific primate surveys would be necessary to follow up if these reflect in fact low densities or more an underrepresentation of capture rates due to their behavioural ecology and applied methods

Forest Elephant

- Forest Elephants occur in the central and northern parts of Wonegizi, but not in the south
- The northern part of Wonegizi is a key elephant habitat, where they roam year-round, while the central parts contain important migration routes and crucial seasonal habitats
- The relative abundance of Forest Elephants in the north was nearly six times higher than in the central study area
- The Wonegizi elephants roam within and around Wonegizi and into Ziama, but there seem to be no regular movements into Wologizi PPA (anymore, see Chapter 3.3)
- Movements between Wonegizi and Wologizi seem to happen only occasionally around crop harvesting time in the second half of the rainy season, when elephants in general

are reported to come closer to farms and human settlements, and then sporadically a few individuals cross the main car road between the two PPAs

- In the past there were several locations where Forest Elephants crossed the main road between Wonegizi and Wologizi, but only one, i.e. between Kotee and Balakpalazu, is left today (see Chapter 3.3)

Ungulates

Pygmy Hippopotamus

- The presence of the Pygmy Hippo in Wonegizi was confirmed both by interviews and field surveys
- At least three key habitats were identified by the rapid assessment, i.e. the Lawa River in the north, Yanwolo Creek and its distributaries in central Wonegizi and the transboundary creek between Wonegizi and Ziama in the eastern part of the PPA

Duikers

- At least five duiker species occur in Wonegizi: the Bay Duiker, Black Duiker, Maxwell's Duiker, Ogilby's Duiker and Yellow-backed Duiker
- The Maxwell's Duiker, Black Duiker, Yellow-backed Duiker and Bay Duiker were the four most often recorded mammal species in Wonegizi
- Local trackers stated having difficulties to distinguish the footprints of the Bay Duiker and Ogilby's Duiker
- Compared to other forests in Liberia, Wonegizi holds a remarkably high population of the Yellow-backed Duiker
- The Jentink's Duiker almost certainly does not occur in Wonegizi
- The Zebra Duiker appeared in the past, but might be very rare if not extinct in Wonegizi today

Hogs

- The Red River Hog is a common species in Wonegizi; it was the sixth most often recorded animal
- The Giant Forest Hog is absent from Wonegizi

Others

- The Leopard and the African Golden Cat were reported to be present in Wonegizi
- Local people further confirmed the presence of all three pangolin species; and one community (Vetesu) stated among others high numbers of the Giant Ground Pangolin - a species that generally is thought to become rare in Liberia's forests today

3.2 Threats

Though it was not the objective of this study to conduct a threat assessment, a few key observations shall be included in this report.

3.2.1 Human Impact

Signs of human impact were visible in both survey areas. The majority of records were hunting signs (84%), mostly gunshells, as well as gunshots, hunting camps and snare traps. The remainder accounted for farms (2%), logging roads (5%) and other signs (9%) such as human footprints and abandoned villages (Figure 17). The logging roads mostly dated back to the logging operations in the 1980s, however one newly opened road was detected during the transboundary corridor survey in northern Ziama (Figure 18). According to local information it is used by trucks to transport logs from a nearby pit-sawing area.

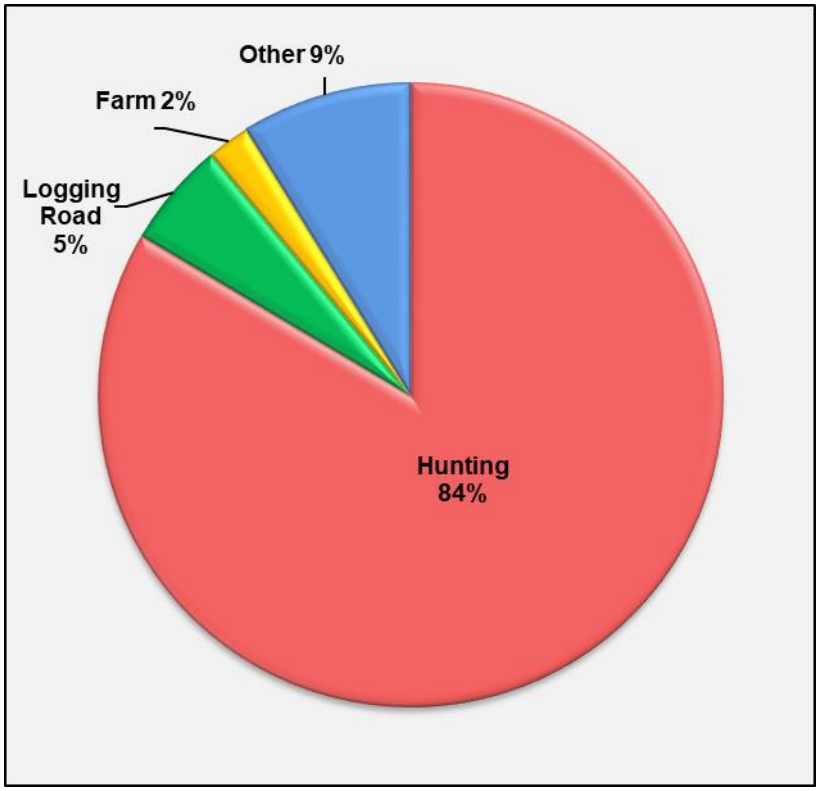
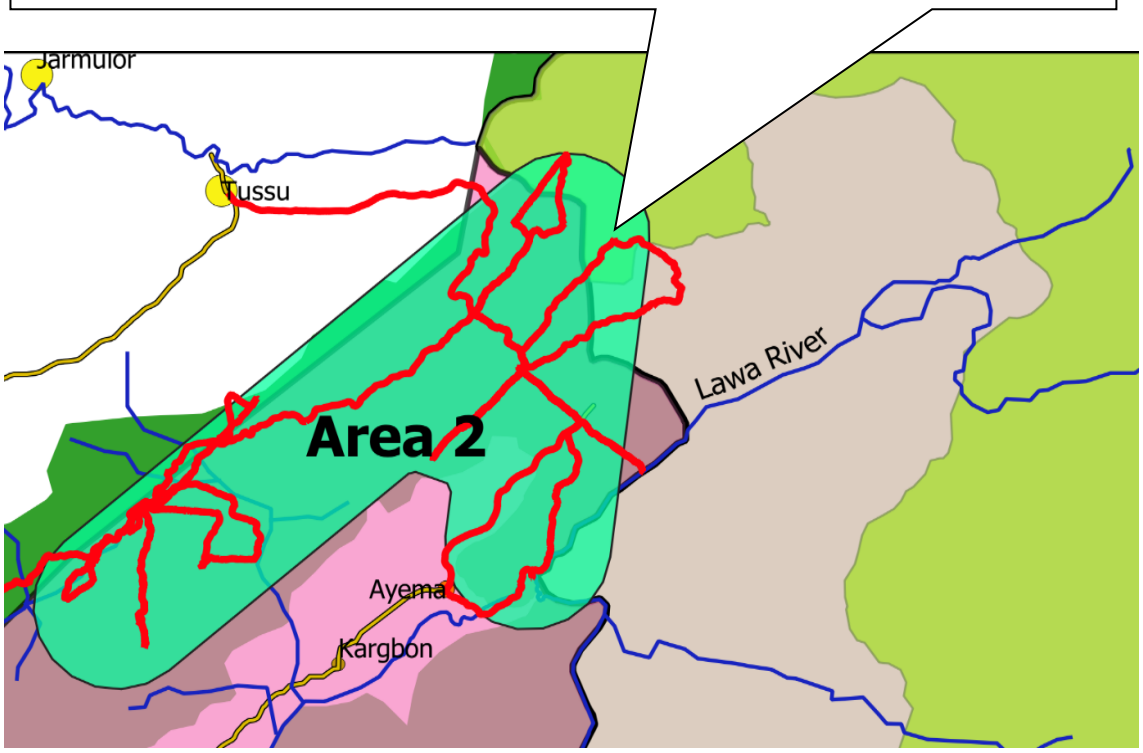


Figure 17. Signs of human impact recorded during the Large Mammal Survey in Wonegizi

The extent of human impact, especially that of hunting was higher in Area 1 (Figure 19). If all signs are considered, the frequency in Area 1 was 1,40 signs/km compared to 0,78 signs/km in Area 2, and that of hunting signs 1,30 signs/km compared to 0,48 signs/km, respectively. In Area 1 a hunter was also directly encountered. In the last night before the team moved out back to Vetesu, several gunshots were heard, and in the morning the team came across a hunter, just a few hundred meters off the camp site. The person dropped his cutlass and ran away with his bag, but could be identified as hailing from Ziggida. The higher hunting pressure in Area 1 matches the interview information about commercial hunting activities in this part of Wonegizi, and it is highly recommended that FDA follows up on this.

Figure 18. Active logging road in Ziama, close to the Liberian border



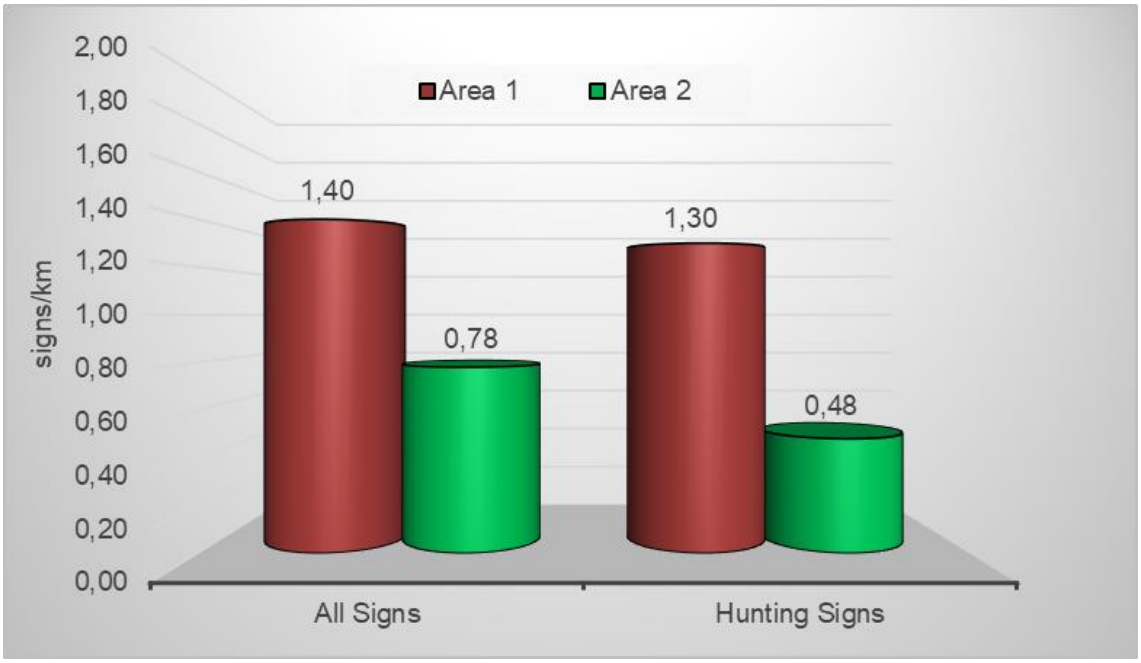


Figure 19. Frequency of human impact signs in Study Area 1 and 2

3.2.2 Forest degradation and fragmentation

Apart from direct threats like hunting, the large mammal fauna in Wonegizi very likely will be negatively affected by progressive habitat loss and fragmentation, especially through the revised demarcation process in the northern part of the PPA. Figure 20 on the left shows the original boundary line as Wonegizi was set aside as PPA, covering an area of approximately 38,000 ha. The demarcation process began in November 2016 with the pre-line cutting to alert the surrounding communities of the suggested boundary line, and was completed in October 2017. After that, in 2018 the harmonization procedure started, i.e. the decision making process which involved visits with the communities to the flagging line to discuss and decide on the final position of the boundary line (Figure 20 right). The final demarcation results in an area loss of ca. 25%. Though the new demarcation includes an extension area of ca. 772 ha in the north (yellow area in the middle picture of Figure 20), large parts of in total 9,914 ha are omitted, mostly around the settlements along Lawa River as well as the western and southern margins of the PPA (red areas in the middle picture of Figure 20), resulting in a net loss of 9,142 ha, i.e. the Protected Area finally will consist of 28,858 ha (Figure 20 right). Secondly, the PA will be heavily fragmented with almost no connectivity left between the northernmost forest stretch and the remaining PA, given that the already limited corridor options are further constricted by the new demarcation line. The only suitable possibility left for the dispersal of large mammals in the north currently seems to be into Ziama, so this transboundary connectivity has to be considered of highest conservation priority and urgently needs to be protected from any further anthropogenic encroachment and disturbance, such as pointed out above (Figure 18).

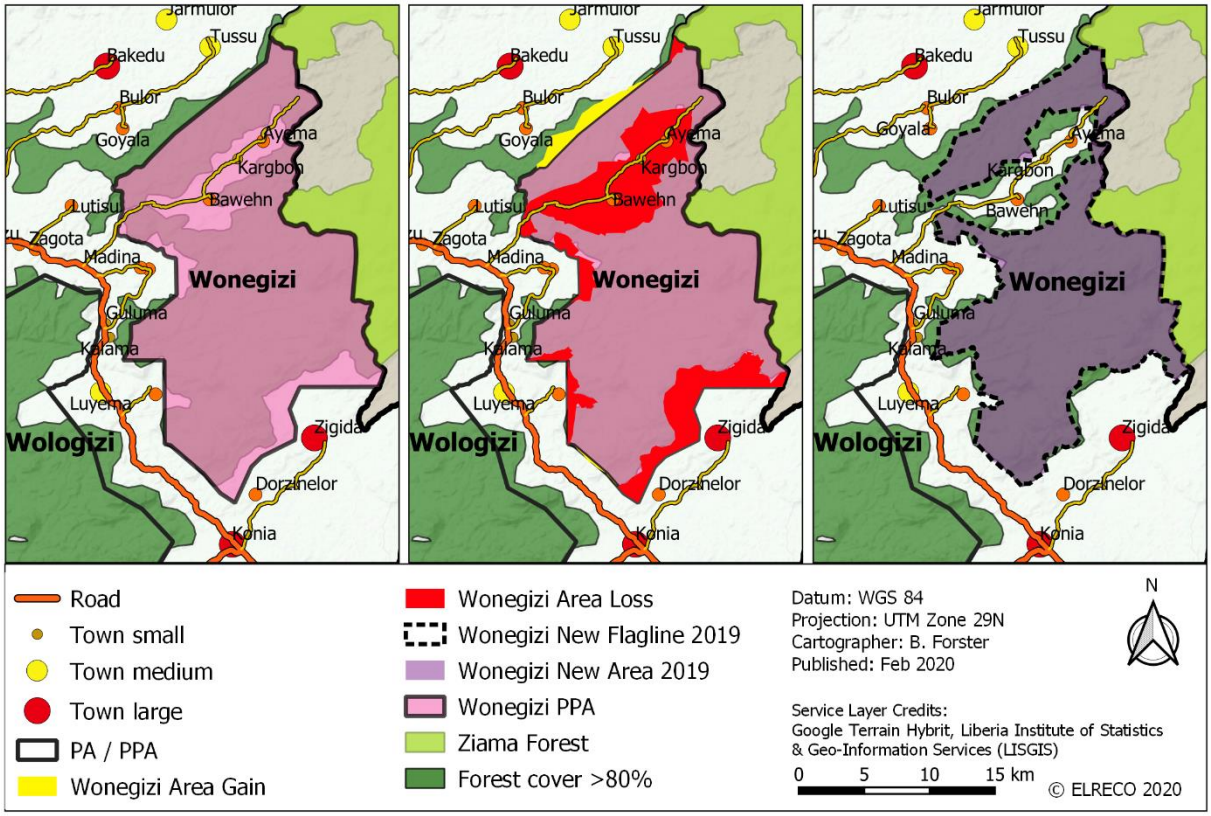


Figure 20. Wonegizi PPA original boundary line (left), area gain and loss (middle, in yellow and red) and new boundary line (right) after re-flagging in 2019

3.3 Corridor Assessment

For better illustration, the six sites that had been identified by satellite imagery for ground-truthing are presented again in Figure 21. The field evaluation showed the following results:

Site 1 (Transboundary Area Northern Wonegizi - Ziama)

Two field surveys were carried out in that site, i.e. one into the southern and one into the northern part of the Wonegizi-Ziama transboundary region (see also map in Figure 18). The forest connectivity is still well contained, with a mix of Old Secondary Forest, Swamps and Bend Bush, and the northern part of the transboundary region is marked by a boundary creek and planted bamboo trees (Figures 22-24). However, large high trees and a closed high canopy are mostly lacking, so this corridor is not very suitable for the dispersal of High Forest Species such as the Red and King Colobus or the Diana Monkey. During the survey several duiker species were recorded, further the Bushbuck and Forest Elephant. The southern survey line in part followed an elephant road, however, most elephant signs in the corridor area were not fresh but between two and six months old. At the end of the southern survey line in Ziama, the field team encountered a newly opened truck road as described above in section 3.2.1 (Figure 18). This indicates that the transboundary corridor, which is crucial for large mammals in northern Wonegizi, is already under threat. The limited width of the corridor, which will be further decimated by the new demarcation line, and the surrounding encroachment make it very vulnerable and hence there is a pressing need to ensure its proper

protection and management. On their way back from the southern survey line, the field team went through the farmland in Guinea from where they had a good view of the transboundary forest corridor (Figure 25) as well as of the mountain ridge in southern Ziama (Figures 26, 9).

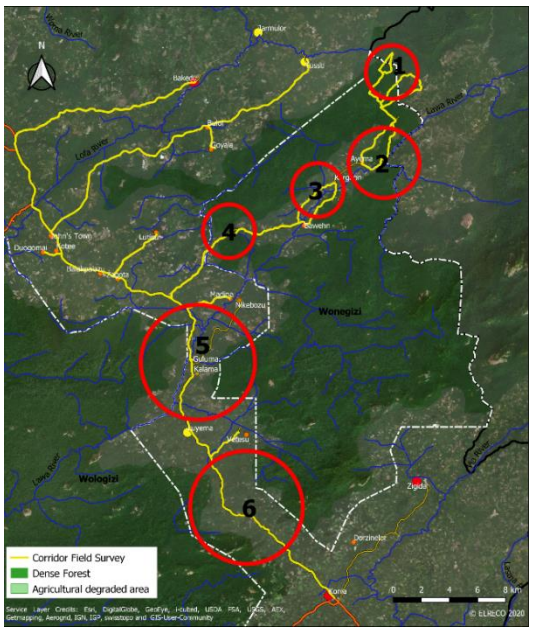


Figure 21. Corridor assessment sites

Figure 22. Boundary creek and bamboo in Site 1

Figure 23, 24. Forest Profile of the transboundary corridor Northern Wonegizi - Ziama (Site 1)

Figure 25. Farmland in Guinea southeast of corridor Site 1 (the forest corridor is visible in the back)

Figure 26. View from the farmland to the mountain range in southern Ziama

Site 2 (Wonegizi – Wonegizi East)

One field survey was carried out from Camp 2 in Area 2 to check the forest connectivity of Northern Wonegizi with the rest of the PPA in the confluence area of Lawa and Buru River, east of the settlement Ayema (Figure 27, see also map in Figure 18).

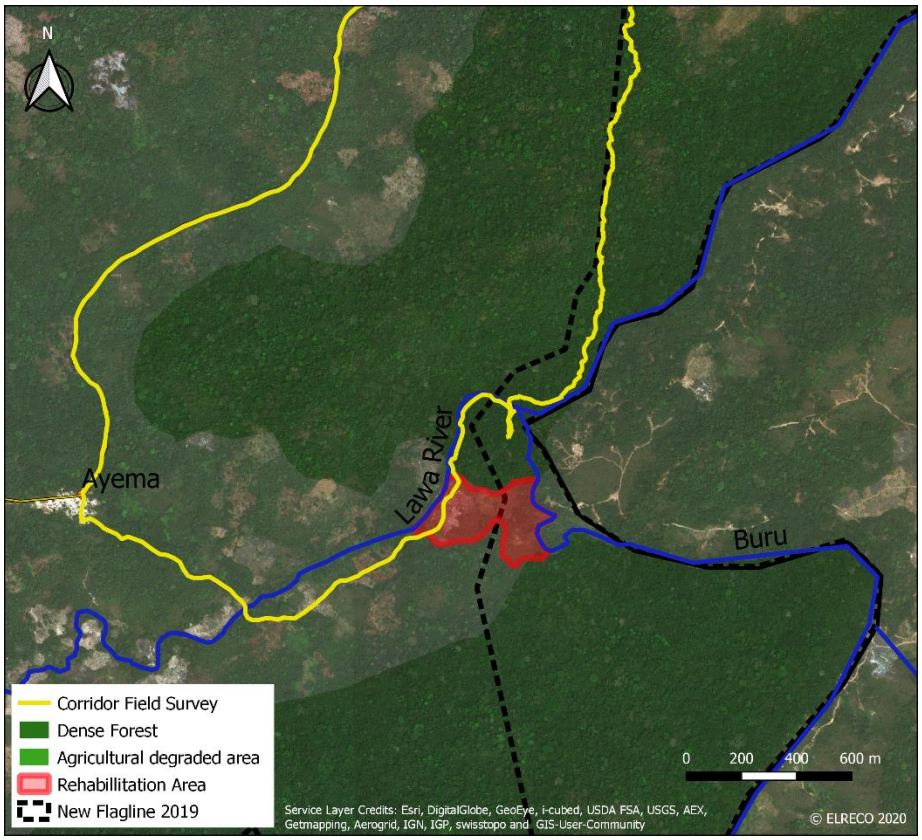


Figure 27. Corridor survey Site 2

Although the connectivity is already interrupted and threatened by human encroachment both on the Liberian and Guinean side, at this stage a potential corridor could still be preserved under the following conditions:

- *Rehabilitation of the disruption area*. The gap in the forest connectivity due to farming between Lawa and Buru River south of their confluence is not yet too large, i.e. covering an area of approximately 8,70 ha with a maximal width of 400 meters (red area in Figure 27) that would have to be restored in order to regain contiguity.
- *Revision of new demarcation line*. As illustrated in Figure 27 the new flagline is running straight through the potential corridor and would require relocation towards the west.
- *Effective management and protection of restored corridor by FDA patrols*. In general, human presence and activities in the surroundings of the corridor will pose a major challenge for its effective conservation. For example, though most of the riverine areas are seasonally flooded and therefore not suitable for farming, in some parts on the Liberian side people seasonally grow peanuts, while the entire neighbouring area on the

Guinean side has already been lost to settlements and agriculture. Human activities within the corridor and its vicinity thus will need to be extremely restricted and rigorously controlled.

Site 3 (Wonegizi – Wonegizi Central)

The potential corridor in Site 3 was assessed by a field walk starting from Bawehn along the southern side of Lawa River to Kargbon, and back to Bawehn along the northern side (Figure 28). The southern route is a forest path, while the northern way is a motorbike road. Farming activities already take place along the eastern side of the forest path, and will be further extended; in fact a few new farms had just recently been established (Figure 29). The remaining forest area on the other side of the path, towards Lawa River, is seasonally flooded and therefore not suitable for the establishment of permanent farms, but used for seasonal peanut farms (Figure 30). On the motorbike road north of Lawa River, only two very narrow forest strips close to Avla and Lubo Creek were found to remain as potential connection sites to the forest area south of Lawa River, but given that they are already largely degraded, this is not really an option anymore (Figures 31 and 32). It further has to be noted that due to the new demarcation line huge parts of the still existent forest in Site 3 will be lost in the near future. Hence the potential to restore forest connectivity in Site 3 is considered as very low and actually not feasible.

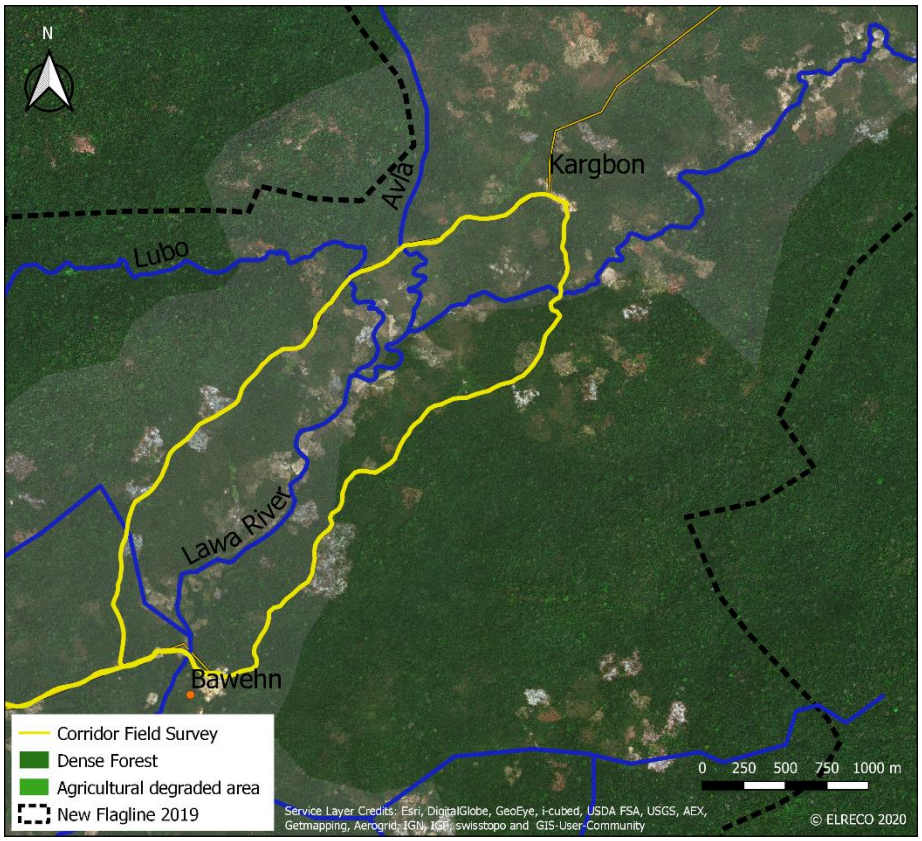


Figure 28. Corridor survey Site 3


Figure 29, 30. Newly brushed farm and seasonal peanut farm along the forest path in Site 3


Figure 30, 31. Remnant degraded forest patches around Avla and Lubo Creek along the motorbike road in Site 3

Site 4 (Wonegizi – Wonegizi West)

The westernmost connection possibility between Wonegizi North and the rest of the PPA lies approximately halfway along a car road that is connecting Bawehn with the main road west of the PPA, and stretches across a distance of ca. 500 m (Figures 21, 32). As the field survey showed, there is still forest present, but in general the site is degraded, i.e. it only contains few bigger trees, the canopy is interrupted by the car road, and in the western part an extensive area has been cleared for farming (Figures 32-34). Again, the new demarcation line will have a negative impact on this site as well, since it can be anticipated that the remaining forest, including the anyway already fragile corridor will be cleared for farming within a short time if the new flagline is not re-negotiated. Hence, Site 4 is of limited suitability, if not practically already lost as potential wildlife corridor. However, the area contains an important elephant migration route. According to local information from Bawehn, Forest Elephants come every year into this part of Wonegizi, mostly between September and December, from Tussu / Goyala, cross the car road and Lawa River, and move on to central Wonegizi and Ziama. The locals further reported that just a few days ago an elephant had crossed the car road, and also described the main crossing point of the migration route, which was checked and confirmed by the survey team (Figures 32, 35).

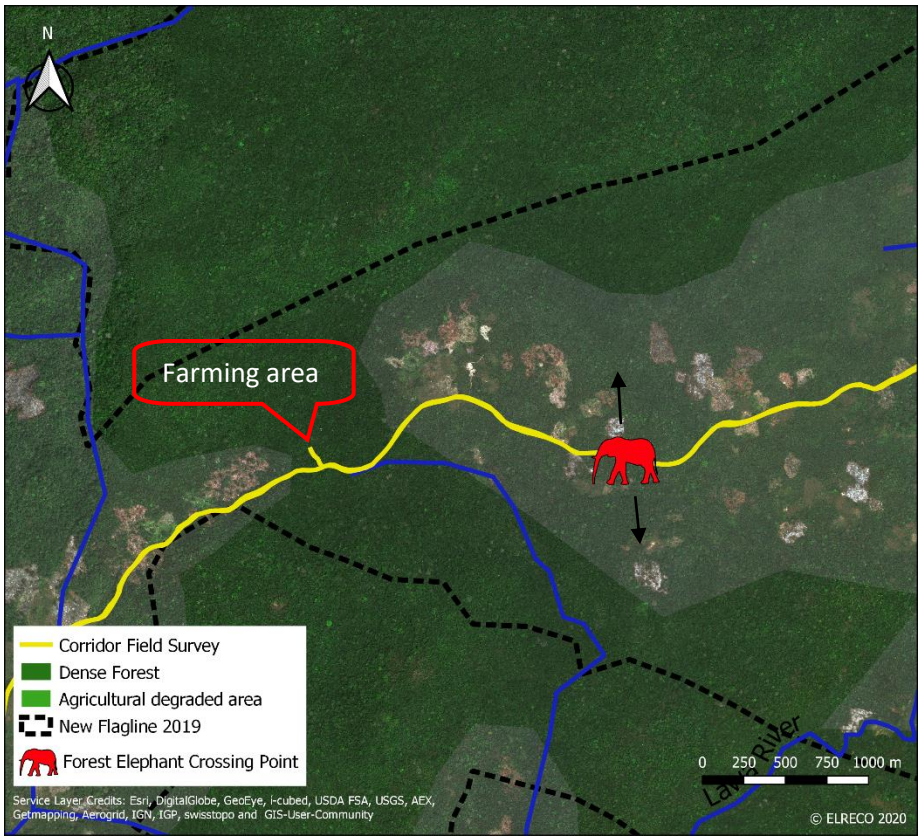


Figure 32. Corridor survey Site 4

Figure 33. Remaining forest “connectivity” in Site 4

Figure 34. Farming area in western part of corridor Site 4

Figure 35. Elephant path crossing the car road (left: direction from south, right: north of the road)

This is crucial with regard to the anticipated increasing farming activities, which very likely will lead to increased Human-Elephant-Conflicts in this area, and sooner or later to a displacement of the Forest Elephant from this part of Wonegizi. Compared to Site 3, the restoration and preservation of Site 4 as wildlife corridor seems more practicable, and besides Site 2 in the east it would be the only other option to reconnect Northern Wonegizi with the rest, and thus mitigate the negative conservation impact of the PPA fragmentation. Therefore the preservation of Site 4 and re-negotiation of the new demarcation line should be seriously considered in current management decisions for Wonegizi.

Site 5 and 6 (Wonegizi – Wologizi Central and South)

The forests of Wonegizi and Wologizi PPA are separated by a main car road, settlements and agricultural activities. As indicated by the satellite map (Figure 36), and confirmed by the field survey, the gap in the forest cover is larger in Site 6, which based on additional field observations such as the high density of human settlements, the presence of the Wonegizi Mountain Range and its rugged terrain, which might not be the most suitable habitat for a number of mammal species, is adjudged ineligible for a potential rehabilitation of the forest connectivity between the two PPAs. In Site 5, the forest edges at least can still be spotted from the main road, but the whole area in between is very much disturbed and fragmented by human activities (Figures 37, 38). Between Guluma and Kalama there was a main crossing point for elephants moving between Wonegizi and Wologizi in the past, but the last time this happened was four years ago, i.e. in 2015. It is also the area where the Lawa River, coming from Wonegizi and flowing into Wologizi, intersects the main road. The Lawa River was identified as crucial Pygmy Hippo habitat, both in Wonegizi (this report) and Wologizi (VOGT

& FORSTER 2019a), and local people from Guluma and Kalama reported that Pygmy Hippos occurred in this area in the past as well. Taking all criteria into account, Site 5 is considered as the best option for the rehabilitation of a wildlife corridor between the two PPAs.

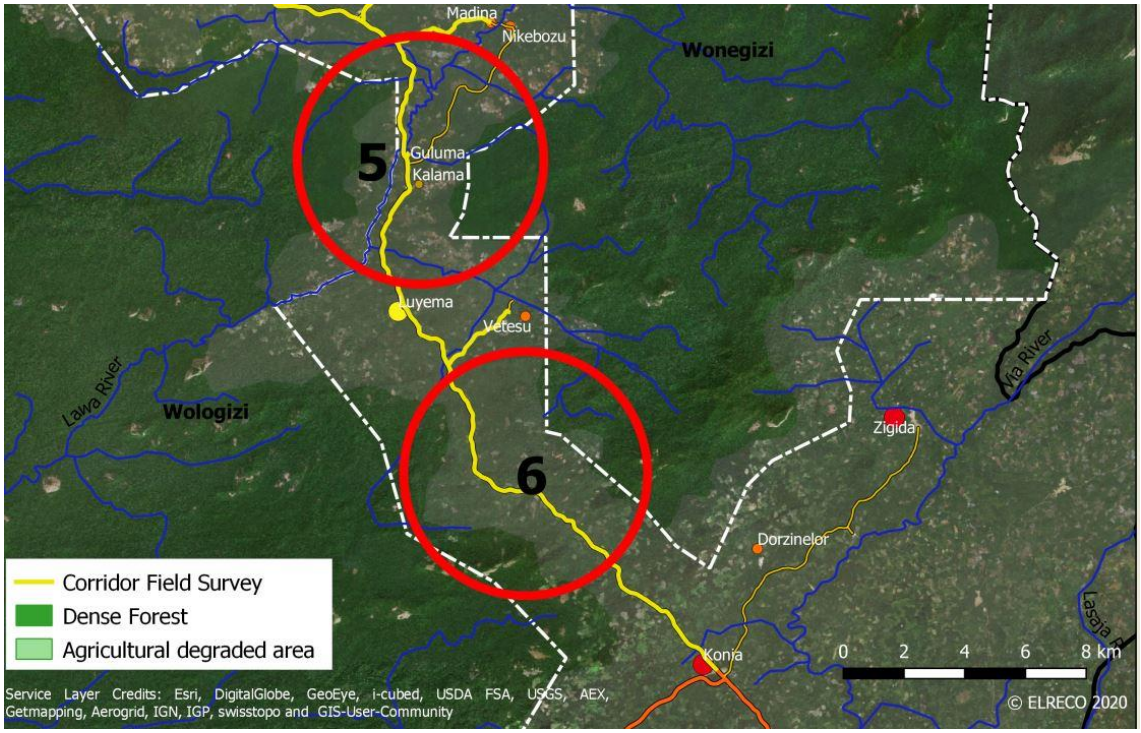


Figure 36. Corridor survey Site 5 and 6

Figure 37. Forest edge of Wonegizi, starting at the second hill (indicated by the arrow), in Site 5

Figure 38. Degraded areas between the main car road and the PPA forests in Site 5

In addition to the six pre-identified sites, the assessment in the field was extended particularly to check up on dispersal options for the Pygmy Hippopotamus along the Lofa River, and to better understand Forest Elephant migration in and around Wonegizi. The additional data gathering focused on the northern area around Wonegizi (i.e. the yellow lines outside the six corridor assessments sites in Figure 21, zoomed out in Figure 39), and included both interrogation of local people and short field walks. In summary the following information was obtained:

Pygmy Hippopotamus

As already pointed out, the most important habitat for Pygmy Hippos in the north is the Lawa River, especially the lesser disturbed parts in the eastern transboundary area (see Figure 11 in Chapter 3.1.3), as well as the western parts between Bawehn and Madina/Nikebozu. No Pygmy Hippos occur in the survey areas along the Lofa River.

Forest Elephant

In general, Forest Elephants are more widespread and come closer to human settlements and farms during the harvesting time, i.e. in the second half of the rainy season around August / September and roam in those areas for several weeks or months. This was reported from all survey communities around Wonegizi, including Tussu, Bakedu, Karzah Junction (the village

where the Lofa River intersects the main road), Kotee, Duogomai, Balakpalazu, Lutisu and Madina, and most of them also reported of crop raiding and related Human-Elephant-Conflicts. The settlements closer to Wonegizi (Tussu, Bakedu, Goyala, Lutisu, Madina) said that the elephants are coming from Wonegizi / Ziama, while those located between Wonegizi and Wologizi along the main car road (e.g. Duogomai, Kotee) stated that elephants come from both Wonegizi and Wologizi. At Karzah Junction, the place where the car road crosses Lofa River, local people said that Forest Elephants used to move along the Lofa River towards/from Wologizi in the past, latest in 2014. Since then, elephants only stay on the eastern side of the road, roaming between Tussu, Bakedu, Karzah Junction and Lutisu. The only location where elephants still cross the main car road between Wonegizi and Wologizi today is between Kotee and Balakpalazu. At the time of the field survey, the latest incident reported by local people dated from August 2019. However, it appears that only few individuals, probably single bulls, occasionally cross, but not like a regular, major migration between the two PPAs is taking place (see also Chapter 3.1.4).

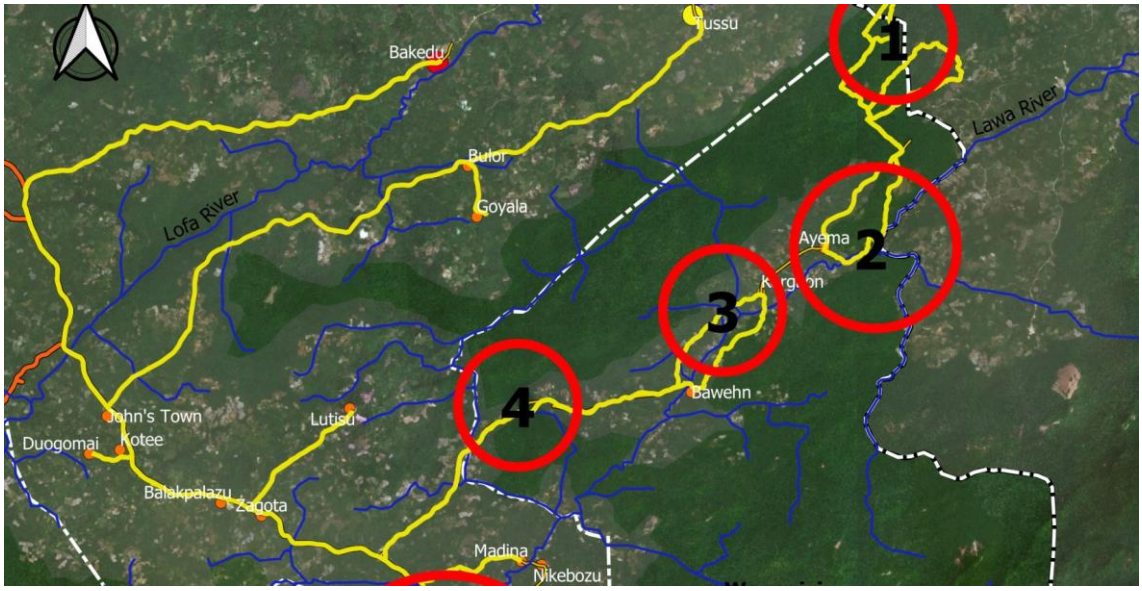


Figure 39. Additional corridor assessment around northern Wonegizi

Based on the above results it is recommended to maintain and restore the following five wildlife corridors (Figure 40):

(1) Wonegizi-Ziama North (WN_ZI North)
(2) Wonegizi-Wonegizi East (WN_WN East)
(3) Wonegizi-Wonegizi West (WN_WN West)
(4) Wonegizi-Wologizi North (WN_WO North)
(5) Wonegizi-Wologizi Central (WN_WO Central)

The corridors between Wonegizi and Ziama and within Wonegizi, i.e. No. 1-3, are crucial to keep the forest connectivity and prevent the total isolation of the northern forest block. However, these sites are already at stake and it will require immediate action to ensure their

survival. An additional option to mitigate the negative impacts of the PPA fragmentation would be an extension of the northern block by including the forest strip at the northwestern corner, and the area along Lofa River between Bakedu and the main car road. This extension could further be linked to proposed corridor No. 4, the northern connection between Wonegizi and Wologizi. The maintenance and protection of this area from further destruction is particularly recommended to sustain and probably revive Forest Elephant movements and exchange between the two PPAs. In that view it would not need a total reforestation but just an identification and proper management of the elephants' main migration route. The best and perhaps most feasible option for a full rehabilitation of a forested wildlife corridor is No. 5 in the central area, which also contains the Lawa River, a key water resource in both PPAs.

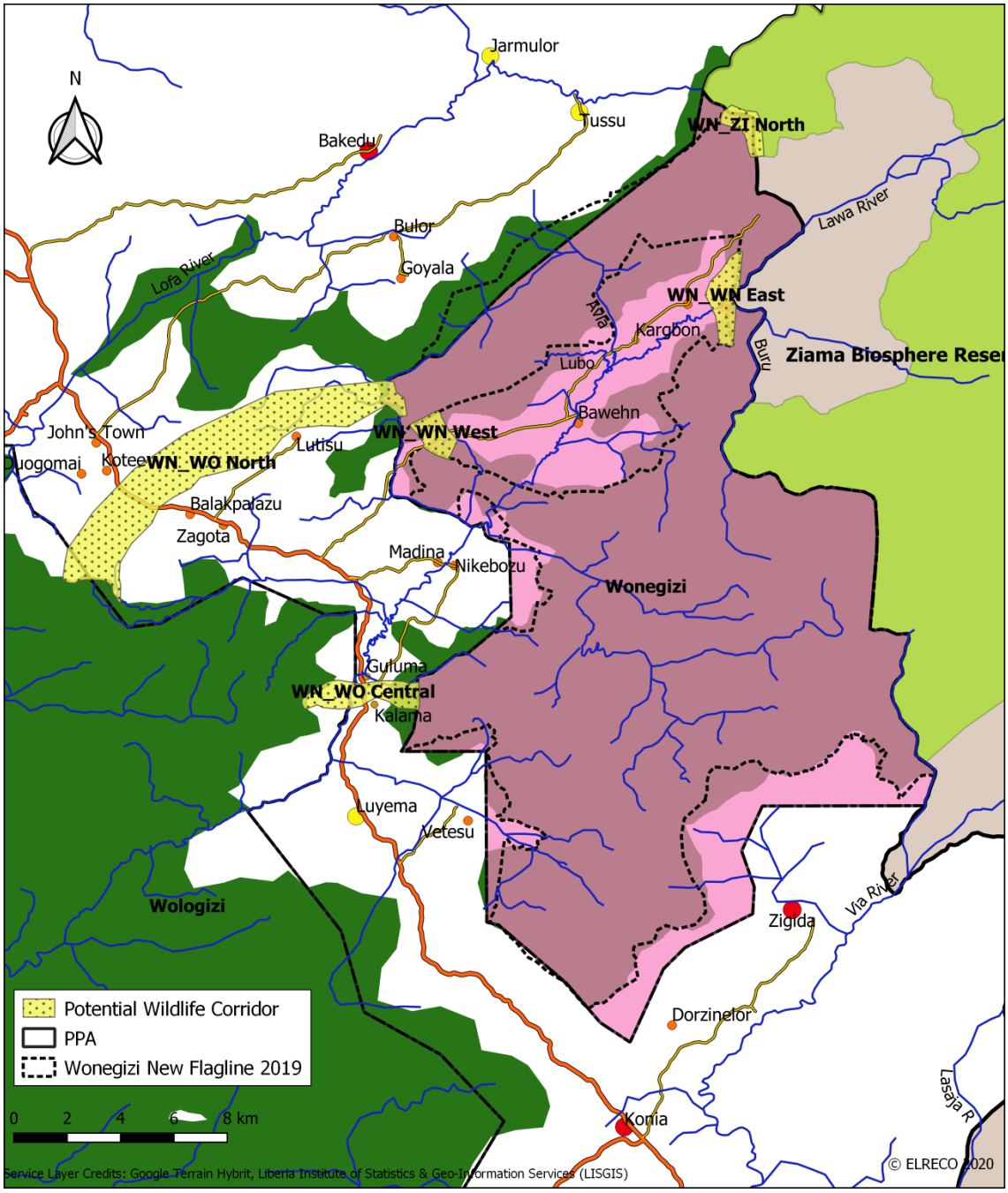


Figure 40. Proposed sites for the establishment and maintenance of wildlife corridors in Wonegizi

4. Conclusions

The Large Mammal Survey showed that Wonegizi plays a crucial role in biodiversity conservation in northern Liberia and the wider region. Located between the transboundary Reserve Ziama in Guinea and Wologizi PPA in the west, Wonegizi represents a significant link in the overall connectivity of the northern forest belt. It offers a variety of habitat types such as lowland forest, important water resources like the Lawa River, numerous creeks and swamps, as well as a large mountain ridge in the south/southeast, which in part is difficult to access for humans and therefore contains potentially undisturbed wildlife refugia. Although the forest profile seems to be mostly dominated by small to medium sized trees and thus, due to the lack of a contiguous high canopy cover, it might not be the most suitable habitat to support large numbers of species that depend on "High Forest", Wonegizi still holds a diverse large mammal fauna, including globally threatened key species like the Western Chimpanzee, Pygmy Hippopotamus, Forest Elephant, Leopard and pangolins. It is also an important area for the Yellow-Backed Duiker. However, despite the fact that Wonegizi is already under PA gazettement, which started in November 2016, its biodiversity is under threat, mainly caused by a high hunting pressure in the southern part, as well as by increasing forest loss and fragmentation due to the recent demarcation of the PA's final boundary line. The latter is especially problematic in the north, where it will lead to a total isolation of the northernmost forest stretch from the rest of Wonegizi. However, if immediate action follows, at this stage it might still be possible to preserve the last two potential corridor sites for re-connection. The transboundary connectivity with the forest of Ziama appears to be still well maintained in the central and southern regions, but is at stake in the northern part of Wonegizi, where it is limited in size and threatened by human encroachment, especially on the Guinean side. Hence, immediate conservation action is required here as well to sustain transboundary dispersal options for large mammals in that region. The general, in part much higher abundances of large mammals in the northern survey area compared to the central site is thought to be caused predominantly by the already extensive isolation of that forest fragment, and might further be linked to better conservation practices of the northern communities. The forest connection between Wonegizi and Wologizi is already completely interrupted by a main car road and human settlements; the gap in the forest cover at its narrowest point is at least four kilometers. Considering this distance and the extent of anthropogenic impact along the car road, the restoration of the PPAs' connectivity and the establishment of a wildlife corridor will be challenging and a long-term operation. Apart from Forest Elephants it is not known which mammal species would indeed use such a corridor if available, or how crucial this option is in terms of sustaining healthy and vital populations in general. However it can be assumed that a closed or isolated habitat at a certain point will reach its maximum species carrying capacity, while an open, extensive area provides much better conditions for a thriving biodiversity, in terms of offering more space, shelter, resources and dispersal options, which will allow genetic exchange and thus enhance intra-specific genetic variability and robustness. From a long-term conservation perspective a reconnection of Wonegizi with Wologizi therefore is considered a valuable objective. A first, immediate step towards this long-term goal would be to prevent any further destruction and extension of human encroachment in the two identified Wonegizi-Wologizi corridor sites.

5. Recommendations

1. Surveys in Zone 1 (southern/southeastern parts of Wonegizi)

It is highly recommended to carry out surveys in this part of Wonegizi as soon as possible, in order to:

- Follow up on the information about commercial hunting activities in that area
- Assess the transboundary forest connectivity between Wonegizi and Ziama
- Investigate the mountainous areas in the south and the eastern transboundary region with regard to their general suitability as wildlife refugia, and especially for the presence of Chimpanzees, Red Colobus, King Colobus and Diana Monkeys

2. Consolidate Large Mammal Survey data by follow-up studies

The following topics are recommended to further increase the knowledge about the mammal fauna in Wonegizi:

- Camera trapping study, to supplement the database on species diversity, relative abundance and spatial distribution, and help to clarify questions such as for example about the presence of the Jentink's Duiker, Zebra Duiker, Green Monkey, Putty-nosed Monkey and the Giant Ground Pangolin
- Primate survey, to shed more light on abundances and strepsirrhines (Potto and Galagos)
- Chimpanzee study, to better understand the population and spatial distribution of this Critically Endangered species in Wonegizi
- Forest Elephant study, to get an estimate of the Wonegizi-Ziama population size and identify their main migration routes
- Pygmy Hippo specific survey especially along additional water bodies to get a better idea about their home range and population size

3. Address Human-Elephant-Conflicts

Assess the extent and severity of Human-Elephant-Conflicts in affected communities, and address HEC in hotspots, e.g. by the introduction of community-based HEC mitigation measures (see also VOGT & FORSTER 2019b).

4. Intensify patrols and law enforcement to stop illegal hunting

5. Maintenance and restoration of wildlife corridors / forest connectivity

The ideal future scenario for conservation in northern Liberia is to restore contiguous forest connection across the entire landscape, i.e. between all the (P)PAs and transboundary forests, including Ziama, Wonegizi and Wologizi. This is a very ambitious goal that will need adequate time and resources. For a start it therefore is recommended to aim at the most urgent and feasible steps that can be taken to reach the overall target in the long-term. Regarding the Ziama-Wonegizi-Wologizi forest block, efforts first of all should focus on the connectivity within Wonegizi and between Wonegizi and Ziama, respectively, which – in contrast to that of Wonegizi-Wologizi – has not been completely interrupted yet, or at least could be easier

restored by swift and adequate short-term measures. The recovery of the Wonegizi-Wologizi linkage will be more elaborate and require a longer time frame, however some instant measures could be taken here as well. The following conservation actions are recommended:

Wonegizi-Wonegizi and Wonegizi-Ziama:

- Prioritization of the protection, rehabilitation and maintenance of Corridors No. 1-3 (WN_ZI North, WN_WN East and WN_WN West) as outlined in Chapter 3.3
- A Transboundary Conservation Management Agreement with Guinea should be worked out, signed and implemented as soon as possible
- To mitigate the negative impact of the isolation of Northern Wonegizi, an extension by including the forest strip at the northwestern corner of the PPA and the area along Lofa River between Bakedu and the main car road should be considered

Wonegizi-Wologizi

- Immediately stop and prevent further degradation and human encroachment in the two identified potential corridor sites (WN_WO North and WN_WO Central, see Chapter 3.3)
- Identify the main migration routes of Forest Elephants in the WN_WO North corridor
- Pilot study to identify corridor parameter such as course, width, length and reforestation options in both sites

General recommendations for the establishment and management of wildlife corridors

- Consider land purchase or lease options of the wildlife corridor area (e.g. by a conservation organization or a conservation trust fund)
- Wildlife corridors must be clearly designated, e.g. by painted trees or natural fences (e.g. bamboo), but not by cut lines (which will reduce forest again and facilitate human access)
- No human activities allowed in the corridor area
- No settlements and no large-impact activities (such as farming, mining, pit-sawing etc.) allowed in the close vicinity of the corridor
- Management of car roads intersecting the corridor (as in the case of Wonegizi-Wologizi) as special areas with certain regulations, e.g. speed limits, no honking, no stopping, forest edges must reach up to the road as close as possible, proper road maintenance (tree falls etc.), no settlements

6. General recommendations for future gazettements

- Since the gazettement is a long process which, like in the case of Wonegizi, can take several years, there is a need for clear interim regulations during the transition process, and an official interim gazettement document (e.g. issued by FDA), which obviously do not exist, but would facilitate FDA operations until the PA status is finally adopted (e.g. what is allowed within the PPA during the gazettement process, which preliminary boundaries have to be respected during the various gazettement stages etc.)
- During the harmonization and decision making process about the PA's final boundary line, the preservation of forest connectivity and potential sensitive corridor sites need to be considered

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Annex 1 Field Survey Timetable and Participants

Timetable Large Mammal Survey Wonegizi

Date	Activity
20.11.19	Preparation field trip, FFI Office Monrovia
21.11.19	Travel Monrovia - Zorzor
22.11.19	LM-RAP Training, FFI Office Zorzor
23.11.19	Travel Zorzor - Vetesu, Interview Vetesu
24.11.19	Move to and set-up Camp 01 in Area 01
25.11.19	Area 01 Survey Day 01 (Recces)
26.11.19	Area 01 Survey Day 02 (Recces)
27.11.19	Area 01 Survey Day 03 (Recce and Pygmy Hippo Survey)
28.11.19	Move out to Vetesu
29.11.19	Travel Vetesu - Goyala, Interview Goyala
30.11.19	Move to and set-up Camp 01 in Area 02
01.12.19	Area 02 Survey Day 01 (Recces and Chimpanzee Survey)
02.12.19	Area 02 Survey Day 02 (Recces)
03.12.19	Move to and set-up Camp 02 in Area 02
04.12.19	Area 02 Survey Day 03 (Recces and Ziama-Wonegizi Corridor Survey)
05.12.19	Area 02 Survey Day 04 (Recces and Ziama-Wonegizi Corridor Survey)
06.12.19	Area 02 Survey Day 05 (Recces)
07.12.19	Move out to Tussu, Travel to Goyala
08.12.19	Wonegizi -Wologizi Corridor Survey Day 01
09.12.19	Wonegizi -Wologizi Corridor Survey Day 02, Travel to Zorzor
10.12.19	Travel from Zorzor to Monrovia
11.12.19	Debrief FFI Office Monrovia

Field Team Large Mammal Survey

No.	Name	Sex	Country	Institution	Responsibility
1	Bernhard Forster	M	Germany	ELRECO	CEO, Team Leader
2	Dr. Tina Vogt	F	Germany	ELRECO	Technical Director, Team Leader
3	George M. Allison	M	Liberia	FFI	Biodiversity Officer
4	Kokuloku P. Sali	M	Liberia	FDA	Zone Warden, Facilitator
5	Zubah Womago	M	Liberia	FDA	LE Ranger, Tracker
6	Bryant Zayzay	M	Liberia	-	Camp Manager
7	Jefferson K. Gblinwon	M	Liberia	FTI	Data Recording
8	Flomo K. Dorbor	M	Liberia	UoL	Data Recording

Trainees Large Mammal Survey

No.	Name	Sex	Country	Institution	Position
1	Kokuloku P. Sali	M	Liberia	FDA	Zone Warden Wonegizi
2	Zubah Womago	M	Liberia	FDA	LE Ranger
3	George M. Allison	M	Liberia	FFI	Biodiversity Officer
4	Bryant Zayzay	M	Liberia	-	Volunteer
5	Jefferson K. Gblinwon	M	Liberia	FTI	Intern
6	Flomo K. Dorbor	M	Liberia	UoL	Intern

Annex 1 Field Survey Timetable and Participants

Focus Group Interviewees Large Mammal Survey

No.	Name	Sex	Age	yrs res	Town	Education	Main activity & source of income
Vetesu; Wonegizi/SW; 23.11.2019							
1	James Kwaytah	M	27	5	Vetesu	10th Grade	Farming
2	John P. Mulbah	M	26	10	Vetesu	11th Grade	Farming, FDA Eco-Guard
3	John Gbelee	M	30	6	Vetesu	12th Grade	Farming
4	Prince Pewee	M	22	12	Vetesu	7th Grade	Farming
5	Descare M. Harris	M	32	20	Vetesu	6th Grade	Farming
6	Larvelee T. Weyea	M	29	29	Vetesu	9th Grade	Farming
7	Johnson Kesselee	M	35	35	Vetesu	11th Grade	Hunting & farming
8	Kpadeh Zaza	M	35	35	Vetesu	9th Grade	Farming, Town Chief
9	Flomo Kesselee	M	31	31	Vetesu	No education	Farming
10	Otis Tarnue	M	33	33	Vetesu	4th Grade	Hunting & farming
11	Sumo Pewee	M	37	37	Vetesu	No education	Hunting, FDA Biomonitoring Auxiliary
12	Harris Kollie	M	34	34	Vetesu	No education	Hunting, Chain Saw Operator
13	Tokusen V. Tarnue	M	63	63	Vetesu	No education	Farming
14	Lurpoe Torkpa	F	25	25	Vetesu	8th Grade	Farming
15	Bill Charleston	M	45	30	Vetesu	10th Grade	Hunting & farming, Chief Hunter, FDA Auxiliary
Goyala; Wonegizi/N; 29.11.2019							
1	Forkpa Zayzay	M	42	21	Goyala	12th Grade	Farming, FDA LE Auxiliary
2	Forkpa Dorboryan	M	30	30	Goyala	No education	Farming
3	Zubah Karson	M	40	40	Goyala	8th Grade	Farming, Town Chief
4	James B. Kolubah	M	32	32	Goyala	11th Grade	Hunting & farming
5	Emmanuel Kpoko	M	34	7	Goyala	7th Grade	Hunting & farming, Missionary
6	Kolubah Yankon	M	39	39	Goyala	No education	Farming, Chief Hunter, FDA Biomon. Auxiliary
7	Gayflor Dollo	M	32	32	Goyala	No education	Hunting & farming
8	Richard Kamara	M	35	35	Bulor	12th Grade	Farming, FDA LE Auxiliary
9	Weedor Musu	F	80	80	Goyala	No education	Farming
10	Mawu Kolubah	F	70	70	Goyala	No education	Farming

Local Field Team Members Large Mammal Survey

No.	Name	Sex	Town	Responsibilities
Area 01 (Wonegizi Central); 24.11.-28.11.2019				
1	John S. Mulbah	M	Vetesu	Tracker
2	Harris Kollie	M	Vetesu	Camp Keeper
3	Sumo Pewee	M	Vetesu	Camp Keeper
4	John P. Mulbah	M	Vetesu	Camp Keeper
5	Flomo Kesselee	M	Vetesu	Tracker
6	James Kwaytah	M	Vetesu	Tracker
7	Larvelee T. Weyea	M	Vetesu	Tracker
8	Bill Charleston	M	Vetesu	Chief Hunter, Tracker
9	Gayduo Kesselee	F	Vetesu	Cook
Area 02 (Wonegizi North); 30.11.-07.12.2019				
1	Karmolu Yamah	M	Tussu	Chief Hunter, Tracker
2	Kolubah Nyanquoi	M	Goyala	Tracker, Camp Keeper
3	Richard Kamara	M	Bulor	Tracker
4	James B. Kolubah	M	Goyala	Tracker
5	Emmanuel Kpoko	M	Goyala	Tracker, Camp Keeper
6	Wolubah Keleko	M	Goyala	Cook
7	Gayflor Dollo	M	Goyala	Tracker, Camp Keeper

Large Mammal Species List for Rapid Assessment in Wonegizi

No.	Species	Scientific name	IUCN	CITES	Liberia
1	Forest Elephant	*Loxodonta cyclotis*	VU	I	P
2	Pygmy Hippopotamus	*Choeropsis liberiensis*	EN	II	P
3	Leopard	*Panthera pardus*	VU	I	P
4	African Golden Cat	*Caracal aurata*	VU	II	P
5	Western Chimpanzee	*Pan troglodytes verus*	CR	I	P
6	Upper Guinea Red Colobus	*Piliocolobus badius*	EN	II	P
7	King Colobus	*Colobus polykomos*	VU	II	P
8	Olive Colobus	*Procolobus verus*	VU	II	P
9	Diana Monkey	*Cercopithecus diana diana*	EN	I	P
10	Sooty Mangabey	*Cercocebus atys atys*	NT	II	P
11	Campbell's Monkey	*Cercopithecus campbelli*	LC	II	P
12	Lesser Spot-nosed Monkey	*Cercopithecus petaurista*	LC	II	P
13	Putty-nosed Monkey	*Cercopithecus nictitans*	NT	II	P
14	Green Monkey	*Chlorocebus sabaeus*	LC	II	P
15	Forest Buffalo	*Syncerus caffer nanus*	NT		P
16	Jentink's Duiker	*Cephalophus jentinki*	EN	I	P
17	Yellow-backed Duiker	*Cephalophus silvicultor*	NT	II	P
18	Bongo	*Tragelaphus eurycerus*	NT		P
19	Zebra Duiker	*Cephalophus zebra*	VU	II	P
20	Ogilby's (Brooke's) Duiker	*Cephalophus ogilbyi (brookei)*	VU	II	P
21	Bay Duiker	*Cephalophus dorsalis*	NT	II	
22	Maxwell's Duiker	*Philantomba maxwellii*	LC		
23	Black Duiker	*Cephalophus niger*	LC		
24	Bushbuck	*Tragelaphus scriptus*	LC		
25	Water Chevrotain	*Hyemoschus aquaticus*	LC		P
26	Red River Hog	*Potamochoerus porcus*	LC		P
27	Giant Forest Hog	*Hylochoerus meinertzhageni*	LC		P
28	Giant Ground Pangolin	*Smutsia gigantea*	EN	I	P
29	Black-bellied Pangolin	*Phataginus tetradactyla*	VU	I	P
30	White-bellied Pangolin	*Phataginus tricuspis*	EN	I	P
31	Aardvark	*Orycteropus afer*	LC		

Conservation Status: IUCN: CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened LC: Least Concern
CITES: Appendix I or II
Liberia: P: species fully protected under Liberian Wildlife Law

Large Mammals RAP - Interviews Personal Data Interviewees	Grid Cell: Forest/Area:	Community: Interview Date:

No.	Name	Age	Res.	Education	Main activity / Main source of income

Key: Grid Cell refers to the grid number of ELRECO's Nationwide Elephant Survey; **Res.**: How many years does the person live in this community

Large Mammals RAP - Interviews Town & Forest Data	Grid Cell: Forest/Area:	Community: Date of Interview:

Town Info		
Number of people living in this town:	Main means of subsistence:	Dependance of town on Foest Resources (high, medium, low):
Where is the nearest market:		
School:		What is the farthest distance to your farms (walking hours):
Clinic:		

Forest Types				
Type	Description	Condition	Distance	Remarks

Description: Age, trees size & density, canopy closure, climber density, dominant tree species; **Condition:** intact, fairly intact, disturbed, highly disturbed

Forest Resources & Use (list the 5 most important resources)			
What FR do you use?	Purpose (sub or commerc)	Maximum distance from town	Remarks

LM RAP - Interviews Large Mammals Questionnaire		Grid Cell: Forest/Area:					Community: Interview Date:	
No.	**Species**	**Is the animal present in your forest?**	**When last time seen or recorded?**	**Type of record**	**Abundance (low, medium or plenty)**	**In what areas do you find it? (forest types and areas on map)**	**Trend (increasing, stable or decreasing)**	**Why? (explain trend)**
1	Forest Elephant							
2	Pygmy Hippopotamus							
3	Leopard							
4	African Golden Cat							
5	Western Chimpanzee							
6	Upper Guinea Red Colobus							
7	King Colobus							
8	Olive Colobus							
9	Diana Monkey							
10	Sooty Mangabey							
11	Campbell's Monkey							
12	Lesser Spot-nosed Monkey							
12a	Putty-nosed Monkey							
13	Green Monkey							
14	Forest Buffalo							
15	Jentink's Duiker							
16	Yellow-backed Duiker							
17	Bongo							

No.	Species	Is the animal present in your forest?	When last time seen or recorded?	Type of record	Abundance (low, medium or plenty)	In what areas do you find it? (forest parts on map)	Trend (increasing, stable or decreasing)	Why? (explain trend)
18	Zebra Duiker							
19	Ogilby's (Brooke's) Duiker							
20	Bay Duiker							
21	Maxwell's Duiker							
22	Black Duiker							
23	Bushbuck							
24	Water Chevrotain							
25	Red River Hog							
26	Giant Forest Hog							
27	Giant Ground Pangolin							
28	Black-bellied Pangolin							
29	White-bellied Pangolin							
30	Aardvark							

Explanation/Shortcuts:	Never Past Yes	Month/Year	See Hear Footprint Dung Nest Burrow NCS (Nut Cracking Site)	L (low) M (medium) P (plenty		↑ ↔ ↓	

LARGE MAMMAL SURVEY — REECE DATA COLLECTION SHEET

Grid Cell:	**Date:**
Forest/Area:	**Start Time:**
Recce Line:	**End Time**
Team:	**Sheet No:**

Weather data - take records every hour

use one of the following numbers for clouds, rain and wind: 0, 1, 2 or 3 (0=none, 1=small, 2=medium, 3=heavy)

Time:										
Clouds:										
Rain:										
Wind:										

No.	Time	Species	Type of sign	Age of sign	Number indiv	Habitat type	GPS Code	29N - Northing	UTM - Easting	Elev.	Notes

Type of sign:	**S** See | **H** Hear | **FP** Footprint | **D** Dung | **ER** Elephant Road | **N** Chimpanzee Nest | **NCS** Nut Cracking Site | **O** Other **SHOT** Gunshot | **GS** Gunshell | **CAM** Camp | **SNA** Snare | **LOG** Logging | **MIN** Mining | **FIS** Fishing | **FARM** Farm
Habitat type:	**PF** Primary/Old Secondary | **YS** Young Secondary | **SWA** Swamp | **BB** Bend Bush | **RF** Riverine Forest | **SAV** Savannah/Grassland **CCA** Cultivated / cleared areas (Farm) | **PCS** Post-cultural secondary vegetation | **DEG** Degraded Area (Bare Soil)

Annex 5 Pygmy Hippo Dung Sampling Protocol

Faecal (Dung) Sampling Collection Protocol

(With sample coding and data sheet)

Each of the dung is collected in two methods. So each dung-pile will have two sampling tubes, dry and wet and each of them will get a code.

These codes should be written on the sampling tubes and all information should also be recorded on the sampling data sheet with the GPS Location of the samples collected.

Coding of Sampling Tubes

The code should contain the following information

Information	Code (the below are examples)
Organisation	FFI
Area	SNP for Sapo National Park
Team Code	1, 2, 3 … Or A, B, C …
Sample Number	01, 02, 03 … consecutively for each day. NOTE: Every day start again with 01, 02, 03 …
Species Code	PH for Pygmy Hippopotamus and EL for Elephant, CH for Chimpanzee
Type of sample	D for Dry and W for Wet
Survey Date	To be written next to the code Date_Month_Year

Examples of coding:

1. Team A of FFI finds in a day PH dung, followed by another PH dung, followed by elephant dung in Sapo National Park on 1st March 2019

Dry sample coding	Wet Sample Coding
FFI_SNPA01PHD 01/03/2019	FFI_SNPA01PHW 01/03/2019
FFI_SNPA02PHD 01/03/2019	FFI_SNPA02PHW 01/03/2019
FFI_SNPA03ELD 01/03/2019	FFI_SNPA03ELW 01/03/2019

Annex 5 Pygmy Hippo Dung Sampling Protocol

2. Team 3 of SCNL finds in a day three PH dung in Foya on 10th January 2020

Dry sample coding	Wet Sample Coding
SCNL_FY301PHD 10/01/2020	SCNL_FY301PHW 10/01/2020
SCNL_FY302PHD 10/01/2020	SCNL_FY302PHW 10/01/2020
SCNl_FY303PHD 10/01/2020	SCNl_FY303PHW 10/01/2020

INSTURCTIONS FOR SWABBING METHOD (WET SAMPLE)

Swabbing dung samples (RZSS WildGenes Lab)

- **Wear gloves**
- Soak the swab in the solution. Remove excess solution by pulling swab against inner rim of tube.
- Wipe swab over all outer surfaces of the dung including the bottom, sides and any indentations and ridges. Do not push swab in to sample.
- Repeat first two steps until the entire sample has been swabbed.
- **Make sure there is still enough buffer left in the tube to cover the swab.**
- When finished put the swab into the tube of solution with the swab end at the bottom, and snap the stick from the swab by carefully bending it until it breaks.
- Ensure the tube is labelled clearly and well-sealed.
- Store in a cool dark place until samples are sent to/collected by WildGenes staff.
- **Contact WildGenes staff if more buffer is needed!** labaccount@rzss.org.uk





Soak Swab Rinse Swab Snap

Annex 5 Pygmy Hippo Dung Sampling Protocol

IMPORTANT:

- Pygmy Hippopotamus:

  - Pygmy Hippopotamus dung is observed to be splattered on the vegetation and the ground. While collecting the samples, ensure that samples on the vegetation (leaves/bark/etc.) and the ground is swabbed.

    For example: After swabbing all over the leaves, dip the swab in the solution and then swab the ground for sample.

  - If the dung is not fresh, then the sample should be taken from the most shaded area of the dung pile

- Elephants:

  - Collect sample from one bolus per dung-pile. This is to avoid errors from taking samples for more than one elephant by assuming that there are more than one dung pile. If there are more than one dun pile in the same location, then choose the freshest dung pile.

  - If the dung pile is old, then the sample should be taken from the bottom surface of the dung pile, which is protected from the sum

INSTRUCTIONS FOR SILICA METHOD (DRY SAMPLE)

Use the wooden spoons to scoop the dung and drop it in the tube with silica bag. A minimum of one tea spoon of dung sample has to be collected from every sample. **Do not use the spoon again for collection**. Break the spoon and discard it.

- Pygmy Hippopotamus:
  - As in the wet sample method, dung piles from the vegetation (leaves/barks/ etc.) as well as the ground has to be scooped for samples.
  - If the dung is not fresh, then the sample should be taken from the most shaded area of the dung pile

- Elephants:
  - Collect sample from one bolus per dung-pile. This is to avoid errors from taking samples for more than one elephant by assuming that there are more than one dung pile. If there are more than one dun pile in the same location, then choose the freshest dung pile.

  - If the dung pile is old, then the sample should be taken from the bottom surface of the dung pile, which is protected from the sum

Annex 5 Elephant Dung Sampling Protocol

ELRECO Forest Elephant Dung Sampling Protocol

This Protocol has been developed especially for elephant dung sampling surveys, based on the *Dung Survey Standards for the CITES MIKE Programme*.

In general, elephant dung records will be taken whenever encountered throughout the whole field survey, not only in the hotspot areas but anywhere found in the forest (e.g. on the way to and from camp sites or between hotspots). Each dung-pile will be recorded both on the Recce Data Collection Sheet, and on the Elephant Dung Sampling Sheet as explained below. On the Elephant Dung datasheets we will use a separate line for each single dung-pile.

Dung Sampling Protocol

1. Fill the Dung Sampling Sheet step by step
2. Determine the Freshness of the dung-pile
3. Take a fecal sample from fresh or reasonably fresh dung-piles
4. Measure the circumference of the 3 largest intact boli of each dung-pile

Definition of Terms for Dung Sampling Protocol	
Dung-pile	Refers to one defecation event from one individual A dung-pile usually consists of several boli (3-8)
Bolus/Boli	The single “balls” dropped during defecation
Fresh dung-pile	Less than 48 hours old •Fresh should be taken as meaning dung-piles dropped within the previous 48 hours •It is important to remember that fresh dung-piles may not be intact •Fresh dung-piles will be moist throughout making them dense and heavy •They feel slimy to the touch and flies will be present •Fresh dung-piles usually are of a lighter-brown colour than older ones
Reasonably fresh dung-pile	No older than 2 weeks •Consists mostly of intact boli that are not obviously degraded (i.e. not mouldy, not infested with termites etc.)
Intact	A bolus is intact if (1) its shape and volume is plausibly the original **and** (2) is coherent **and** (3) can be handled without crumbling (breaking up)
Coherent	A fragment consisting of plant fibres embedded in a matrix of other fecal material that does not crumble when handled. If plant fibres are held together by mud only the fragment **is not** coherent

Annex 5 Elephant Dung Sampling Protocol

The MIKE ‘S system’ of dung-pile classification defines the decay stage of dung-piles rather than the actual age (which is defined by the Freshness).

The MIKE 'S system' for dung-pile classification	
Stage	**Definition**
S1	All boli are intact
S2	One or more boli (but not all) are intact
S3	No boli are intact, but coherent fragments remain (fibres are held together by fecal material)
S4	No boli are intact; only traces (e.g. plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud)

Notes
•A bolus is **intact** if (1) its shape and volume is plausibly the original and (2) is coherent and (3) can be handled without crumbling (breaking up)
•When examining boli to determine whether they are coherent gently touch and rock it to see whether the whole bolus moves as one or in fact already split up into more than one fragment. It further may be necessary to break them open to see if they are held together by mud or fecal material
•**Coherent** means that plant fibres are held together by fecal material and not by mud only; and that the bolus or fragment does not crumble when handled
•Check if ants or termites have hollowed-out boli. Such boli will crumble easily when examined
•When examining fragments they should be passed frpm one hand to the other and rubbed gently between the fingers to determine whether the fibres are truly coherent or whether they separate easily; but do not pull them apart or crush them
•Dung-piles may not be in Stage S1 when freshly dropped, they can be in Stage S2 or even S3
•For the definition of the Stage it is not important to know the exact number of intact boli. For example if a dung-pile has 5 boli, of which one definitely is intact and one definitely is not intact, don't waste time to determine the other boli's intactness, because it anyway will be Stage S2
•You must be careful when deciding how many dung-piles the boli you find come from. Sometimes you will find 2 or more dung-piles close together. In such cases you will need to look at the single boli's size and appearance (colour, shape), how degraded the boli are as well as how far apart of each other the boli are. This will help you to decide which boli will belong to which dung-pile and how many dung-piles are present.The number of boli should also be used as a guide: Most dung-piles consist of 3-8 boli.

Annex 5 Elephant Dung Sampling Protocol

Dung Sampling Protocol

Step 1: The Dung Sampling Sheet

For each dung-pile use a separate line for the data recording.

Date: Day**.**Month**.**Year (e.g. 01.12.2019)

GPS Code: Use the same Code as in the Recce Data Collection Sheet

Freshness: **F** for Fresh (less than 48 hours old)
R for Reasonably fresh (less than 2 weeks old)
O for any dung older than 2 weeks

Sample Y/N: If you have collected a fecal sample enter **Y** for Yes, if not enter **N** for No

Fecal samples will be only collected from Fresh or Reasonably fresh dung-piles, because DNA is degrading over time, so older samples are useless.

Within 2m strip: This only applies if we conduct a recce line survey. In that case it will be important to know whether the dung-pile center lies within 1m left or right of the recce line. It can be estimated, there is no need to measure the exact distance of the dung-pile from the line. If the dung-pile center point lies within 1m left or right the line enter **Y** for Yes, if not enter **N** for No.

Circumference: Measure the circumference (girth) in cm of the 3 largest intact boli of the dung-pile. If only 1 or 2 intact boli are present still take their measurement.

!!! *Important* This needs to be done AFTER you took the fecal sample!!! (see Step 3)

Decay Stage: Use the MIKE 'S System' codes 1-4 for age classification of dung-piles

It is the same code that you have already entered in the Column "Age of sign" in the Recce Data Collection Sheet

The MIKE 'S system' for dung-pile classification	
Stage	**Definition**
S1	All boli are intact
S2	One or more boli (but not all) are intact
S3	No boli are intact, but coherent fragments remain (fibres are held together by fecal material)
S4	No boli are intact; only traces (e.g. plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud)

Annex 5 Elephant Dung Sampling Protocol

Step 2: Determine the Freshness of the dung-pile

Fecal samples will be only collected from fresh or reasonably fresh dung-piles. Use the classification explained above to determine if a dung-pile is fresh or reasonably fresh. If it is older than 2 weeks there is no need to take a fecal sample, and you can go immediately to Step 4.

Step 3: Fecal Sample Collection

Throughout the field survey, fecal samples from fresh or reasonably fresh dung.-piles will be collected whenever possible. The samples will be used for later genetic DNA analysis and need to be stored in alcohol in a dark and cool place for the meantime. The genetic material is very sensitive and only useful for analysis if dung samples are carefully collected in the correct way. It is crucial to work cleanly, in order to avoid damage or contamination of the species' DNA. Please make sure you follow the instructions below.

Material:
- Latex Gloves
- Sterilized Sample Tubes 30 ml with spoon and labels
- 95% Ethanol
- Parafoil
- Ziplock Bags
- Styrofoam Box
- Elephant Dung Sampling Sheet

Collection Methodology:

- Always wear latex gloves when collecting the samples. Do not allow your skin to touch the dung-pile or the outside of your gloves when putting them on.
- Only collect samples from "Fresh" or "Reasonably Fresh" dung-piles.
- Only collect from one bolus per dung-pile, always choose the freshest one. This is to prevent errors from mistakenly thinking boli from two or more dung-piles are from one pile and thus possibly collecting fecal material from more than one elephant per sample.
- It is best to collect samples from outside the bolus if it is very fresh, but from the underside if it is not very fresh.
- Use the tube's integrated spoon to collect approximately 10g of dung (1/5 of the tube). Place the dung in the tube but do not pack it down.
- Add approximately 10ml of ethanol, just enough to cover the sample completely. Do not fill the tube completely, because the sample will expand as it absorbs the liquid. If necessary shake the tube a little bit to make sure the fecal material is completely saturated with ethanol.
- Remove the spoon from the cap lid and discard it in a plastic bag. Never use the same spoon for different dung-pile samples.
- Close the tube tightly with the lid. Wrap some Parafoil around the lid cap.
- Mark the tube label with: the **Date**, the **GPS Code** (the same that you filled in the Dung Sampling Sheet) and the **species' name** (usually this will be Elephant)

- Place the tube in a ziplock bag
- Protect the samples from sunlight as UV light may damage the DNA. When you return to the camp in the evening, put the tubes in the Styrofoam Box for storage.
- Store tubes in a dark and cool place. They can be kept at room temperature, but if refrigeration is available it will extend the life of the samples.
- For long-term storage or shipping top-up ethanol again

Step 4: Measuring the circumference of <u>intact</u> boli

This should be always done, regardless if a fecal sample has been taken or not. In case a fecal sample is taken it is important that this is collected <u>before</u> measuring the circumference. Measurement of the circumference should always be the last step.

The idea behind is that the boli size (expressed by the circumference) will allow some inference on the elephant's size, i.e. boli average circumference, together with other information such as footprint size and sex (if available from the genetic analysis of the fecal sample) can be used as an indicator for the elephant's age and size.

<u>Instructions:</u>

- Wear latex gloves
- Measure the circumference (in centimeter) of the **3 largest intact boli** of the dung-pile using a flexible plastic measure tape (see figure below)
- If only one or two intact boli are present they should still be measured
- Enter the data in cm in the Dung Sampling Sheet

How to measure the boli circumference of a dung-pile:

Annex 5 Elephant Dung Sampling Protocol

ELRECO	ELEPHANT DUNG SAMPLING SHEET							
Date	GPS Code	Fresh ness	Sample Y/N	Within 2m strip	Circumference (cm)			Decay Stage
					1	2	3	

FRESHNESS	
Code	**Definition**
F	**Fresh dung-pile** Less than 48 hours old
R	**Reasonably fresh dung-pile** Not older than 2 weeks
O	**Older** Older than 2 weeks

DECAY STAGE	
Stage	**Definition**
1	All boli are intact
2	One or more boli (but not all) are intact
3	No boli are intact, but coherent fragments remain (fibres are held together by fecal material)
4	No boli are intact; only traces (e.g. plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud)

CIRCUMFERENCE
Measure the circumference (girth) in cm of the **3 largest intact boli** of the dung-pile. If only 1 or 2 intact boli are present still take their measurement.