Appendix 15 Small Mammal Baseline Survey
Environmental and Social Impact Assessment - Yaoure Mining Site
Yaoure Gold Project – Côte d'Ivoire

For

Amara Mining Côte d'Ivoire SARL

Authors

Dr. Akpatou Bertin and Bohoussou Hilaire

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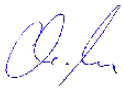
Project Manager Approval	**Dr. Christian Kunze**	 18 November 2015	

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EXECUTIVE SUMMARY

The gold-mining site of Yaoure is situated about forty kilometres north-west of the city of Yamoussoukro, more specifically in the prefecture of Bouaflé. This site has been the focus of several mining campaigns led by different companies. Artisanal mining has been carried out there since the 19th Century, and commercial mining began more recently in the 1980s. As a result of new mining activities being proposed for this area, an environmental and social impact assessment has been commissioned by Amara Mining plc.

The purpose of this study is to gather baseline data for small mammals (split into two groups, micromammals and small carnivores). The study includes the identification and description of potential impacts on these species as a result of the proposed mining activities. It also presents actions that should be taken to avoid or mitigate the potential identified impacts.

The methodology used in this study is based on four survey methods: 1) interviews with target groups (e.g. hunters and farmers); 2) survey on foot (recces); 3) camera trapping; and 4) pitfall trapping, used to complement data on micromammals. The diversity and equitability indices were calculated per block and by habitat type in order to understand the factors determining the spatial distribution of the species of small mammals in the study area.

This study was carried out in the dry season, from 16 to 29 January 2015. The surveys have confirmed the presence of eight species of small mammal in the study zone, of which four are micromammals and the other four are small carnivores. The micromammals' survey was less enlightening regarding the twenty odd species that could be present in this region according to the literature. This could be fundamentally due to the dry season not being a favourable survey period because of lower species mobility. There was very little sighting of small carnivores, which may indicates high anthropic pressure on the natural environment and its wildlife. The gallery forests and the fallow lands demonstrated the highest levels of signs of presence for small carnivores.

The eight species confirmed for the study area are common species, which are not threatened according to the IUCN Red List. On the other hand, it may be that certain species of genet present are recorded on the IUCN Red List. Indeed, the data gathered has not allowed us to precisely identify the species belonging to this group; moreover, the taxonomy of this group is not very well understood and is still being investigated.

The potential impacts of this project are twofold: direct loss of habitats preferred by small mammals, and the reduction of their population size. These impacts can also affect the spatial distribution of these species and the availability of food resources.

Impacts can be mitigated, whenever possible, with a reduction of habitat fragmentation and/or with the rehabilitation of neighbouring habitats, and by adopting good environmental practices that aim to limit the harmful effects on the environment.

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List of abbreviations

CCI	: Chamber of Commerce and Industry
EIES	: Etude d'Impact Environnemental et Social (Study on Environmental and Social impact)
GDP	: Gross Domestic Product
IKA	: Indice kilométrique d'Abondance (Index per kilometre of Abundance)
IUCN	: International Union for the Conservation of Nature
OIPR	: Office Ivoirien des Parcs et Réserves (Ivorian Parks and Reserves Authority)
PAST	: PAleontological STatistics
SODEFOR	: Société de Développement des Forêts (Society for the Development of Forests)
TMF	: Tailings Management Facility
WRD	: Waste Rock Dump

1.0 INTRODUCTION

Mining has become an essential source of added revenue for many African countries during the last two decades. Unfortunately, this is not done without changes to the human and natural environment. In fact, changes due to mining can have consequences that differ in scale and intensity depending on the circumstances, processes and methods used. Commercial mining is relatively recent in Côte d'Ivoire and is largely focus on the exploitation of gold, iron, manganese, bauxite and nickel resources. It contributes 2.3% to the GDP, with gold counting for 0.7% (CCI, 2015). Numerous exploration and exploitation sites are spread over the whole country, with different historic backgrounds and length of operations.

In 1996, the Ivorian government initiated a law that required a study on the environmental and social impacts to be carried out for all projects that may have an effect on the environment. For this study, the environmental aspect focuses, amongst other things, on the impacts on wildlife. Specifically, this study takes into account two components: micromammals and small carnivores. Each of the components concerned has issues that are worth being understood, appreciated and evaluated in order to get a better feel for the impacts that may affect their population through mining activities.

Micromammals are amongst the most diversified of land vertebrates and include more than 500 species (Musser and Carleton, 1993). They occur in different types of habitat where they create communities whose composition is directly linked to the physiognomy of the landscape, thereby indicating how the environment concerned has evolved. In fact, certain species of micromammals are very sensitive to changes in their surroundings. They can, therefore, provide a good indication of the levels of habitat degradation via certain biological warning signs. Micromammals are also at the heart of numerous issues. Indeed, certain species are pests for various crops and can be the cause of food insecurity in rural Africa. Other species have been indexed with many cases of zoonoses coming either from reservoirs, or from re-emerging vector-borne diseases. In the natural environment, micromammals occupy an exceptional position in the food web where they are the preferred food choice for small carnivores and other reptilian predators, or they are the primary consumers. In this last case, one can see their role in the natural regeneration of vegetation. All this justifies the significance placed on micromammals through this study.

In contrast to large carnivores, which are charismatic species but generally possess lower population density; small carnivores are not only common but also relatively abundant in their natural environments. However, their small size renders them more discrete in their environment. Nevertheless, the intensity of their activities allows us to get a good picture of their presence and their numbers in a given area. Their diet is wide in range going from insects to carrion, and including small rodents. Being an important link in the food chain, small carnivores are well placed to have a better appreciation of the biological diversity of the natural environment. This component of the study is aiming to identify and understand the impacts of mining activities on several biological groups through the study of small carnivores.

The work involving the above-mentioned component has been led by two specialists and a student intern. These are:

- Dr Akpatou Kouamé Bertin, Mammologist, Teacher-Researcher at the Laboratory of Zoology and Animal Biology at Félix Houphouet-Boigny University. Dr Akpatou has led mammal surveys for numerous studies on social and environmental impact assessment in Côte d'Ivoire, Liberia and Guinea. Furthermore, he has led several field studies as team leader or principal expert.
- Monsieur Bohoussou kouakou Hilaire is a specialist in small terrestrial mammals. He has led several studies on small mammals in different habitat types in Côte d'Ivoire and in Liberia. Mr. Bohoussou has perfect knowledge of the methods and techniques used for mammal studies.
- Monsieur Zago Huges is a student at the Laboratory of Zoology and Animal Biology at Félix Houphouet-Boigny University where he is studying for a "master 2" in Zoology and wildlife management. He has expert knowledge in fieldwork techniques and general knowledge of small mammals.

1.1 Purpose of the Study

This study aims to establish the baseline condition for small mammals (i.e. small carnivores and micromammals). Specifically, this involves:

- Estimating the biological diversity of micromammals and small carnivores;
- Evaluating the relative abundance of species present;
- Identifying refuges used by small mammals;
- Documenting the conservation status of the different species;
- Identifying the main factors that determine the actual state of the animal species concerned;
- Evaluating the potential impacts of the proposed gold-mining activities on small mammals;
- Proposing a plan for mitigating the impacts of mining activities on the species of animals concerned.

1.2 Desktop Review

Numerous studies have been undertaken on mammals in several regions of Côte d'Ivoire. However, there have been relatively few studies on micrommals and small carnivores. Indeed, studies on micromammals, and to a lesser extent on small carnivores, have often been carried out as part of larger programmes. This explains why these two groups seem to have been neglected. Nevertheless, the situation does not seem dramatic considering the quality of certain studies previously undertaken in the project area and in larger regions. For example, the studies of Tano Yao *et al*. (2007) led on a previous operating licence from Cluff Gold plc Côte d'Ivoire. These surveys confirmed the presence of ten species of small mammals living in this area. Studies conducted by Gaubert (2003) have also improved our knowledge of small carnivores in West Africa. In fact, these studies have clarified the taxonomy and distribution of certain

groups of small mammals from the genus Genetta. The recent studies of Pacheco *et al.* (2013), on the Johnston Genet, are also a source of reference. These studies, in fact, have shown that the opportunities for discovering new species of small carnivores are not negligible.

With regards to micromammals, the recent studies have essentially been conducted to clarify the taxonomic status of several species of the genera *Praomys* (Akpatou, 2009), *Hylomyscus* (Nicolas et al., 2006) and *Malacomys* (Bohoussou et al. 2014).

1.3 Legal Provisions

The sustainable use of natural resources has benefited from an appropriate legal and institutional framework since the independence of Côte d'Ivoire. On an institutional level, we can see that there is a permanent position for a Minister for the environment and forests in different governments. We also note the creation of numerous specialist bodies such as the Society for the Development of Forests (SODEFOR), the Ivorian Parks and Reserves Authority (OIPR) and the National Agency for the Environment.

The legislative and legal framework put into place has brought about protected status for many natural areas, ranging from classified forests to national parks including different types of reserves, without forgetting rural areas. Measures taken for managing these spaces aim to regulate the use of natural resources in order to guarantee sustainable development.

Therefore, the forestry code, inspired from colonial law, collective traditional law and international conventions, took on amendments as needed in order to adapt to the changing context of managing forestry resources.

In general, legislative and regulatory texts put in place by the Côte d'Ivoire government for managing the Environment and Biological Diversity covers amongst other areas, the following sectors: wildlife and hunting; the exploitation of timber, as well as mining and quarries.

Since 2014, Côte d'Ivoire has also had a new mining code (LAW 2014-138 of 24 March 2014 called CODE MINIER (MINING CODE)).

The legal loophole regarding studies on the environmental and social impact has been covered by law n°96-766 3 October 1996 called Code de l'Environnement (Environment Code).

On an international level, several conventions have been signed and/or ratified, for example:

- The International Convention for the protection of fauna and flora in Africa, signed in London 8 November 1933;
- The African Convention on the conservation of nature and the natural resources adopted in Algiers 15 September 1968;

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora, adopted in Washington;
- The Convention Concerning the Protection of the World's Cultural and Natural Heritage;
- The Rio Convention on biological diversity;
- The Convention framework regarding climate change signed in Rio.

1.4 Report Structure

This report is structured in four parts. The first part covers all introductory sections of this study. The second part deals with the methodological approach and presents the different tools used to collect and analyse data. The third part focuses on presenting and discussing the results. Finally, the fourth part concerns the evaluation of the impacts, the methods of mitigation and plan for long term monitoring.

2.0 METHODOLOGY

2.1 The Subject of the Study

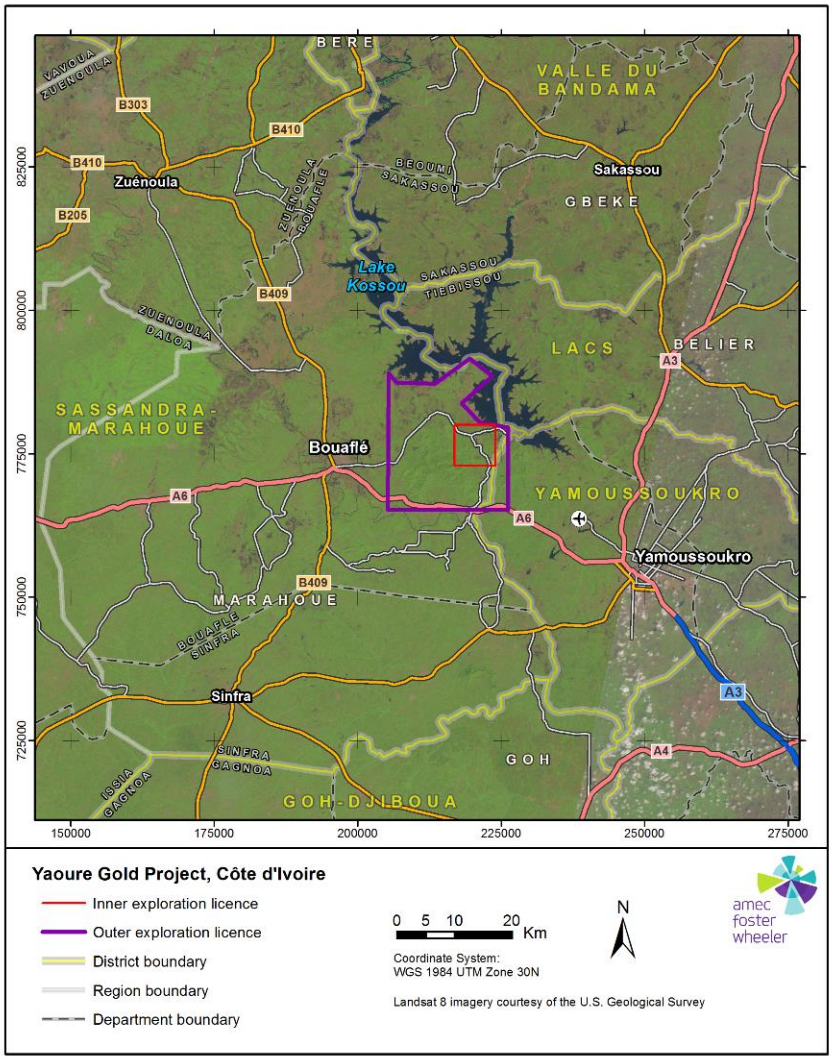
This study targets small mammals (including micromammals and small carnivores). The micromammal refers to small rodents and insectivores of less than 300g, such as mice, African dormice and shrews. As for the group of small carnivores, this includes species of 1-3kg, such as mongooses and genets.

2.2 The Site of the Study

The gold-mining site of Yaoure is situated about forty kilometres north-west of the city of Yamoussoukro (the political capital of Côte d'Ivoire), more specifically in the prefecture of Bouaflé. Artisanal mining has been practised there for many decades and commercial mining has been carried out by various companies since the start of the 1980s. Amara Mining plc's exploration permit covers around 50 km2 ('Inner Exploration Licence' cf. Figure 2-1). The surveys have been conducted inside this area and more specifically across the different proposed infrastructures options, when presenting the results we will call such an area a 'block'.

The natural habitat of this area is made up of forest formations presenting various levels of degradation. There are several savannah formations and numerous monospecific plantations (e.g. cocoa, coffee and teak), as well as crop fields. The ground is relatively suited to agriculture, but badly damaged as a result of the different mining activities.

Figure 2-1: Location of the Study Area



2.3 Sampling Effort

2.3.1 Sampling Period

This study was carried out in the dry season, over a period of 15 days from 16 to 29 January 2015. The details of the fieldwork are given in Appendix 1. This study should have been objectively carried out over two different climatic seasons (i.e. dry and rainy seasons). This would have allowed us to collect a fairly comprehensive sample. However, the above-mentioned period allowed us to carry out a representative survey for small carnivores. On the other hand, this period is not appropriate for carrying out a survey of micromammals whose activity rhythm is relatively low and often disrupted during the dry season.

2.3.2 Distribution of Sampling Points

Sampling points were distributed throughout the whole project area targeted for this study (including blocks WRD West; WRD North; WRD South; TMF 1; TMF 2; TMF 3 and TMF 4). Four categories of sampling points were adopted for this study (Figure 2-2). These are:

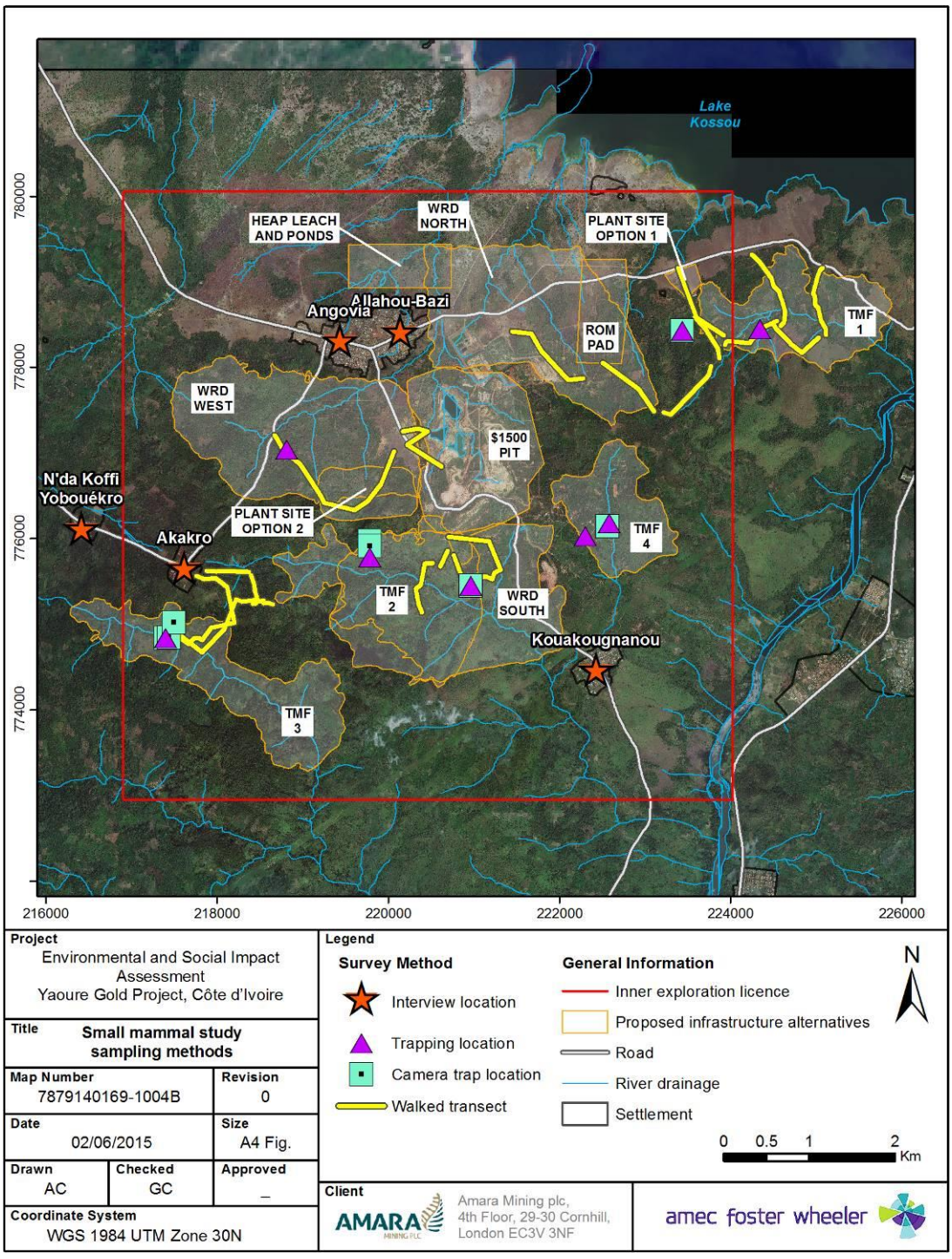
1) Trapping points for micromammals;

2) Transect walks for the inventory of small carnivores;

3) Camera trap installation sites;

4) Villages where the ethnozoological surveys were carried out.

Figure 2-2: Distribution of the Sampling Points based on the Four Survey Methods Used



2.3.2.1 Distribution of trapping sites for micromammals

The distribution of trapping sites for micromammals was done in such a way as to cover as much as possible the area of interest. The characteristics of these trapping sites are given in Table 2.1.

Table 2.1: Characteristics of the Trapping Sites for Micromammals

Block	Period	Habitat	Longitude	Latitude	Trap type	Trap number	Nights of trapping	Trapping effort
TMF 4	17 to 20/01/15	Fallow land	222296	776037	pitfall	18	3	54
					Sherman	20	3	60
					Tamahwak	2	3	6
					Tapette	5	3	15
	18 to 20/01/15	Gallery forest	222579	776186	Sherman	37	2	74
TMF 3	20 to 23/01/2015	Plantation	217397	774843	Sherman	17	3	51
					pitfall	18	3	54
					Tapette	5	3	15
					Tamahwak	2	3	6
		Gallery forest	217397	774843	Sherman	38	3	114
					Tapette	5	3	15
					Tamahwak	4	3	12
TMF 2	23 to 25/01/2015	Fallow land	219780	775787	Sherman	20	1	20
					Tapette	5	2	10
					Tamahwak	3	2	6
		Gallery forest	220966	775454	Sherman	20	2	40
					Tapette	5	2	10
WRD West	24 to 28/01/2015	Gallery forest	218814	777044	Sherman	23	4	92
					Tapette	8	4	32
					Tamahwak	2	4	8
TMF1	25 to 28/01/2015	Gallery forest	224338	778451	Sherman	20	3	60
					pitfall	18	3	54
WRD North	25 to 28/01/2015	Fallow land	223433	778431	Sherman	18	3	54

2.3.2.2 Distribution of transects to survey small mammals

The 20 transect paths were randomly positioned throughout the whole Inner Exploration Licence area. The reconnaissance walk method was used to focus the team in looking for presence indicators for small carnivores. The choice of areas to visit was at times guided by the guides' level of knowledge. The number of transects and the distances walked are indicated in Table 2.2.

Table 2.2: Summary of the Distances Covered by Transect and by Block

Block	Transect (m)					Total number of transects	Total distance covered (m)
	1	2	3	4	5		
TMF1	670	955	789	547	903	5	3864
TMF2	574	202	407	607	-	4	1790
TMF3	464	494	430	634	966	5	2988
WRD North	566	776	831	996	-	4	3169
WRD West	522	611	-	-	-	2	1133
Total						**20**	**12944**

The geographical distribution of transects in different blocks is shown in Figure 2-2.

2.3.2.3 Distribution of camera trap installation sites

Eight camera traps were installed at different sites that had been previously explored and considered as relevant for capturing images of small carnivores. The duration of the installation and the number of cameras varied from site to site, since we had explored several sites. Table 2.3 shows the characteristics of each site.

Table 2.3: Characteristics of the Camera Trap Installation Sites

Sites	Habitat	Installation date	Withdrawal date	Longitude	Latitude	Number of cameras installed	Number of nights	Trapping effort (traps*days)
TMF 4	Fallow land	18/01/2015	22/01/2015	222562	776148	2	4	8
				217397	774843	2	3	6
	Gallery forest	20/01/2015	23/01/2015	217433	774845	1	3	3
TMF 3	Secondary forest	23/01/1015	27/01/2015	217494	775027	2	4	8
TMF 2	Fallow land	23/01/2015	27/01/2015	219782	775977	1	4	4
				219783	775918	1	4	4
	Secondary forest	24/01/2015	27/01/2015	220966	775454	1	3	3
WRD North	Wooded savannah	25/01/2015	27/01/2015	223433	778431	2	2	4
Total								**40**

2.3.2.4 Distribution of ethnozoological survey sites

The villages in the study area that were the closest to the different proposed mining infrastructures were systematically selected for the ethnozoological surveys. The surveys were conducted in five villages (i.e. Allahou Bazi, Angovia, Kouakougnanou, Akakro and N'Da Koffi Yobéoukro, see Figure 2-2). These villages were selected in order to ensure diversity and to get a representative sample for the surveys.

2.4 Survey Methods

The methods used are specific to each zoological group involved. However, all methods mentioned below are standard and used regularly for biological surveys.

2.4.1 Survey Method for Micromammals

Trapping was the main survey method used for terrestrial micromammals. Two trapping techniques were used. The first consisted of using conventional Sherman type traps (55), Tomahawk (6), and mousetrap (10) baited with palm kernels. The Sherman traps were distributed equally, around five metres apart, over the trapping lines. The trapping lines were positioned in order to cross different habitat types. The Tomahawk and mousetraps were placed inside the Sherman sampling scheme. The trapping lines varied in length depending on the level of habitat homogeneity. Once the traps were installed, they were visited each morning and the animals captured were euthanized in order to process to their autopsy. Release was systematic for pregnant animals.

The two trapping techniques were made up of pitfall lines. Each pitfall line was composed of 18 buckets of around seven litres each. The buckets were buried up to their upper opening, and set out five metres apart. A plastic barrier was set up with sticks that passed along the upper edges of each bucket, in order to constrain the animal to fall into the bucket. The buckets were pre-drilled in order to allow water to flow through in case of rain, so as to avoid drowning any potential specimens that were captured. Once these traps were installed, they were visited each morning in order to identify the species captured. Shrews were systematically euthanized since they are a group of taxonomical interest.

2.4.2 Survey Method for Small Carnivores

Three methods were used to obtain baseline data on small carnivores of the project site. Each method enabled us to collect data of different types. The first method has been through interviews in the form of ethnozoological surveys conducted in the five main villages (Akakro; Allahou Bazi; Kouakougnanou; N'Da Koffi Yobouékro and Angovia) included in the project's area of influence. A questionnaire structured in three parts (1-Data on the village and the interviewees; 2-General data on the mammalian wildlife, and 3-Description of the relative abundance of small carnivore species) was used for the surveys. These surveys aimed to evaluate the interviewees' general level of knowledge on the small carnivores present in this area. They were indirectly aimed at identifying the best guides that could help the team in field data collection. Hunters of various ages were the preferred target group. Photographs and identification guides of African mammals (Kingdon, 1997 & 2004) and Happold (2013) were used during the interview in order to confirm the species

names given by the interviewees. When available, indirect signs (e.g. skin, bones) that could help confirm the presence of certain species were examined in the villages.

The second method consisted of walking transects carried out according to the reconnaissance walk (recce) method. This involved a walk through each block submitted for the study. The walk was organised to follow the pre-established routes within each block. All presence indicators, whether direct or indirect, that were found during the walk were observed, analysed and recorded on a data collection sheet prepared for this purpose. Paths providing the greatest diversity in crossing habitats were chosen.

The third method was the use of camera traps. Eight cameras were placed in different places judged likely to be good for getting pictures of small carnivores.

2.5 Data Analysis

The data collected for micromammals was insufficient to conduct any specific statistical analysis. However, a literature review enabled us to draw up the list of the potential species present in the study area. On the basis of this list, we were able to confirm which species belonged to the specimens captured.

With regards to the small carnivores, the Sphinx software was used for the development of the questionnaire for the ethnozoological surveys. It was also used to enter and analyse the data.

Excel was used for the compilation, and the pre-processing of the data. The data organised after pre-processing was then used to calculate the Kilometre Abundance Index (IKA). The software programme PAST (PAleontological STatistics) allowed us to calculate the diversity index for Shannon-Wiener and the equitability index for Piélou. These calculations were carried out in each block sampled, and then by habitat type.

3.0 RESULTS AND DISCUSSION

3.1 List of Micromammals at the Yaoure Site

With a trapping effort of 862 trap-nights, only eight specimens were captured in the different trap devices. These specimens involved three genera and three species. No species was captured in savannah (Table 3.1).

Table 3.1: List of Micromammals Captured during the Trapping Sessions

Date	Site	Longitude	Latitude	Habitat	Zoological group	Species	Trap	Sex
20/01/2015	TMF4	222296	776037	Forest	Rodent	*Praomys rostratus*	sherman	F
20/01/2015	TMF4	222296	776037	Forest	Rodent	*Praomys rostratus*	sherman	M
21/01/2015	TMF3	217397	774843	Forest	Rodent	*Praomys rostratus*	sherman	M
21/01/2015	TMF3	217397	774843	Forest	Rodent	*Praomys rostratus*	sherman	F
22/01/2015	TMF3	217397	774843	Plantation	Rodent	*Mus baoulei*	sherman	M
22/01/2015	TMF3	217397	774843	Plantation	Rodent	*Mus baoulei*	pitfall	F
22/01/2015	TMF3	217397	774843	Forest	Shrew	*Crocidura obscurior*	pitfall	M
26/01/2015	TMF1	224338	778451	Forest	Shrew	*Crocidura obscurior*	pitfall	M

These results are for the most part insufficient to undertake statistical analysis. In fact, the dry season is recognised as the least active season for the majority of micromammals (Duplantier, 1989). The savannahs have generally been burnt, which does not encourage micromammals to move around as this would expose them to numerous predators. Therefore, several species may not have been recorded by our devices installed in the main habitat types on the project area.

The bibliographical research, which was essentially based on Happold (2013), has enabled us to draw up a list of micromammals that are possibly present in the Yaoure area (Table 3.2). This list indicates that around 25 species of micromammals have their range overlap with the project area. Amongst these 25 species, the interviews have shown that 12 are common and relatively well known by the local populations, one of which is listed as near threatened (NT) according to the IUCN Red List.

Table 3.2: List of possible Micromammals present in the Kossou Area (Happold, 2013)

Zoological group	Common name (French)	Common name (English)	Scientific name	Confirmed by		Population trend	IUCN[2]
				Trapping	Interviews		
Rodents	Arvicanthis	Unstriped grass rat	*Arvicanthis rufinus*			Unknown	LC
	Rat des marais	Shaggy swamp rat	*Dasymys rufulus*			Unknown	LC
	Dephomys	Dephua mice	*Dephomys defua*			Unknown	LC
	Loir d'Afrique	African dormice	*Graphiurus lorraineus*			Unknown	LC
	Souris sylvestre africaine	African woodmice	*Hylomyscus sp*		x	Stable	LC
	Rat rayé d'Afrique	Zebra mice	*Lemniscomys striatus*		x	Increase	LC
	Rat hérissé tacheté de jaune	Brush-furred mice	*Lophuromys sikapusi*		x	Unknown	LC
	Rat à mamelles multiples	Multimammate rat	*Mastomys erythroleucus*		x	Stable	LC
	Rat à mamelles multiples	Multimammate rat	*Mastomys natalensis*		x	Stable	LC
	Souris grise	Baoule's Mouse	*Mus baoulei*	x	x	Stable	LC
	Souris grise	Pygmy Mouse	*Mus minutoides*		x	Stable	LC
	Souris grise	Common mice	*Mus musculoides*			Unknown	LC
	Souris grise	Peter's Mouse	*Mus setulosus*			Stable	LC
	Grande souris sylvestre	Forest Soft-furred Mouse	*Praomys rostratus*	x	x	Unknown	LC
	Grande souris sylvestre	Tullberg's Soft-furred Mouse	*Praomys tullbergi*		x	Stable	LC
	Taterillus	Taterillus gerbil	*Taterillus gracilis*			Stable	LC
	Souris épineuse	Uranomys mouse	*Uranomys ruddi*			Decrease	LC
Shrew	Crocidure de Buettikofer	Buettikofer's Shrew	*Crocidura buettikoferi*		x	Decrease	NT
	Crocidure	Crosse's Shrew	*Crocidura crossei*			Unknown	LC
	Crocidure	Obscure White-toothed Shrew	*Crocidura obscurior*	x		Unknown	LC
	Crocidure	Olivier's Shrew	*Crocidura olivieri*		x	Unknown	LC
	Crocidure	West African Long-tailed Shrew	*Crocidura muricauda*			Unknown	LC
	Crocidure	Fraser's Musk Shrew	*Crocidura poensis*		x	Unknown	LC
	Crocidure	Therese's Shrew	*Crocidura theresae*			Unknown	LC
	Pachyure	Musk shrew	*Suncus megalura*			Unknown	LC

[1]Population trend according to the IUCN; [2]NT = Near Threatened, LC = Least Concern.

3.2 List of Small Carnivores at the Yaoure Site

3.2.1 Ethnozoological Survey Data

The interviews have been conducted in five villages, including 34 interviewees aged between 25 and 80 years old (Table 3.3).

Table 3.3: General Data on Interviewees

Date	Area	Age group	Number of people
20/01/2015	Akakro	45-70	5
20/01/2015	Allahou Bazi	35-80	6
20/01/2015	Angovia	45-75	8
21/01/2015	Kouakougnanou	35-75	4
21/01/2015	N'Da Koffi Yobouékro	25-75	11
Total			**34**

According to this survey, all the people interviewed take part in farming and hunting, 80% are also involved in gold-mining activities and 40% in fishing. All people interviewed confirm that they have a very good knowledge of the study area. The main animal groups present in this area were identified as: monkeys; rodents; carnivores; duikers and, to a lesser degree, insectivores.

The more detailed questions regarding the species of carnivores have allowed us to evaluate the level of knowledge of the interviewees on their descriptions of each species and on their relative abundance (Table 3.4). The list of species was taken from Happold (2013) and Kingdon (1997, 2006). This section of the questionnaire also enabled us to test the knowledge of potential candidates before they could help the teams in collating data in the field. Thus, certain species (e.g. *Lutra lutra*) not found in West Africa, have been introduced into the list in order to check the reliability of identification done by the interviewees.

Data analysis shows that the description of certain species is done easily in all villages, this is the case with the common mongoose, the civet, spotted hyena and large cats (e.g. leopard and cheetah). On the other hand, other species (e.g. otters, certain rare mongooses and genets) are very badly described, most likely because they are not very well represented in this area, and because of the variety of phenotypes (Gaubert, 2003).

Table 3.4: Data Gathered from Interviews on Carnivores at the Yaoure Site

Species			Quality of the description of the species			Relative abundance of the species						Population trend	IUCN[2]
French name	**English name**	**Scientific name**	Very good	Average	Bad	Extinct	Rare	Little abundance	Abundant	Very abundant	Nothing to report		
Chat doré	African golden Cat	*Profelis aurata*	1	2	2	3	1	0	0	0	1	Decrease	NT
Chacal à flanc rayé	Side striped jackal	*Canis adustus*	0	2	3	3	1	0	0	0	1	Stable	LC
Lycaon	African wild Dog	*Lycaon pictus*	1	1	3	2	1	0	0	0	2	Decrease	EN
Ratel	Honey badger	*Mellivora capensis*	0	1	4	3	0	0	0	0	2	Decrease	LC
Loutre à joues blanches	African Clawless Otter	*Aonyx capensis*	0	0	5	0	2	0	0	0	3	Stable	LC
Loutre d'Europe	Common Otter	*Lutra lutra*	0	0	5	1	1	0	0	0	3	Decrease	NT
Loutre à coup tacheté	Spotted-necked Otter	*Lutra maculicollis*	0	0	5	0	1	0	0	0	4	Decrease	LC
Mangouste de Gambie	Gambian Mongoose	*Mungos gambianus*	2	0	3	1	0	2	0	0	2	Stable	LC
Mangouste brune	Common Cusimanse	*Crossarchus obscurus*	1	1	3	0	1	1	1	1	1	Unknown	LC
Mangouste Ichneumon	Egyptian Mongoose	*Herpestes ichneumon*	0	1	4	0	2	0	0	0	3	Stable	LC
Mangouste rouge	Slender Mongoose	*Herpestes sanguineus*	5	0	0	0	0	0	1	4	0	Stable	LC
Mangouste des marais	Marsh Mongoose	*Atilax paludinosus*	0	2	3	0	1	1	0	0	3	Decrease	LC
Mangouste à queue blanche	White-Tailed Mongoose	*Ichneumia albicauda*	0	0	5	2	0	0	0	0	3	Stable	LC
Hyène tachetée	Spotted Hyaena	*Crocuta crocuta*	5	0	0	5	0	0	0	0	0	Decrease	LC
Genette d'Europe	Commun Genet	*Genetta genetta*	1	0	4	2	0	0	1	0	2	Stable	LC
Genette tigrine	Cape Genet	*Genetta tigrina*	4	1	0	0	0	0	3	2	0	Unknown	LC
Genette de Villiers	Hausa Genet	*Genetta thierryi*	0	1	4	2	0	0	0	0	3	Unknown	LC
Poiane	West African Linsang	*Poiana leightoni*	4	1	0	0	0	1	1	3	0	Decrease	DD
Civette d'Afrique	African Civet	*Civettictis civetta*	5	0	0	0	0	0	2	3	0	Unknown	LC

Species			Quality of the description of the species			Relative abundance of the species						Population trend	IUCN[2]
French name	**English name**	**Scientific name**	Very good	Average	Bad	Extinct	Rare	Little abundance	Abundant	Very abundant	Nothing to report		
Nandinie	African Palm Civet	*Nandinia binotata*	2	0	3	0	0	0	1	1	3	Unknown	LC
Chat sauvage	Wildcat	*Felis silvestris*	0	3	2	2	1	0	0	0	2	Decrease	LC
Caracal	Caracal	*Caracal caracal*	0	0	5	2	0	0	0	0	3	Unknown	LC
Panthère	Leopard	*Panthera pardus*	5	0	0	5	0	0	0	0	0	Decrease	NT
Guépard	Cheetah	*Acinonyx jubatus*	5	0	0	5	0	0	0	0	0	Decrease	VU

[1]Population trend according to the IUCN; [2]EN= Endangered, VU=Vulnerable, NT = Near Threatened, LC = Least Concern, DD=Data Deficient.

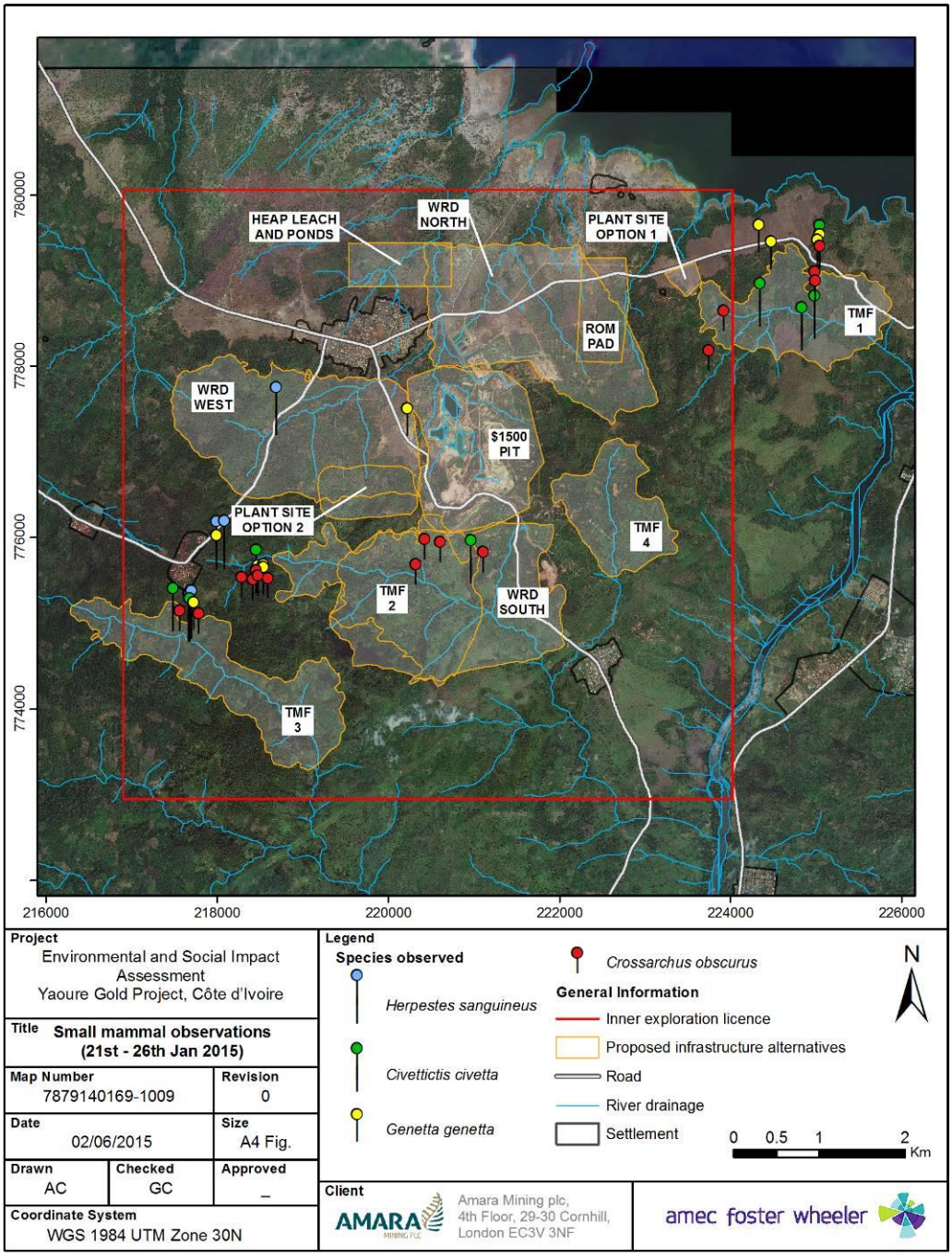
3.2.2 Data from Reconnaissance Walks

Twenty transects of a total length of 12,944 metres were walked across all blocks targeted in this study. Thirty nine signs of presence of small carnivores were recorded. Analysis of these signs confirms the presence of four species of small carnivores at the site (Table 3.5). These are: *Civettictis civetta*; *Crossarchus obscurus*; *Genetta genetta* and *Herpestes sanguineus*. Blocks TMF3 and TMF1 show the largest number of signs recorded (Figure 3-1). The species *Crossarchus obscurus* has the highest signs of presence recorded, followed by *Genetta genetta* and *Civettictis civetta*. The species *Herpestes sanguineus* shows the lowest presence indicator.

Table 3.5: Number of Sightings of Small Carnivores by Sample Block

Scientific name	Sample block					Total
	TMF1	TMF2	TMF3	WRD North	WRD West	
Civettictis civetta	4	1	3	0	0	8
Crossarchus obscurus	4	4	7	1	0	16
Genetta genetta	4	0	5	0	1	10
Herpestes sanguineus	0	0	5	0	0	5
Total	**12**	**5**	**20**	**1**	**1**	**39**

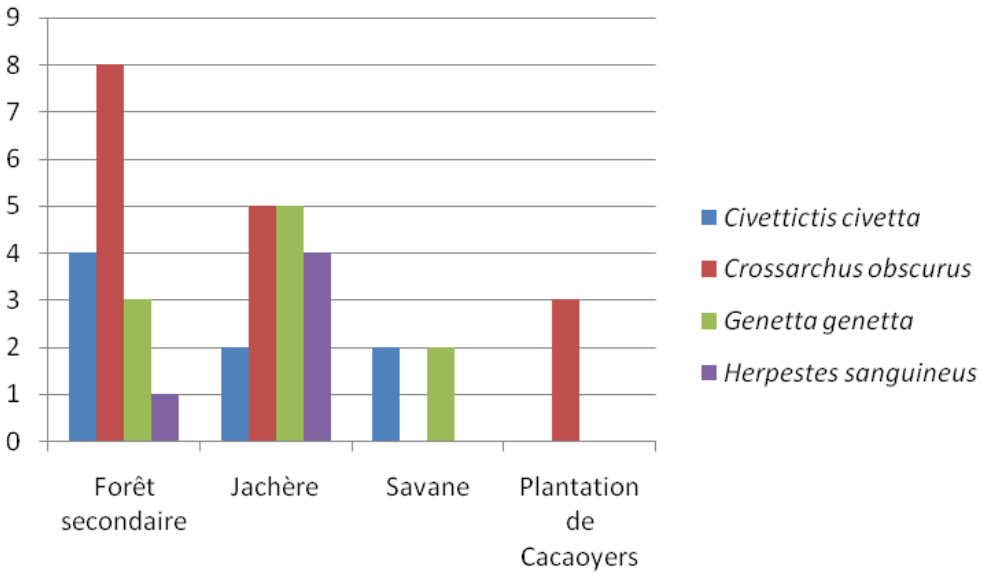
Figure 3-1: Spatial Distribution of Sightings of Four Species of Small Carnivores along the Transect Paths



The analysis of the distribution of presence indicators by habitat type shows that signs of presence are higher in secondary forests and fallow lands (Figure 3-2). There were very few signs of presence recorded in savannah and in monospecific plantations. *Crossarchus obscurus* and *Civettictis civetta* presented more presence indicators in secondary forest than in other habitat types, this was not the case for *Genetta genetta* and *Herpestes*

sanguineus whose presence indicators were higher in fallow land than in other habitats (Figure 3-2).

Figure 3-2: Frequency of Signs of Presence Recorded for Small Carnivores in the Various Habitats of the Yaoure Site



The total signs of presence recorded could have been an under-estimation, as human presence would cause the animals to be more secretive (Ewer, 1973). The species then hide in habitats that are generally difficult to access (Happold, 2013).

3.2.2.1 Diversity of small carnivores

Diversity of small carnivores by block

The analysis of the diversity of small carnivores by block revealed that blocks TMF3 and TMF1 were the most diverse (Table 3.6). The equitability index was the highest in blocks TMF1, TMF3 and TMF2. Blocks WRD North and WRD West show diversity and equitability indices of a zero value.

Table 3.6: Diversity and Equitability Indices According to Blocks

Parameters	Sample block				
	TMF1	TMF2	TMF3	WRD North	WRD West
Number of species	3	2	4	1	1
Number of observations	12	5	20	1	1
Diversity index (Shannon Wiener)	1.099	0.500	1.345	0	0
Equitability index	1.000	0.722	0.970	0	0

Diversity of small carnivores by habitat type

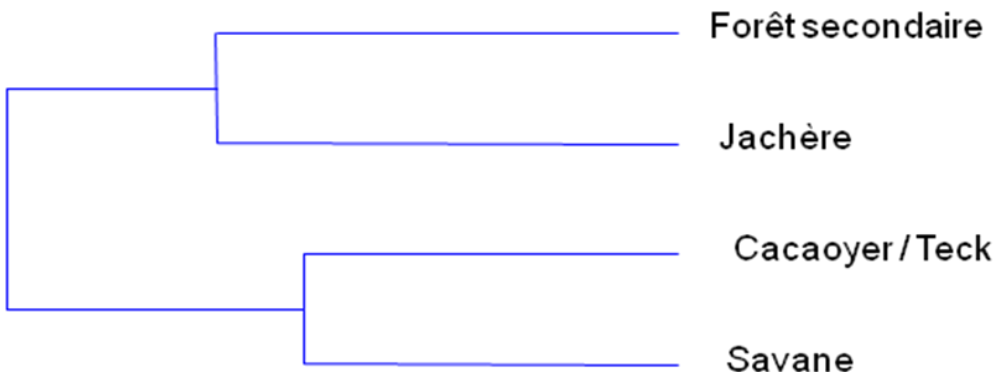
The diversity of small carnivores according to habitat types shows that secondary forests and fallow land have the highest diversity (**Error! Reference source not found.**). The equitability index is approximately the same in the three habitat types (i.e. savannah, fallow lands and secondary forest). The equitability index value for cocoa tree plantations is zero.

Table 3.7: Diversity and Equitability Indices According to Habitat Types

Parameters	Habitat type			
	Secondary forests	Fallow lands	Savannahs	Cocoa tree plantations
Number of species	4	4	2	1
Number of observations	16	16	4	3
Diversity index (Shannon Wiener)	1.180	1.333	0.693	0
Equitability index	0.851	0.962	1.000	0

Based on the data for habitat diversity, the analysis of hierarchical classification subdivides the habitats into two groups (Figure 3-3). The first group is composed of secondary forest and fallow lands. The second group is formed of monospecific plantations and savannahs. This grouping matches similar environmental conditions for the habitats in each group. Thus, secondary forests would be closer to fallow lands than monospecific forests and savannahs (with regards to the structure of the vegetation).

Figure 3-3: Habitat Grouping According to the Composition of the Small Carnivores' Community



3.2.3 Estimation of Encounter Rates Based on Signs of Presence of Small Carnivores

The analysis of relative abundance is expressed in the form of Kilometre Abundance Index (IKA), meaning signs of presence recorded per kilometre covered. This analysis is done per block then by habitat type. The calculations are also done for each species confirmed during the inventory walks.

Overall, rates of sightings are generally low, with some blocks having less than one sign of presence recorded per kilometre walked (Table 3.8 and Table 3.9). Blocks TMF1, TMF2 and TMF3 presented the highest IKA (Table 3.8). Throughout the whole area, the species *Crossarchus obscurus* has the highest IKA.

The encounter rates are higher in secondary forests and in fallow lands, than in the savannah (Table 3.9). These results show that the spatial distribution is influenced by the different habitat types.

Table 3.8: Kilometre Abundance Index (IKA) per Species and by Block Sampled. The distance covered in each habitat type is indicated in parenthesis.

	Sample block										Total (12.944 km)	
	TMF1 (3.864 km)		TMF2 (1.790 km)		TMF3 (2.988 km)		WRD North (3.169 km)		WRD West (1.133 km)			
Species	OBS[1]	IKA[2]	OBS	IKA	OBS	IKA	OBS	IKA	OBS	IKA	OBS	IKA
Civettictis civetta	4	1.04	1	0.56	3	1.00	0	0	0	0	8	0.62
Crossarchus obscurus	4	1.04	4	2.23	7	2.34	1	0.32	0	0	16	1.24
Genetta genetta	4	1.04	0	0	5	1.67	0	0	1	0.88	10	0.77
Herpestes sanguineus	0	0	0	0	5	1.67	0	0	0	0	5	0.39
Total	**12**	**3.11**	**5**	**2.79**	**20**	**6.69**	**1**	**0.32**	**1**	**0.88**	**39**	**3.01**

[1]OBS: total number of observations; [2]IKA: Kilometre Abundance Index

Table 3.9: Kilometre Abundance Index (IKA) per Species and by Habitat Type. The distance covered in each habitat type is indicated in parenthesis.

	Habitat type								Total (12.944 km)	
	Secondary forest (3.087 km)		Fallow land (4.361 km)		Savannah (1.589 km)		Plantation (3.907 km)			
Species	OBS[1]	IKA[2]	OBS	IKA	OBS	IKA	OBS	IKA	OBS	IKA
Civettictis civetta	4	1.30	2	0.46	2	1.26	0	0	8	0.62
Crossarchus obscurus	8	2.59	5	1.15	0	0	3	0.77	16	1.24
Genetta genetta	3	0.97	5	1.15	2	1.26	0	0	10	0.77
Herpestes sanguineus	1	0.32	4	0.92	0	0	0	0	5	0.39
Total	**16**	**5.18**	**16**	**3.67**	**4**	**2.52**	**3**	**0.77**	**39**	**3.01**

[1]OBS: total number of observations; [2]IKA: Kilometre Abundance Index

3.2.4 Data for Camera Trapping

Only three camera traps, out of the eight installed at different locations, contributed to capturing 33 pictures of small mammals. These pictures confirm the presence of five species of small mammals (Giant pouched rat, Cusimanse, Civet, Red-legged sun squirrel, African brush-tailed porcupine) (Table 3.10). A more arboreal species, the red-legged sun squirrel, was only confirmed by this survey method.

Table 3.10: Overview of Species Captured by Camera Traps

Date	French name	English name	Scientific name	TMF 3	TMF 2	WRD North	Total
23/01/2015	Rat de Gambie	Giant pouched rat	*Cricetomys gambianus*	1	1		**2**
	Mangouste brune	Cusimanse	*Crossarchus obscurus*	3	3		**6**
24/01/2015	Rat de Gambie	Giant pouched rat	*Cricetomys gambianus*		2		**2**
	Rat de Gambie	Giant pouched rat	*Cricetomys gambianus*	1	2	1	**4**
25/01/2015	Mangouste brune	Cusimanse	*Crossarchus obscurus*		2		**2**
	Civette d'Afrique	African civet	*Civettictis civetta*	1			**1**
	Rat de Gambie	Giant pouched rat	*Cricetomys gambianus*		1	3	**4**
	Héliosciure à pattes rousses	Heliosciurus	*Heliosciurus rufobrachium*		1		**1**
	Athérure africain	Brush-tailed porcupine	*Atherurus africanus*			1	**1**
26/01/2015	Mangouste brune	Cusimanse	*Crossarchus obscurus*			1	**1**
	Rat de Gambie	Giant pouched rat	*Cricetomys gambianus*	1	1	2	**4**
	Mangouste brune	Cusimanse	*Crossarchus obscurus*		1		**1**
27/01/2015	Athérure africain	Brush-tailed porcupine	*Atherurus africanus*			4	**4**
Total				**7**	**14**	**12**	**33**

The results obtained with camera traps did not allow us to confirm the presence of the more cryptic species (e.g. the genet) which have been the cause of disagreement during ethnozoological surveys. This is probably due to the short period during which the camera traps were used. However, in other studies camera traps have often revealed the presence of threatened species and have even discovered new species of mammals (Pacheco, 2013).

3.2.5 List of Small Carnivores

According to the literature, there are potentially 11 species of small carnivores present in the study area (Table 3.11). This study only confirmed the presence of four of these species.

Table 3.11: List of Possible Small Carnivores Present at the Yaoure Site

Species			Source		Status according to the IUCN[1]
French name	**English name**	**Scientific name**	**Kingdon,2006 ; Happold, 2013**	**This study**	
Mangouste de Gambie	Gambian Mongoose	*Mungos gambianus*	*x*		LC
Mangouste brune	Common Cusimanse	*Crossarchus obscurus*	*x*	*x*	LC
Mangouste rouge	Slender Mongoose	*Herpestes sanguineus*	*x*	*x*	LC
Mangouste des marais	Marsh Mongoose	*Atilax palidinosus*	*x*		LC
Genette d'Europe	Commun Genet	*Genetta genetta*	*x*	*x*	LC
Genette tigrine	Cape Genet	*Genetta tigrina*	*x*		LC
Genette de Villiers	Hausa Genet	*Genetta thierryi*	*x*		LC
Poiane	West African Linsang	*Poiana leightoni*	*x*		DD
Civette d'Afrique	African Civet	*Civettictis civetta*	*x*	*x*	LC
Nandinie	African Palm Civet	*Nandinia binotata*	*x*		LC
Chat sauvage	Wildcat	*Felis silvestris*	*x*		LC

3.3 Status of the Species of Small Mammals in the Area

This study did not confirm the presence of threatened small mammal species according to the IUCN Red List. The only more threatened species potentially present in this area, but that were not confirmed by our surveys, are the Buettikofer's shrew (*Crocidura buettikoferi*), a species considered as Near Threatened (NT), and the West African Linsang (*Poiana leightoni*), a species listed as Data Deficient (DD).

However, the scale of local threats means that specific attention should be given to the small carnivores present to ensure their survival in this area. Moreover, more focused studies should be conducted in order to clarify the species of genets present in this area.

Forested area and hills are of major importance for animal species in this area. In fact, these sites represent refuges for the animals who take cover there in order to escape various anthropic pressures.

4.0 EVALUATION OF THE IMPACTS

4.1 Description of the Impacts

The implementation of the project will require significant changes to the natural environment. These changes will impact different components of the environment, including the micromammals and small carnivores. The main impacts identified are:

- Direct impacts: Habitat fragmentation, Habitat loss, Potential pollution of waterways;
- Indirect impacts: Disturbance of the ecology of animal species.

4.2 Evaluation of the Impact

The description of the above-mentioned impacts is provided in Tables Table 4.1, Table 4.2,Table 4.3 and Table 4.4.

Table 4.1: Evaluation of the Impact of 'Habitat Fragmentation'

Impact	**Habitat fragmentation**			
Nature	Negative			
	Habitat fragmentation may lead to the formation of sub-populations whose interactions may be reduced if large parts of the habitat are affected, this could, in turn, hinder gene exchange.			
Nature of Impact	Direct			Cumulative
	Setting up different infrastructures for mining will open up vegetation. Moreover, the rehabilitation and deviation of the access routes to the mining sites will also contribute to the fragmentation of the different habitats crossed.			
Likelihood / Probability	1 = Unlikely	2 = Possible	3 = Likely	4 = Definite likelihood
	Soil stripping and the construction of roads will inevitably cause habitat fragmentation.			
Duration	1 = Short term	2 = Medium term	4 = Long term	4 = Permanent
	This impact will be long term as seen by the slow reforestation of significantly damaged environments			
Extent / Spatial	1 = Localised	2 = Site	3 = Wider and Adjacent Region	4 = National / International
	The activities may require the exploitation of resources in the neighbouring regions.			
Magnitude / Scale	1 = Low	2 = Minor	3 = Moderate	4 = High

Impact	Habitat fragmentation			
	This impact will change how the habitats are occupied by wild fauna. Certain species will be confined to their preferred habitats, others (species of open environments) will however flourish.			
Resource/Receptor Sensitivity/ Importance of Value	2 = Low	4 = Moderate Low	6 = Moderate	8 = High
	Previous mining has already disturbed the natural environment. Its composition is therefore not exceptional enough (some species have a particular status that should not be ignored).			
Significance of the impact	1 – 20 = Negligible	21 – 56 = Low	57 – 92 = Medium	93 – 128 = High

Table 4.2: Evaluation of the Impact of 'Habitat Loss'

Impact	Habitat loss			
Nature	Negative			
	Habitat loss may directly affect the small mammals and may cause local extinctions.			
Nature of Impact	Direct			Cumulative
	In certain places, the destruction of hills and other habitats rich in biodiversity will result in their total disappearance. Potential obstruction of certain water sources will lead to the local extirpation of animal species associated with these environments.			
Likelihood / Probability	1 = Unlikely	2 = Possible	3 = Likely	4 = Definite likelihood
	Habitat loss will cause the irreversible disappearance of these species and is needed for infrastructure locations. The impact on certain water sources cannot be avoided due to the scale of some of the mining works.			
Duration	1 = Short term	2 = Medium term	4 = Long term	4 = Permanent
	The impact could be permanent.			
Extent / Spatial	1 = Localised	2 = Site	3 = Wider and Adjacent Region	4 = National / International
	Sensitive habitats are found in isolated areas.			
Magnitude / Scale	1 = Low	2 = Minor	3 = Moderate	4 = High

Impact	Habitat loss			
	Sensitive habitats are the only refuge for animal populations. Their extinction will be accompanied by the loss of their biological components.			
Resource/Receptor Sensitivity/ Importance of Value	2 = Low	4 = Moderate Low	6 = Moderate	8 = High
	The sensitive habitats are points of attraction for numerous species. Their importance therefore goes beyond that of the project site.			
Significance of the impact	1 – 20 = Negligible	21 – 56 = Low	57 – 92 = Medium	93 – 128 = High

Table 4.31: Evaluation of the Impact of 'Pollution in Waterways'

Impact	Pollution of waterways			
Nature	Negative			
	The possible pollution of water will lead to poisoning of wildlife. It could cause local extinctions.			
Nature of Impact	Direct			Cumulative
	The use or potential spill of chemical products can lead to the contamination of waterways through rainwater runoff.			
Likelihood / Probability	1 = Unlikely	2 = Possible	3 = Likely	4 = Definite likelihood
	The implementation of good environmental practices can mean that water pollution is avoided.			
Duration	1 = Short term	2 = Medium term	4 = Long term	4 = Permanent
	The duration of this impact is linked to that of the project and to the quality of the products used.			
Extent / Spatial	1 = Localised	2 = Site	3 = Wider and Adjacent Region	4 = National / International
	If water enters the Bandama, even sites that are very far away may be polluted.			
Magnitude / Scale	1 = Low	2 = Minor	3 = Moderate	4 = High
	The waterways could benefit from a depollution programme.			

Impact	Pollution of waterways			
Resource/Receptor Sensitivity/ Importance of Value	2 = Low	4 = Moderate Low	6 = Moderate	8 = High
	The waterways drain from environments beyond the project area.			
Significance of the impact	1 – 20 = Negligible	21 – 56 = Low	57 – 92 = Medium	93 – 128 = High

Table 4.4: Disturbance of the Ecology of Animal Species

Impact	Disturbance of the ecology of animal species			
Nature	Negative			
	The disturbance of the ecology of animal species can change certain behaviours linked to reproduction and inter/intraspecific competition.			
Nature of Impact	Direct		indirect	Cumulative
	The species will try to adapt to the new environmental conditions.			
Likelihood / Probability	1 = Unlikely	2 = Possible	3 = Likely	4 = Definite likelihood
	The presevations of sufficiently large areas may guarantee that the social organisation of species is maintained.			
Duration	1 = Short term	2 = Medium term	4 = Long term	4 = Permanent
	The duration of this impact is linked to that of the project and the intensity of the disturbance.			
Extent / Spatial	1 = Localised	2 = Site	3 = Wider and Adjacent Region	4 = National / International
	The animal populations concerned are territorial with relatively small home range.			
Magnitude / Scale	1 = Low	2 = Minor	3 = Moderate	4 = High
	Animal populations generally develop a resilience strategy adapted to the change in environmental conditions.			
	2 = Low	4 = Moderate Low	6 = Moderate	8 = High

Impact	**Disturbance of the ecology of animal species**			
Resource/Receptor Sensitivity/ Importance of Value	Animal populations are confronted with various anthropic pressures (e.g. hunting, bush fires, farming).			
Significance of the impact	1 – 20 = Negligible	21 – 56 = Low	57 – 92 = Medium	93 – 128 = High

4.3 Location of Infrastructures

Signs of presence of small carnivores have been observed in all blocks. However, certain blocks show more presence indicators than others. Thus, on the basis of frequency of the presence indicators for small carnivores, blocks TMF3 and TMF1 show the greatest sensitivity. Bloc TMF2 shows an average sensitivity. The sensitivity of blocks WRD West and WRD North show the lowest sensitivity levels. The above-mentioned levels of sensitivity can vary significantly according to type, intensity and the duration of the activity being conducted in a specific way.

5.0 CONDITIONS FOR MANAGING AND MONITORING IMPACTS

5.1 Conditions for Mitigating Impacts

Different mitigation measures can be implemented in order to reduce the magnitude of impacts and are proposed below:

- **Habitat fragmentation:** adopt efficient mining strategies that are less invasive and which spares habitats that are not favourable for mining exploitation. The internal road network of the site should be as less dense as possible with an efficient use of the main access roads.
- **Loss of sensitive habitat types:** avoid the destruction of vegetation on hills. For that, a local policy for the conservation of the remaining hills must be devised and implemented. The galleries forests should also receive special attention guaranteeing the tranquillity of the animals.
- **Pollution of waterways:** use registered chemical products in quantities that respect standards. It is also necessary to install control devices and monitor pollution levels of the waters and the scale of the pollution.
- **Disturbance of the ecology of animal species:** devise and implement a programme for monitoring animal species. This programme will ensure the regular evaluation of trends in the level of indicator species. Parts of the forest must be interconnected in order to ensure the gene flow and the viability of animal populations.

5.2 Residual Impact

The residual impact will depend on the effective application of management measures. In effect, a rigorous application of the management measures will lead to a reduction in residual impacts. However, habitat loss by stripping vegetation will be irreversible.

5.3 Conditions for Monitoring

The monitoring of animal populations should be carried out twice a year (dry season and wet season). This programme should be entrusted to biologists. A participative and multidisciplinary approach will allow monitoring to be tackled in a holistic way. The tools for monitoring must be varied in order to guarantee the quality of data.

6.0 SUMMARY AND CONCLUSION

6.1 Constraints on the Study

This study has allowed us to get data on the baseline condition for small mammals before the start of the mining activities. However, it has major shortcomings with regards to the season chosen and the time allowed to carry out activities. In fact, each climatic season has its advantages and inconveniences regarding the inventory of small mammals. Preferably, this study should have been conducted over two different climatic seasons (i.e. dry and wet seasons). This would have allowed us to collect a comprehensive sample. The dry season during which these surveys have been conducted have allowed us to carry out a representative inventory for small carnivores. On the other hand, this period is not so good for collecting data on micromammals whose activity rhythm is relatively low and often disrupted during the dry season.

Thus, an additional inventory carried out in the dry season would allow us to supplement the data collect and draw up an exhaustive list of small mammals present in the area.

6.2 Conclusion

The choice of season was not favourable to collect a representative sample for micromammals. This group, whose importance has already been demonstrated, merits special attention. Indeed, the micromammals' communities can be used as an indicator species for the study of numerous other groups, including birds of prey, reptiles and small carnivores.

This study did not provide many direct signs of presence. However, the different survey methods used allowed us to confirm the presence of eight species of small mammals. The cusimanse (*Crossarchus obscurus*) and the civet (*Civettictis civetta*) seem to have developed a better resilience strategy in the face of anthropic pressures present in their natural environment, considering their higher encounter rates in the study area. Several signs of presence (e.g. feces and footprints) were identified as originating from the genet. However, the species level could not be confirmed in many instances. In fact, this genus comprises several species which are very similar and are still of interest on a systematic level.

The project will definitely impact the natural environment and have an effect on the wildlife composition of the area. The mammals in general, and the small mammals in particular, will be disturbed on different levels such as: habitat loss, habitat fragmentation, disruption during their reproductive period and changes in their resource availability.

The proposed project is situated on a site that has already undergone mining exploitation. It therefore already has numerous stigma from previous exploitation. The above-mentioned impacts can be minimised if the old infrastructures are upgraded and exploited in order to avoid new damage. We must aim to considerably reduce the ecological impact of the project by ensuring a good fit between the social benefits and environmental negative impacts.

7.0 ACKNOWLEDGEMENTS

This study has been possible thanks to several people who we would like to thank by way of a few lines. We are grateful to Professor Tano Yao who has trusted us and given us the opportunity to carry out this study. We would like to thank all the guides (Maxime, Gérard, Germain and Mathieu) who helped us considerably throughout our stay. In addition, we would like to thank the AMARA Mining plc drivers for their patience and support. Thanks also to Mr Yao Michel and Mr Ano Daniel for their constant support. A special thanks to Amanda Pyper and Genevieve Campbell for their contribution on various levels including improving this report. Thanks to those near and far, who have contributed directly or indirectly to this study.

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APPENDICES

Appendix 7: The Schedule of Activities Conducted by the "Small Mammal" Team

Date	Activity	Issues[1]
16/01/2015	Trip Abidjan_Kossou	RAS
	Induction and meeting for first contact (administration)	RAS
	Presentation of the project (administration)	RAS
	Initial site visit	RAS
17/01/2015	Full site visit	RAS
	50% installation of the traps for small mammals in block TMP4	RAS
	Transect walk (inventory of small carnivores) in block TMP4	RAS
	First contact with the guides at Angovia	RAS
18/01/2015	Visit to the trap device (Block TMP4)	RAS
	Finalising the installation of the trap device (Block TMP4)	RAS
	Search for presence indicators for small carnivores (Block TMP4)	RAS
	Installation of two cameras (Block TMP4)	RAS
		RAS
19/01/2015	VisIt to the traps (Block TMP4)	Two removable traps stolen
		RAS
	Meeting of the relationship manager with the communities (administration)	RAS
	Finalising and printing the questionnaire (Kossou)	RAS
	Visit to and removal of the traps for small rodents (Block TMP4)	RAS
		RAS
20/01/2015	Interview with Allahou Bazi	RAS
	Interview with Angovia	RAS

Date	Activity	Issues[1]
	interview with Akakro	RAS
	Visit to and removal of the traps for small rodents (Block TMF3)	RAS
	Installation of three cameras (Block TMF3)	RAS
		RAS
21/01/2015	Visit to and removal of the traps for small rodents (Block TMF3)	RAS
		RAS
	interviews with N'Da Koffi Yobouékro	RAS
	Interview with Kouakougnanou	RAS
	Inventory for small carnivores (TMF3)	RAS
	Changing the bait in the trap device for small rodents (TMF3)	RAS
22/01/2015	Discussions with the client (administration)	RAS
	Transect walks for inventories of small carnivores (TMF3)	RAS
		RAS
	Visit to the capturing device for small mammals (Block TMF3)	RAS
	Removal of the cameras (TMP4)	RAS
	Viewing the camera images	RAS
23/01/2015	Visit to and removal of the trap device for small mammals (Block TMF3)	A second vehicle is required
	Removal and reinstallation of the cameras (TMF3)	RAS
	Installation of the trap device for small mammals (TMF2)	RAS
	Installation of the cameras (TMF2)	RAS
		RAS
24/01/2015	Visit to the trap device (TMF2)	RAS
	Inventory for small carnivores (TMF2)	RAS

Date	Activity	Issues[1]
	Installation of one camera (TMF2)	RAS
		RAS
	Inventory for small carnivores (WRD west)	RAS
	Traps for small mammals (WRD west)	RAS
	Installation of a Pitfall (TMF1)	RAS
25/01/2015	Removal of a trap device (TMF2)	RAS
	Visit to the trap device (TMF1)	RAS
	Visit to the trap device (WRD west)	RAS
	Inventory for small carnivores (TMF1)	RAS
	Installation of a camera (WRD North)	RAS
	Installation of a Sherman (WRD North)	RAS
	Night inventory (TMF3)	RAS
26/01/2015	Visit to the trap device for small mammals (TMF1, WRD West, WRD North)	RAS
	Inventory for small carnivores (WRD west)	RAS
27/01/2015	Visit to the trap device for small mammals (TMF1, WRD West, WRD North)	RAS
	Removal of cameras (WRD North, TMF3, TMF2)	RAS
28/01/2015	Visit to the trap device for small mammals (TMF1, WRD West, WRD North)	RAS
	Viewing the camera SD cards and confirming the species with the local guides	RAS
	Organisation of the return of the team to Abidjan	RAS
29/01/2015	Return of material (Cameras and other items)	RAS
	Return to Abidjan	RAS

[1] Issues: RAS= Nothing to report

Appendix 8: Raw Data of the Small Carnivores Survey at the Yaoure Site

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
21 01 2015	TMF3	1	217480	774892	FS	0	Start	Transect
21 01 2015	TMF3	1	217480	774892	FS	0	Civet	Small carnivores
21 01 2015	TMF3	1	217666	774769	Fallow land	223	Slender mongoose	Small carnivores
21 01 2015	TMF3	1	217675	774777	FS	228	Civet	Small carnivores
21 01 2015	TMF3	1	217675	774777	FS	229	Slender mongoose	Small carnivores
21 01 2015	TMF3	1	217699	774807	Fallow land	235	Slender mongoose	Small carnivores
21 01 2015	TMF3	1	217722	774837	Fallow land	248	Common Genet	Small carnivores
21 01 2015	TMF3	1	217782	774841	Fallow land	307	Common cusimanse	Small carnivores
21 01 2015	TMF3	1	217819	774818	Cocoa trees	347	Habitat	Habitat
21 01 2015	TMF3	1	217933	774966	Cocoa trees	464	End	Transect
21 01 2015	TMF3	2	217955	774968	Cocoa trees	0	Start	Transect
21 01 2015	TMF3	2	218201	775019	Cocoa trees	249	Cartridge case	Human activities
21 01 2015	TMF3	2	218113	775436	Cocoa tree	497	Habitat	Habitat
21 01 2015	TMF3	2	218113	775436	Fallow land	497	Habitat	Habitat
21 01 2015	TMF3	2	217979	775541	Fallow land	530	Habitat	Habitat
21 01 2015	TMF3	2	217844	775528	FS	575	Habitat	Habitat
21 01 2015	TMF3	2	217753	775565	FS	634	End	Transect
22 01 2015	TMF3	1	217872	775623	Fallow land	0	Start	Transect
22 01 2015	TMF3	1	217989	775616	Fallow land	116	Slender mongoose	Small carnivores
22 01 2015	TMF3	1	217989	775616	Fallow land	116	Common Genet	Small carnivores
22 01 2015	TMF3	1	218082	775624	Fallow land	208	Slender mongoose	Small carnivores
22 01 2015	TMF3	1	218366	775612	Fallow land	494	End	Transect
22 01 2015	TMF3	2	218391	775573	FS	0	Start	Transect
22 01 2015	TMF3	2	218427	775471	Fallow land			habitats
22 01 2015	TMF3	2	218441	775384	FS	196		habitats
22 01 2015	TMF3	2	218451	775341	FS	238	Common cusimanse	Small carnivores
22 01 2015	TMF3	2	218451	775341	FS	238	Civet	Small carnivores

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
22 01 2015	TMF3	2	218472	775263	FS	322	Common Genet	Small carnivores
22 01 2015	TMF3	2	218537	775278	FS	329	Common Genet	Small carnivores
22 01 2015	TMF3	2	218537	775248	FS	371	Common Genet	Small carnivores
22 01 2015	TMF3	2	218592	775254	FS	378	Common cusimanse	Small carnivores
22 01 2015	TMF3	2	218650	775231	FS	430	end	Transect
22 01 2015	TMF3	3	218451	775244	FS	0	start	Transect
22 01 2015	TMF3	3	218416	775237	FS	35	Common cusimanse	Small carnivores
22 01 2015	TMF3	3	218475	775282	FS	89	Common cusimanse	Small carnivores
22 01 2015	TMF3	3	218284	775267	FS	170	Common cusimanse	Small carnivores
22 01 2015	TMF3	3	218284	775267	Fallow land	170		habitats
22 01 2015	TMF3	3	218221	775290	Fallow land	237	End fallow land, cocoa plantation	Habitat
22 01 2015	TMF3	3	218221	775290	Cocoa tree	237	start of the cocoa plantation	Habitat
22 01 2015	TMF3	3	218084	774943	Cocoa tree	475	Cacao Tree	Habitat
22 01 2015	TMF3	3	217822	774673	Cocoa tree	851	End of cocoa trees	Habitat
22 01 2015	TMF3	3	217822	774673	Fallow land	851	Fallow land	Habitat
22 01 2015	TMF3	3	217558	774876	Fallow land	966	Common cusimanse	Small carnivores
22 01 2015	TMF3	3	217558	774876	Fallow land	966	end of transect	Transect
23 01 2015	WRD West	1	218669	777206	Fallow land	0	Start	Transect
23 01 2015	WRD West	1	218690	777183	Fallow land	870	Slender mongoose	Transect
23 01 2015	WRD West	1	218773	777030	FS	761	Sacred forest	Transect
23 01 2015	WRD West	1	218971	776869	Teak and cocoa trees	593	Sacred forest	Transect
23 01 2015	WRD West	1	219212	776498	Cocoa tree	604	Cocoa Tree	Transect
23 01 2015	WRD West	1	219250	776420	FS	654	Mining site	Transect
23 01 2015	WRD West	1	219601	776333	Cocoa trees	676	Cocoa Tree	Transect

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
23 01 2015	WRD West	1	219750	776433	FS and Fallow land	610	Piémont hill, entirely damaged by artisanal mining	Transect
23 01 2015	WRD West	1	219913	776640	Fallow land	522		habitats
23 01 2015	WRD West	1	220063	777019	Wooded savannah		End	Transect
23 01 2015	WRD West	2	220167	777253	Savannah	0	Start	Transect
23 01 2015	WRD West	2	220346	777285	Savannah	182	Several village mining holes	
23 01 2015	WRD West	2	220456	777256	Savannah	347	Telling (TIF)	Human activities
23 01 2015	WRD West	2	220218	777095	Savannah	385	Common Genet	Small carnivores
23 01 2015	WRD West	2	220617	776841	Savannah	611	End	Transect
24 01 2015	TMF2	1	220388	775140	Cocoa trees	0		habitats
24 01 2015	TMF2	1	220351	775230	Fallow land	82		habitats
24 01 2015	TMF2	1	220315	775416	Fallow land	270	Common cusimanse	Small carnivores
24 01 2015	TMF2	1	220379	775461	Banana plantations/Cocoa trees	306	Cocoa Tree	Hbitat
24 01 2015	TMF2	1	220379	775461	Banana plantations/Cocoa trees	306	Several village mining holes	
24 01 2015	TMF2	1	220379	775461	Banana plantations/Cocoa trees	306	Around 20 holes per 100m2	Human activities
24 01 2015	TMF2	1	220419	775710	Fallow land	557	Common cusimanse	Small carnivores
24 01 2015	TMF2	1	220513	775714	FS	574	Habitat	Habitat
24 01 2015	TMF2	2	220601	775675	FS	0	Common cusimanse	Small carnivores
24 01 2015	TMF2	2	220688	775857	FS	202	Camp miners (End)	Human activities
24 01 2015	TMF2	3	225804	775804	Fallow land	0	Mining trench	Human activities

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
24 01 2015	TMF2	3	220894	775454	Fallow land	376	hill on the level of the main camp at burkinabé	Habitat
24 01 2015	TMF2	3	220966	775454	Fallow land	407	Civet	Small carnivores
24 01 2015	TMF2	3	220994	775478		END		habitats
24 01 2015	TMF2	4	221022	775509	FS	0	Banfora Hill	Habitat
24 01 2015	TMF2	4	221108	775560	FS	101	Common cusimanse	Small carnivores
24 01 2015	TMF2	4	221140	775557	FS	126		habitats
24 01 2015	TMF2	4	221140	775557	Fallow land	126		habitats
24 01 2015	TMF2	4	221211	775528	Fallow land	190		habitats
24 01 2015	TMF2	4	221211	775528	Cocoa trees	190		habitats
24 01 2015	TMF2	4	221238	775603	Fallow land	236		habitats
24 01 2015	TMF2	4	221307	775638	Forest/Cocoa trees	312	Edge of the gold-mining site (impact of the species at the edge)	Human activities
24 01 2015	TMF2	4	221307	775638	Cocoa trees	363		habitats
24 01 2015	TMF2	4	221169	775966	Cocoa trees	482	Intense gold-mining under cocoa trees	Human activities
24 01 2015	TMF2	4	221089	771089	Fallow land	505		habitats
24 01 2015	TMF2	4	220704	776024	Savannah	607		habitats
25 01 2015	TMF1	1	223929	778262	FS	0		habitats
25 01 2015	TMF1	1	223948	778306	Cocoa trees	46		habitats
25 01 2015	TMF1	1	223978	778307	FS	67		habitats
25 01 2015	TMF1	1	224215	778285	Fallow land	287		habitats
25 01 2015	TMF1	1	224338	778451	FS	452	Civet	Small carnivores
25 01 2015	TMF1	1	224535	778547	typical	670	Pitfall and Sherman	
25 01 2015	TMF1	2	223917	778375	FS	0	Common cusimanse	Small carnivores
25 01 2015	TMF1	2	223595	778585	FS	383		habitats
25 01 2015	TMF1	2	223381	779161	FS	955	End	Transect
25 01 2015	TMF1	3	225072	779163	Fallow land	0		habitats
25 01 2015	TMF1	3	225037	779131	Fallow land	48	Common cusimanse	Small carnivores

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
25 01 2015	TMF1	3	225037	779131	Fallow land	48	Common Genet	Small carnivores
25 01 2015	TMF1	3	225037	779131	Fallow land	48	Civet	Small carnivores
25 01 2015	TMF1	3	225013	779066	Wooded savannah	114	Common Genet	Small carnivores
25 01 2015	TMF1	3	224957	778862	Teak/Fallow land	324		habitats
25 01 2015	TMF1	3	224979	778829	Teak/Fallow land	349	Common cusimanse	Small carnivores
25 01 2015	TMF1	3	224986	778724	Teak/Fallow land	450	Common cusimanse	Small carnivores
25 01 2015	TMF1	3	225015	778702	Cocoa trees	467		habitats
25 01 2015	TMF1	3	225051	778552	Fallow land	616		habitats
25 01 2015	TMF1	3	225107	778447	FS	721		habitats
25 01 2015	TMF1	3	225107	778380	Savannah	789	End	Transect
25 01 2015	TMF1	4	225025	778349	Wooded savannah	0		habitats
25 01 2015	TMF1	4	224976	778309	Wooded savannah	63	Civet	Small carnivores
25 01 2015	TMF1	4	224826	778173	Wooded savannah	227	Civet	Small carnivores
25 01 2015	TMF1	4	224714	778267	Wooded savannah	321	Large woody savannah	
25 01 2015	TMF1	4	224524	778458	FS	343	Secondary forest	Habitat
25 01 2015	TMF1	4	224499	778507	FS	547	Point of Pitfall	Human activities
25 01 2015	TMF1	5	224581	778488	Wooded savannah	0		habitats
25 01 2015	TMF1	5	224619	778534	FS	61		habitats
25 01 2015	TMF1	5	224632	778646	FS	166		habitats
25 01 2015	TMF1	5	224632	778646	Cocoa trees			habitats
25 01 2015	TMF1	5	224600	778763	Fallow land	275		habitats
25 01 2015	TMF1	5	224572	778839	Cocoa trees	353		habitats
25 01 2015	TMF1	5	224559	778887	Teak/Fallow land	402		habitats
25 01 2015	TMF1	5	224496	778956	Fallow land	479		habitats
25 01 2015	TMF1	5	224471	779047	Fallow land	573	Common Genet	Small carnivores
25 01 2015	TMF1	5	224324	779241	Fallow land	800	Common Genet	Small carnivores
25 01 2015	TMF1	5	224240	779319	Savannah	903	end	Transect
26 01 2015	WRD North	1	228590	778590	Cocoa trees	0		habitats

Date	Site	Transect	Longitude	Latitude	Habitat	Distance	Observation	Observation type
26 01 2015	WRD North	1	223694	778460	Fallow land	173		habitats
26 01 2015	WRD North	1	223844	778223	Cocoa trees	456		habitats
26 01 2015	WRD North	1	223854	778185	Fallow land	492		habitats
26 01 2015	WRD North	1	223866	778106	Fallow land	566		habitats
26 01 2015	WRD North	2	223766	778014	Cocoa trees/Fallow land	0		habitats
26 01 2015	WRD North	2	223737	777914	Cocoa trees/Fallow land	107	Common cusimanse	Small carnivores
26 01 2015	WRD North	2	223296	777450	Cocoa trees/Fallow land	737	Mossaic Cocoa trees fallow land	Habitat
26 01 2015	WRD North	2	223209	777475	Cocoa trees/Fallow land	776	Fallow land	Habitat
26 01 2015	WRD North	3	223102	777488	Cocoa trees/Fallow land	0		habitats
26 01 2015	WRD North	3	223080	777511	Cacao Tree	27		habitats
26 01 2015	WRD North	3	222921	777747	Cacao Tree	317		habitats
26 01 2015	WRD North	3	222921	777747	Mossaic fallow land	317		habitats
26 01 2015	WRD North	3	222499	778057	Fallow land	831	End	Transect
26 01 2015	WRD North	4	222272	777872	Fallow land	0	Start	Transect
26 01 2015	WRD North	4	222096	777856	Fallow land	177		habitats
26 01 2015	WRD North	4	221783	778195	Fallow land	587		habitats
26 01 2015	WRD North	4	221669	778397	Wooded savannah	801		habitats
26 01 2015	WRD North	4	221443	778423	Wooded savannah	996		habitats

Appendix 9: Selected Photos of Habitat and Artisanal Mining Sites

Hill with forest formation

Wooded savannah

Old mining exploitation site

Artisanal mining exploitation site

A view of Bandama River from Kossou dam

Appendix 10: Selected Photos of Different Survey Devices Used in this Study

 Tomahawk trap baited with palm kernels (W: 222296 ; N: 776037)	 Pitfall line (W: 224338 N: 778451)
 Notes from a transect walk. (W: 224957 ; N: 778862)	 Camera trap installed at the base of a tree. (W: 223433 ; N: 778431)

Appendix 11: Photographs Showing some Indication of the Presence of Small Carnivores

African Palm Civet: Nandinia binotata? (Photo from a hunter)

Civet pelt: *Civettictis civetta*

Tails from small canivores (Not identified)

Civet footprint: *Civettictis civetta*

Small carnivore droppings on a termite mound (Not identified)

Small carnivore droppings on an access trail (Not identified)

Appendix 12: Photographs taken by Camera Traps

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Cusimanse Crossarchus obscurus</td>
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African brush-tailed porcupine Atherurus africanus</td>
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Maxwell's duiker Philantomba maxwellii</td>
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Giant pouched rat: Cricetomys gambianus</td>
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