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Environmental and Social Impact Assessment of the CBG Mine Expansion Project

Chapter 3 – Biology Baseline Study

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ABBREVIATIONS AND ACRONYMS

(Note: Text in square brackets [] is a translation of a French term for which there is no official English version.)

°C: Degrees Celsius

AFD Agence Française de Développement [French development agency]

AIDS: Acquired immune deficiency syndrome

AIP: Annual investment plan

AMC: Alliance Mining Commodities Ltd.

ANAÏM: Agence Nationale d'Aménagement des Infrastructures Minières [national agency for mining infrastructure development]

APA: Laboratoire Archéologie et Peuplement de l'Afrique [African archeology and settlement laboratory]

APAÉ: Association des parents et amis d'élèves [parents and friends of students]

ARV: Antiretroviral

BAP: Biodiversity action plan

BEPC: *Brevet d'études du premier cycle du second degré* [middle-school leaving certificate]

BGÉÉE: Bureau Guinéen d'Études et d'Évaluation Environnementale [Guinean bureau of environmental studies and assessment]

BM: Banque Mondiale / World Bank (WB)

BPII: *Bonnes pratiques industrielles internationales* / Industrial international best practices

C/P: Frontline fishing camps and ports

CA: *Chiffre d'affaires* [revenues]

CBG: Compagnie des Bauxites de Guinée

CCME: Canadian Council of Ministers of the Environment

CCNUCC: *Convention-cadre des Nations Unies sur le changement climatique* / World Bank United Nations Framework Convention on Climate Change (UNFCCC**)**

CDD: *Contrat de durée déterminée* [contract of defined length]

CDI: *Contrat de durée indéterminée* [contract of indefinite length]

CÉCI: *Centre d'études et de coopération internationale* / Centre for international Studies and Cooperation

CECIDE: Centre du Commerce International pour le Développement [international trade center for development]

CEDEAO: Communauté économique des États de l'Afrique de l'Ouest / United Nations Economic Commission for Africa (UNECA)

CFB: Chemin de Fer de Boké [Boké railroad]

CITES: Convention on International Trade in Endangered Species

CMG: Chambre des Mines de Guinée [Guinean chamber of mines]

COD: Chemical oxygen demand

COPC: Contaminant of potential concern

CoPSAM: Comité Préfectoral de Suivi des Activités des Miniers [prefectoral mining activity monitoring committee]

CPC: *Contaminant potentiellement préoccupant* / contaminant of potential concern (COPC)

CPD: Comité Préfectoral de Développement [prefectoral development committee]

CPÉ: *Consultation et participation éclairées* / informed prior consent (IPC)

CR: *Commune rurale* [rural commune]

CRD: *Commune rurale de développement* [rural development commune]

CSA: Centre de santé amélioré [improved health center]

CSO: Civil society organizations

CSR: Corporate social responsibility

CU: *Commune urbaine* [urban commune]

CVÉ: *Composante valorisée de l'écosystème* / valued ecosystem component (VEC)

dB: Decibel

dBA: A-weighted decibel

dBZ: Decibel relative to Z

DEP Direction Préfectorale de l'Éducation [prefectoral directorate for education]

DPUHC: Direction préfectorale de l'urbanisme de l'habitat et de la construction [prefectoral directorate for housing and construction]

DUDH: *Déclaration universelle des droits de l'homme* / Universal Declaration of Human Rights (UDHR)

ÉDG: Électricité de Guinée

EIA: Environmental impact assessment

ÉIE: *Étude d'impact environnemental* / environmental impact assessment

ÉIS: *Étude d'impact social* / social impact assessment

EITI: Extractive Industries Transparency Initiative

EPA: Environmental Protection Agency (United States)

EPI: Extended Program on Immunization

EPT: Ephemeroptera, Plecoptera and Trichoptera (types of aquatic insects)

ESCOMB: *Enquête de surveillance comportementale et biologique sur le VIH/SIDA* [HIV/AIDS behavioral and biological surveillance survey]

ESIA: Environmental and social impact assessment

ESMP: Environmental and social management plan

ETAE: *Eaux tropicales de l'Atlantique Est* [tropical waters of the Eastern Atlantic]

FEL 1: Front-end loading – preliminary economic assessment

FEL 2: Front-end loading – prefeasibility study

FEL 3: Front-end loading – detailed engineering study

FPIC: Free prior and informed consent

GAC: Guinea Alumina Corporation

GdG: *Gouvernement de la Guinée* / Government of Guinea (GoG)

GDP: Gross domestic product

GES: *Gaz à effet de serre* / greenhouse gas (GHG)

GHG: Greenhouse gas

GIEC: Groupe d'experts intergouvernemental sur l'évolution du climat / Intergovernmental Panel on Climate Change (IPCC)

GIS: Geographic information system

GNF: Guinean franc

GoG: Government of Guinea

GPS: Global positioning system

GRI: Global Reporting Initiative

GTP: Ground truth point methodology

Ha: Hectare

HAP: *Hydrocarbure aromatique polycyclique* / polycyclic aromatic hydrocarbon (PAH)

HFO: Heavy fuel oil

HP: Horsepower

HSE: Health, safety and environment

IBA: Important bird area

ICCPR: International Covenant on Civil and Political Rights

ICESCR: International Covenant on Economic, Social and Cultural Rights

ICMM: International Council on Mining and Metals / Conseil International des Mines et des Métaux

IFC: International Finance Corporation / *Société Financière Internationale* (SFI)

IFI: International finance institutions / *institutions financières internationales*

ILO: International Labor Organization

IPCC: Intergovernmental Panel on Climate Change

ISQG: CCME Interim Sediment Quality Guideline

IST: *Infections sexuellement transmissibles* / sexually transmitted infections (STIs)

ITIE: Initiative pour la Transparence des Industries Extractives / Extractive Industries Transparency Initiative (EITI)

IUCN: International Union for Conservation of Nature / Union internationale pour la conservation de la nature (UICN)

km: Kilometer

km^2: Square kilometer

LA_{eq}: Equivalent sound level (dBA)

LDIQS: CCME Interim Sediment Quality Guideline

L_{eq}: Equivalent sound level (dB)

m: Meter

m^2: Square meter

m^3: Cubic meter

m^3/h: Cubic meters per hour

MDDEP: Ministère du Développement durable, de l'Environnement et des Parcs du Québec, now called the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques [Quebec ministry of sustainable development, environment and parks, now called the ministry of sustainable development, environment and the fight against climate change]

MDT: *Matières dissoutes totales* / total dissolved solids (TDS)

ml: Milliliter

mm: Millimeter

MME: Ministère des Mines et de l'Énergie / Ministry of Mines and Energy

MTPA: Million tonnes per annum

MW: Megawatt

N/A: Not applicable

NEP: *Niveau d'effet probable du CCME* / CCME probable effects level (PEL)

NGO: Nongovernmental organization

NP: *Norme de performance de la SFI* / IFC Performance Standard (PS)

NSP: *Ne s'applique pas* / not applicable (N/A)

OAU: Organization of African Unity

OCDE: Organisation de Coopération et de Développement Économique / Organization for Economic Cooperation and Development (OECD)

OECD: Organization for Economic Cooperation and Development

OIT: Organisation internationale du Travail / International Labor Organization (ILO)

OMS: Organisation mondiale de la Santé / World Health Organization

ONG: *Organisme non-gouvernemental* / nongovernmental organization

ONU: Organisation des Nations-Unies / United Nations

OSC: *Organisations de la société civile* / civil society organizations

OUA: Organisation de l'unité africaine / Organization of African Unity

OWINFS: Our World Is Not for Sale

PACV: *Programme d'appui aux organisations villageoises* [village support program]

PAH Polycyclic aromatic hydrocarbon

PAI: *Plan annuel d'investissement* / annual investment plan

PARC: *Plan d'action de réinstallation et de compensation* / resettlement and compensation action plan (RAP)

PCB: *Plan de conservation de la biodiversité* / biodiversity action plan (BAP)

PCS: *Partenaires contre le SIDA* [AIDS prevention group]

PDL: *Plan de développement local* [local development plan]

PEL: CCME probable effects level

PEPP: *Plan d'engagement des parties prenantes* / stakeholder engagement plan (SEP)

PÉV: *Programme élargi de vaccination* / Expanded Programme on Immunization (EPI)

PGES: *Plan de gestion environnementale et sociale* / environmental and social management plan (ESMP)

PIB: *Produit intérieur brut* / gross domestic product (GDP)

PIDCP: *Pacte international relatif aux droits civiles et politiques* / International Covenant on Civil and Political Rights (ICCPR)

PIDESC: *Pacte international relatif aux droits économiques, sociaux et culturels* / International Covenant on Economic, Social and Cultural Rights (ICESCR)

PK: Point kilométrique / kilometer point

PM_{10}: Particulate matter in air up to 10 micrometers in size

$PM_{2.5}$: Particulate matter in air up to 2.5 micrometers in size

PMH: *Pompe à motricité humaine* / manually operated pump

PNUD: Programme des Nations-Unies pour le Développement / United Nations Development Program (UNDP)

PP: *Parties prenantes* / stakeholders

PPV: Peak particle velocity

PRCB: Projet de renforcement des capacités de Boké [Boké rural community development project]

PS: IFC Performance Standard

QSE: Quality, safety and environment

RAP: Resettlement and compensation action plan

RAP: Rapid assessment program / rapid biological assessment

RSE: *Responsabilité sociale des entreprises* / corporate social responsibility (CSR)

RTA: Rio Tinto Alcan

SAG: Société Aurifère de Guinée [Guinea gold corporation]

SDT: *Solides dissous totaux* / total dissolved solids (TDS)

SEG: Société des Eaux de Guinée [Guinea water corporation]

SEP: Stakeholder engagement plan

SFI: Société Financière Internationale / International Finance Corporation (IFC)

SIA: Social impact assessment

SIDA: *Syndrome d'immunodéficience acquise* / acquired immune deficiency syndrome (AIDS)

SIG: *Système d'information géographique* / geographic information system (GIS)

SNAPE: Service national des points d'eau [national water supply points service]

SO_x: Sulphur oxides

SP: *Sous-préfecture* [subprefecture]

SSC: Species Survival Commission

SSE: *Santé, sécurité, environnement* / health, safety and environment (HSE)

SST: *Solides en suspension totaux* / total suspended solids (TSS)

STI: Sexually transmitted infections

TDR: *Termes de référence* / terms of reference (TOR)

TDS: Total dissolved solids

TOR: Terms of reference

TPE: *Très petite entreprise* / very small business

TPH: Tonnes per hour

TSP: Total suspended particulates

TSS: Total suspended solids

UDHR: Universal Declaration of Human Rights

UICN: Union internationale pour la conservation de la nature / International Union for Conservation of Nature (IUCN)

UN: United Nations

UNDP: United Nations Development Program

UNECA: United Nations Economic Commission for Africa

UNESCO: United Nations Organization for Education, Science and Culture / Organisation des Nations unies pour l'éducation, la science et la culture

UNFCC: United Nations Framework Convention on Climate Change

UniGE: Université de Genève / University of Geneva

UTM: Universal Transverse Mercator

VEC: Valued ecosystem component

VIH: *Virus de l'immunodéficience humaine* / human immunodeficiency virus (HIV)

WB: World Bank / Banque Mondiale (BM)

WHO: World Health Organization / Organisation mondiale de la Santé (OMS)

ZÉE: *Zone économique exclusive de la Guinée* [Guinea economic exclusive zone]

ZICO: *Zone importante pour la conservation des oiseaux* / important bird area (IBA)

CHAPTER 3 – BIOLOGY BASELINE STUDY

3.1 Introduction

The CBG Project is described in Chapter 1.

This biology baseline study contributes to a good understanding of the biological elements in the potentially affected areas and forms, with the physical and social baseline studies, the basis for an exhaustive study of the impacts related to an increase in the extraction rates.

3.1.1 Goals of the study

3.1.1.1 Objectives

The objectives of the biology baseline study were:

- to identify and characterize the habitats of the Study Area based on aerial photographs and satellite imagery available;
- to assess the faunistic and floristic diversity, in particular in the habitats affected by the Project; and
- to determine the presence of vulnerable or threatened species (according to the lists of the *Monographie Nationale* and the IUCN).

3.1.1.2 Aspects studies in the field

The biological studies specifically look at the following main topics:

- vegetation;
- large and medium terrestrial mammals;
- freshwater fauna (Sangarédi only);
- birds;
- reptiles and amphibians; and

- marine mammals, turtles and crocodiles (Kamsar only).

Other important studies not directly related to plant or animal inventories and linked with the social studies (Chapter 5) were also undertaken:

- fishing study (Kamsar only);
- firewood and charcoal study; and
- hunting and bushmeat study.

For each of these studies, a specialist of international repute was associated with at least one senior national researcher.

Nearly all of the species present come from fieldwork undertaken in 2013 for the ESIA. In some cases, data from other studies are mentioned and in those cases the sources of those observations are clearly mentioned.

3.1.1.3 The seasons

There are two distinct seasons in Guinea: the rainy season and the dry season. Normally, biological studies are undertaken during both seasons to take seasonal variations into account. The presence or the visibility of different species varies from the rainy season to the dry season. It was decided to carry out a single period of fieldwork to cover both seasons. The decision to carry out a single field campaign at the interface of the wet and dry season (October to December) is a profitable approach to biological fieldwork, considering that for the majority of taxonomic groups a significant difference will be evident during this short period. For example by starting towards the end of the rainy season it would be possible to inventory the majority of the amphibians (more discrete in the dry season), in spite of the fact that at the end of the rainy season several species of this group would have quit calling and thus make themselves known readily. For birds, some African migratory species would have started their migration south by the inter-season whereas northern species would be arriving.

For the freshwater fauna, a significant decrease in water flow in the watercourses towards the end of the rainy season will result in certain species having moved to downstream habitats.

For vegetation, the presence of flowers may be essential for the identification of some plants. In some species flowering may be continual, whereas in others flowering may be in the middle of the rainy season or in full dry season.

An inventory at the interseason is complex in view of the annual variations in rainfall that may shorten or prolong the dry or wet seasons.

3.1.2 Study Areas

3.1.2.1 Identification of areas affected by the Project

The Study Areas have been described in a general way in Chapter 1. Only some specific aspects related to the biological studies are brought up here.

3.1.2.2 Zone 1

Fieldwork for establishing the biological baseline data were concentrated on:

- the areas that would see changes linked to the increase in the rate of bauxite extraction; and
- reference sites.

Indeed, even without an increase in the rate of extraction, CBG would continue to mine a considerable additional surface area in the 2014-2028 period. ÉEM therefore asked Sylvatrop Consulting to conduct the field work in the following order:

- as a first priority the direct impact areas subject to the effects of the increase in extraction rate (defined by CBG in the zones to be mined during 2024-2028 on the *CBG Long Term Mining Plan 2013-2028* [CBG LTMP 2013-2028 27B]) ;
- as a second priority, areas that might be potentially important or different biologically in the indirect impact areas. This in order to complete knowledge of the species present in Zone 1; and

- as a third priority, zones to be mined in the period 2013 to 2028 with the exception of those already identified as first priority targets.

The areas surrounding Boulléré were selected as a reference site. The remnant forest near Boulléré, in spite of an observed degradation, still offer some biological diversity.

3.1.2.3 Zone 2

The environmental Study Area for Zone 2 took into account the main islands bordering the Rio Nuñez that could eventually be affected directly or indirectly by the Project (construction activities at the new ore quay and potential dredging of the access channel), namely the islands of Taïgbé, Taïdi and the northwest part of Binari.

The northern part of Binari Island was selected as a biological reference site. This island, whose southern part is within a Ramsar site, by its distance from Kamsar and its limited accessibility, seemed at first glance during the scoping study to have an environment that was less modified by anthropic activities than the islands closer to Kamsar. A site is called a "Ramsar site" when it is recognized under the International Convention on Wetlands, also called the Ramsar Convention.

It should be noted that especially in the marine environment, the biological Study Area in Kamsar was slightly extended towards the southwest to take into account the influence of potential dredging activities (transport of sediment in suspension for example) and the possible presence of an ore ship transfer point. Studies on marine mammals and reptiles and the fishery study therefore extended beyond the Study Area limits determined during the scoping study.

3.1.2.4 Zone 3

Zone 3 was not the subject of specific biological studies, apart from visits by the team botanists to the new siding areas. The railroad already has a fairly significant traffic that reduces the likelihood of presence of sensitive species. In addition, the

proximity to the railroad has undoubtedly contributed to a high human population density and the elimination of much natural habitat.

3.1.3 Participants

The ESIA Project team is described in a general way in Chapter 1.

For the biology baseline study the key persons were:

CBG

Stéphane Dallaire – of the *Service Santé, Sécurité, Environnement du Projet d'extension de la CBG* and principal contact between the biology team and the client.

ÉEM

Eric Muller – Leader of the environmental study

ÉEM had the overall responsibility of the ESIA studies and of the reports and project management.

Sylvatrop Consulting SARL

Sylvatrop Consulting had the specific responsibility for the field studies and the reports on the biology baseline. Sylvatrop Consulting was responsible for the choice and management of the field specialists, and for the writing of the synthesis of the field studies.

- Sylvain Dufour – Director general of Sylvatrop Consulting.
- Michel Bureau – Scientific director
- M. Kaman Pé Sagno – Responsible for field logistics
- M. Alpha Oumar Baldé – Responsible for logistics in Conakry

Specialists

- Botany: Charlotte Couch and Lucia Lopez Poveda (Royal Botanic Gardens, Kew)
- Medium and large mammals: Janette Baarman
- Ornithology: Hugo Rainey
- Herpetology (reptiles): Laurent Chirio
- Herpetology (amphibians): Joseph Doumbia
- Marine biology: Caroline Weir
- Renewable natural resources (marine fishing, wood energy, and bushmeat): Adam Manvell
- Freshwater ecology: Edia Oi Edia, Mexmin Konan Koffi, Félix Koffi Konan

Note: the complete list of people involved in the field studies and later analyses may be found in the specialist reports (Annexes 3-1 to 3-13).

3.1.4 Prior studies

3.1.4.1 Introduction

All of the ÉEM teams (the physical, biological and social teams), tried to obtain and consult all prior studies likely to reduce or help direct the extent and orientations of the fieldwork needed.

3.1.4.2 General references

Two recent studies provided important data for the present ESIA.

GAC ESIA

Guinea Alumina Corporation (GAC) has a project for a bauxite mine in an area close to the CBG mine and that is in a similar physiographic area. They also have projects in Kamsar. The GAC studies (Knight Piésold and Co., 2008) therefore have useful data for Kamsar and the CBG mine site.

AECOM ESIA for CBG

In 2011, AECOM produced an ESIA for CBG for a production increase from 13.5 MTPA to 16.5 MTPA (3% free moisture content). The ÉEM team incorporated the relevant baseline and other data collected and/or compiled for that study, to avoid duplicating the work. In terms of biology baseline studies, AECOM did not conduct systematic fieldwork in the 2011 ESIA. AECOM based their work on biological data from other studies, particularly those of the 2008 GAC ESIA.

3.1.4.3 Specific studies

BERCA-baara EIA for the N'Dangara and Boundou Wandé mining plateaus

This is a preliminary version of a 2003 report commissioned by CBG and written by consulting firm BERCA-baara, entitled *Étude d'impact sur l'environnement du Projet d'exploitation des gisements de N'Dangara et de Boundou Wandé* (BERCA-Baara-BERD, 2003).

BERCA-baara study of flora of the plateaus

This is a 2003 report commissioned by CBG and written by consulting firm BERCA-baara, titled *Inventaire de la flore des plateaux miniers de Sangarédi, Bidikoum, Silidara et N'Dangara* (BERCA-Baara, 2003).

This study is useful and provides interesting data, particularly on ethnobotanical aspects and the use of certain species for revegetation.

Boké RAP study

The 2006 survey *A Rapid Biological Assessment (RAP) of Boké Préfecture, Northwestern Guinea* (Wright et al, 2006) is a good assessment of selected sites in Boké prefecture: "The RAP survey was carried out at several sites in Boké Préfecture along the coast of northwestern Guinea (Guinée Maritime): Sarabaya (Rio Kapatchez), Kamsar (including 5 subsites), and Boulléré."

The RAP 41 survey provides highly useful data and has helped focus the biological fieldwork by indicating the species that may be present.

Critical Habitat Assessment Report, Guinea Alumina Corporation Project

This study was published in 2008 on the habitats of certain mammals (chimpanzees mainly) in the GAC concession (Ecology and Environment Inc. et Kormos, 2008).

3.1.5 Structure of the report

All of the reports from the specialist's fieldwork are in appendices (Annexes 3-1 to 3-12). Some of the reports are in English and some in French and they are all presented here in their original versions. Certain reports may contain references to potential activities to be undertaken by CBG that were in consideration during the fieldwork but were finally not retained. This is the case notably for channel dredging work. It seemed useful for the understanding of the fieldwork to keep these references.

The fieldwork served as a base for Sylvatrop Consulting to carry out the production of a series of syntheses that form Section 3.3 to 3.12 of this Chapter. In addition, Sylvatrop Consulting was responsible for the section on habitats (Section 3.2).

3.2 Habitats

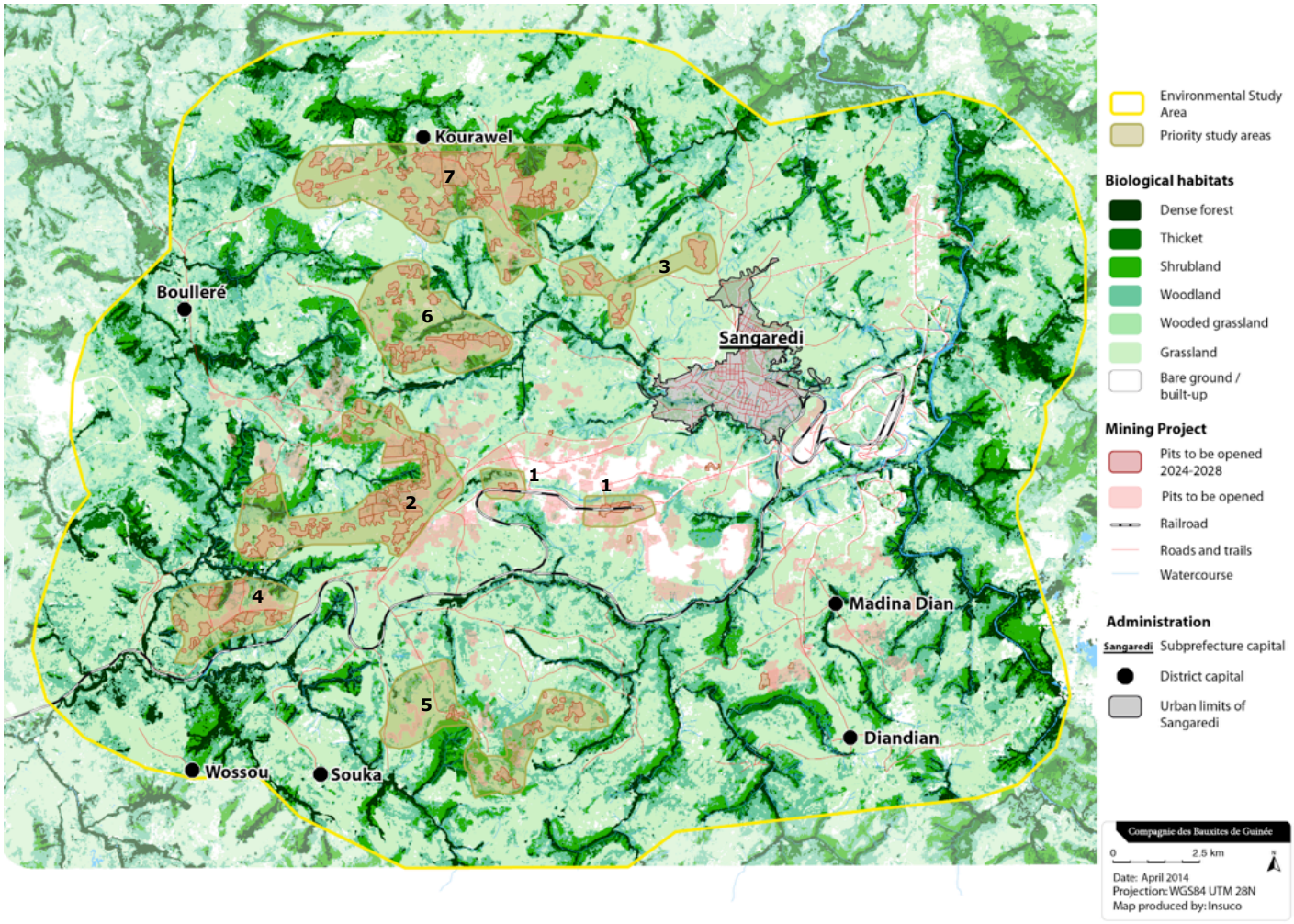
To ensure a degree of uniformity in the terms used for habitats in the presentation of results for each of the terrestrial groups studied (birds, mammals, reptiles and amphibians), White's (1983) classification of vegetation forms, commonly used in Africa, was adapted to the Study Areas of the Project (Table 3-1).

The mapping of the various types of vegetation, that represent as many different habitats for the fauna, can allow by the measurement of the surfaces occupied by the vegetation types, and determine their relative abundance and importance within the Study Area. This mapping is particularly important during the impact study because the overlaying of the Project on the mapped habitats allows the determination of the nature and surface area of the habitats affected and their associated fauna.

Maps 3-1 and 3-2 show the cartography of the vegetation in the Study Areas around Sangarédi and Kamsar. It is based on White's classification to the extent that interpretation of 2013 satellite images allowed.

Photo 3-1 Bowal

Map 3-1 Habitats around Sangarédi



Map 3-2 Habitats around Kamsar

Within the context of this mandate, each of the specialists linked faunistic observations to the vegetation types used. This allowed mapping, for each type of vegetation, all of the species noted as using it, including threatened species. However, the observations were made in a specific temporal context, at the beginning of the dry season. This period is also the burning period. Thus several habitats, such as bowés or some fallow areas, were already set on fire, which would degrade their natural properties and consequently their use by fauna. Inventories during the rainy season would lead to a different assessment of the affected habitats in terms of biodiversity.

The botanical inventories done as part of the Project fieldwork allowed a reduction from the number of vegetation types used in White's classification to retain only those present in the Study Areas. The botanical inventories also identify the plant species associated with the retained vegetation types.

It must be noted that in the Sangarédi region, the habitats have been modified by human activities. For example the shrublands and thickets found there are typically secondary vegetation arising from cultivated lands left fallow. Shrubland is the first stage of succession, when cut stumps re-sprout and is typically open with a higher percentage of grasses present. This grows into thicket, which is a closed stand of very dense 'poles' as a result of coppicing tree species. The closed canopy of thicket means that grasses and other understory herbs are shaded out. Thicket generally forms in the fallow phase between years 4-5 or less after farming.

Table 3-1 Main vegetation formations found in the Project Study Areas (adapted from White, 1963)

Main vegetation formations found in the Study Areas	
Habitat Types	Description
Forest	A continuous stand of trees at least 10 m tall, their crowns interlocking
Woodland	An open stand of trees at least 8 m tall with a canopy cover of 40% or more. The field layer is usually dominated by grasses
Bushland	An open stand of bushes usually between 3 and 7 m tall with a canopy cover of 40% or more
Thicket	A closed stand of bushes and climbers usually between 3 and 7 m
Shrubland	An open or closed stand of shrubs up to 2 m tall
Grassland	Land covered with grasses and other herbs, either without woody plants or the latter not covering more than 10% of the ground
Wooded grassland	Land covered with grasses and other herbs, with woody plants covering between 10% and 40% of the ground
Mangrove	Open or closed stands of trees or bushes occurring on shores between high- and low-water mark
Freshwater aquatic	Herbaceous freshwater swamp and aquatic vegetation

Main vegetation formations found in the Study Areas	
Halophytic	Saline and brackish swamp vegetation
Anthropic	Manmade landscapes, e.g., agricultural, urban etc.

3.3 Vegetation

3.3.1 Introduction

The botanical inventories in the Study Area were carried out between November 18 and 27, 2013. Of these nine days of inventories, by two teams, seven were devoted to the Sangarédi Study Area and two to the Kamsar one. In total, 242 plant specimens were collected for subsequent identification, leading to the identification of 255 plant species.

Seventy-eight ground truthing points (Ground Truth Point methodology - GTP) were surveyed in the Sangarédi region. In Kamsar, spot observations were carried out.

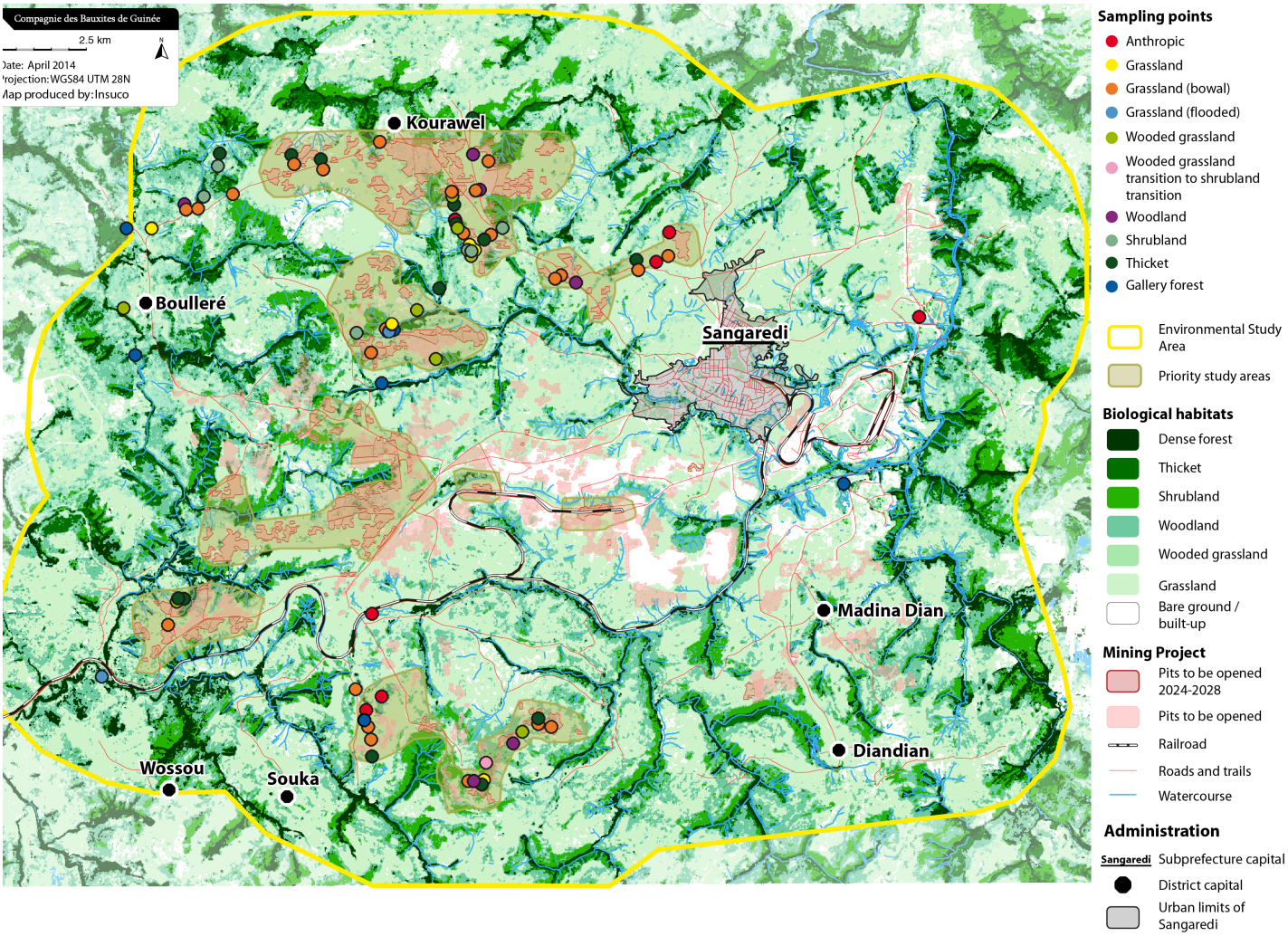
It should be noted that given the amount of time available for the botanical survey and the expected habitat disturbances, the inventory effort centered more particularly on the mining expansion area of Sangarédi.

The sites inventoried in Kamsar are presented on Map 3-3 and those for Sangarédi on Map 3-4. These maps use the habitat base derived from the botanical studies (Maps 3-1 and 3-2).

The complete report on the botanical fieldwork prepared for Sylvatrop Consulting by Royal Botanical Gardens, Kew (Kew, 2014) is presented as Annexe 3-1.

Map 3-3 Botanical sampling points at Kamsar

Map 3-4 Botanical sampling points at Sangarédi



3.3.2 Context

The Upper Guinea forest area is a biodiversity hotspot (Myers et al, 2000), though it is under great pressure across the region due to an increasing human population. There are remnants of this forest left in the gallery forests and occasional treed islands found in the Project area. The Fouta Djallon, further east of the Project site

is a hotspot for regional endemics, but many of these do not stretch as far west as the project area.

The area in and around Kamsar and one of the reference sites for this study at Boulléré was previously studied in 2005 for a Conservation International Rapid Assessment Programme (CI RAP 41) (Couch & Williams, 2006). The report highlighted the degradation in the area due to the increasing population. Agriculture and cattle grazing have had a large impact on the vegetation of this region.

The Study Area around Sangarédi was once largely a matrix of wooded grassland and woodland, grassland bowal vegetation and forest along the rivers and watercourses. Much of this wooded grassland and woodland was cleared for farming in previous centuries, and the gallery forests are increasingly impinged upon because of fires set to clear land for agriculture; however, fragments and gallery forest can provide refuge for a number of conservation-important forest species.

Botanical inventories carried out for RAP 41 (Couch and Williams, 2006), were not undertaken in an optimal season so as to offer a complete portrait of the vegetation of the area. September-October would have been more favorable. The present study was done from November 18 to 27 2013 and did not allow for an adequate assessment of the bowal grasslands because villagers had already burned these areas. Also some species found in the field could not be identified because they were not in flower during the survey period. However the 2003 report commissioned by CBG and produced by consultants from BERCA-baara titled *Inventaire de la flore des plateaux miniers de Sangarédi, Bidikoum, Silidara et N'Dangara* includes fieldwork during September (2002). The results of this study were considered in this ESIA and help to complete the more recent inventories.

Although there is now a published Flora (*Flore de la République de Guinée*, Lisowski 2009), botanical knowledge in the country is incomplete with little progress in recent decades. Currently only 3 - 5% of plant species in Guinea have been formally assessed for their IUCN conservation status.

3.3.3 Methodology

The survey was carried out using Ground Truth Point (GTP) methodology. This sampling method was developed for ground truthing the vegetation map of Madagascar (Moat and Smith, 2007). This method is used to verify vegetation types on the ground against the vegetation map developed using remote sensing techniques. The data recorded may vary depending on the locality for example the size of the area being mapped will vary; it is an indication of the extent of the vegetation type in that particular area. The structure of the vegetation is noted, this is in accordance with White (1983) (Table 3-1), and the major species components of each layer are recorded. Voucher specimens are taken where these are not identifiable in the field. Also recorded are the intactness of the vegetation and any threats as well as geographical characteristics of the site as this may influence the vegetation. This method was to maximize the use of time and effort across the study site and will facilitate future vegetation mapping and assessing changes over time. At these points, the vegetation was characterized and dominant species, percentage cover and intactness were recorded. Other site characteristics were noted including slope, aspect and soil type (mostly laterite). An example of the plot form data captured can be found in Annexe 3 of the full botanical report (Annexe 3-1 of this report).

Field identifications were made in the field where possible using the *Flore de la république de Guinée* Lisowski (2009). If not possible, specimens that were in flower or fruit, if present, were collected for later identification in a laboratory by taxonomic experts.

Observations were made at points where there was an interesting feature or significant plant collections were made, and data recorded.

3.3.3.1 Inventory sites

The areas surveyed are those expected to be affected by the expansion of the CBG Project. At Kamsar these are the islands and beaches of the Rio Nuñez where the CBG port is located as well as areas that might be affected by future railroad

structures, including PK 14. At Sangarédi it is mainly the future zones of bauxite mining and PK 118.

In addition two reference sites were retained, that of Binari Island, to the south of Kamsar, and that of Boulléré, northwest of the town of Sangarédi (see Chapter 1 for the Study Areas). It was not possible to inventory the Binari Island site however, because of low tide conditions that made it inaccessible during the survey period.

3.3.3.2 Kamsar

No plot data was collected here due to the time restrictions. Only visual observations and some specimen collections were made. Twenty-three species of 13 families were identified, the majority in the coastal forest or the interface of this forest and the sand beaches.

The area studied around Kamsar was mostly coastal vegetation, dominated by mangrove. The beach area at Taïdi Island was sampled for flowering and fruiting material, when field identification was not possible. Taïgbé East was visited to assess the presence of a range restricted species flagged up in RAP 41 (Couch and Williams, 2006). Elsewhere in the marine zone, the coastline was assessed for vegetation types by boat.

3.3.3.3 Sangarédi

Six of the seven zones inventoried at Sangarédi are in the proposed CBG bauxite mining expansion area. It includes zones 1, 3, 4, 5, 6 and 7 (see Map 3-1). The seventh zone is Boulléré, considered as a biological reference site (see Section 3.1). Zone 1 is within the current mining area and has been partially inventoried. The other zones were intensely studied and sampled.

In the 7 inventoried zones, 78 sampling units were done, including 9 in the Boulléré reference zone.

Specific diversity of the different habitat types found in the Sangarédi area is generally fairly low. For any given type of habitat, the species composition is fairly similar but the relative importance of species found may vary.

3.3.4 Results

3.3.4.1 Sampling locations

The coordinates of the 78 sampling points (Map 3-4) are given in Annexe 1 of the full botanical report (Annexe 3-1 of the present report). Table 3-2 presents the distribution of sampling points (GTPs) by habitat types.

Table 3-2 Distribution of vegetation sampling points by habitat types

Habitat type	Number of ground truth points recorded
Bowal	24
Undisturbed wooded grassland and grassland	17
Woodland patches in bowal	6
Secondary shrubland and thicket	21
Gallery forest	5
Anthropic	5

3.3.4.2 Species

A total of 242 specimens and 748 sight records were recorded during the field survey. This resulted in 255 species from 82 families identified in the botanical report (Annexe 3-1). This survey has identified two species that are *Vulnerable* according to IUCN. Other species that are known to be range restricted or rare were also noted.

Within the context of an inventory of the flora of the Sangarédi plateaus in 2002, 199 species of plants were identified (BERCA-Baara, 2003). Approximately sixty of these are in common with the species identified in the current study. Some species might prove to be common to both lists but with different Latin names. For example, *Albizzia sassa* in BERCA-Baara (2003) is under the name *Albizia adianthifolia* in the 2014 study. In any case, the comparatively few number of common species between the two studies suggest a greater species diversity in the Study Areas than might be indicated by the results of these two studies. The *Monographie Nationale* (Bah *et al*., 1997) reports that there are 3,076 plant species in Guinea, the majority of them angiosperms.

Approximately 95% of the specimens collected were identified as to species, and 99% to genus. The legumes with 43 species and the bedstraws with 19 species present the largest floristic diversity. The grasses (17 species) and sedges (13 species) also show a fairly good diversity. This diversity might have been higher if the botanical survey in the bowé had been done before the area was burned.

3.3.4.3 Floristic composition of the habitats

The vegetation classification system adopted in this report is a combined physiognomic-floristic approach, which describes both the vegetation structure and the floristic composition. The physiognomic method allows easy recognition of the vegetation types in the field. The vegetation types can be related to spectral response from satellite images, which make future mapping feasible.

The physiognomic vegetation types are related to the floristic composition and key environmental variables to fully describe and characterize the vegetation of the area.

The following text details the different types of habitat found in the Study Area and the characteristic plants for each type. Table 3-1, presented in the section on habitats, summarizes the principal characteristics of these habitats.

There is no official list of French names for the African continent. In fact, for most species there is simply no French name. Where available from a web search, one of

the French names is used [in the original French version of this chapter – not the translated version]. When that is not the case, Latin names are used.

Dense forest

This is a climax vegetation type that is generally diverse in species, including conservation-priority species. Surviving forest is rarely encountered since all the forests visited have been modified more or less strongly by human activities, such as harvesting of species for wood and encouraging the growth of specific species such as the oil palm (*Elaeis guineensis*). In the Study Area, what remains is therefore degraded forests, particularly along watercourses: the gallery forests.

Gallery forests

Possibly persisting because of the need to stabilize riverbanks, this vegetation is relatively respected by people on the banks. The gallery forests often include swamp forest species that are present because the water table is higher on riverbanks than under "forest islands." In general the gallery forests in the survey areas were narrow (around 50m wide) and partially degraded on the landward edges, owing to agriculture, including burning.

Characteristics and Composition

Canopy 15-30m tall, canopy closed, crowns touching, typically 80-95% cover. Tree species are highly diverse. Few or no forest species are found in woodland habitats. The climber, understory tree/shrub, and ground layers, are all well developed and species are diverse in intact extensive forest. Oil palm (*Elaeis guineensis)* may occur but as a canopy 'tree' not an emergent.

The gallery forest areas that were surveyed were highly variable in their intactness. Some areas were dominated by *Elaeis guineensis*, suggesting that these areas have been manipulated by the villagers in order to have a larger source of palm oil. This was noticeable by the river Topolili near Para Gogo village.

More or less intact gallery forest in the area had tree species including *Milicia excelsa, Xylopia aethiopica, Pterocarpus santalinoides* and *Parkia bicolor.* The shrub layer diversity was often lower than we would have expected and this could be attributed to human influence. The shrub layer had some Rubiaceae species such as *Rutidea parviflora, Psychotria psychotrioides* and *Pauridiantha sp.*

Where the forest has become degraded, species such as *Combretum grandiflorum* and *Trema orientalis* can be found in greater abundance.

At the source of the Bwito River near Boulléré, several good riverine forest tree species were identified: *Homalium africanum*, *Napoleonaea vogelii, Xylopia aethiopica* and *Malouetia heudelottii*. This is in line with the findings of Couch and Williams (2006) in the area. The high density of stilt rooted trees (*Uapaca heudelotii*) suggests that the rivers in this area can have a high volume of water in the wet season that endures into the dry season. The intactness of the canopy of these rivers also helps retain water. Few rivers in the study area appeared to retain a large volume of water into the dry season.

Photo 3-2 Typical gallery forest

Species of Conservation Interest

Rungia erostachya, a rare herbaceous species, was found close to the Woupili River and *Milicia regia* which is a *Vulnerable* species according to the IUCN classification was also registered as a sight record, but could not be verified with a specimen because fertile material was not available. However, it should be taken into consideration that this species has been highlighted as present in Guinea (UICN, 2013).

Wooded grassland and woodland

The wooded grassland and patches of woodland are typical of the Sudan-Guinea grassland-woodland biome, and the diversity of these formations is lower in areas with limited precipitation, such as in the Study Area.

Photo 3-3 Woodland at Boulléré

These are the most widespread and common vegetation types in Guinea and have a broadly similar species composition from Mauritania in the west to South Sudan in the east. In Sangarédi one subtype appears to occur, Haute Niger Region Woodland. This vegetation type has often been termed "savannah" but that term has been widely misapplied. This last term has actually been removed from international standards for descriptions of African vegetation (White, 1983).

Characteristics and Composition

Woodland has 40% or more canopy cover. Woodland differs from forest in that canopy interlocking does not occur. Wooded grassland has trees between 5 and 15 m high whose canopy has a percentage cover of 10 to 40%.

Forest indicators such as *Erythrophleum suaveolens* are often present in the woodland patches.

The plots had a dominance of tree species typical of this environment: *Pterocarpus erinaceus, Parkia biglobosa, Piliostigma thonningii* and *Combretum micranthum, Combretum nigricans* var. *elliotii* and *Terminalia glaucescens*. These formations are not particularly diverse due to the pressures of cattle and agriculture.

Trees and shrubs woodland such as *Combretum* spp., *Allophylus africanus*, *Annona senegalensis, Holarrhena floribunda* and *Sarcocephalus latifolius,* do not occur in forest. Many woodland tree species have a related 'twin' species in forest e.g. in the genera *Pterocarpus*, *Lophira*, *Erythrophleum*, *Daniellia*, *Parkia*.

Areas have been cleared and re-cleared over many years by the local population resulting in stunted woodland with small trees or suffrutices growing back following fire and cultivation, with occasional large trees of *Parkia biglobosa, Parinari excelsa* or *Erythrophleum suaveolens.*

Woodland trees have thick corky, fire resistant bark and if burnt to the ground in severe fires, the ability to re-grow from rootstocks. These features are usually absent in forest tree species.

Species of Conservation Interest

There were no species of conservation concern recorded from this vegetation type during this survey.

Bowal grassland

Bowal is a form of grassland characterized by a hard substrate, impeded drainage and thin or absent organic soils that result in an absence of woody plants. It is seasonally inundated grassland and with a unique assemblage of species, including some restricted to bowal. It is a natural climax formation and not degraded, as suggested for example by Lisowski (2009).

Photo 3-4 Bowal at Kourawel

Several different microhabitats occur in bowal grassland:

The dominating microhabitat is flat seasonally wet (wet season) grassland (1-2m tall) areas on thin soils (1-4mm deep) that dry and burn in November. *Schizachyrium*, *Hyparrhenia* and *Andropogon* species dominate. The fieldwork led to the identification of *Schizachyrium pulchellum*, d'*Andropogon pseudapricus* and *A. tectorum*.

The *Hyparrhenia* clade and several other species of the tribe are unique to bowal, particularly in the genus *Schizachyrium* and among the annual *Anadelphia* species. Less predominant are the Loudetoid grasses, which also radiate and have endemics here e.g. *Dilophotriche occidentalis* (not identified in the field).

The second microhabitat consists of shallow pools with black peat substrate. Among the specialised community here, the Guinean endemic *Nymphoides guineensis* occurs but it was not observed during field work. These stay wet for months into the dry season.

The third microhabitat consists of gravel areas, with pisoliths, in which there may be small islets of herbaceous plants that can include conservation priority species.

The fourth microhabitat consists of low-lying areas with black peat soils characterized by *Panicum* spp., *Bryaspis lupulina*, *Hydrolea macrosepala*, *Ludwigia* spp. and a diversity of *Eriocaulon* species, which are actively evolving. These areas dry out after the first microhabitat, and can remain wet weeks into the dry season.

The last microhabitat is the transition between woodland and the bowal grassland with its suite of species.

Bowal appears superficially as unremarkable flat grassland without trees. It is defined by the substrate of concretized ironstone that forms an orange-red rock-like, usually flat surface, more or less impervious to water. The herbaceous plants found there, of a height of around one meter, are shorter and more dispersed than those found on the wooded grasslands, these developing on deeper and hence less limiting soils. The bowé of the Sangarédi region seem to have a lower diversity than those found elsewhere in Guinea, as on the border of the Fouta Djallon, near Mamou. These latter bowals stay wet longer as the dry season advances (Schnell, 1976).

In the Study Area the dominant grass species differ at generic level and are commonly dominated by *Schizachryium pulchellum*, however its relative importance varies with the presence of *Afrotrilepis pilosa* (Cyperaceae). At the edges of the bowal *Pennisetum purpureum* was the dominant species, this then led into non-bowal grassland with *Andropogon tectorum.* Other species present were *Cyperus richardii*, *Pycreus capillifolius* and *Bulbostylis lanifera.* Other herbaceous species present but more dispersed were *Oldenlandia herbacea, Cantinoa Americana, Scoparia dulcis* and *Striga asiatica*.

Wet patches have a higher diversity especially where there are pools of water or seepage areas. Found there are *Bryaspis lupulina, Hydrolea macrosepala, Drosera indica, Utricularia rigida* and *Xyris anceps* as well as a diversity of *Eriocaulon* species (*E. plumale, E. afzelianum, E. setaceum).*

Species of Conservation Interest

There were no species of conservation concern recorded from this vegetation type during this survey.

Non-bowal grassland

This formation is found on deeper soils associated with wooded grassland and therefore gives rise to a different species composition from that of bowal and is characterized by tall grasses typically 2 to 3 m high. In the study area they are dominated by *Andropogon tectorum* and *Loudetia arundinacea* with some other grass species such as *Schizachyrium pulchellum* and herbaceous plants including *Sida linifolia, Virectaria multiflora, Crotalaria goreensis* and legume twiners present e.g. *Vigna* sp. There were also occasional shrubs of *Rauvolfia vomitoria* and *Bombax costatum* and large trees like *Daniellia oliveri* and *Parkia biglobosa* that are left standing, as they are useful trees.

Shrubland and thicket

In the Sangarédi area, all shrubland or thicket is secondary vegetation that has replaced as the original vegetation after cultivation. Shrubland is the first stage of succession, when cut stumps re-sprout and is typically open with a higher

percentage of grasses present. This grows into thicket, which is a closed stand of very dense 'poles' as a result of coppicing tree species. The closed canopy of thicket means that grasses and other understory herbs are shaded out. Thicket generally forms between years 4-5 or less after farming, in the fallow phase.

Shrubland, up to 2 m tall, can include various species including *Combretum* spp., *Annona senegalensis*, *Sarcocephalus latifolius* as well as tree species *Dialium guineense*, *Allophylus africanus*, *Newbouldia laevis* and *Holarrhena floribunda* and liana species *Mezoneuron benthamianum.*

Thickets are mainly a small subset of forest or woodland trees, shrubs and climbers that can regenerate readily from underground rootstocks after clearance and fire. In the Sangarédi area, evergreen forest species typically include *Diospyros heudelotii*, *Anisophyllea laurina*, *Anthonotha macrophylla* with some woodland species e.g. *Sarcocephalus latifolius* and *Dichrostachys cinerea.* Climbers can be present such as *Dioscorea hirtiflora*, *Monanthotaxis barteri, Mezoneuron benthamianum* (others unidentifiable due to lack of flowers or fruit), but the ground layer is absent or with only one or two species usually found near the edge such as *Indigofera capitata, Cyathula prostrata* var. *prostrata* and *Lippia chevalieri.* Dense thickets of *Dialium guineense* have been observed near Kewl Bond.

Edaphic formations

Mangrove and coastal forest are the edaphic formations. Mangrove is characterized by open or closed stands of trees or bushes occurring on shores between high and low watermark. Mangrove in Guinea is characterised by the three Atlantic coast species: *Rhizophora mangle, R. harrisonii* and *R. racemosa,* in addition to *Avicennia germinans*.

Photo 3-5 Mangrove on the island of Taïdi

The coastal forest is a thin strip, along the coast above the sandy shore. All trees present are coastal specialists: *Avicennia germinans, Terminalia catappa* and *Terminalia scutifera.* In addition littoral lianescent shrubs such as *Guilandina* (*Caesalpinia*) *bonduc* and *Canavalia rosea* were also recorded.

In disturbed areas, such as those around the Taïdi Island, Taïgbé West area and areas previously cleared for rice cultivation there is already colonization by the native coastal salt-tolerant, succulent species of the Amaranthacea family: *Blutaparon vermiculare*. Other salt-tolerant species found in association with the mangrove-beach interface include numerous Cyperaceae species and several *Ipomaea* species, including *Ipomoea violacea*. This species was seen on the beach of Taïdi Island and, although not rare, constitutes a new record for Guinea and West Africa.

The coastal forest is mainly composed of species with a wide range such as *Guilandina* (*Caesalpinia*) *bonduc* and *Canavalia rosea*. The presence of *Terminalia scutifera*, a species of restricted range is confirmed at Taïgbé.

Anthropic formation

Plantations of *Anacardium occidentale* have been seen around villages and in revegetated areas on CBG mined sites. *Citrus* sp., *Psidium guajava* and *Mangifera indica* are also grown in plantations close to settlements. Crop species such as *Manihot esculenta*, *Panicum miliaceum*, *Sorghum bicolor* and *Arachis hypogaea* were recorded in cultivated fields.

Invasive species

Chromalaena odorata, an invasive species from the Neotropics, was seen in several places in the Study Area. *Anacardium occide* could also present an invasion risk.

Railroad corridor

Gallery forest was found at PK 118 however it was found to be degraded due to the proximity of the railway line and past cultivation. The canopy was quite open but there was flowing water containing *Eriocaulon setaceum,* an aquatic plant requiring considerable sunlight. Few tree species were identifiable due to the lack of fertile material. It is not expected to contain species of conservation concern. Revisiting in a more optimal season would help to confirm this.

PK 14 is so close to a human settlement that the vegetation is significantly degraded and there would be no need to revisit this site.

3.3.5 Summary of species of interest for conservation

3.3.5.1 Kamsar

A range-restricted species (*Terminalia scutifera)* was found on the Island of Taïgbé. It had already been observed previously in the same are during the RAP 41 study (Couch et Williams, 2006).

3.3.5.2 Sangarédi

According to IUCN criteria, *Khaya senegalensis*, observed in wooded grassland near Kagnaka, is considered as *Vulnerable*. *Milicia regia* has been tentatively identified from gallery forest near Boulléré. However, the plant had no flowers or fruit and it was not possible to formally identify the specimen. This species is considered *Vulnerable*.

Rungia eriostachya, recognized as rare but not yet assessed by the IUCN, was seen on the banks of the Woupilili near Paragogo.

In the BERCA-Baara (2003) study, three species identified had the status of *Vulnerable* according to the IUCN: *Afzelia africana*, *Albizia ferruginea* and *Khaya senegalensis*.

3.3.5.3 Railroad corridor

No species of interest was noted at PK 14 and 118.

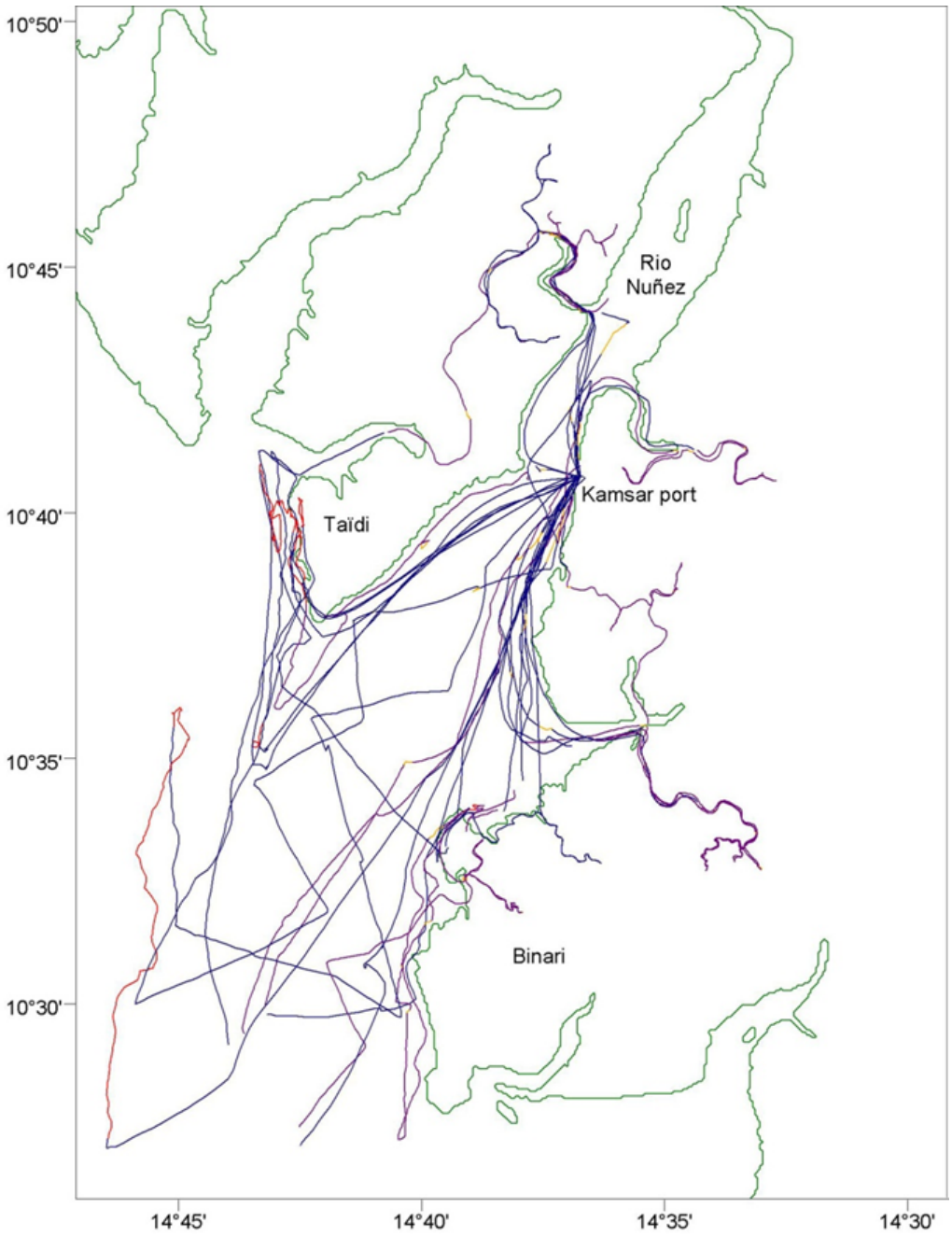
3.4 Marine mammals, turtles and crocodiles

3.4.1 Introduction

The inventories for this group were carried out between October 24 and November 8, covering a linear total of 893.5 km. Visual survey was the major survey method, with a total of 829.8 km coverage. A total of 266.8 km of survey coverage was achieved with a side scanning sonar and led to nine echoes of interest. However, because of the high turbidity, the large amount of suspended particles and the muddy nature of the bottom, these echoes did not lead to the positive identification of marine animals. Fifty-one local fishermen were interviewed during their time at sea. The details of the methodology used for the study of these taxa can be found in Annexe 3-2.

Photo 3-6 Atlantic humpback dolphin

Map 3-5 Tracking of surveys for marine mammals, turtles and crocodiles[1]



[1] Visual observation alone in blue, visual observation plus sonar in purple, questionnaires and follow-up in orange.

3.4.2 Results

3.4.2.1 Cetaceans

The occurrence of cetaceans in the tropical eastern Atlantic (ETA) (bordering the west coast of Africa) is very poorly documented (Jefferson et al., 1997; Weir, 2010a, 2011a,b). Most of the available data relate to historical whaling records (1700s–1970s) and occasional stranding/capture records (usually dated), and there is relatively little information available on live sightings and present-day occurrence.

A total of 30 cetacean species has been recorded to date in the waters between Mauritania and Côte d'Ivoire. Of these, 11 are currently confirmed to occur in the waters of Guinea. Based on their known occurrence elsewhere in the ETA (Weir, 2010b, 2011a) and their worldwide distribution, it is expected that that all of the other species except for the long-finned pilot whale and the harbor porpoise (which are respectively found from Mauritania and Senegal northwards) will occur off Guinea on at least an occasional basis. Consequently, it is likely that the cetacean fauna of Guinea comprises around 28 species,

Table 3-3 give a list of these species as well as their IUCN *Red List* status (IUCN, 2013) and according to the *Monographie nationale de la diversité biologique de la Guinée.*

Table 3-3 Occurrence and IUCN conservation status of cetacean species in the waters off Guinea and adjacent countries

Species	IUCN Status[1]	Status in Guinea[2]	Habitat
Blue whale (*Balaenoptera musculus*)	EN	In peril	O
Fin whale (*Balaenoptera physalus*)	EN	In peril	O
Sei whale (*Balaenoptera borealis*)	EN	In peril	O
Bryde's whale (*Balaenoptera brydei*)	DD	In peril	C
Common minke whale (*Balaenoptera acutorostrata*)	LC	In peril	C
Humpback whale (*Megaptera novaeangliae*)	LC	In peril	C
Sperm whale (*Physeter macrocephalus*)	VU	In peril	O

Species	IUCN Status[1]	Status in Guinea[2]	Habitat
Dwarf sperm whale (*Kogia sima*)	DD	In peril	O
Pygmy sperm whale (*Kogia breviceps*)	DD	In peril	O
Cuvier's beaked whale (*Ziphius cavirostris*)	LC		O
Blainville's beaked whale (*Mesoplodon densirostris*)	DD		O
Gervais' beaked whale (*Mesoplodon europaeus*)	DD		O
Killer whale (*Orcinus orca*)	DD		C
Long-finned pilot whale (*Globicephala melas*)	DD		O
Short-finned pilot whale (*Globicephala macrorhynchus*)	DD	In peril	O
False killer whale (*Pseudorca crassidens*)	DD		O
Melon-headed whale (*Peponocephala electra*)	LC		O
Pygmy killer whale (*Feresa attenuata*)	DD	In peril	O
Atlantic humpback dolphin (*Sousa teuszii*)	VU		S
Rough-toothed dolphin (*Steno bredanensis*)	LC	In peril	O
Risso's dolphin (*Grampus griseus*)	LC		O
Bottlenose dolphin (*Tursiops truncatus*)	LC	In peril	C
Pantropical spotted dolphin (*Stenella attenuata*)	LC		O
Atlantic spotted dolphin (*Stenella frontalis*)	DD		O
Spinner dolphin (*Stenella longirostris*)	DD		O
Clymene dolphin (*Stenella clymene*)	DD		O
Striped dolphin (*Stenella coeruleoalba*)	LC		O
Common dolphin (*Delphinus* sp.)*	DD/LC		C
Fraser's dolphin (*Stenella coeruleoalba*)	LC		O
Harbour porpoise (*Phocoena phocoena*)	LC		S

IUCN (2013) status: EN=Endangered; VU=Vulnerable; DD=Data deficient; LC=Least concern. Usual habitat: O=Oceanic (>200 m water depth); C=Cosmopolitan (shelf and oceanic habitat); S=Shelf only (<200 m water depth).

* Species whose presence in Guinea is confirmed (Bamy *et al*., 2010; Weir, 2010a)

[1] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 6 November 2013.

[2] In the *Monographie nationale de la diversité biologique*, it is considered that certain CITES Annex I and II species are in peril in Guinea.

Of the 28 species expected or confirmed to occur in Guinean waters, the majority (N=21; Table 3-3) are typically found in deep water beyond the shelf edge (>200 m depth) and would not be expected to occur in a coastal estuarine environment. Six

species are considered to be cosmopolitan in the ETA and occupy a range of habitats from the coast to deep, oceanic waters (Weir, 2011a).

Of these species, only the bottlenose dolphin and the Atlantic humpback dolphin are likely to routinely utilize shallow brackish estuarine environments with sandbanks, as found in the Rio Nuñez Estuary (although killer whales can enter such estuaries on occasion). The remaining species are likely to occur only in the more open waters and slightly further offshore from the study area.

Bottlenose dolphin

The first record of a bottlenose dolphin in Guinea was an adult female specimen caught in a fishing net and landed at Bonfi on 10 March 2002, followed by a second by-caught specimen was landed at Conakry on 11 December 2005 (Bamy et al., 2010). Additionally, a bottlenose dolphin was photographed in February 2012 south of Conakry (Simandou Project, 2013a).

The species was not observed during fieldwork. However, according to fairly reliable interviews (N=31 for a total 51) among the fishermen during fieldwork, three individuals were observed in the marigot of Taïdi in 2013 and two individuals captured one at the mouth of the Dougoubona River (2006), one at in the channel of the Rio Nuñez (2013).

Atlantic humpback dolphin

There had been only one verified record of an Atlantic humpback dolphin in Guinean waters to date: a male specimen landed by artisanal fishers at Dixinn on 13 March 2002 (Bamy et al., 2010).

In the context of the ESIA, the species was observed eight times in the Study Area (including the observations of S. Dufour and A. Manvell). The largest group seen was a school of approximately 25 individuals. Locations of observations are shown on Map 3-6. Photographs of dolphins were taken and through their interpretation, the population of the area was estimated to be at least 47 individuals. The analysis of the observations leads to the conclusion that there is a regular presence of the Atlantic humpback dolphin close to the east side of Taïdi Island. According to

queries among fishermen, an Atlantic humpback dolphin was captured in the Dougoubona River in 2012.

Photo 3-7 Atlantic humpback dolphin with young

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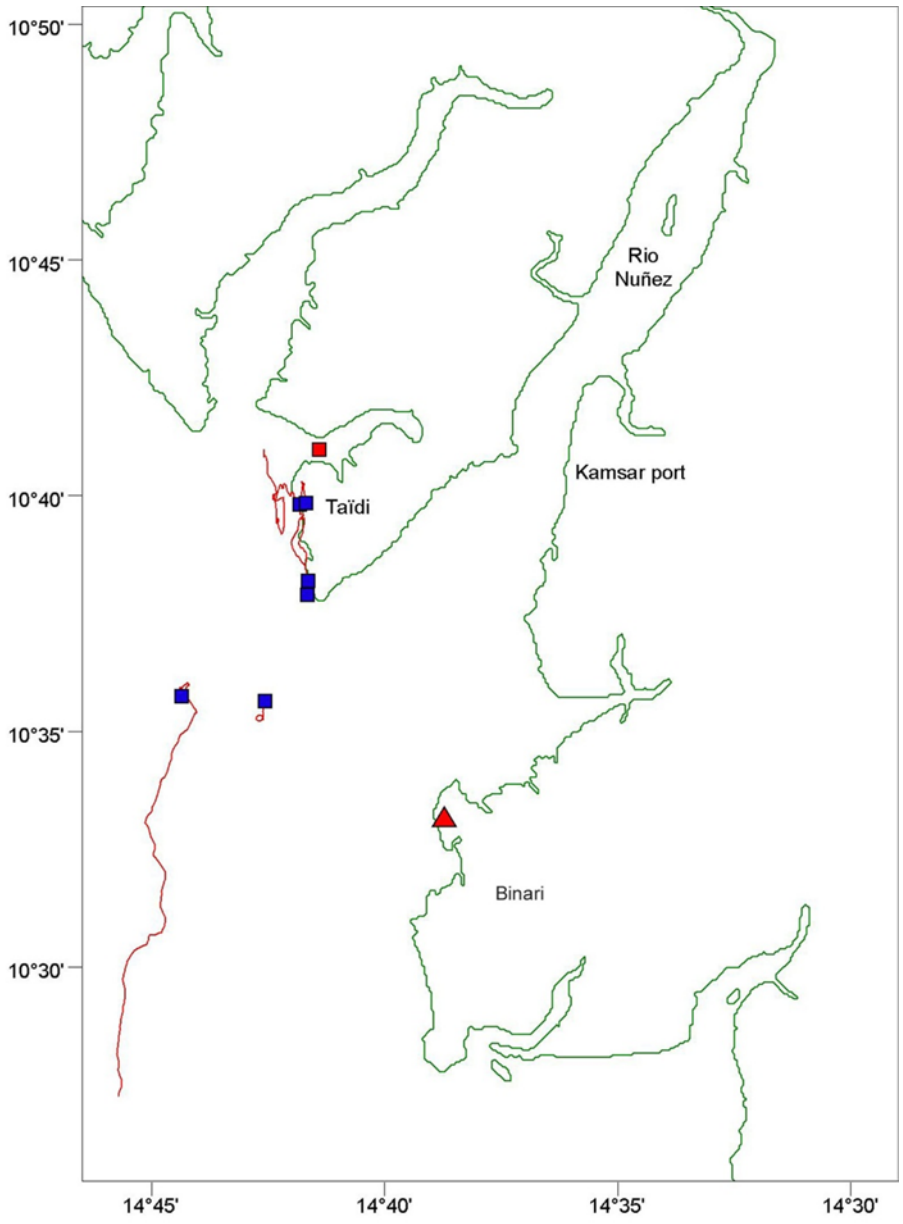
Map 3-6 Location of dolphin records and dolphin encounter effort (red)[1]



[1] Key: Opportunistic sighting (red square); on-effort sighting (blue square); dead dolphin (red triangle).

3.4.2.2 Sirenians

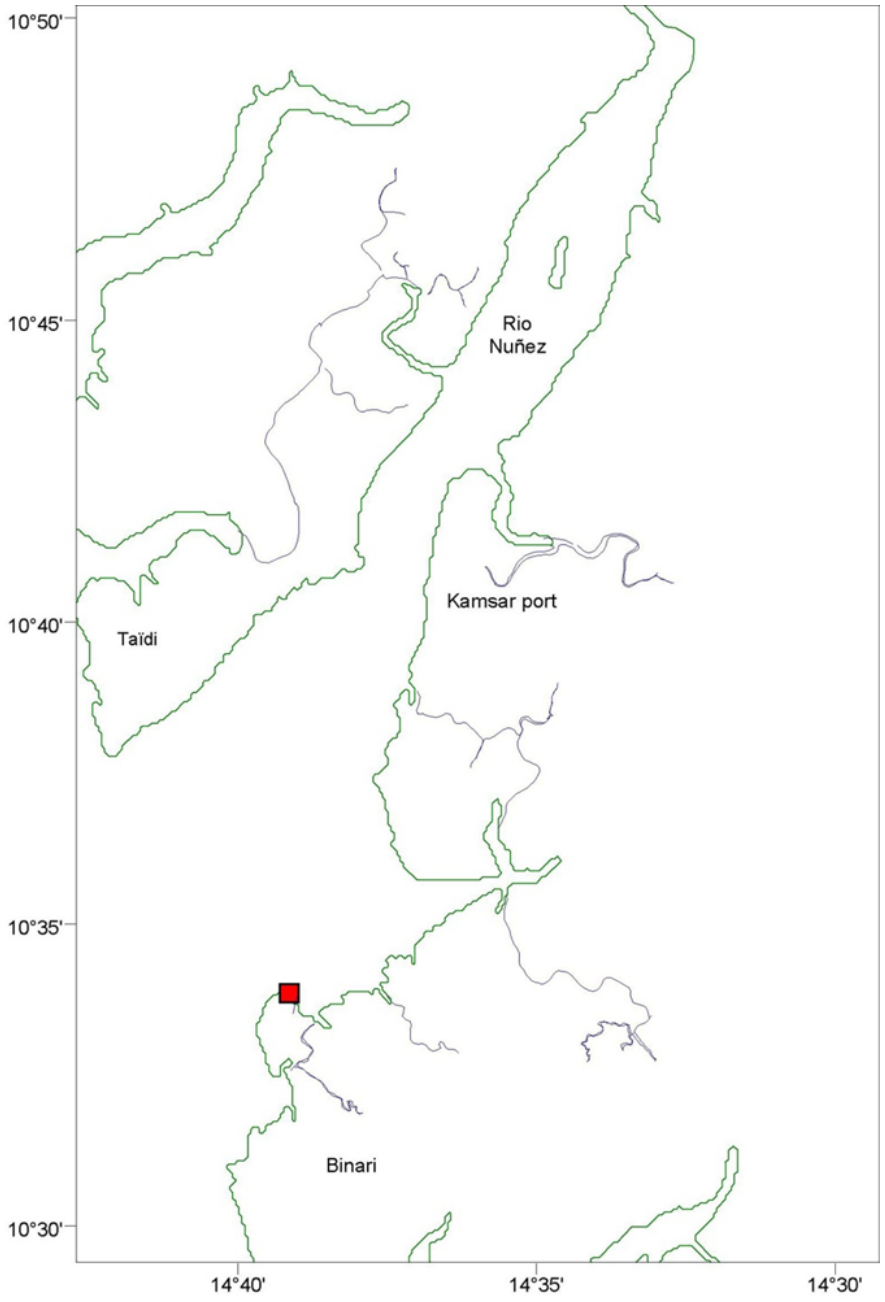
The West African manatee (*Trichechus senegalensis*) is endemic to the west coast of Africa. Its range extends from the Senegal River in southern Mauritania (16°N) to the Longa River in Angola (Powell, 1996; Perrin, 2001; Dodman et al., 2008). The conservation status of the West African manatee is considered to be *Vulnerable* (IUCN, 2013) and in peril according to the *Monographie nationale sur la diversité biologique*. It has been estimated that fewer than 10,000 remain (Powell and Kouadio, 2008). It has been recognized as present in coastal marshes, in the Niger and Gambia watersheds, as well as tidal channels in the estuaries of the Componi, Nuñez, Pongo, Konkouré, Bofon, Mellacorée and Debreeka (Powell, 1996; Barnett and Pragley, 1997; Keita, 2002; Dodman *et al.*, 2008). Two individuals were observed close to Touguyiré in August 2012 (Simandou Project, 2013a).

A single adult West African manatee was observed in the waters between Binari Island and the Banc de Dapiar during the ESIA (Map 3-7). It should be noted that this species is hard to observe. Fishermen that were interviewed (N=31) reported seeing or capturing 12 individuals (marigot of Taïdi, bank of Bencer, marigot of Kasopo, mouth of the Dougoubona, marigot of Koufen). Nearly all of the observations or captures date from 2013. In March 2014, a manatee was injured near the beginning of the access channel, then captured and sold at the village port in Kamsar.

Photo 3-8 West African manatee

It should be noted that Luiselli et al. (2012), in the context of studies in the Niger River, report manatee have a tendency to avoid habitats where crocodiles, in particular the West African Nile crocodile (*Crocodylus suchus*) are abundant.

Map 3-7 Observations of manatee



3.4.2.3 Crocodiles

The IUCN (2013) currently recognizes three species of African crocodiles: the Nile (*Crocodylus niloticus*: *Least Concern*), African dwarf (*Osteolaemus tetraspis*: *Vulnerable*) and slender-snouted (*Mecistops cataphractus*: *Data Deficient*) crocodiles. However, the taxonomical status of two of those species is under revision by the IUCN specialist group on crocodiles.

Hekkala et al. (2011) carried out a genetic study of the Nile crocodile and found two divergent lineages: (1) the traditional Nile crocodile (*Crocodylus niloticus*) occurring primarily in eastern and southern Africa with smaller populations in central Africa; and (2) a West African Nile crocodile (*Crocodylus suchus*) distributed in the Congo basin and throughout West Africa (including Guinea: Simandou Project, 2013d). Given evidence for declines due to anthropogenic pressures, it is likely that *Crocodylus suchus* qualifies for *Vulnerable* (or higher) IUCN status compared with *C. niloticus* currently considered of *Least Concern* (Simandou Project, 2013d).

In a genetic study of the African dwarf crocodile, Eaton et al. (2009) found support for a valid West African taxon (*Osteolaemus* cf. *tetrapsis* [*sp. nov*.; West African dwarf crocodile]) which appears to be distributed from Gambia westwards at least till Benin and therefore including Guinea. The West African dwarf crocodile likely qualifies for *Endangered* (or higher) IUCN status compared with *Osteolaemus tetraspis* that has a status of *Vulnerable* (Simandou Project, 2013d).

West African Nile crocodile

Little is known of the distribution of this species in Guinea given the few studies on this species. The *Rapport sur la biodiversité marine et côtière* (Bah, year not specified) mentions its presence at Sonfonia, the Rio Pongo and the estuary of the Motéba. According to *Communication sur la situation des crocodiles en Guinée* (Kourouma et *al,* 2007), it is present in four prefectures in Guinea (Macenta, Boffa, Forécariah et N'Zérékoré). During targeted surveys around Kabak, prefecture of Forécariah, in 2011/2012, this species was seen a total of 211 times (but including some double-counts) (Simandou Project, 2013e).

In the context of the present mandate, in spite of the fact that the inventories were done in the day whereas they would have been more effective at night, there were eight sightings of crocodiles of which six were positively identified as West African Nile crocodile0, four observations of tracks (species not identified) and two individuals in captivity (West African Nile crocodile). Map 3-8 presents the observation points for crocodiles. During the surveys among fishermen (N=31), three crocodiles were reported as seen or captured in the marigot of Taïdi.

Photo 3-9 West African Nile crocodile

West African dwarf crocodile

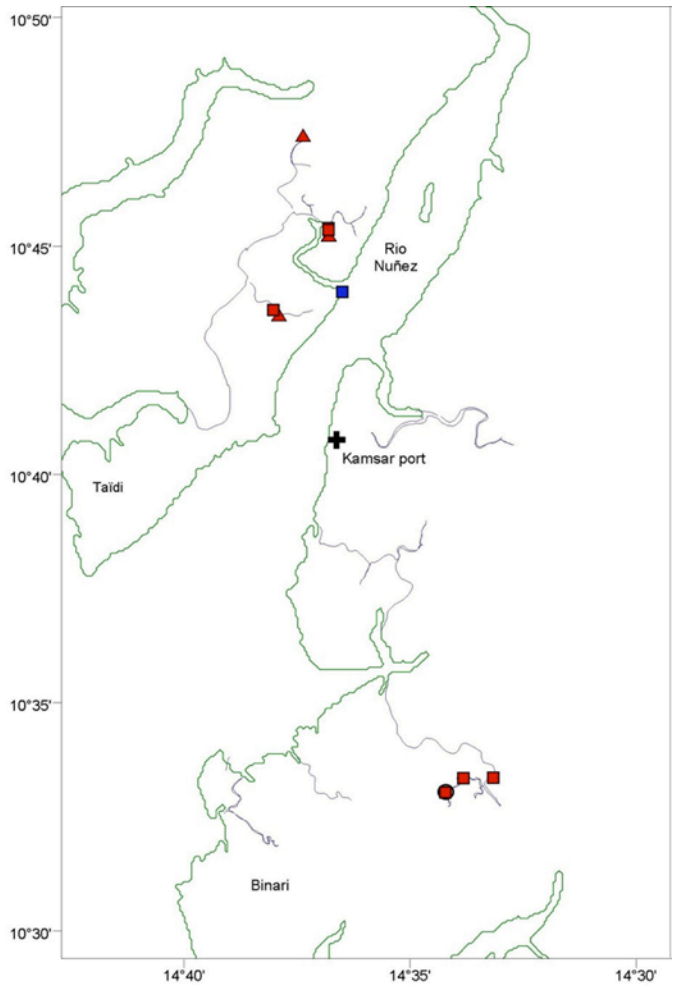
The *Communication sur la situation des crocodiles en Guinée* (Kourouma *et al.*, 2007) reports its presence in 15 of the 19 of the country (not reported for Kissidougou, N'Zérékoré, Forécariah and Boffa). However within the context of targeted studies on crocodiles in the region of Kabak Island, prefecture of Forécariah south of Conakry, 6 to 8 animals were recorded using camera-traps placed at their burrow entrances (Simandou Project, 2013e). No individual of this species was noted during the inventories in the marine and brackish waters of the Kamsar Study Area. However, the species was seen twice in the Sangarédi Study

Area (L. Chirio), one sub-adult in zone 1 (Map 3-1), close to the control station for bauxite loading, and in the reference zone near Boulléré (an adult and at least 15 juveniles)

Slender-snouted crocodile

This species of crocodile is considered one of the least known in the world (Kourouma *et al.*, 2007).

Map 3-8 Observations of marine crocodiles[1]



[1] on-effort West African Nile crocodile sightings (red squares); on-effort unidentified crocodile sighting (orange circle); crocodile tracks (red triangles); captive animals (blue square); opportunistic sighting (black cross).

3.4.2.4 Marine turtles

Five species of sea turtle have been reported from Guinean waters, and all are of IUCN conservation concern (Table 3-4).

Table 3-4 Occurrence and IUCN conservation status of sea turtle species in Guinean waters

Species	IUCN Status[1]	Status in Guinée[2]
Green turtle (*Chelonia mydas*)	EN	In peril
Loggerhead turtle (*Caretta caretta*)	EN	In peril
Leatherback turtle (*Dermochelys coriacea*)	CR	In peril
Hawksbill turtle (*Eretmochelys imbricata*)	CR	In peril
Olive ridley turtle (*Lepidochelys olivacea*)	VU	In peril

[1] IUCN 2013. *IUCN Red List of Threatened Species*. Version 2013.1. <www.iucnredlist.org>.

[2] In the *Monographie nationale de la diversité biologique*, it is considered that certain CITES Annex I and II species are in peril in Guinea.

Green turtle

This species is considered likely to occur throughout Guinean coastal waters. Neighboring Guinea-Bissau holds one of the largest green turtle nesting populations (Catry et al., 2009), just to the north of Guinea. In Guinea, captures, remains and nesting signs have been reported from Tristao Islands, Loos Islands, Foulayeh to Bongolon, Tempinataye and Bonfi (Simandou Project, 2013b). The presence of developmental foraging areas for immature green turtles along the coast of Guinea seems likely, based on occurrence in nearby countries (Liberia and Côte d'Ivoire: Fretey, 2001; Formia, 2002; Peñate et al., 2007). Within the context of the ESIA, a carapace identified as of this species was found in a fishing camp at the mouth of a tidal channel in the northwest of Binari Island (Map 3-9)

Loggerhead turtle

Some loggerhead turtles satellite-tagged in the Cape Verde islands moved through Guinean waters on foraging excursions (Hawkes et al., 2006), and the species is therefore expected to in the economic exclusive zone (EEZ) of Guinea. A skeleton is known from Foulayeh village in the prefecture of Boffa, confirming its presence. Nesting of this species in West Africa appears to be concentrated at the Cape Verde islands (Marco et al., 2011) and possibly with small numbers at Senegal (Fretey, 2001). This species was not seen during the ESIA.

Leatherback turtle

The leatherback turtle is primarily a pelagic species. It is expected that foraging and migrating leatherback turtles might occur in pelagic waters within the Guinean EEZ year-round, with an increased abundance and an inshore movement into coastal waters during the nesting season (however, there are no data to evaluate this). The species may have been observed by fishermen close to Conakry (Simandou Project, 2013b). There are records of nesting in neighboring Guinea-Bissau (Catry et al., 2009) and Sierra Leone (Aruna, 2007) and so some nesting activity should also be expected in Guinea. The species was not seen during the ESIA.

Hawksbill turtle

This species has been confirmed to nest on beaches in the Loos Islands, in the Tristao Islands and on the mainland near Rhoudindé and Foulayeh (prefecture of Boffa). At Loos Islands, nesting occurs from August to November, while in the Tristao Islands there are two nesting periods in April/May and from August to November (Simandou Project, 2013b). During fieldwork for this mandate, a small hawksbill turtle was observed to the southwest of Binari Island (Map 3-9)

Olive ridley turtle

As with the hawksbill turtle, this species is likely to occur throughout coastal waters in Guinea, with carapaces and captures documented from many ports and coastal villages and some nesting thought to occur in the Tristao Islands (Simandou Project,

2013b). Based on good nesting densities in neighboring countries including Guinea-Bissau (Catry et al., 2009) and Liberia (LSTP, 2003), the olive ridley turtle is expected to nest wherever suitable habitat exists along the entire Guinean coastline. Nesting activity in Guinea-Bissau and Liberia peaks between November and February. The carapace of an adult of this species was observed on Taïgbé Island.

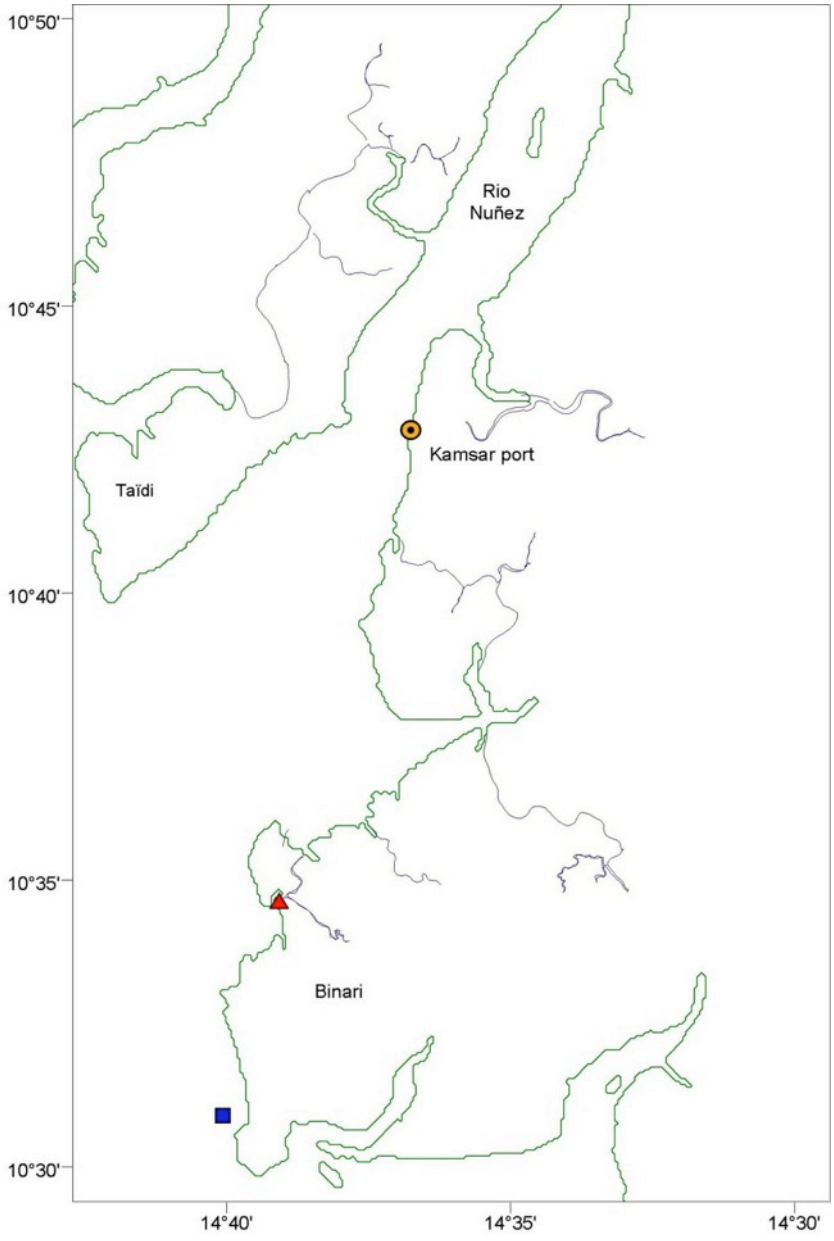
3.4.2.5 Freshwater turtles

During the present mandate, a species of freshwater turtle was seen near the port of Kamsar. It was identified as a Nile softshell turtle (*Trionyx triunguis*). It is recognized as present in certain East African coastal countries, from the eastern Mediterranean to West Africa (including Mali, Mauritania, the Democratic Republic of the Congo, Senegal, Guinea-Bissau, Sierra Leone and Liberia). Its presence in Guinea was therefore very probable. It has been seen twice before in Guinea in the *Parc National du Haut-Niger* and in *Guinée Forestière* (Böhme et al., 2011). This would represent the third observation of this species in Guinea.

The species frequents rivers, lakes and estuaries, often where there is exposed sand or mud banks. It tolerates salt water and it can be found frequently at sea, allowing it to colonize new watersheds (Kasparek, 2001; www.reptile-database.org).

Until recently it was on the IUCN *Red List* as *Critically Endangered* (European Reptile and Amphibian Specialist Group, 1996, category CR C2A). However it has been removed from the list in 2010 because of lack of data on population declines (Shanas et al., 2012).

Map 3-9 Observations of marine turtles during inventories[1]



[1] Hawksbill turtle (blue square); dead green turtle (red triangle) and Nile softshell turtle (orange circle).

Surveys on turtles among the fishermen

In contrast to manatees and crocodiles, most of the interviewees stated that turtles were most commonly encountered in the Rio Nuñez estuary and out at sea rather than in the creeks. The rocky coast along southwest Binari appeared to be the most reliable place to find sea turtles within the Study Area. The status of sea turtles in the creeks and rivers remains unclear due to likely confusion between sea and freshwater turtle species.

3.4.3 Species of concern

The species considered below are those that may be found in the Study Area and that are considered threatened according to the IUCN *Red List*, with the status of *Vulnerable*, *Endangered* or *Critically Endangered*.

3.4.3.1 Marine mammals

The Atlantic humpback dolphin and the West African manatee are both considered to be *Vulnerable*. As mentioned earlier, the presence of these two species in the Study Area was confirmed.

Atlantic humpback dolphin

The Atlantic humpback dolphin, a shy species, is one of the least known species of the Delphinidae. It is usually found at depths of less than 20 m.

The species is found close to shores, in the immediate coastal zone with sand banks, as well as in estuaries fringed with mangrove. It is found in brackish and turbid water with temperatures ranging from 17 °C to 28 °C (Maigret, 1980; Ross et al. 1994 in IUCN, 2013). As with other dolphins of this type, it would feed, among other prey, on fish and cephalopods.

The observations made during this study suggest that there is a regular presence of a population of Atlantic humpback dolphin near the west coast of Taïdi Island.

West African manatee

The West African manatee occupies a variety of marine, brackish water and freshwater ecological niches characterized by relatively warm waters and easy access to food, such as coastal shallow lagoons, bays and estuaries, preferably with water 3 to 4 m deep. It is a strict herbivore and can consume up to 10% of its weight each day. Its food consists of silica-rich vegetation that helps wear its teeth down (Ndour, 2010).

According to Ndour's thesis (Ndour, 2010), the manatee's food is composed of varied aquatic plants (water hyacinths, water lettuce, water lilies, cattails, mangroves, *Paspalum vaginatum*, *Echinochloa* sp.). In the Study Area, mangroves, particularly those in tranquil tidal channels, are probably the main food source of manatees since many of the other plant species they eat are not present because they tend to be more of freshwaters and mangrove are plentiful.

3.4.3.2 Crocodiles

The only species of interest according to the IUCN Red List that might be found in the Study Area is the West African dwarf crocodile since it has been found in similar habitats as in the Study Area, the tidal channels around Kabak Island (prefecture of Forécariah) (Simandou Project, 2013e).

This species lives in burrows during the day and feeds at night. Of course it may be seen during the day, but its activity peak is at night. This little crocodile species generally frequents swamps and riparian forests of the larger watercourses as well as smaller watercourses. During the rainy season, the species disperses to the larger territory that is now accessible to it. In the dry season, it is likely that the dwarf crocodiles seldom go out of their burrows. The species constructs elevated nests during the rainy season, near the watercourses it frequents (Shirley et Eaton, 2012). It feeds on fish, crustaceans and amphibians.

3.4.3.3 Marine turtles

The five species of marine turtles are considered as threatened and all can be found at least offshore from Kamsar. However the green turtle and the hawksbill turtle are recognized as using the coastal habitats off West Africa year-round for feeding, especially along rocky coasts and reefs as on the west coast of Binari Island. Several interviewed fishermen consider it as a good place to see turtles.

The majority of turtles prefer to lay their eggs on sandy beaches without rocks, tree trunks or other material that could affect access or laying.

During the scoping mission the sandy beaches of the western side of Taïgbé and Taïdi islands were visited. They were judged to offer little potential for turtle nesting since during very high tides the majority of the sandy beaches are submerged.

The west shore of Taïgbé Island is subject to strong erosion that reduces even more the available sandy zones. As to the west shore of Taïdi Island, heavy sand sedimentation was observed, in particular on the north side. It is possible that within a more or less long period this part could offer a higher potential for turtle nesting. The southern part of the west shore of Binari Island has long sandy stretches that could offer some potential for turtle nesting. Although these sandy beaches were not inventoried during the fieldwork being outside the Study Area, it is very probable that some turtles nest there, based on the convincing statements of several fishermen interviewed.

The peak of the green turtle nesting in Guinea-Bissau is in August and September, but extends to the whole of the rainy season, or May to October. Occasionally egg laying may occur throughout the year (Fortes *et al*., 1998; Catry *et al*., 2009).

According to observations in the region of Kabak, the peak of the hawksbill turtle nesting is from April to June and again from October to November. For this species also, irregular egg laying may occur throughout the year (Simandou Project, 2013b).

In Guinea-Bissau and Liberia, the peak of the olive ridley is from November to February (Catry *et al*., 2009; LSTP, 2003).

Photo 3-10 West African Nile crocodile

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3.5 Marine fisheries

3.5.1 Introduction

This section deals with a topic that includes biological elements but also social elements. It is thus important to also refer to Chapter 5 of the ESIA.

Fishing constitutes an important socioeconomic pillar in Guinea. Its contribution to the state's revenues in 2004 was of around $US 5,000,000 or 5% of the gross national budget (Sylvain, 2008 in Diallo et al., 2009). Enda (2007 in Diallo et al., 2009) reports that per capita annual consumption was 13 kg in 2005. It was estimated that this could rise to 17% by 2010. Without considering the jobs it creates, it ensures a considerable contribution of animal proteins for the population.

However, according to certain assessments of the fish stocks, for the period 1985 to 1991 the abundance of Guinean demersal marine fish resources have decreased from 30 to 80% according to the species. For the 24 species analyzed (all together) the average captures by scientific fishing have gone from 419 kg / 30 min to less than 200 kg / 30 min during that period (Diallo et al., 2009).

The marine fisheries study took place from November 17 to December 9 2013. The complete report on the fieldwork for marine fisheries is included as an appendix (Annexe 3-3). It concentrated on the frontline artisanal fishing camps and ports (hereafter referred to as C/P) around the access channel to the port of Kamsar, a length of approximately 17 km. This was done in consideration of the possibility that the increase in bauxite extraction rate by CBG might require additional dredging of the channel to deepen and widen it.

Port Néné is the second fishing port in the country in terms of its fishing fleet. However a majority of this fleet, composed primarily of large boats of the *grand yoli* or *grand salan* type, was not considered in the context of this study. These large boats tend to use fishing grounds further out, requiring being at sea for 4 to 5 days, a large crew, motors of over 25 hp, adapted fishing equipment and ice for preserving the fish. Although some of these boats may occasionally fish at the entrance to the channel, it is not their main fishing ground. The study therefore

concentrated on the fleet of little artisanal fishermen, with smaller boats, reduced equipment, with or without motors, and consequently fishing closer to their camps or homeport.

Photo 3-11 Kamsar fishing port

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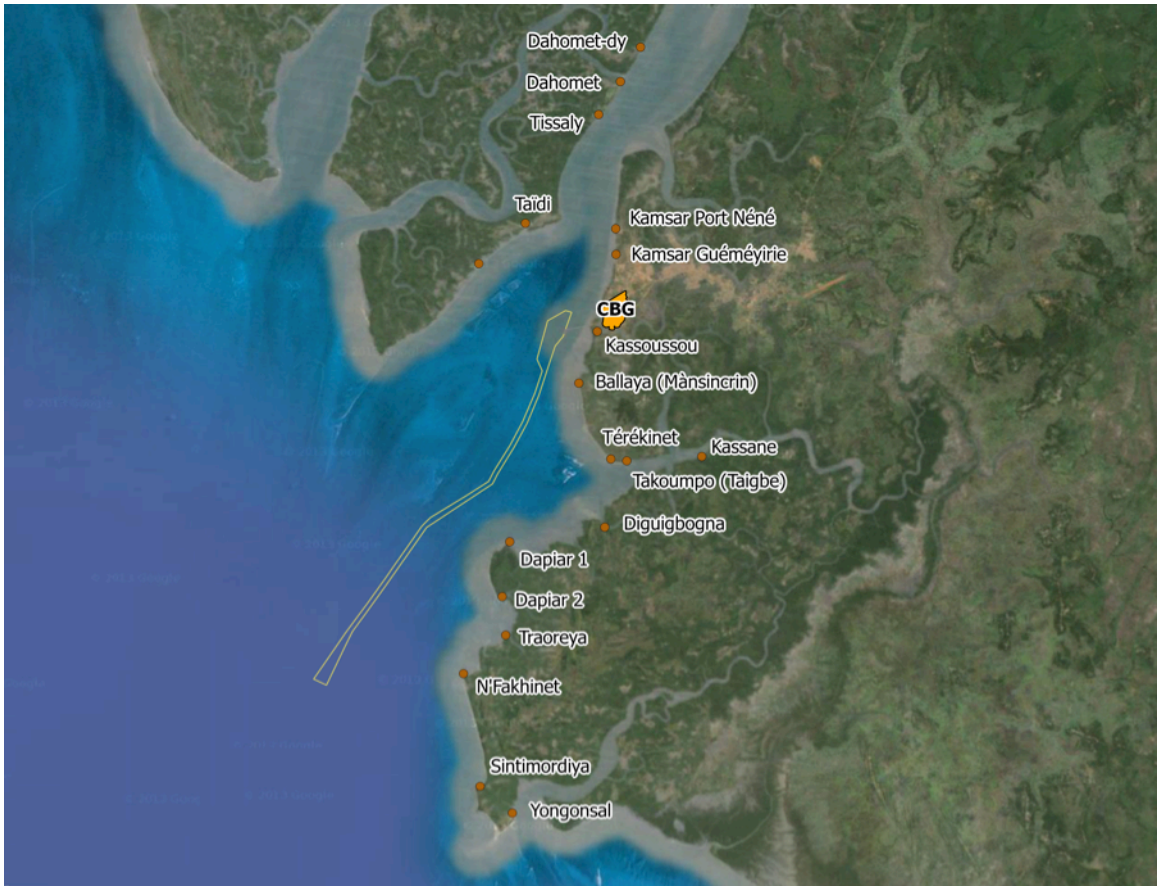
3.5.2 Inventoried sites

Map 3-10 shows the location of the 18 rapidly inventoried fishing camps/ports that are considered to be in the front line of potential fisheries impacts from potential developments in and around the access channel to the CBG quay. It should be noted that there are other fishing camps/ports upstream of Kamsar (Dougoula on the east bank and Dèm Nimpe and Daranta on the west), but time did not permit a visit to them. Also un-visited were any fishing camps/ports west of Taïdi, but un-motorized craft from here are thought unlikely to pass the Lahara-dy (this Susu name means 'near death' in reference to the perils of crossing it when leaving the estuary) or Kilensi spit (indicated by an arrow), to enter into the Rio Nuñez. Motorized boats from these could potentially fish near the entrance to the channel. A final point to note about Map 3-10 is that it is boat-biased and therefore does not show communities where fishing occurs without these.

Map 3-10 Frontline fishing camps/ports around the access channel to the port



3.5.3 Methodology

From November 17 to 23, all the artisanal fishing camps/ports in the area around the channel were visited to obtain basic information from the head of the port, or person responsible for the fishing community (type of boat, number, fishing equipment, etc.). Of these 18 C/P, eight were retained on the basis of their size and their location so as to cover the fishing activities along the channel and upstream and downstream, for a subsequent study from November 25 to December 9. At these eight C/P, the fish caught were identified, weighed and measured, and the fishing zones identified by the use of GPS. The species caught were identified in the field wherever possible. No specimen was kept for later identification.

3.5.4 Results

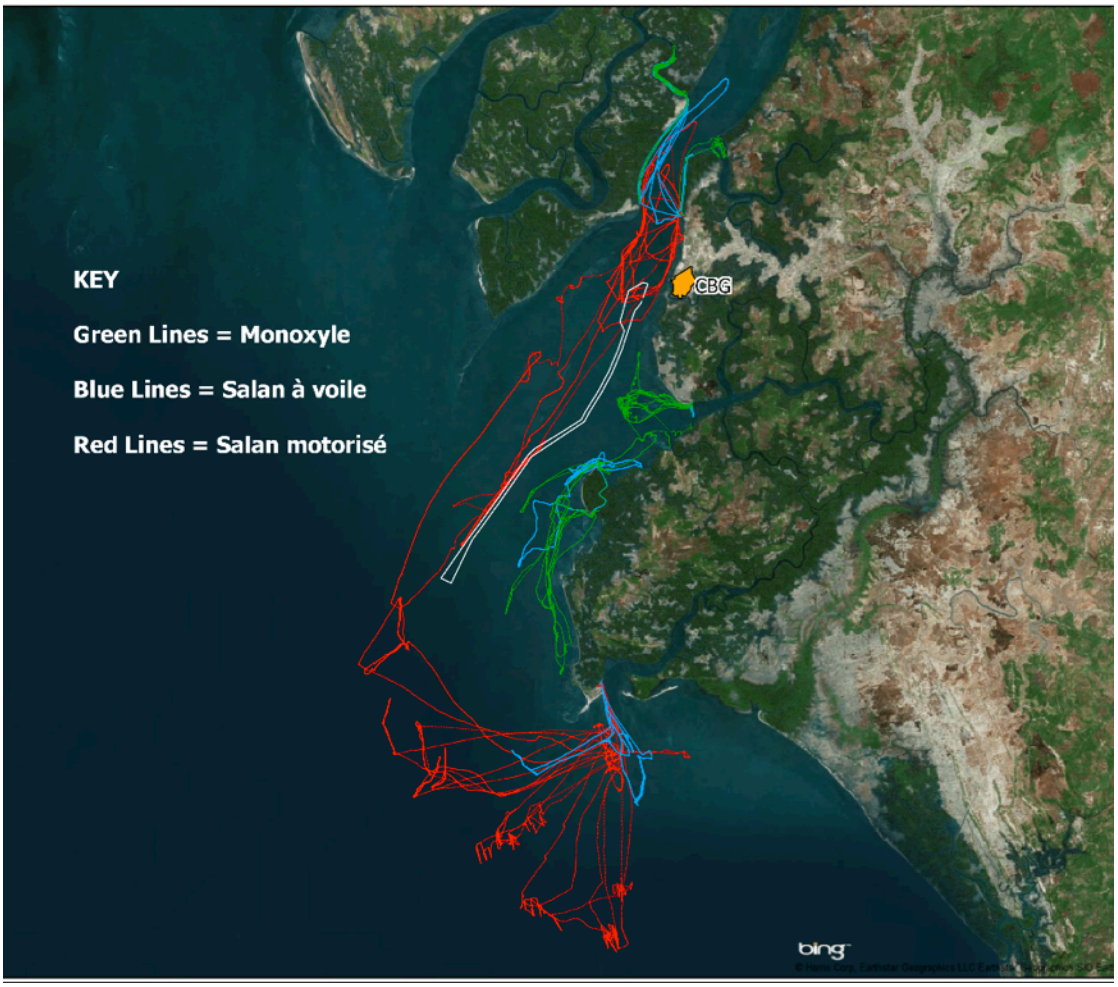
3.5.4.1 Characteristics of the artisanal fleet

As Table 3-5 indicates, there is a great variation between the 18 camps/ports in terms of the size and composition of the resident fishing fleet. A boat's means of propulsion, as well as its size and design, has a significant bearing on where and for how long it can be taken fishing. Map 3-11 illustrates how spatial fishing strategies can vary according to the type of craft used. Though the data in Table 3-5 for the monoxyle fleet does not differentiate between those that can or can't be rigged with a sail, the GPS tracking data (Map 3-11) suggests, at least during the short period of the study, that the unmotorized-craft (*monoxyle* and *salan à voile*) operate much closer to their ports than the motorized ones. At Yongonsal this is easy to discern where the tracked motorized craft went out approximately double the distance offshore (up to 13 km) compared to the tracked craft under sail. Though sail and paddle-powered craft could exploit more distant grounds, a key consideration shaping all fishing strategies is time. None, or very few, of the fleet that are the focus of this study are thought to carry ice boxes, therefore there is a need to balance fishing time with fish decay rates and travel time back to port/camp. Motorized craft have a clear distance-time advantage over non-motorized craft, but this comes with increased investment and operating costs.

Table 3-5 Characteristics of the resident, inshore artisanal fishing fleet in the 18 front line fishing camps/ports

Port/Camp (débarcadère) from North to South	**TYPE OF CRAFT**			
	Dugouts (monoxyles)	**Salan à voile**	**Salan motorisé**	**Total**
Dahomey-dy	3	3	-	**6**
Dahomey	7	18	-	**25**
Tissali	13	-	-	**13**
Taïdi	5	21	4	**30**
Kamsar Port Néné	15	20	16	**51**
Kamsar Guèmèyiré	2	6	32	**40**
Kassoussou	5	-	4	**9**
Ballaya (Mémsingrin)	4	-	-	**4**
Térékiné	1	-	-	**1**
Tokoumpou (Taïgbé)	22	2	-	**24**
Kassane	8	-	-	**8**
Diguigbogna	4	-	1	**5**
Dapiar 1	4	3	3	**10**
Dapiar 2	7	3	-	**10**
Trawalia	5	-	-	**5**
N'Fakhiné	1	7	-	**8**
Sintamodiya	1	2	-	**3**
Yongonsal	2	5	20	**27**
TOTALS	**109**	**94**	**76**	**279**

Map 3-11 GPS tracks of 59 fishing trips out of 8 front line fishing camps/ports around the access channel between 25th November and 10th December 2013



An important characteristic of fishing activity around the channel is the variable nature of the fishing population. Table 3-6 provides some complementary information, albeit very preliminary, to Table 3-5 on the migrant fishing populations who frequent 16 of the 18 front line camps/ports. Map 3-11 indicates several of the locations where these migrant fishermen come from. Detailed research would undoubtedly add more places.

Table 3-6 hints at the diversity of the strategies of these migrant fishermen. Some movements are very local and short term, e.g. just crossing the river to fish the

neap tides twice a lunar month, or local and longer term, such as the numerous reported movements between the 16 camps/ports. Many, but not all migrations follow a seasonal pattern and are especially notable during the dry season, when fishing conditions are better. In some instances, the timing of dry season movements is also dependent on the rice-farming calendar since some of the fishermen are also rice farmers. There is also a very significant movement of fishermen downstream at the end of the rainy season that is linked to the river discharge and the location of the saline water that target fish follow. In short, the number of fishing boats which exploit the fisheries under review is probably more than double the estimated resident fleet (279) and whilst a great deal remains to be known about all the fisher stakeholders, this is especially true for the less visible but very significant migrant group.

Assuming that the average crew of a *monoxyle* or a *salan à voile* is two persons and of a motorized *salan* three, there would therefore be (109 x 2) + (94 x 2) + (76 x 3), or 634 resident fishermen in the 18 C/P, without counting the migrant fishermen that could swell this figure, conservatively, to around 800 fishermen.

Table 3-6 Migrant fishers summaries for the 18 front line fishing camps/ports

Port/Camp	Resident Fleet Size	Migrant Fishers
Dahomet-dy	6	Sept-Nov, c. 60 boats from upstream, come down during peak river flow to get the salty water where the fish are.
Dahomet	25	Aug-Nov, c. 100 boats from upstream. Also *bimbinyi* fishermen who come over from Kamsar during neap tides (twice every lunar month, which are called *bimbinyi*) and lodge there.
Tissaly	13	20-30 from upstream in same period as above.
Taïdi	30	Don't come to the village but to one of the six camps on their islands. Come from places up the Tinguilinta such as Katougouma, Bogoriya, Rapas, Dougoula, Katongoro
Kamsar Port Néné	51	Not asked but known to frequent this port

Kamsar Guèmèyiré	**40**	More than 100 boats come from Koukoude, Kapchek, Yongonsal as well as from nearby places
Kassoussou	**9**	Can double number of boats, from March to May. Come from Dahomet after the rice harvest (which ends Jan-Feb) and before the sea gets agitated in the rains (June). Also from Kamsar & Dapiar
Ballaya (Mémsingrin)	**4**	Come from Kamsar, Taïgbé & Dapiar for 2-3 months from December to February
Tèrékiné	**1**	None: occasional overnighters only
Takoumpo (Taïgbé)	**24**	More than 20 come in dry season (Dec-May) from Kaleyiré, N'Tiébé, Kaloum, Kassane & Kamsar. All monoxyle except some salan à voile from Kamsar.
Kassane	**8**	From Kamsar, Yongonsal, N'Fakhinè. The number of boats normally found here can double for 3 months
Diguigbogna	**5**	After the rice harvest from Taïgbé, Kamsar, Kassane, Koufin until the beginning of the rains. Only with monoxyle.
Dapiar 1	**10**	A couple of boats often come from Boffa and Koukouba for six months. Also a few monoxyles come from Kamsar.
Dapiar 2	**10**	From Kamsar and the islands (Tamouya, Bintimodia, Taïgbé) from 2 weeks to 3 months
Trawalia	**5**	From Feb-March, from Kawass, Gbogonia, Kakouss, Bigori, Koukouba, all monoxle after rice harvest
N'Fakhiné	**8**	From Kamsar & Yongonsal
Sintimordiya	**3**	No migrants, just those on transit for a few days if they need drinking water etc.
Yongonsal	**27**	From Kamsar, Kondeyiré, Bongolon, Koukoudé who work with the collectors (societies). They can come any time.

Map 3-12 Origins of some of the migrant fishermen who fish around the access channel

Photo 3-12 Villagers with net

3.5.4.2 Characteristics of the fishing equipment

Before, up to the beginning of the 19th century, Guineans, Baga and Nalou among others, carried out subsistence fishing from the shore, sometimes with *monoxyles*, with simple and inexpensive equipment. They used cast nets, lines and fixed gill nets in the tidal channels. The arrival of the Susus and migrant fishermen led to the development towards the 1930s of much more productive fishing techniques such as driftnets (Diallo et al., 2009).

A range of fishing gears is employed around the channel. Following the FAO classification (Nédélec & Prado, 1990) these can be categorized as follows.

Seine nets

Boat seines

These double stick nets are called *sèki yèlè* (and sometimes *bendounyi)* in Susu and are employed in shallow water, generally by two operators, but one man operation is possible, with one person remaining with the boat, typically, a small un-motorized dugout or salan, and the other taking one stick end out to encircle the fish. Mesh

sizes are in the 20-25mm range. These nets are employed in shallow waters at specific times in the tide cycle.

Lift nets

Portable lift nets

According to Bouju & Chavance, (2000: 251) the classic circular scoop net used by women in Guinea is called the *tètè yèlè* in Susu or *yalan y tètèno y'alop* in Baga. This was seen at Taïdi but was probably under-reported elsewhere. Another type of lift net was seen at Yongonsal village (west of the fishing camp of this name) and consisted of a small meshed rectangular net circa 2.5 x 2.5 m held between two wooden poles. Two women operate this and the fish scooped out of the center with a calabash. As with the preceding gear, lift nets are employed in shallow water at specific times in the tide cycle.

Falling gear

Cast nets

They were only reported at Kassane but may have been under-reported elsewhere. They can be deployed from a boat or on-foot, with the latter method often being dependent on specific times in the tide cycle. The widespread Guinean name for these nets is a corruption of their English name, *kassi nété*.

Gillnets and entangling nets

Set or anchored gillnets

Though often called the *légotine*, a variety of other Susu names exist for these nets, depending on their mesh sizes and target species, e.g. *bobo yèlè* and *yangban.* As well as the mesh sizes these nets are arranged in a variety of lengths (200 to 1600m) and heights (2-7m) depending on both the intended fishing zone and the financial means of the operator. When set they are anchored to the bottom and their location marked by buoys to aid the fishermen locate them when he returns to the fishing area.

Drifting gillnets or driftnets

According to Bouju & Chavance, (2000), this is the most common gear used along the Guinean coast and though used essentially for capturing the much sought after *bonga* (*Ethmalosa fimbriata*), it also catches other small pelagic species. It has different names in Guinea such as *founfounyi, bonga yèlè* and *fèlè fèlè* with any differences probably down to mesh size. These nets are found arranged in a variety of lengths (200-900 m) and heights (2-4 m) according to the owner's means and the size of the boat to transport them. They are operated as floating nets that drift along with the tide or current. The GPS tracking shows drifts of over 10 km long.

Encircling gillnets

Two types of encircling nets are used around the Rio Nuñez estuary with the difference between them being their mesh sizes and consequently the target species they are used for: *boboè yèlè* for the bobo croaker (*Pseudotolithus elongatus)* and *bonga yèlè* for the *bonga* (*Ethmalosa fimbriata*). They are used in lengths between 200-800 m with a net height in the 6 to 12m range.

Fixed gillnets on stakes

Fixed gillnets, known as *bambanyi* in Susu, can be seen deployed across many entrances to tidal channels. They are perhaps more a subsistence orientated fishing method of the indigenous farming population than a commercially orientated gear.

Traps

Pots were not reported but were seen at Taïgbé and Taïdi and are probably used mainly by women from the local farming population to get small fish for subsistence purposes in the watercourses and channels that criss-cross the local mangroves and rice fields.

Hooks and lines

Set longlines

According to Bouju & Chavance, (2000), the *dalbane* is the second most widely using fishing gear in Guinea after the drift net. It is an anchored line with baited hooks (from 600 to 1,500). The need to bait the hooks means that fishermen using longlines have to fish for their bait or obtain it before installing the line.

Table 3-7 presents a summary of the fishing equipment used in the 18 C/P.

Table 3-7 Summary of fishing gear used in the 18 frontline fishing camps/ports[1]

Fishing gear category	Dd	Dh	Ti	Td	Kn	Kg	Ks	Ba	Te	Tb	Ka	Dg	D1	D2	Tr	NF	Si	Yg
Boat seines					x					x			x	x			x	
Portable lift nets				x														x
Cast nets				x							x	x						
Set gillnets (anchored)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Driting gillnets	x	x	x	x	x	x	x	x		x	x	x	x					x
Encircling gillnets	x	x		x	x	x	x	x					x		x			
Fixed gillnets	x	x			x	x		x		x	x	x	x					
Pots				x						x								
Set longlines	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

[1] Fishing Port/Camp Codes Listed in approximate order from upstream to the estuary mouth: Dd = Dahomey-dy, Dh = Dahomey, Ti = Tissali, Td = Taïdi, KN = Kamsar Port Néné, KG = Kamsar Guèmèyiré, Ks = Kassoussou, Ba =

Ballaya (Mémsingrin), Te = Tèrèkiné, Tb = Tokoumpou (Taïgbé), Ka = Kassane, Dg = Diguigbogna, D1 = Dapiar 1, D2 = Dapiar 2, Tr = Trawalia, NF = N'Fakhinè, Si = Sintamodiya and Yg = Yongonsal.

3.5.4.3 Fishing zones and use patterns

Fishermen from a particular camp or port fish depend on a variety of factors such as the gear(s) they intend to deploy, the fish they are after, the weather, tide, currents, crowding from other fishers, type and propulsion of their craft and local knowledge. Mostly, but not always, fishermen sell their catch at the place they set out from, so fishing activity tends to take place within a certain radius of their home port/camp. The exception to this is where fishing might be orientated closer to a more favorable market than the departure point, such as Kamsar.

As discussed above, fishing distances are notably shaped by propulsion and travel time/catch spoilage considerations. Motorized craft are part of the resident fleet in just 6 out of the 18 front line camps/ports (Table 3-5), and are only a significant portion in three of these (Yongonsal and the two Kamsar ports). The largest reported fishing area from a single port/camp is, not surprisingly given the limited water area in the vicinity, the one with the largest fleet, Port Néné, where fishing was said to take place between Bateau Gare (Map 3-13) and Kafarandé, which is 7 km upstream from Sourigbé Island

Map 3-13 Major fishing zones of the front line fishing camps/ports around the channel

Although Map 3-13 indicates neatly demarcated named fishing grounds, it is important to appreciate that for most grounds, where one ground begins and another ends varies according to individual perceptions. Most fishing grounds are named in relation to a land or seamark or a geographical feature of the location. The access channel and associated infrastructure has provided a notable number of these names, starting with the conveyor belt (Pont 10), then a warning beacon on a sand bank (Plaque), to the various marker buoys along the channel (2, 3 & 4 *bouées*) and finishing with the area where boats wait for the pilot to take them into the channel (Bateau Gare). Bateau Kobi refers to a boat that ran aground in 1970 and is still visible.

The overlap shown in Map 3-13 between Bateau Gare and Bateau Kobi is underpinned by data from the GPS tracking which shows fishermen using both names for this area, and this is probably a widespread phenomena. Several named fishing grounds are not directly shown on Map 3-13 because they refer simply to an area opposite a known place on the shore, or because they refer to areas that are too large (fishing in the channel) to correspond to areas they can reach with their boat or area too imprecise to map (fishing near the rock). It should also be understood that a majority of fishermen cannot interpret a marine chart and define on it their fishing area.

Certain names used by fishermen are clear. The *latara* fishing grounds refer to the tidal flats exposed at low tide. The pale green areas in Map 4 show the major areas exposed at low tide according to the British Admiralty Chart 1562 (Port Kamsar and Approaches). Even if the limits to these zones can vary slightly according to the cycle of the tides, the intertidal zones are still better mapped than the offshore fishing areas. It should be noted however that the latest version of the 1562 marine chart dates from 1997 and that, since then, erosion and sedimentation may have changed the contours of the exposed zones.

3.5.4.4 Seasonal use of the fishing zones

Fishermen around the Rio Nuñez Estuary, as they do elsewhere along the Guinean coast, generally divide the year into five seasons, which correspond to the following months of the Gregorian calendar:

- *Libiti*: December to January
- *Dentè foyé*: February to April
- *Yèmè sodè*: May to June
- *Yèmè tagui*: July to August
- *Naraba*: September to November

Although the best fishing season is generally considered to be *libiti* followed by *yèmè sodè,* time did not permit much information to be gained on how seasonal

conditions affect the use of the different fishing zones. Fishermen at Kamsar Port Néné reported only occasional use of their seaward grounds from February to August because of the prevalence of choppy waters, powerful currents, strong offshore winds and tornadoes in this period. How and where people at the seaward camps/ports fish during this periods is unknown, it may simply be less often (with diversification into other livelihood activities), more inshore and perhaps making greater use of the channels and more upstream in the Rio Nuñez Estuary, as may be the case for all of the C/P.

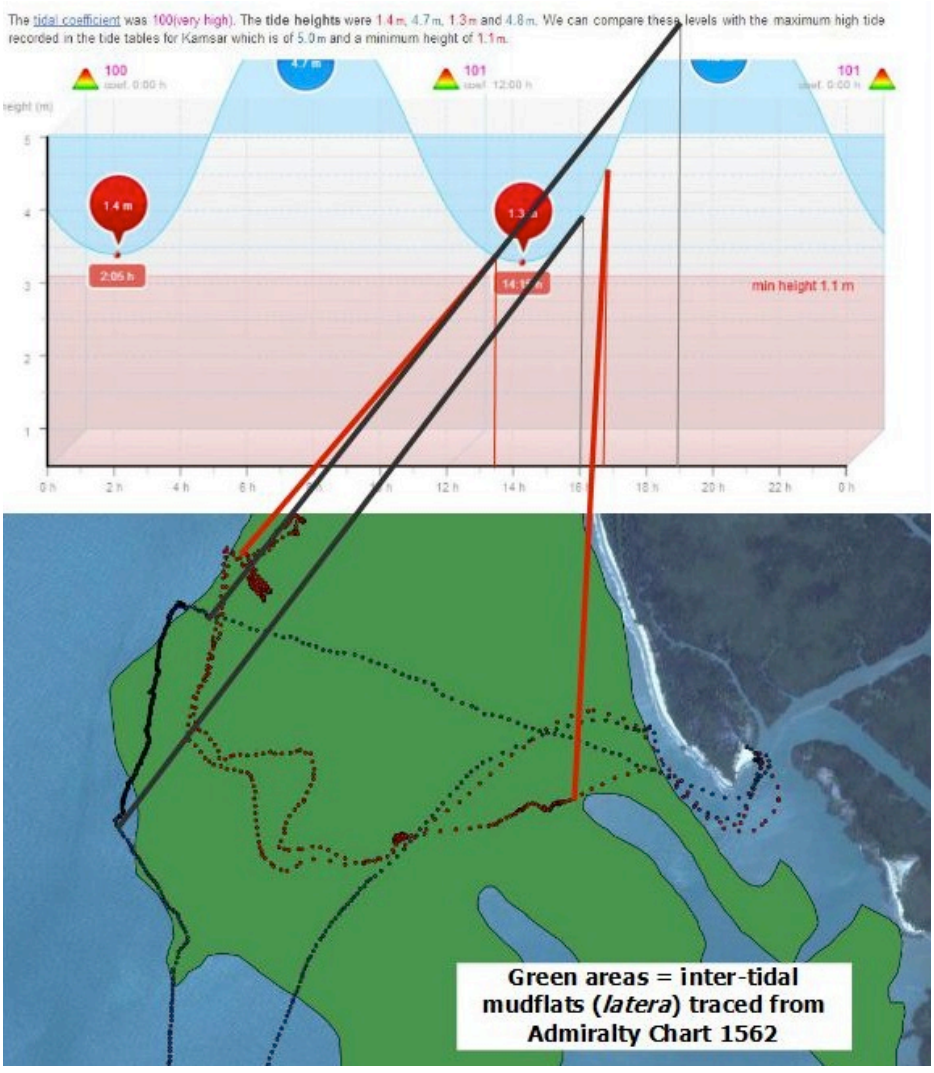
Tidal use patterns

The tide cycle has a very significant bearing on fishing patterns on a variety of levels. At the most basic it determines when craft can actually get into the water in the majority of camps/ports. It can also have a strong influence on routes taken to particular destinations: if the timing is wrong, certain places may be inaccessible or require more time, paddling effort or fuel.

Figure 3-1 shows, based on GPS data linked to the tidal cycle how certain fishermen from Dapiar 2 fish in the intertidal zone.

Figure 3-1 An example of temporal partitioning of a fishing ground: Dapiar 2 *latera*, 2nd December 2013

Trip & gear in zone shown	Start fishing	End fishing	Time back
D20602: Benbounyi: boat seine	**13:38:27**	**16:48:20**	**17:01:40**
D20901: Dalban: longlines	**16:01:51**	**18:48:09**	**19:21:59**



At 13:38, the craft with the red tracks started boat seining (*benbounyi)* at the edge of the *latera* at virtually the lowest point of the tide and then worked its way back closer to shore, as the tide gradually rose, before finishing fishing around 16:48, by which time the tide had risen about 1m, which is significant given that this fishing method requires wading in water. The rising tide which forced the retreat of the *benbounyi* boat from the edge of the *latera* enabled around 16:00 hrs. a second boat (black tracks) to set longlines on the same edge about 2 hours and 20 minutes later. What is also interesting to note about this longline trip is that the fishermen in question had on the same low tide, been boat seining on his own on the *latera* near N'Fakhiné in order to get his bait.

Fish are known to make tidal migrations in tropical environments (Krumme, 2009) and this hasn't gone unnoticed by fishermen in the markedly tidal Rio Nuñez estuary, particularly the changes that occur during the neap-spring cycle.

This tide cycle essential follows the lunar cycle, but usually with a delay of one or two days. On spring tides (*grande marée)*, which occur approximately around the full and new moons, tidal ranges and current speeds reach a maximum and at this time though the fishermen are impeded from going far. It is said to be a good period at least at the beginning to catch the much sought after sea catfishes (*Arius* spp.) with *dalbane* (longlines). Conversely, during neap tides (*marée de morte-eau*), which occur approximately around the waxing and waning of the moon, tidal ranges are significantly reduced and current speeds are much weaker. At this time, fishermen can travel further on their trips and it is said to be a good period to catch fish such as the desirable Bonga (*Ethmalosa fimbriata*) with drift nets.

Clearly not all fishermen are able or willing to change between the two supposedly ideal gears for each tidal phase, and a variety of factors are likely to intervene in their choices, including the nature of their boats, its means of propulsion and the fishing equipment available. It also does not mean that using this equipment outside of these precise periods does not lead to good catches.

3.5.4.5 Exploited species

Table 3-8 provides a first list of 21 identified fish species from the sub-sample of 8 fishing camps/ports around the channel where GPS tracking was attempted. Of course if a species was captured in any given C/P, it is probable that it would be present in other C/Ps. Several other species are undoubtedly present in the Study Area, although they were not captured in the context of the surveys. They might for example be present at other times of the year or be present inn other habitats not fished. There are also fluctuations in the physical and chemical parameters with time in the estuary (salinity, suspended matter, currents, etc.) and the interactions between the species present. It should also be noted that some fish were only identified to the genus level (seven genera – see Table 3-9).

To put these results in perspective, 102 species were found in the Fatala Estuary (Baran, 1995). However, that study, of a one-year duration, targeted spatial and temporal variations of species populations present in the estuary based on a fishing protocol that remained the same over time and space and on a standardized fishing effort.

The French names for the fish species in Table 3-8 were taken particularly from the report on marine and coastal biodiversity (Bah, year not specified).

Table 3-8 Species identified in eight fishing camps/ports

Latin name	Local name	French name	Dh	Td	KN	KG	Tb	D1	D2	Yg
Brachydeuterus auritus *	Bobo	Lippu pelon		x			x			
Chloroscombrus chrysurus *	Kotomoni	Sapater				x				
Drepane africana *	Debelenyi	Forgeron ailé					x	x	x	
Epinephelus guaza EN *	Thiof	Mérou noir								x
Ethmalosa fimbriata *	Bonga	Ethmalose d'Afrique	x	x	x				x	
Galeoides decadactylus *	Sanis	Petit capitaine	x				x	x		x
Ilisha africana *	Lati	Alose rasoir	x				x	x	x	
Lobotes surinamensis	Bintigbé ou Toki	Croupia roche				x				x
Pentanemus quinquarius *	Gbalakassa	Capitaine royal			x			x		
Polydactylus quadrifilis *	Soori	Gros capitaine		x						x
Pseudotolithus brachygnathus *	Fouta	Courbine gabo	x	x	x		x	x	x	x
Pseudotolithus elongatus *	Boboè	Otolithe bobo	x	x	x		x	x	x	

Latin name	Local name	French name	Dh	Td	KN	KG	Tb	D1	D2	Yg
Pseudotolithus epipercus *	Boboé foré	Otolithe guinéen					x	x	x	x
Rhinobatos cemiculus EN	Mateki	Guitare de mer fouisseuse					x	x		x
Rhinoptera marginata NT	Barounkou	Mourine échancrée						x		
Sardinella maderensis *	Bonga séri	Grande allache	x			x				
Scomber japonicas *	Makreni	Maquereau espagnol						x		x
Sphyraena barracuda *	Kouta	Grand barracuda	x					x		
Trachinotus maxillosus *	Kawré	Pompaneau chevron				x		x		x
Trichiurus lepturus *	Pani yékhé	Poisson-sabre	x	x	x	x	x	x		
Tylosurus crocodilus	Simbè yékhé	Aiguille crocodile	x				x			

Camp/port codes follow Table 3-7.

Red fill indicates IUCN *Endangered* species and orange fill indicates a *Near Threathened* species.

Table 3-9 presents fish caught in the boats monitored that were identified only to the genus level. In several cases the Susu name given to a fish may cover more than one species. For example *fagba* can just as well be *Cynoglossus monodi* as *Cynoglossus senegalensis* or again *sossoé* may be *Pseudotolithus senegalensis* or *Pseudotolithus typus*.

Table 3-9 Fish identified only to the genus level

Latin name	Local name	French name	Dh	Td	KN	KG	Tb	D1	D2	Yg
Arius spp.	Konkoé	Mâchoirons	x	x		x		x	x	x
Cynoglossus spp.	Fagba	Soles					x	x	x	
Liza spp.	Seki	Mulets	x	x	x	x	x	x	x	
Pamadasys spp.	Kessi kessi	Grondeurs	x						x	x
Pseudotolithus spp.	Sossoé	Otolithes	x				x	x		x
Sardinella spp.	Bonga sèri	Allaches	x			x				
Lutjanus spp.	Woli	Carpes rouges								x
Tilapia spp.	Khobè	Tilapias	x							

Camp/port codes follow Table 3-7.

A subsample of the fish caught by the fishermen followed by GPS in the eight C/P was analyzed. The weight and length of the species caught in these subsamples were noted and Table 3-10 presents these results.

Table 3-10 Weights and length of fish specimens in a subsample of from the eight C/P

Species	Total weight of the subsample (kg)	Number of fish	Average weight (kg)	Minimum and maximum lengths (cm)	Average length (cm)
Brachydeuterus auritus	1.4	27	0.05	7 to 14	11.11
Chloroscombrus chrysurus	0.5	3	0.17	14 to 16	15.00
Drepane africana	9.9	11	0.90	14 to 38	23.36
Epinephelus guaza	2	2	1	39 to 40	39.50
Ethmalosa fimbriata	261.6	1 741	0.15	6 to 25	17.77
Galéoides decadactylus	34	104	0.33	9 to 41	19.42
Ilisha africana	1	40	0.03	4 to 19	11.50
Lobotes surinamensis	3.7	3	1.23	28 to 40	35.33
Pentanemus quinquarius	1.6	5	0.32	10 to 18	13.00
Polydactylus quadrifilis	110.5	10	11.05	47 to 145	85.91
Pseudotolithus brachygnathus	164.5	102	1.61	16 to 77	42.17
Pseudotolithus epipercus	21.2	31	0.68	10 to 60	22.36
Pseudotolithus elongatus	163.8	387	0.42	7 to 47	27.36
Rhinobatos cemiculus	31	8	3.88	51 to 130	88.50

Species	Total weight of the subsample (kg)	Number of fish	Average weight (kg)	Minimum and maximum lengths (cm)	Average length (cm)
Rhinoptera marginata	6.1	3	2.03	21 to 67	36.67
Scomber japonicus	9.2	5	1.84	26 to 72	46.17
Sphyraena barracuda	3.1	4	0.78	36 to 72	61.50
Trachinotus maxillosus	46	15	3.07	42 to 78	66.00
TrIchiurus lepturus	11	50	0.22	10 to 84	65.24
Tylosurus crocodilus	1.1	2	0.55	37 to 70	53.50

Sidibé et al. (2002 in Diallo et al. 2009) report that the size of the caught *Galeoides decadactylus* for a few years of data (1995-1999), artisanal and commercial fishing combined, varied from 4 to 46 cm. For *Pseudotolithus elongatus* it varied from 4 to 54 cm. These size data are similar to those found in the present study.

In addition, Diallo et al. (2008 in Diallo et al. 2009) give the average lengths for fish landings from artisanal fishermen for the years 2005 to 2008. The average length for *Galeoides decadactylus* is 15.25 cm and 15.29 for *Drepane africana*. In the context of this study, the average lengths for these two species are 19.42 cm and 23.36 cm respectively (Table 3-10).

3.5.4.6 Mollusks

In addition to the fish identified above, three species of shellfish gathered in some of the subset of camps/ports visited for the tracking studies have been identified.

These are the mangrove oyster (*Crassostrea gasar*), the heavy African ark (*Senilia senilis*) and the giant hairy melongena (*Pugilina morio*). These data must be considered preliminary as just up the coast on Tristão Island, Doumbouya (2010) conducted a detailed survey of edible mollusks and identified six species of bivalves and seven species of gastropods that were exploited. He reports that shellfish from Tristão are sold at Kamsar (and Boké), which suggest strong local demand.

According to the surveys in the Study Areas, molluscs are gathered mainly by women, often for subsistence use or as a complimentary food source, which seems in contradiction with the preceding, in view of the strong local demand. It is known that the captures by the villagers of Kassoussou, close to the CBG plant, are sold to employees. These data are preliminary and do not allow further interpretation.

3.5.5 Species of concern

3.5.5.1 Fish

Among the species identified as the landings in the eight C/Ps (Table 3-8), two species are on the IUCN *Red List* as threatened species, the dusky gouper (*Epinephelus marginatus syn. E. guaza*) and the blachin guitarfish (*Glaucostegus cemiculus syn. Rhinobatos cemiculus*), both of *Endangered* status. One species, the Lusitanian cownose ray (*Rhinoptera marginata*) is considered *Near Threatened* (IUCN 2013).

Apart from *Lobotes surinamensis*, all the species listed in Table 3-8 are considered threatened in Guinea (Bah et al., 1997), because of their general over-exploitation (Diallo et al., 2009).

The daisy stingray (*Dasyatis margarita*) and the scalloped hammerhead (*Sphyrna lewini*), two species considered *Endangered* (UICN, 2013), were seen respectively at Yongosal and at Port Néné. However it is not known where they were captured. They are considered threatened at the national level (Bah et al., 1997).

Dusky grouper (Endangered)

Among the fish caught in boats followed by GPS two individuals of this species were idnetifed at Yongonsal, each weighing one kg and about 40 cm in size (Table 3-10). The tracking of the boat involved (Map 3-14) gives an indication of the area of their capture.

The species is found in the eastern Atlantic (north, center and south), the southwest Atlantic, the western part of the Indian Ocean, the Mediterranean and the Black Sea. It frequents rocky habitats at a depth of between 8 and 300 m (Cornish, A. and Harmelin-Vivien, M., 2004).

The depths used by the species depend on the age of the fish, the youngest are limited to the less deep zone close to shore and the older ones can occupy the whole of the continental shelf. Young fish of more than one year (length between 13 and 40 cm) generally are found at depths of less than 15 m (Harmelin, J.-G. and Harmelin-Vivien, M., 1999).

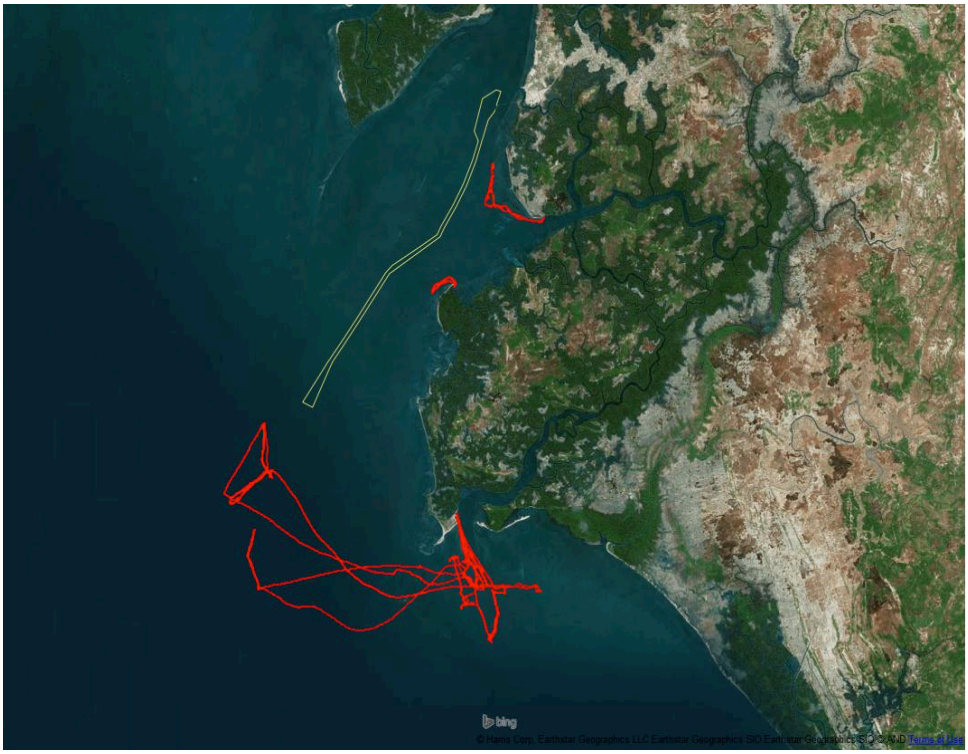
They feed mainly on crab and octopus, the larger individuals taking a larger proportion of fish associated with rocky habitats (www.fishbase.org).

Map 3-14 Tracks of boats that caught dusky grouper

Blackchin guitarfish (Endangered)

Among the boats tracked by GPS, eight individuals of this species were identified at Taïgbé, Dapiar 1 and Yongonsal (Table 3-8). The average weight was 5.88 kg and the length varied from 51 to 130 cm (Table 3-10). The tracking of the boats by GPS give an indication of the possible capture locations (Map 3-15).

Map 3-15 Tracks of boats that caught blackchin guitarfish



The species is found in the Mediterranean and in the Atlantic (from Portugal in the north to Angola). It is a demersal species that frequents marine and bracksih waters, close to a sandy or muddy bottom to depths reaching 100 m. It gives birth between September and October off of sandy or muddy shores. It is therefore particularly vulnerable at this time (Notarbartolo di Sciara et al., 2007).

According to fishermen surveys individuals of this species, the young in particular, are abundant in the landings at Port Néné in December and January. At Dapiar it is reported abundant year-round.

Lusitanian cownose ray (Near Threatened)

Among the boats tracked by GPS, three individuals of this species were identified at Dapiar 1, with an average weight of a little more than 2 kg and a length beteen 21 and 67 cm (Table 3-10). The tracking of the boats by GPS give an indication of the possible capture locations (Map 3-16).

There is little information about this species found in the central eastern Atlantic and the Mediterranean. The species is more common in shallow waters of the continental shelf (around 30 m depth where fishing pressure is strong) but can be found at depths to 100 m (Notarbartolo di Sciara et al., 2009). It feeds near the bottom capturing molluscs, crustaceans and fish (www.fishbase.org). According to fishermen surveys individuals of this species, in particular the young, are abundant in the landings at Port Néné in December and January.

Map 3-16 Tracks of boats that caught Lusitanian cownose ray

Daisy stingray (Endangered)

Although this species was not captured by one of the boats with GPS tracking, it is possible that this species is present close to the channel given the habitats it is known to frequent. This species is found on sandy and sandy-clayey bottoms , from the shore to depths of about 60 m and lagoons. It is captured with beach seines (Seret, 2011).

This species can be confused with the pearl stingray (*Dyasatis margaritella*) that occupies the same habitats but is smaller and more common in coastal waters. This species is listed as *Data Deficient* by the IUCN (2013).

Both species have a distribution roughly similar to the blackchin guitarfish.

Scalloped hammerhead (Endangered)

This is a circumglobal species whose presence is confirmed in the eastern Atlantic (Mauritania, Senegal, Gambia, Guinea Bissau, Guinea, Sierra Leone, Ivory Coast, Gabon and Congo). This coastal and semi-oceanic pelagic shark is found from the intertidal zone to a depth of at least 275 m. The young tend to stay in coastal zones, close to the bottom where the fishing pressure is strong (Baum et al., 2007).

Mollusks

None of the three species of mollusks is considered threatened by the IUCN and none is on the national list.

3.6 Freshwater fish and macroinvertebrates

3.6.1 Introduction

Freshwater ecology inventories of fish and macroinvertebrates were undertaken in the Sangarédi Study Area between November 17 and December 7, 2013. In total, 38 sites were studied, split between the two watersheds of the area studies: that of the Cogon River (17 sites) and that of the Tinguilinta River (21 sites).

The inventories enabled the identification of 58 species of fish, including two considered *Endangered* and two considered *Vulnerable* according to the IUCN criteria, and three species endemic to Guinea.

As for the freshwater marcoinvertebrates, 105 taxa at the generic and specific level were identified, dominated by insects. None of these taxa are of particular conservation interest.

3.6.2 Inventoried sites

Map 3-17 shows the location of the 38 sites inventoried in the Study Area.

Table 3-11 shows the watersheds in which the studied watercourses lie and the geographic coordinates of the 38 sites, 11 in the Cogon watershed and 21 in the Tinguilinta.

Photo 3-13 Measurment of physical and chemical parameters

Map 3-17 Aquatic ecology sampling points

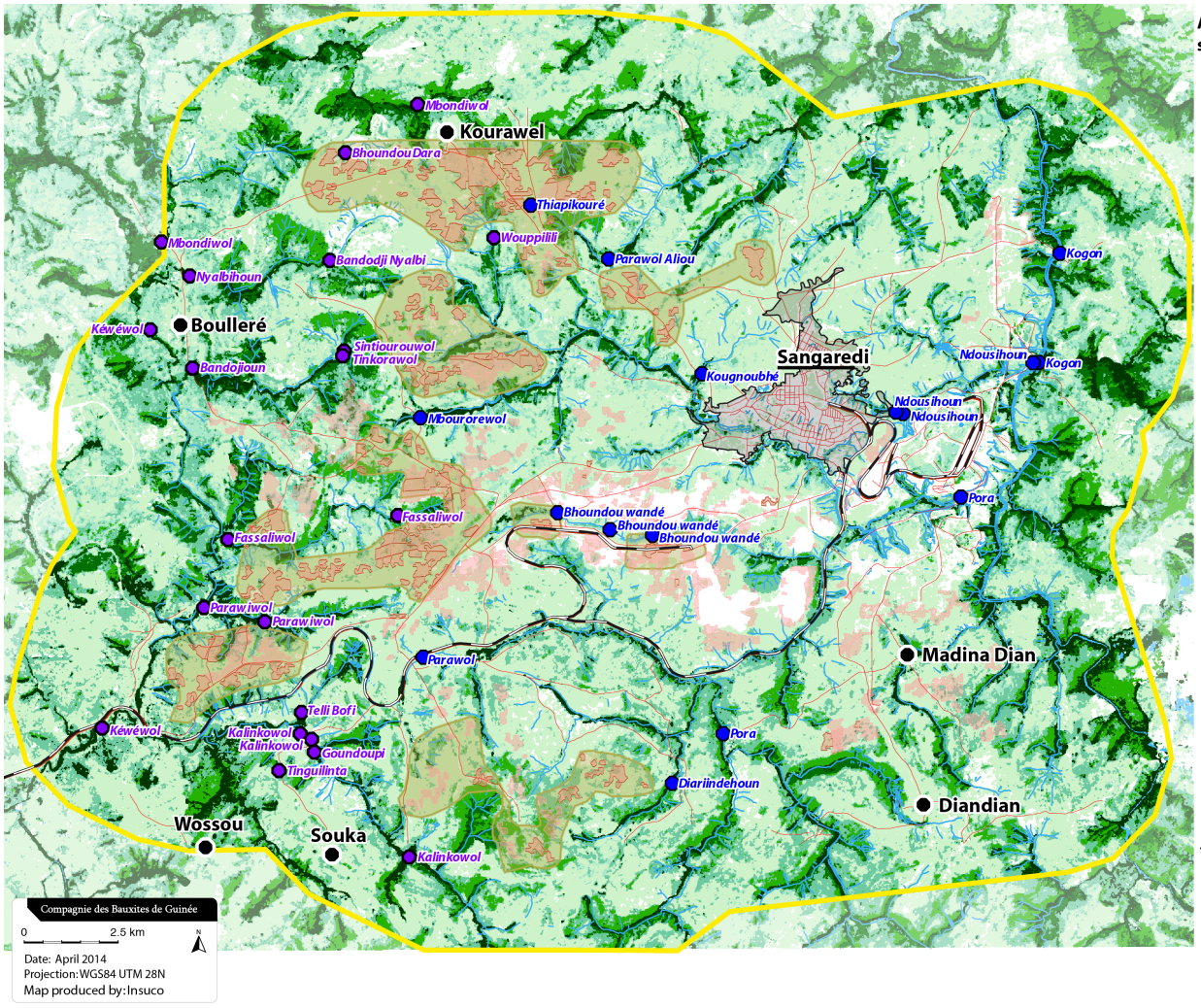


Table 3-11 Distribution of freshwater ecology sampling points in the Study Area

Watershed	Watercourse	Site code	Geographic coordinates	
			Latitude	Longitude
Cogon	Cogon	Kog1	1231797	636498
	Cogon	Kog2	1228964	635951
	Ndousihoun	Ndo1	1227672	632220
	Ndousihoun	Ndo2	1227638	632404
	Ndousihoun	Ndo3	1228955	635866
	Pora	Pora	1225478	633924
	Bhoundouwandé	Z1.1	1224516	625911
	Bhoundouwandé	Z1.2	1224630	624839
	Bhoundouwandé	Z1.3	1225078	623472
	Kougnoubhé	Z3.1	1228663	627195
	Diariindehoun	Z5.4	1218090	626440
	Pora	Z5.5	1219347	627773
	Parawol	Z5.6	1221332	619977
	Mbourorewol	Z6.1	1227556	619908
	Nyaléwol	Z7.1	1239463	625626
	Thiapikouré	Z7.2	1233061	622767
	ParawolAliou	Z7.3	1231656	624783
Tinguilinta	Mbondiwol	BO.1	1232092	613214
	Nyalbihoun	BO.2	1231204	613914
	Kéwéwol	BO.3	1229816	612905

Watershed	Watercourse	Site code	Geographic coordinates	
	Bandojioun	BO.4	1228822	613999
	Kéwéwol	Kew	1219501	611674
	Tinguilinta	Ting	1218417	616260
	Fassaliwol	Z2.1	1225027	619324
	Fassaliwol	Z2.2	1224404	614927
	Parawiwol	Z4.1	1222621	614307
	Parawiwol	Z4.2	1222268	615869
	TelliBofi	Z4.3	1219914	616839
	Kalinkowol	Z4.4	1219367	616789
	Kalinkowol	Z5.1	1219220	617078
	Goundoupi	Z5.2	1218903	617156
	Kalinkowol	Z5.3	1216166	619618
	Tinkorawol	Z6.2	1229165	617911
	Sinthiourouwol	Z6.3	1229261	617928
	Mbondiwol	Z7.4	1235663	619834
	Wouppilili	Z7.5	1232185	621814
	Bhoundou Dara	Z7.6	1234413	617972
	Bandodji Nyalbi	Z7.7	1231618	617561

3.6.3 Methodology

3.6.3.1 Physical and chemical characteristics of the sampling locations

Measurements of pH and conductivity were made in situ with previously calibrated instruments. In addition, the canopy and the composition of the substrate were assessed visually and expressed in percentage coverage of the site (Gordon et al., 1994; Arab et al., 2004; Rios et Bailey, 2006).

Discharge velocity was estimated with a float (Gordon et al., 1994; Soldner et al., 2004). The depth was measured on a crossection perpendicular to the streambed, at several relatively equidistant points, to arrive at an average depth. The stream flow was determined from the stream width, the average depth and the velocity.

3.6.3.2 Fish

Two fishing techniques were used to sample fish: passive fishing and active fishing.

The passive fishing was done with gillnets and fish traps.

The capture of fish using gillnets was done with experimental fishing nets with a mesh size from 10 to 40 mm, a length of 25 m and a height of 1.5 to 2.5 m. In the small and medium watercourses the nets were left in for a three-hour set. In the larger watercourses (Kewewol, Tinguilinta and Cogon), the nets were put out from 16:00 to 17:00 and taken up from 7:00 to 9:00 the following day.

The capture of fish using fish traps (pots) was done using nylon traps 43 cm long, 25 cm wide and 25 cm high. The traps, baited with manioc or fresh meat, were placed in both small and large watercourses, in areas with weak current. The traps were taken out at the same time as the gillnets.

The active fishing was done with cast nets and dip nets.

The cast net is a rounded net with weights that is thrown from the shore or the watercourse itself when the depth allows it.

Fishing with dip nets is done in shallow waters (< 0.5 m). The dip net is dragged with the opening toward the upstream of the watercourse. The microhabitats explored with the dip net were riverbanks, submerged vegetable litter, aquatic vegetation and wood debris.

In the small watercourses, a 100m^2 section was delimited by two seines placed upstream and downstream of the selected area. Pieces of wood and branches were removed from the section to make the fishing easier. They were replaced after the sampling.

Photo 3-14 Fishing with cast net

Identification of the fish collected was made to the species level, where possible, with the help of identification keys (Paugy et al., 2003a and b; Sonnenberg and Busch, 2009; Eschmeyer, 2013; Froese and Pauly, 2014). The majority of fish were photographed. Species whose identification was problematic were preserved in 90% ethanol for laboratory analysis (224 specimens). The numbers of specimens per species identified were determined.

3.6.3.3 Macroinvertebrates

The macroinvertebrates were sampled using a special dip net, following the methods established for the SASS (South African Scoring System) (Dickens et Graham, 2002). This methood involves sampling different biotopes present at the stations. Sampling is done by submerging the net and dragging it in the water column for a certain time or a certain distance, depending on the habitat being sampled.

During the study, boulder (average diameter over 2 cm) biotopes were sampled for 2 minutes whereas habitats with gravel, sand or mud subtrates (average diamters under 2 cm) were sampled for 1 minute. Sampling of bank and aquatic vegetation were sampled respectively for a length of 2 m or a $1m^2$ surface area.

For crustraceans (crabs and shrimps), traps and dip nets were used in addition the special dip net.

The biological material thus collected was sorted in situ and conserved in 90% alcohol. Later, the material was analyzed in a laboratory to identify specimens to the lowest possible taxonomic level using identification keys (Monod, 1966, 1980; Dejoux et al., 1981; Cumberlidge and Huguet, 2003; Tachet et al., 2003; de Moor et al., 2003; Konan, 2009). Specimens were also counted.

The relative abundance of Ephemeroptera, Plecoptera, and Trichoptera (EPT) was used to evaluate the ecological quality of the different sites sampled. This relative abundance is derived by the ratio, in percentage, between the EPT abundance at a given station and that of the total macroinvertebrate abundance. This measurement has been proposed by several authors (Baptista et al., 2007; Moya et al., 2007; Couceiro et al., 2012) as an efficient tool for the evaluation of the quality of watercourses. The measurment increases with the quality of the environment explored.

Photo 3-15 Sampling for benthic invertebrates

3.6.4 Results

3.6.4.1 Physical and chemical characteristics of the watercourses at the sampling locations

Table 3-11 presents the characteristics at the samplig stations.

3.6.4.2 Fish

A total of 2,039 fish specimens were collected during the course of this study, including 57 fish identified to species and 1 to the genus level. They are distributed within 33 genera, 18 families and 7 orders.

Figure 3-2 presents the rate of occurrence at sampling stations of species and genera inventoried in all of the watercourses. The most common species is *Epiplatys barmoiensis* that was observed in 27 of the 38 sites visited, an occurrence rate of 71.1%. This species is followed by *Barbus macrops* with a 60.5 % rate of occurrence, *Ctenopoma kingsleyae* and *Epiplatys* sp. with an occurrence of 57.9 % each and *Hemichromis fasciatus* with 55.3 % occurrence.

Photo 3-16 *Epiplatys barmoiensis*

Photo 3-17 *Epiplatys olbrechtsi*

Table 3-12 Physical and chemical characterisitcs at the sampling stations [1]

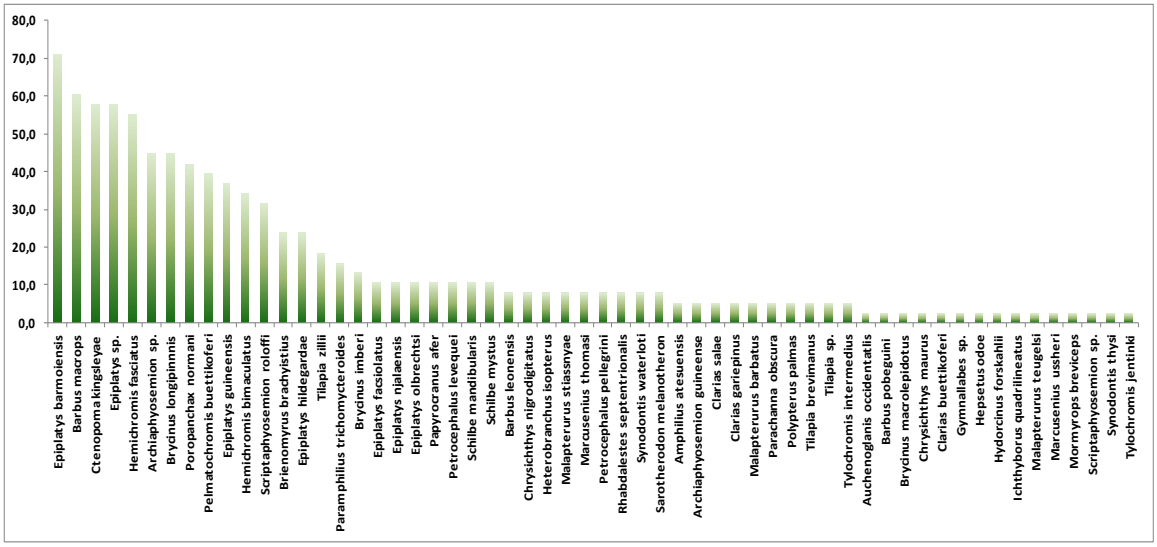
Water-shed	Sta-tion	Temp. (°C)	pH	Cond. ($\mu S.cm^{-1}$)	Transp. (m)	Dep. (m)	Wid. (m)	Vel. ($m.s^{-1}$)	Debit ($m^3.s^{-1}$)	MSG (%)	Boulders (%)	Rocks (%)	Bedrock (%)	Mud (%)	VD (%)
Cogon	Kog1	25.3	7.6	16.7	Fv	-	-	-	-	60	30	0	0	3	7
	Kog2	26	7.79	14.8	Fv	-	-	-	-	40	40	20	0	0	0
	Ndo1	26.7	8.1	26.2	Fv	0.28	3.16	0.30	0.269	80	20	0	0	0	0
	Ndo2	26.8	6.8	77	Fv	0.55	3.13	0.25	0.429	55	0	0	0	15	30
	Ndo3	27.4	7.57	18.6	Fv	0.52	3.91	0.65	1.317	45	20	0	30	5	0
	Pora	24	7.5	12.6	Fv	0.7	22.67	0.56	8.822	30	60	10	0	0	0
	Z1.1	27.5	6.9	14.1	Fv	0.36	2.97	0.39	0.408	55	40	0	0	0	5
	Z1.2	26	7.32	13.6	Fv	0.53	9.93	-	-	5	5	0	0	80	10
	Z1.3	25.2	7.45	17.4	Fv	0.34	5.42	0.55	1.037	30	40	0	20	0	10
	Z3.1	27.5	7.79	10.6	Fv	0.63	9.77	0.26	1.584	85	0	0	0	0	15
	Z5.4	25.2	8.25	9.5	Fv	0.74	5.83	0.25	1.094	80	15	0	0	0	5
	Z5.5	25.3	7.22	10.9	Fv	1.1	11.87	0.16	2.115	60	0	0	0	20	20
	Z5.6	25.2	7.9	11.1	Fv	-	-	-	-	0	10	0	20	30	40
	Z6.1	25.5	7.56	8.7	Fv	0.29	4.1	0.30	0.365	90	7	0	0	0	3

Water-shed	Sta-tion	Temp. (°C)	pH	Cond. ($\mu S.cm^{-1}$)	Transp. (m)	Dep. (m)	Wid. (m)	Vel. ($m.s^{-1}$)	Debit ($m^3.s^{-1}$)	MSG (%)	Boulders (%)	Rocks (%)	Bedrock (%)	Mud (%)	VD (%)
	Z7.1	24.8	7.54	10.1	Fv	0.4	9.95	0.28	1.115	15	80	5	0	0	0
	Z7.2	24.6	7.55	9.5	Fv	0.74	11.33	0.21	1.744	90	10	0	0	0	0
	Z7.3	27.3	8.02	9.1	Fv	-	-	-	-	0	0	0	0	0	0
Tinguilita	Bo.1	28.7	8.62	10	Fv	1.37	16.67	0.32	7.367	85	0	5	0	5	5
	Bo.2	26.2	9.6	12.7	Fv	0.42	8.6	0.35	1.269	80	0	7	0	3	10
	Bo.3	21.3	6.8	11	Fv	-	-	-	-	0	0	0	0	0	0
	Bo.4	26.2	6.6	11	Fv	0.67	6	0.27	1.086	82	0	10	0	0	8
	Kewe	25.5	7.91	9	Fv	-	-	-	-	5	60	0	10	25	0
	Ting	25.7	7.6	10	-	-	-	-	-	70	20	0	0	10	0
	Z2.1	26.8	8.2	10.8	Fv	0.28	5.04	0.20	0.278	35	60	0	0	0	5
	Z2.2	25.9	7.8	10.6	Fv	-	-	-	-	72	25	0	0	0	3
	Z4.1	25.3	7.89	13	Fv	0.61	5.95	0.17	0.63	0	0	0	0	0	0
	Z4.2	26.3	6.9	10.21	Fv	0.36	4.7	0.27	0.46	35	60	3	0	0	2
	Z4.3	26.3	7.4	8.6	Fv	-	-	-	-	13	10	7	60	0	0
	Z4.4	25.8	7.6	9.1	Fv	-	-	-	-	95	3	0	0	0	3

Water-shed	Sta-tion	Temp. (°C)	pH	Cond. ($\mu S.cm^{-1}$)	Transp. (m)	Dep. (m)	Wid. (m)	Vel. ($m.s^{-1}$)	Debit ($m^3.s^{-1}$)	MSG (%)	Boulders (%)	Rocks (%)	Bedrock (%)	Mud (%)	VD (%)
	Z5.1	26.2	7.5	8.6	Fv	1.06	8	0.60	5.1	60	0	30	0	5	5
	Z5.2	26.6	7.2	8.2	Fv	-	-	-	-	40	0	0	50	0	10
	Z5.3	25.5	7.3	10.6	Fv	0.98	6.73	0.16	1.07	70	0	5	0	25	0
	Z6.2	26.3	7.4	8.3	Fv	0.12	7.20	0.43	0.5	78	20	0	0	0	2
	Z6.3	28	7.85	14.3	Fv	0.12	1.25	0.45	0.07	20	20	0	60	0	0
	Z7.4	25.6	7.7	9.1	Fv	0.6	10.17	0.22	1.32	80	10	10	0	0	0
	Z7.5	26.8	7.65	11.7	Fv	-	-	-	-	60	30	0	5	0	5
	Z7.6	26	7.04	18.6	Fv	0.31	2.16	0.39	0.26	5	0	5	90	0	0
	Z7.7	26	6.8	11.2	Fv	0.43	2.59	0.32	0.36	10	60	30	0	0	0

[1] In this table the following abbreviations wer used: Temp. (temparature) ; Cond. (conductivity) ; Transp. (transparence) ; Dep. (average depth) ; Wid. (width) ; Vel. (average stimated velocity) ; MSG (mixure sand and gravel) ; VD (vegetable debris) ; Fv (visible bottom) ; - (missing values).

Figure 3-2 Frequency of occurrence (%) of fish species in the sampling stations of the Study Area



The species collected are distributed as follows according to fish orders: Siluriformes (6 families and 17 species), Perciformes (3 families and 11 species), Characiformes (3 families and 7 species), Cyprinodontiformes (2 families and 12 species), Ostéoglossiformes (2 families and 7 species), Cypriniformes (1 families and 3 species) and Polyptériformes (1 families and 1 species).

The most diversified families in terms of number of species present are, in decreasing order, the Nothobranchiidae (11 species), the Cichlidae (9 species), the Mormyridae (6 species), the Alestidae (5 species) and the Clariidae (5 species). The Cyprinidae, the Claroteidae and the Malapteruridae are represented each by 3 species. The Amphiliidae, Mochokidae and Schilbeidae each have 2 species. The Anabantidae, Channidae, Distichodontidae, Hepsetidae, Notopteridae, Poeciliidae and Polypteridae, all have a single species present.

The largest number of species (18) found was at Cogon Lengué (Kog1, site on the Cogon River); followed by Kéwéwol aval (Kewe), Telli Bofi (Z4.3) (Tinguilinta watershed) and Cogon Station (Kog2) with 15 species each; Pora (Pora) (Cogon watershed) and Tinguilinta (Ting) with 14 species each; and Thiapikouré (Z7.2, Cogon watershed) with 13 species. The lowest species diversity (2 species) was observed at Kalinko (Z5.1, Tinguilinta watershed).

Among the 2,039 fish caught during the course of this study, the greatest abundance (192 specimens or 9.4% of the total abundance observed during the study) was recorded at the Kéwéwol aval site. This site is followed by Telli Bofi with 141 specimens, Ndousihoun 1 (118), Ndousihoun 2 (Ndo2, 116) and Kougnoubhé (Z3.1, 101). Only two fish were caught at the Kalinko (Z5.1) site.

The Cyprinidae *Barbus macrops* is the species with the largest number of specimens (281 specimens, or 13,8 % of the total abundance observed), followed by *Brycinus longipinnnis* (265, or 13,0 %), *Poropanchax normani* (250, or 12,3 %), *Epiplatys barmoiensis* (203, or 10,0 %). Single specimens of the following taxa were found during the study: *Barbus pobeguini*, *Auchenoglanis occidentatlis*, *Clarias buettikoferi*, *Gymnallabes* sp., *Malapterurus teugelsi* and *Scriptaphyosemion* sp.

Table 3-13 presents the conservation status and the distribution of the fish species collected. Most of the species found (45 species, 84,9 %) have a wide distribution at the West African or even African scale (Bah et al., 1997; Paugy et al., 2003*a* and *b*; Sonnenberg et Busch, 2009; Eschmeyer, 2013; Froese and Pauly, 2014).

Table 3-13 Conservation status and distribution of freshwater fish

Orders	Families	Species	IUCN status	Distribution
Characiformes	Alestidae	*Brycinus longipinnis*	Least Concern	Africa: widely distributed
		Brycinus macrolepidotus	Least Concern	Afrique: intertropical
		Brycinus imberi	Least Concern	Africa: widely distributed
		Hydorcinus forskahlii	Least Concern	Africa: widely distributed
		Rhabdalestes septentrionalis	Least Concern	Central and western Africa
	Hepsetidae	*Hepsetus odoe*	Least Concern	Africa: widely distrributed in central and western Africa including the majority of coastal rivers of West Africa from Senegal to Angola: Niger, Volta, Tchad, Ogowe, Congo and Zambezi
	Distichodontidae	*Ichthyborus*	Near	West Africa

Orders	Families	Species	IUCN status	Distribution
		quadrilineatus	Threatened	
Cypriniformes	Cyprinidae	*Barbus leonensis*	Least Concern	West Africa
		Barbus macrops	Least Concern	Africa: widely distributed
		Barbus pobeguini	Least Concern	West Africa
Cyprinodontiformes	Aplocheilidae	*Archiaphyosemion guineense*	Least Concern	West Africa
		Archiaphyosemion jeanpoli = *Nimbapanchax jeanpoli*	Endangered	Africa: upper parts of the Mano River, Liberia and Guinea
	Nothobranchiidae	*Epiplatys hildegardae*	Vulnerable	Africa: only known from the type locality (Nzérékoré in southeast Guinea)
		Epiplatys barmoiensis	Least Concern	West Africa: southwest of Sierra Leone to southwest of Liberia; Guinea.
		Epiplatys facsiolatus	Least Concern	West Africa: from Guinea Bissau to southern Liberia, around Monrovia.
		Epiplatys guineensis	Vulnerable	Africa: Guinea.
		Epiplatys njalaensis	Endangered	West Africa: Njala, southwest of Sierra Leone. Guinea.
		Epiplatys olbrechtsi	Least Concern	West Africa: Liberia, Ivory Coast, Guinea.
		Epiplatys sp.		
		Scriptaphyosemion roloffi	Near Threatened	West Africa: Sierra Leone, Liberia, Guinea.
		Scriptaphyosemion geryi.	Least Concern	West Africa: Sierra Leone, Guinea.
	Poeciliidae	*Poropanchax normani*	Least Concern	Africa: from Senegal to Benin, Tchad, Cameroon, Central African Republic, Sudan
Polypteriformes	Polypteridae	*Polypterus palmas*	Least Concern	West Africa: Ivory Coast, Liberia, Senegal, Liberia, Guinea.

Orders	Families	Species	IUCN status	Distribution
Osteoglossiformes	Mormyridae	*Marcusenius thomasi*	Least Concern	West Africa: Guinea, Sierra Leone, Liberia. Reported from Guinea Bissau
		Marcusenius ussheri	Least Concern	West Africa: from Liberia to Ghana, Benin.
		Petrocephalus pellegrini	Least Concern	West Africa
		Petrocephalus levequei	Near Threatened	West Africa: Guinean Atlantic slope, Liberia.
		Mormyrops breviceps	Least Concern	Africa: Ivory Coast, Ghana, Liberia et Guinea Bissau
		Brienomyrus brachyistius	Least Concern	Africa: Senegal to Democratic Republic of the Congo.
	Notopteridae	*Papyrocranus afer*	Least Concern	Africa: Niger basin, coastal rivers of Senegal, Ghana. Cross and Sanaga basins east of the Niger delta.
Perciformes	Cichlidae	*Hemichromis bimaculatus*	Least Concern	Africa: widely distributed
		Hemichromis fasciatus	Least Concern	Africa: widely distributed in West Africa. Also known from the Nile, Lake Tchad and the Zambezi
		Pelmatochromis buettikoferi	Least Concern	Africa: from the upper Casamance River in Senegal to past the St. John River in Liberia
		Tilapia zillii	Not Evaluated	Africa and Eurasia: widely distributed
		Tilapia brevimanus	Least Concern	Africa: coastal rivers from Guinea Bissau to Liberia, Ivory Coast
		Tilapia louka	Least Concern	Africa: from Guinea Bissau (Corubal River) to Liberia
		Sarotherodon melanotheron	Not Evaluated	Africa: lagoons and estuaries from Mauritanie to Cameroon. Introduced to several countries in Asia, the USA and Europe
		Tylochromis intermedius	Least Concern	Africa: coastal rivers from Gambia to the Tanoé River in

Orders	Families	Species	IUCN status	Distribution
				Ghana
		Tylochromis jentinki	Least Concern	Africa: coastal rivers from Gambia to the Tanoé River in Ghana
	Anabantidae	*Ctenopoma kingsleyae*	Least Concern	Africa: from Senegal to the DRC. Reported in Mauritania
	Channidae	*Parachanna obscura*	Not Evaluated	Africa: Nile, from Senegal to Tchadian system above the Congo system.
Siluriformes	Amphiliidae	*Amphilius atesuensis*	Least Concern	Africa: from Guinea (Gbin River) and Sierra Leone to Ghana (Pra River). Also known from the St. John River in Liberia and the Mono River in Togo
		Paramphilius trichomycteroides	Near Threatened	Africa: head of the Senegal River, and the Konkouré, Corubal, Little Scarcies watersheds and the Fouta Djalon region in Guinea.
	Mochokidae	*Synodontis thysi*	Near Threatened	Africa: Little Scarcies and Jong in Sierra Leone, Kolenté and Konkouré in Guinea. Reported from the Rokel River in Sierra Leone.
		Synodontis waterloti	Least Concern	West Africa: Sierra Leone, Liberia, Ivory Coast; Ghana, Guinea
	Malapteruridae	*Malapterurus barbatus*	Near Threatened	Africa: From the Kolenté River (Sierra Leone/Guinea) to the Borlor River (Liberia)
		Malapterurus stiassnyae	Near Threatened	Africa: head of the Bofon River (Guinea) to the St. Paul River (Liberia); also reported from the Cavally River
		Malapterurus teugelsi	Near Threatened	Africa: Cogon River (Guinea).
	Claroteidae	*Chrysichthys maurus*	Least Concern	Africa: Senegal and Pra Rivers (Ghana), Ivory Coast rivers, Guinea, Guinea Bissau, Sierra Leone and Liberia.

Orders	Families	Species	IUCN status	Distribution
		Chrysichthys nigrodigitatus	Least Concern	Africa: from Senegal to Cabinda, Angola. Mauritania, lower Congo
		Auchenoglanis occidentatlis	Least Concern	Africa: present in the majority of West African rivers, Lake Tchad, Congo and Nile watersheds, lakes of East Africa and the Omo and Giuba.
	Clariidae	*Clarias buettikoferi*	Least Concern	Africa: head of the Gambia to the Agnébi River in Ivory Coast. Reported from Ghana.
		Clarias salae	Least Concern	Africa: From the Konkouré River (Guinea) to the Cavally River (Ivory Coast)
		Clarias gariepinus	Not Evaluated	Africa: panafrican.
		Heterobranchus isopterus	Least Concern	Africa: coastal watersheds of Guinea (Konkouré) to southeast Nigeria (Cross River); also known from the upper Senegal River.
		Gymnallabes typus	Least Concern	Africa: lower Niger and delta, Cross River watershed in Nigeria. Alsoknown from Cameroon
	Schilbeidae	*Schilbe mandibularis*	Least Concern	West Africa
		Schilbe mystus	Least Concern	Africa: including the Nile and Zambezi.

3.6.4.3 Macroinvertebrates

Taxonomic composition

One hundred and five generic and specific taxa belonging to 43 families and 9 orders were found in the sites sampled. In addition, two taxa (and Hirudinea) were identified only to the subclass level. All of the macroinvertebrates sampled belong to four zoological groups, namely the Hirudinea, Oligochaeta, insects, and crustaceans (Malacostraceans). The insects are the best represented with 40 families and 102 taxa (95.3% of the taxonomic diversity). Within the insects, the Coleoptera order

with 25 generic and specific taxa in six families is the most diverse. The Odonata with 20 generic and specific taxa in six families are next.

The crustaceans are represented by three species belonging to three genera and three families.

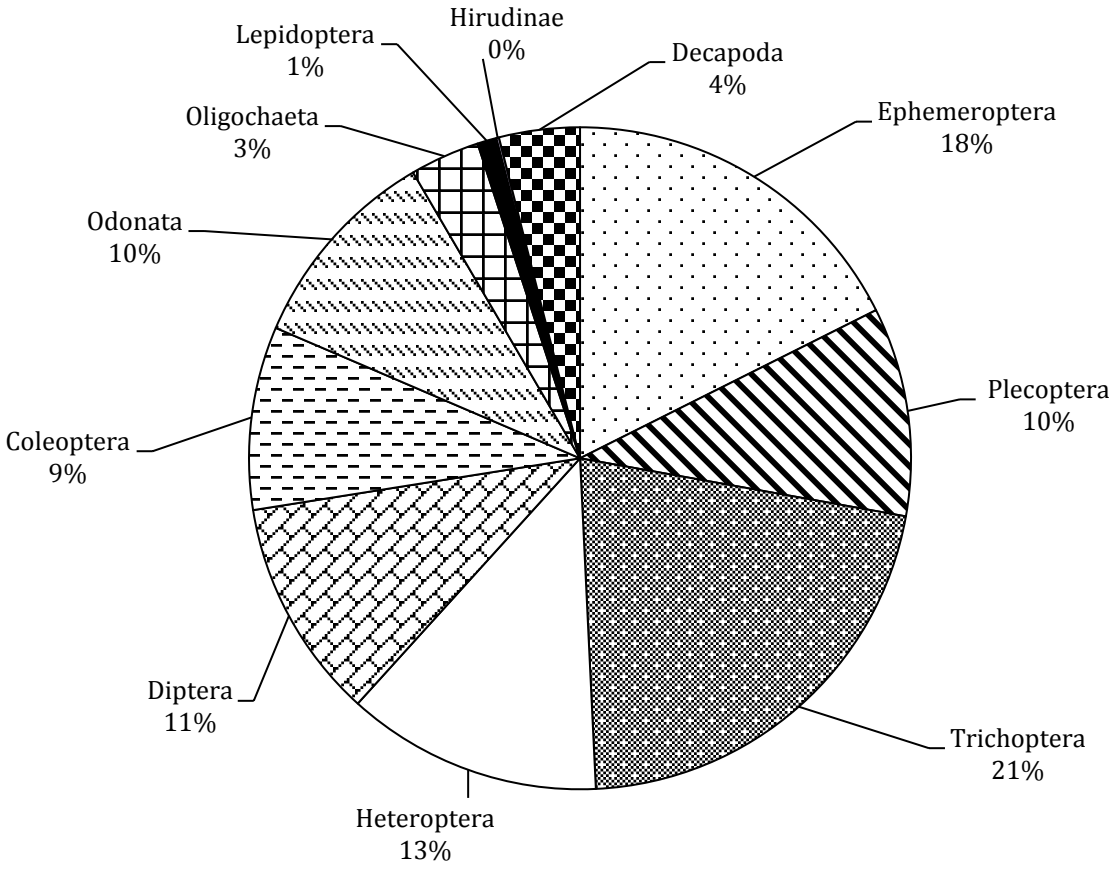
In the Cogon River watershed, there were 84 macroinvertebrate taxa belonging to the four zoological groups found in the prospected watercourses. Stations Z5.5 and Z7.1, located respectively on the Pora and Nyaléwol rivers have the most diversified fauna with 27 taxa each. They are followed by Z6.1 on the Mbouroréwol with 26 taxa. The lowest taxonomic diversity (7 taxa) was at station Ndo3 on the Ndousihoun River.

On the Tinguilinta watershed, the macroinvertebrates (Hirudinea, Oligochaeta, insects, and crustaceans) sampled included 94 taxa. The fauna at station Z2.1 on the Fassaliwol River is the most diversified (31 taxa). On the other hand the macroinvertebrates of stations Bo3 and Kewe on the Kéwéwol River, have the lowest diversities with 11 and 12 taxa respectively.

To our knowledge, except for crustaceans (Cumberlidge, 2005 in Wright et al., 2006), no work had been done on the macroinvertebrates of the rivers explored. However, work done in the Simandou Mountains in southeastern Guinea (Edia, unpublished data) identified the presence of all of the taxa found during the present study. In terms of crustaceans, two species (*Liberonautes latidactylus* and *Caridinopsis chevalieri*) out of the three have already been reported in Boké prefecture (Cumberlidge, 2005). The three species are widely distributed in West Africa (Monod, 1966, 1980; Cumberlidge and Sachs, 1989; Cumberlidge, 1999, Cumberlidge and Huguet, 2003).

In terms of numbers, the macroinvertebrate communities are dominated by insects, and in particular by the EPT complex (Ephemeroptera, Plecoptera, and Trichoptera). These three orders represent more than 50% of the specimens collected (Figure 3-3). The importance of these orders would be signs of relatively good water quality in the area studied (Rosenberg and Resh, 1993). However, further studies would be required to refine the results.

Figure 3-3 Relative importance of the macroinvertebrate orders in terms of specimens collected in all of the sampling stations



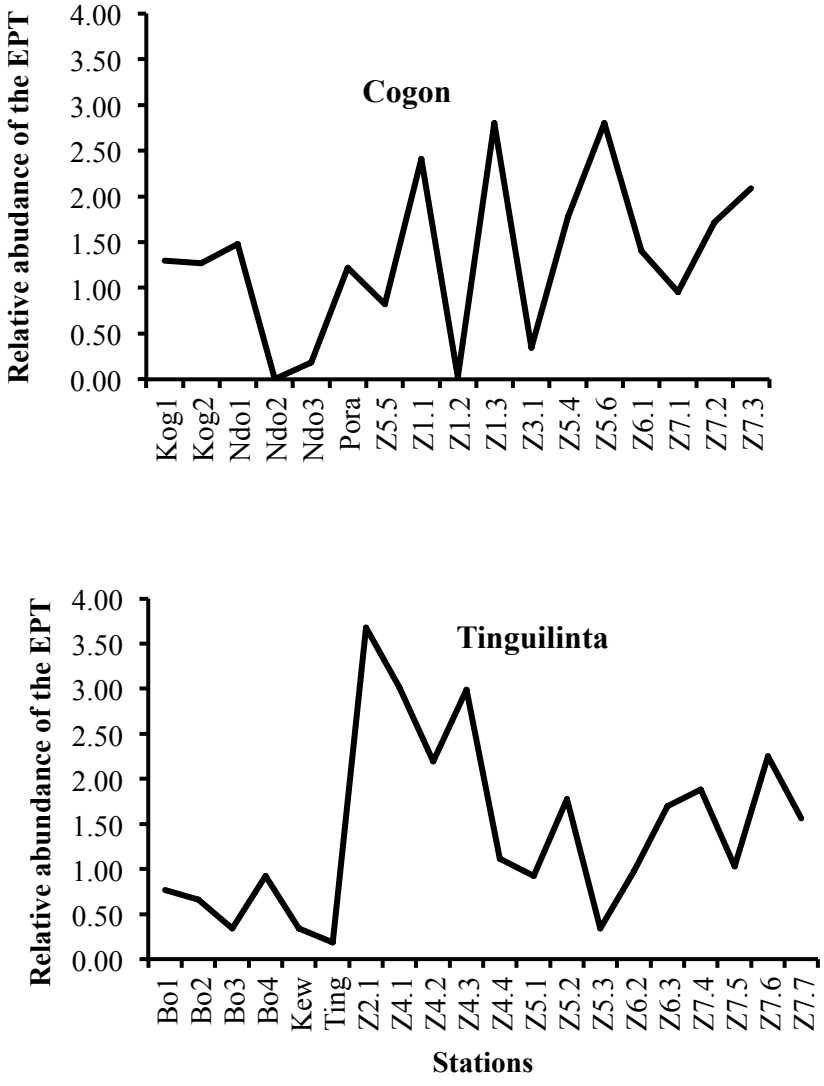
Spatial variations in the EPT indices

Spatial variations in the EPT indices are presented on Figure 3-4. In the Cogon River watershed, this index is zero at station Ndo2 of the Ndousihoun River. The highest values were at stations Z1.3 and Z5.6 on the Bhoundouwandé and Parawol rivers respectively.

On the Tinguilinta watershed, this index varies from 0.19 to 3.68. These extreme values come respectively from stations Ting on the Tinguilinta and Z2.1 on the Fassaliwol.

Overall, the Tinguilinta watershed stations present higher EPT values than those from stations on the Cogon watershed. The watercourses of the Tinguilinta watershed would therefore be less disturbed than those of the Cogon watershed.

Figure 3-4 Spatial variations in the EPT relative abundance in the watercourses of the two watersheds



The EPT index shows for example that station Ndo2 on the Ndousioun River present a lower ecological quality than those of other stations since this station had no

taxon of the EPT present. These orders (Ephemeroptera, Plecoptera, and Trichoptera) are recognized as having a majority of species that are sensitive to pollution (Rosenberg and Resh, 1993). The relatively bad ecological quality at this site could be the result of effluents coming from the water treatment plant for the town of Sangarédi.

In addition it is apparent from a comparison between the watersheds that the stations of the Tinguilinta present higher relative abundances than those recorder for the stations from the Cogon watershed. The watercourses of the Tinguilinta watershed would thus be less disturbed than those of the Cogon watershed. This might be due to the fact that the watercourses draining the prior and current CBG mining areas are all within the Cogon watershed.

3.6.5 Species of concern

3.6.5.1 Fish

According to the IUCN

The species of fish identified during the course of this study can be divided into five groups (*Not Evaluated*, *Least Concern*, *Vulnerable*, *Endangered* and *Near Threatened*) according to the International Union for the Conservation of Nature (IUCN) classification in relation to their conservation status (see Table 3-13).

Of the 57 species identified, 4 (or 7.5%), have not been assessed by the IUCN: *Parachanna obscura*, *Clarias gariepinus*, *Tilapia zillii* and *Sarotherodon melanotheron*. Forty species are considered of *Least Concern*, or 75.5% of the species that have been evaluated by the IUCN.

The species on the IUCN *Red List* as threatened (*Endangered* or *Vulnerable*) or *Near Threatened* are:

> *Epiplatys njalaensis* and *Archiaphyosemion jeanpoli*, considered to be *Endangered*;
>
> *Epiplatys hildegardae* and *Epiplatys guineensis,* considered to *Vulnerable*; and
>
> *Epiplatys olbrechtsi, Scriptaphyosemion roloffi*, *Ichthyborus quadrilineatus*, *Malapterurus barbatus*, *Malapterurus stiassnyae*, *Malapterurus teugelsi*, *Paramphilius trichomycteroides* and *Petrocephalus levequei*, to be *Near Threatened*.

Endangered species

Epiplatys njalaensis

This *Endangered* species would only be present in Sierra Leone according to the IUCN (Lalèyè, P., 2010 in IUCN 2013). However it is also found in Guinea according to Fishbase (http://www.fishbase.org). It is present in small rivers under forest cover. In the Study Area, it was captured in both the watersheds (Cogon 3 sites and Tinguilinta 1 site). It should be noted that, at sampling point Z3.1, 80 individuals were captured. This point is on the Kougnoubhè, a tributary of the Thiapikouré in the Cogon watershed.

Photo 3-18 *Epiplatys njalaensis*

Archiaphyosemion jeanpoli

This *Endangered* species has a range of 5,500 km^2 restricted to Guinea and Liberia. It is thus a species of limited distribution. It is present in small savannah streams. In the Study Area, it was captured once at station Z2.1 in the Tinguilinta watershed.

Vulnerable species

Epiplatys hildegardae

This *Vulnerable* species is endemic to Guinea. It is known as being present in the region of N'Zérékoré in *Guinée Forestière*. It occurs in quiet parts of small watercourses (Lalèyè, P., 2010 in IUCN, 2013). Therefore its presence in the Study Area represents a range extension for the species. In this study it was found in the two watersheds (Cogon, six sites ; Tinguilinta, three sites).

Epiplatys guineensis

This *Vulnerable* species is also endemic to Guinea. It was found on a few areas on the Konkouré watershed in the Fouta Djallon region, in shallow areas of streams and small rivers (Lalèyè, P., 2010 in IUCN, 2013). In this study it was found in the Cogon watershed (five sites) as well as in Tinguilinta watershed (nine sites). These are new watersheds for the species.

Near Threatened species

Epiplatys olbrechtsi

This species includes several subspecies. The subspecies typically found in Guinea is *Epiplatys olbrechtsi* ssp. *Olbrechtsi*, a subspecies considered *Near Threatened* (Entsua-Mensah, M., 2010). This species is found in Guinea, Liberai and Ivory Coast. It lives in small streams, rivers and swamps.

Scriptaphyosemion roloffi

This *Near Threatened* species is endemic in Liberia and Sierra Leone according to IUCN. It is found in shallow and stagnant parts of ponds, sawmps and small watercourses (Lalèyè, P., 2010 in IUCN, 2013). However, according to Fishbase (www.fishbase.org), the species is also present in Guinea in the Kolenté watershed, north of Kindia in the heights of the Fouta Djallon.

Ichthyborus quadrilineatus

This species is found in Guinea, Guinea-Bissau, Senegal and Sierra Leone. The Study Area is within the range reported by the IUCN (Bousso, T. et Lalèyè, P., 2010 in IUCN, 2013).

Malapterurus barbatus

This species is present in Guinea, Sierra Leone and Liberia. In Guinea it is found in the Kolenté watershed, east of the Fouta Djallon. This fish is found in rocky areas or those with roots of submerged trees (Lalèyè, P., 2010 in IUCN, 2013). This is thus a range extension for this species within the context of this study. It was found in only two sites in the Tinguilinta watershed.

Malapterurus stiassnyae

This species is also present in Guinea, Sierra Leone and Liberia. In Guinea it is found in watersheds east of the Fouta Djallon. The species frequents the same type of habitats as *M. barbatus* (Lalèyè, P., 2010 in IUCN, 2013). This is a range extension for this species that was noted in the two watersheds (Cogon, two sites; Tinguilinta, one site).

Malapterurus teugelsi

This species is endemic to Guinea. It is known only from the Cogon River watershed. It frequents the same habitats as *M. barbatus* and *M. stiassnyae* (Lalèyè, P., 2010 in IUCN, 2013). A single individual was captured in the context of this study in the Cogon watershed.

Paramphilius trichomycteroides

This fish is found in Ethiopia, Guinea, Sierra Leone and Liberia. In Guinea it is found in the Fouta Djallon watersheds and in the Macenta watershed, in *Guinée Forestière* (Bousso, T. et Lalèyè, P., 2010 in IUCN, 2013). This is thus a range extension for this species that is present in both of the watersheds of the Study Area.

Petrocephalus levequei

This species is present in Guinea, Guinea-Bissau and Sierra Leone. Its known distribution in Guinea includes the Study Area (Entsua-Mensah, M., 2010 in IUCN, 2013). It was captured in three sites in the Cogon watershed during this study.

According to the Monographie Nationale

None of the species identified during this study appears on the list of species with a particular status in the *Monographie nationale de la diversité biologique de la Guinée* (Bah et al., 1997).

3.6.5.2 Macroinvertebrates

The macroinvertebrate taxa identified during this study do not have any particular conservation status.

Word done on the watercourses of the Simandou Mountains, in the southeast of Guinea (Edia, unpublished data) reported the presence of all the taxa collected during this study. For crustaceans, two of the three species found during the study *(Liberonautes latidactylus* and *Caridinopsis chevalieri*) were already noted from Boké prefecture (Cumberlidge, 2005). The three species are widely distributed in all of West Africa (Monod, 1966, 1980; Cumberlidge and Sachs, 1989; Cumberlidge, 1999; Cumberlidge and Huguet, 2003).

3.7 Mammals

3.7.1 Introduction

Inventories of large mammals in Boké prefecture, and more precisely in the Study Areas of Kamsar and Sangarédi, were undertaken between November 12 and December 9, 2013. The presence of 25 species and 3 genera was confirmed, including several on the IUCN *Red List*. A little more than 72 km of linear reconnaissance surveys for mammals and 645 days of photographic traps were carried out. The complete large mammal report is present as an appendix (Annexe 3-5).

In spite of habitat degradation due to anthropic activities, several species on the IUCN *Red List* were found including chimpanzee (*Pan troglodytes verus*) and sooty mangabey (*Cercocebus atys*). Two studies had previously been done on the mammals of Boké prefectures, those of Barrie and Camara (2006) and of Eriksson and Kpoghomou (2006) for the RAP 41 study (Wright et al., 2006) and the one by Ecology and Environment Inc. and Kormos (2008) for the Guinea Alumina Corporation (GAC) concession.

3.7.2 Inventoried sites

3.7.2.1 Kamsar

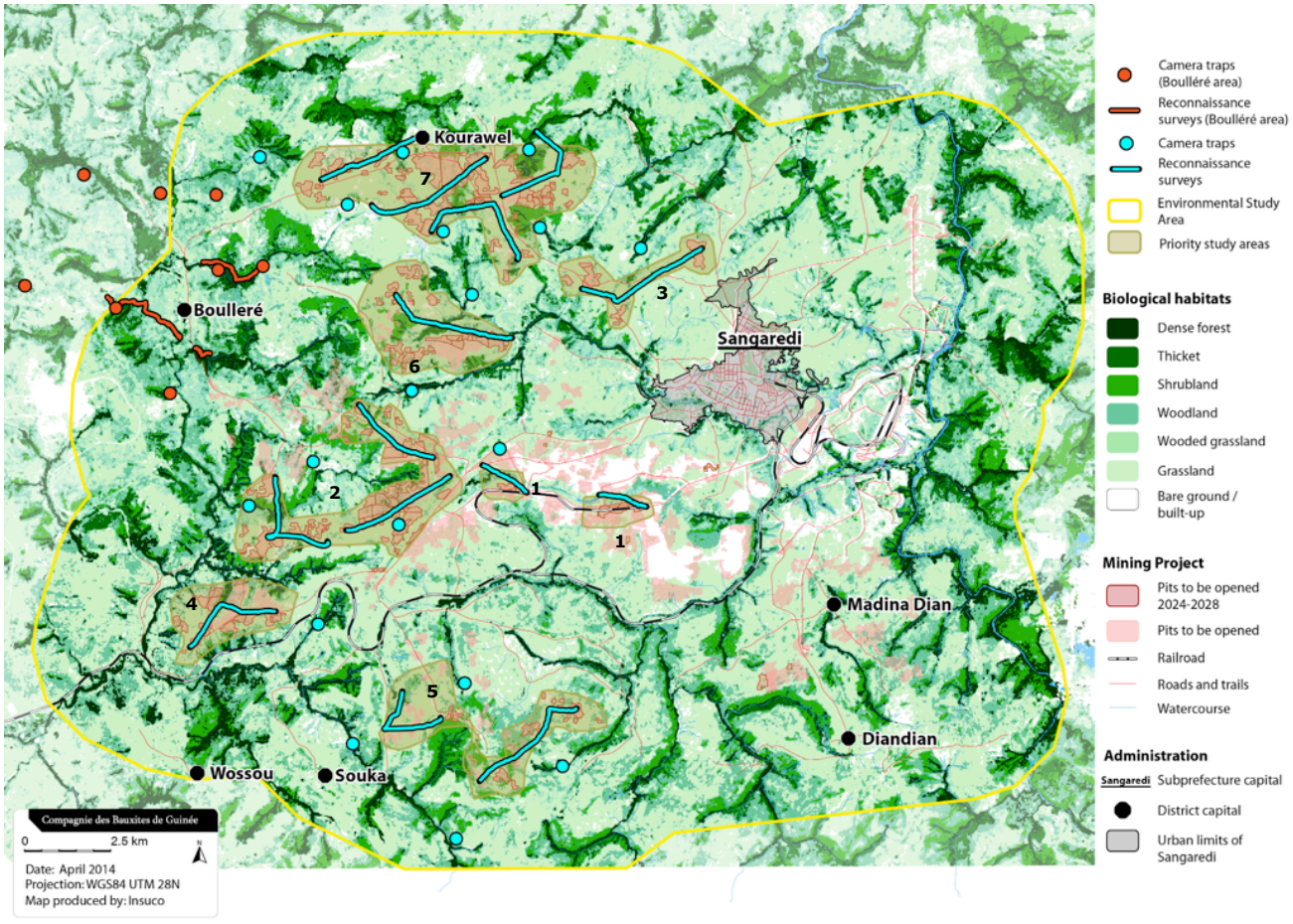
Five sites were studied in the Kamsar region (Map 3-18). Four of these sites are on the edge of the coast. The fifth, on Binari Island is the reference site for the Kamsar Study Area.

3.7.2.2 Sangarédi

Inventories were done on the seven areas that will be eventually mined in the context of the CBG Project in Sangarédi, plus a reference site for this Study Area in the region of Boulléré (Map 3-19).

Map 3-18 Mammal observation points at Kamsar

Map 3-19 Mammal observation points at Sangarédi



3.7.2.3 Habitats

Eight habitat types, based on White's (1983) classification, were visited and inventoried. The detailed description of these habitats is given in the sections on habitats (Section 3.2) and vegetation (3.3). One type of habitat was added to this classification: the sand beaches in the Kamsar region. All of these habitats have been subject to anthropic pressures to varying degrees that have modified intrinsic value.

Table 3-14 presents for each of these habitats, for both Kamsar and Sangarédi, the relative inventory effort

Table 3-14 Habitats[1] and relative recce effort per habitat (%)

Habitat		DF	W	T	S	G	WG	M	SB	A
% of recce	Kamsar	13.6 %	3.9 %	4.2 %	2.2 %	2.2 %	0.3 %	26.9 %	20.4 %	23.7 %
	Sangarédi	4.1 %	9.4 %	8.3 %	12.9 %	49.4 %	10.0 %	n.a.	n.a.	5.8 %

[1]Abbreviations used in this table for habitats: DF (dense forest); W (woodland); T (thicket); S (shrubland); G (grassland); WG (wooded grassland); M (mangrove); SB (sandy beach); A (anthropic)

3.7.3 Methodology

3.7.3.1 Reconnaissance inventory (recce)

The reconnaissance inventories were carried out on foot in the different habitat types. The team, generally at least three persons, went through the habitat walking in a predetermined direction by the easiest way with a speed of from 0.5 to 2 km/hr. Direct observations of individuals (seen or heard) and indirect observations (tracks, trails, feces, remains of food, and nests) were noted on field sheets and on a GPS equipped with Cybertracker software. For each observation, the species, number and activity the animal was engaged in and the habitat were noted.

Data on chimpanzees were recorded on separate sheets on which the number and age of nests, their distribution in trees and the tree species were recorded.

Table 3-15 presents the number of days devoted to each Study Area and the reference sites and the reconnaissance inventory effort. In total more than 72 km were covered during these inventories.

Table 3-15 Work effort of the reconnaissance survey in the different areas

Recce survey					
	Number of days	**Maximum length of recce (m)**	**Minimum length of recce (m)**	**Average length of recce (m)**	**Total distance (m)**
Kamsar (K)	5	5,090	1,220	3,622	18,110
Binari (Bi)	1	2,910	2,910	2,910	2,910
Sangarédi (S)	14	4,140	2,840	3,344	44,953
Boulléré (Bo)	4	2,430	460	1,635	6,375
Total	**24**				**72,348**

As to Table 3-16, it details the reconnaissance inventory effort in each habitat in each Study Area and reference site, as well as an estimate of the degree of disturbance from anthropic activities. The human activities considered here are primarily the cutting and burning of vegetation for agriculture.

Table 3-16 Mammal recce effort by habitat

	Habitat	**Total distance in the habitat (m)**	**Distance through burned or cut areas (m)**	**Disturbance of habitats (%)**	**Relative importance of the habitat (%)**
Sangarédi					
	Grassland	25,163	21,079	83.8	56.0
	Shrubland	5,348	321	6.0	11.9
	Thicket	3,716	265	7.1	8.3
	Wooded grassland	4,298	1,994	46.4	9.6
	Woodland	3,283	230	7.0	7.3
	Anthropic	2,959	0	100	6.6
	Dense forest	186	0	0	0.4
	Total	**44,953**			

	Habitat	Total distance in the habitat (m)	Distance through burned or cut areas (m)	Disturbance of habitats (%)	Relative importance of the habitat (%)
Boulléré					
	Grassland	200	0	0	3.1
	Shrubland	1,268	0	0	19.9
	Thicket	541	0	0	8.5
	Wooded grassland	828	0	0	13.0
	Woodland	1,562	0	0	24.5
	Anthropic	15	0	100	0.2
	Dense forest	1,961	0	0	30.8
	Total	**6,375**			
Kamsar					
	Grassland	340	0	0	1.9
	Shrubland	390	0	0	2.2
	Thicket	764	0	0	4.2
	Wooded grassland	4,280	0	0	23.6
	Woodland	390	0	0	2.2
	Anthropic	4,565	0	100	25.2
	Mangrove	6,076	5,031	82.8	33.6
	Dense forest	1,305	0	0	7.2
	Total	**18,110**			
Binari					
	Grassland	120	0	0	4.1
	Shrubland	70	0	0	2.4
	Thicket	125	0	0	4.3
	Wooded grassland	70	0	0	2.4
	Woodland	420	0	0	14.4
	Anthropic	420	0	100	14.4

Habitat	Total distance in the habitat (m)	Distance through burned or cut areas (m)	Disturbance of habitats (%)	Relative importance of the habitat (%)
Mangrove	135	0	0	4.6
Dense forest	1,550	0	0	53.3
Total	**2,910**			

It is not always possible to identify the animal species only from tracks, some because they are little known and other because they are similar for different species within a genus. This is the case for example for several small carnivores belonging to the family of the Herpestidae (mongooses) and the genets (*Genetta* spp.). This last group includes both common and threatened species. Other species that are discrete, nocturnal or found in trees can also be difficult to observe directly or indirectly. In this light, the use of camera traps improved upon the data collected during the reconnaissance inventories.

3.7.3.2 Camera traps

Thirty-four camera traps (Reconyx HC-600 Rapidfire) were installed in the Study Areas. This type of camera, sensitive to movements in its immediate environment, can be left in place for weeks and take hundreds of photographs practically without affecting the fauna present (Dajun et al., 2006). They are as efficient during the day as during the night for the photographic captures of animal species (Silveira et al., 2003).

Table 3-17 presents the effort in terms of numbers of camera traps and the days devoted to each of the Study Areas and reference sites. The cameras were left in the field as long as possible, given the time allotted to the field study. The average capture effort per camera is 19 days for a total of 645 days for all of the cameras.

Table 3-17 Work effort of the camera trapping in the different areas

Camera trapping					
	Number of cameras	**Maximum capture days**	**Minimum capture days**	**Average**	**Total trapping effort in days**
Kamsar (K)	5	21.9	21.1	21.4	107
Binari (Bi)	3	20.1	19.8	19.9	59.7
Sangarédi (S)	18	16.7	18.8	17.9	323
Boulléré (Bo)	8	19.9	18.8	19.4	155.5
Total	**34**				**645.2**

Initially, the camera traps were distributed by studying the satellite imagery for habitat types so as to spread the cameras equally in the different types. Later, the final positioning of the cameras was refined in the field, taking into account areas that might be frequented by mammals and not by villagers. The cameras are solidly fixed in trees to a height of 0.5 m above ground. The location of each camera was characterized in terms of habitat type, canopy cover, presence of intermediate vegetation strata, presence of water close by and signs of animal or human presence close by. They were located more particularly in habitats that offered a greater chance of presence of mammals of concern (dense forest and woodlands).

Photo 3-19 A camera trap

Photo 3-20 An African clawless otter caught in a camera trap

3.7.4 Results

3.7.4.1 Species diversity

A total of 25 species and 3 genera were identified in the context of this study, including the species noted during the reconnaissance inventories as well as those found in the photographs from the camera traps. Table 3-18 shows the number of species noted for each of the sites inventoried. Areas 5 and 7 of the Sangarédi Study Area and the Sangarédi reference site (Boulléré) offered the greatest species diversity with 19, 21 and 19 species respectively. Of course the same species can be found on several sites as can be seen on Table 3-18.

Table 3-18 Number of mammals species found in each site

Mammal families	Sangarédi							Boulléré	Kamsar	Binari
Sites	**1**	**2**	**3**	**4**	**5**	**6**	**7**			
Artiodactyla	2	2	0	3	5	2	5	4	2	2
Carnivora	3	5	4	3	5	0	7	5	6	3
Primates	1	1	2	0	3	3	3	5	2	1
Rodentia	5	4	3	1	5	3	5	4	3	4
Lagomorpha	0	1	1	1	1	1	1	0	0	0
Number of species	11	13	10	8	19	9	21	19	13	10
Total				**23**				**19**	**13**	**10**

Table 3-19 presents the list of the 25 species and 3 genera, their distribution in the sites and their conservation status.

Table 3-19 Mammals species and genera found by Study Areas

				Areas				Conservation status	
_	Order/species	English name	French name	Kamsar	Binari	Sangarédi	Boulléré	IUCN[1]	MN[1]
	ARTIODACTYLA								
1	*Cephalophus rufilatus*	Red-flanked duiker	Céphalophe à flanc roux			X	(X)		**M**
2	*Phacochoerus africanus*	Common warthog	Phacochère d'Afrique			X			**M**
3	*Philantomba maxwellii*	Maxwell's duiker	Céphalophe de Maxwell	X	(X)	X	X		
4	*Potamochoerus porcus*	Red river hog	Potamochère			X	X		**M**
5	*Tragelaphus scriptus*	Bushbuck	Guib harnaché	X	X	X	X		
	CARNIVORA								
6	*Aonyx capensis*	African clawless otter	Loutre à joues blanches	X					**M**
7	*Atilax paludinosus*	Marsh mongoose	Mangouste des marais	X	X	X	X		
8	*Caracal aurata**	African golden cat	Chat doré africain			X		**NT**	**P**
9	*Civettictis civetta*	Civet	Civette d'Afrique	X	X	X			
10	*Genetta pardina*	Pardine genet	Genette pardine	X	(X)	X	X		
11	*Genetta thierryi**	Hausa genet	Genette de Thierry				X		
12	*Herpestes sanguineus**	Slender mongoose	Mangouste rouge			X			
13	*Ichneumia albicauda**	White-tailed mongoose	Mangouste à queue blanche			X			
14	*Leptailurus serval**	Serval	Serval	X					
15	*Mungos gambianus**	Gambian mongoose	Mangouste de Gambie			X	X		

				Areas				Conservation status	
16	*Nandinia binotata*	African palm civet	Nandinie				X		
17	*Canis* sp.	Jackal				X			
	LAGOMORPHA								
18	*Lepus* sp.	Hare	Lièvre			X			
	PRIMATES								
19	*Cercocebus atys*	Sooty mangabey	Mangabey couronné			X	X	**VU**	
20	*Cercopithecus campbelli*	Campbell´s monkey	Mone de Campbell	X			X		**M**
21	*Chlorocebus sabaeus*	Green monkey	Singe vert	X	X	X	X		
22	*Erythrocebus patas*	Patas monkey	Patas			X	X		
23	*Pan troglodytes verus*	West african chimpanzee	Chimpanzé commun			X	X	**EN**	**M**
	RODENTIA								
24	*Atherurus africanus*	African brush-tailed porcupine	Athérure d'Afrique			X	X		
25	*Cricetomys* sp.	Giant pouched rat	Cricétome	X	X	X	X		
26	*Hystrix cristata*	Crested porcupine	Porc-épic à crête	X	X	X	X		**VU**
27	*Thryonomys swinderianus*	Greater cane rat	Grand aulacode	X	X	X	X		
28	*Xerus erythropus*	Striped ground squirrel	Écureuil fouisseur	X	X	X	X		

[1] Status according to IUCN: NT (*Near Threatened*); VU (*Vulnerable*); EN (*Endangered*). Status according to the *Monographie Nationale sur la diversité biologique de la Guinée*: M (threatened); P (in peril); VU (vulnerable).

*An asterisk after a name indicates that it is a new species for Boké prefecture.

(X) Likely species based on tracks.

In the Sangarédi Study Area, including Boulléré, 23 species and 2 genera were identified. At Kamsar, including the Binari Island reference site, 12 species and one genus were noted. The presence of 9 of the 25 species was confirmed from the photographs of the camera traps.

For the RAP 41 study (Wright et al., 2006), 24 species were noted from Boulléré and 18 species from the Kamsar area. The studies done for the GAC (Guinea Alumina Corporation) concession just to the west of the Study Area led to a total of 32 mammal species (Ecology and Environment Inc. and Kormos, 2008).

The present study confirms the presence of 6 new species for the Boké prefecture (Table 3-19), all from the use of camera traps.

Considering the species found in the RAP 41 study (Wright et al., 2006), the study for GAC and those from this study, Boké prefecture thus has at least 38 mammal species.

For the whole of Guinea, Barnett and Prangley (1997) following a review of 26 documents related to the large fauna of Guinea list 190 mammal species. The *Monographie nationale sur la diversité biologique de la Guinée* (Bah et al., 1997) lists 260 species.

3.7.4.2 Mammal species according to habitats

Given the time allotted for the field study and the extent of the territory, the inventory effort was quite variable according to habitats. In addition the diversity of habitats and the anthropic pressure vary from one site to another. These anthropic pressures can contribute to limit the presence of some species while favoring others.

Table 3-20 presents the distribution of mammals according to habitats and the Study Areas. It is apparent from this that the dense forest and woodlands present the highest species diversity, followed by grasslands and thickets with respectively 19, 19, 14 and 15 species. In addition the bushbuck and greater cane rat can be found in nearly all habitats.

Table 3-20 Distribution of mammals by habitat and sites

	K	Bi	S	B	K	Bi	S	B	K	R	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	K
	Anthropic				Grassland				Shrubland				Thicket				Wooded grassland				Woodland				Dense forest				Mangrove		Beach
ARTIODACTYLA																															
Cephalophus rufilatus											T	X			T	X							X								
Phacochoerus africanus							X				X												X				X				
Philantomba maxwellii							X				X	X			X	X				X			X		X	T	X				
Potamochoerus porcus								X			X	X			X	X			X	X			X	X			X	X			
Tragelaphus scriptus	X			X	X		X				X	X			X	X				X	X		X	X	X	X	X	X	X		
CARNIVORA																															
Aonyx capensis	X																												X		X
Atilax paludinosus	X		X				X								X							X	X				X	X	X		X
Caracal aurata																											X				
Civettictis civetta							X								X				X						X		X		X	X	X
Genetta pardina	T						T								X										T		X	X	X	T	X
Genetta thierryi																							X								
Herpestes sanguineus															X												X				
Ichneumia albicauda																			X								X				
Leptailurus serval																													X		X

	K	Bi	S	B	K	Bi	S	B	K	R	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	K
	Anthropic				Grassland				Shrubland				Thicket				Wooded grassland				Woodland				Dense forest				Mangrove		Beach
Mungos gambianus														X									X				X				
Nandinia binotata																															
Canis sp.							X												X												
Herpestidea sp.	T						T															T	T								
PRIMATES																															
Cercocebus atys																							X				X	X			
Cercopithecus campbelli																							X					X	X		
Chlorocebus sabaeus	X						X												X			X	X		X		X	X	X		X
Erythrocebus patas							X												X				X								
Pan troglodytes verus														X					X			X	X				X	X			
Primate sp.			T	T																											
RODENTIA																															
Atherurus africanus											X	X		X					X				X				X	X			
Hystrix cristata								X	X		X	X		X									X	X	X	X	X	X			
Cricetomys gambianus	X		X	X										X					X	X			X	X			X	X	X		
Thryonomys swinderianus	X		X		X		X	X	X		X		X		X		X		X		X	X	X					X		X	
Xerus erythropus														X			X		X				X		X	X	X	X			
LAGOMORPHA																															
Lepus sp.							X																								

	K	Bi	S	B	K	Bi	S	B	K	R	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	S	B	K	Bi	K
	Anthropic				Grassland				Shrubland				Thicket				Wooded grassland				Woodland				Dense forest				Mangrove		Beach
Total number of species	9				14				8				15				13				19				19				10		6

(Note: X indicates a confirmed presence, T indicates the presence of tracks or signs only, the letters above the table mean: K = Kamsar ; Bi = Binari ; S = Sangarédi ; and B = Boulléré)

3.7.4.3 Habitats at Sangarédi (including Boulléré)

Anthropic formation

On the basis of tracks, the rodents (Rodentia on Table 3-20) are the most abundant in the formation, represented by one species, the greater cane rat. The only ungulates found in this formation are the bushbuck and the bush pigs. An old chimpanzee nest was observed in a cultivated area but it dated from a time before the areas was put into agricultural use. Traces of primates were seen in the mining area and according to local workers are of green monkeys.

This habitat is of no particular conservation value even if it is known that primates may go into this habitat searching for food.

Grassland formation

This formation is regularly burned for agro-pastoral reasons. This favors small mammals that have short gestation period and can reproduce several times within an annual cycle (Nowak, 1999). In order, the lagomorphs and rodents are the groups most represented in this formation. Indeed, hares were only observed in this habitat. Some carnivore tracks were observed (*Canis* sp., civet and mongooses). A few ungulates such as the bushbuck and the common warthog frequent this habitat. Primates are not abundant in this habitat, the patas monkey being the most common. None of the 14 species noted from this habitat are on the IUCN *Red List*.

Shrubland

This habitat is generally made up of two to three year old fallow lands. The rodents are also the most abundant, dominated by the greater cane rat. The African brush-tailed porcupine and crested porcupine were also observed here. All of the ungulates found during the study were present in this formation. No signs of carnivores or primates were noted in this habitat, however it is likely that carnivores that frequent thickets would also be present in this environment.

This habitat offers no particular conservation value.

Thicket

This habitat is made of fallow lands four to five years old. All of the large mammal groups, except for primates, are well represented in this environment. Compared to shrubland, the greater cane rat is less abundant whereas the crested porcupine is more abundant. Among the ungulates, the red river hog was noted more frequently than the bushbuck.

As to carnivores, five species were noted (Table 3-20) thanks to the photographic captures. A single chimpanzee nest was seen in this formation.

The habitat is of no particular conservation value.

Wooded grassland

The observations made in this habitat suggest that, apart from primates, it is less frequented by the large mammal groups than thickets. Among the primates are the patas monkey, the green monkey and the chimpanzee, related to the presence of large trees. The presence of the primates makes this habitat more important for conservation than the preceding habitats.

Woodland

All of the ungulates, rodents and primates noted in this study are present in this formation (Table 3-20). Chimpanzee nests were noted in 16 different places for a total of 68 nests. Two IUCN threatened species were seen in this habitat (chimpanzee and sooty mangabey).

This habitat has a high environmental value because of its species diversity and the presence of species of concern for conservation.

Dense forest

All of the large mammal groups are well represented in this formation. The signs of carnivore presence were higher than in all other formations, with the marsh mongoose being the dominant species followed by genets. On top of the two threatened primates (chimpanzee and sooty mangabey), the *Near Threatened* African golden cat is present. This is the only habitat where this species was found.

Like the woodlands, this habitat has a high conservation value du to its species diversity and the presence of species of concern for conservation.

3.7.4.4 Habitats at Kamsar

Because of time restrictions the limited construction work anticipated by CBG in the terrestrial habitats of the Study Area, the work effort within the Kamsar area was concentrated on the mangrove and the sand beaches around the Rio Nuñez, in case the port constructions might have an impact on these habitats. The degradation of the mangrove habitats was visible in the sites inventoried.

Anthropic formation

Most of the anthropic environments visited were composed of traditional rice fields (*rizières sur bougounis* – term that means both the rice field with dikes and the dikes). The reconnaissance inventories were done by using the little dikes. As these dikes are relatively dry and are located between a rice field and mangrove or between two rice fields, they are well used by the local fauna. All of the large groups of mammals were noted. The greater cane rat (rodent), the bushbuck (ungulate), the marsh mongoose, genets and otters (carnivores) as well as the green monkey were observed directly or indirectly. These *bougounis* serve as trails allowing species to pass from one habitat to another.

Grassland

This formation was the least frequently found among the sites inventoried. The greater cane rat and the bushbuck were noted from this habitat.

Shrubland

As with the preceding, this formation was found infrequently among the sites studied. Two rodents were noted, the greater can rat and the crested porcupine.

Thickets

The thickets visited during the reconnaissance inventories offer no particular value for large mammals. Tracks of the greater cane rate were observed as well as those of an ungulate (Bovidae species).

Wooded grassland

This formation was found on Binari Island only. Only greater cane rate tracks were observed. A camera trap installed near the village of Soplia that was running for twenty-odd days only recorded striped ground squirrel.

Woodland

The habitats of this type visited in the Kamsar Study Area were dominated by oil palm. Only the bushbuck and greater cane rate were observed. At Binari the formation visited bordered on dense forest and was disturbed by human activities. The same species as in the Kamsar area were noted.

Dense forest

The dense forests of the Kamsar Study Area have a higher species diversity than the other habitats inventories, except for the mangrove and beach habitats. A single primate species was found (green monkey). In total, five species were found in this habitat.

Mangrove

A third of the reconnaissance effort was placed on this habitat given its local importance. A bit more than 80% of the mangrove visited had already been cut and showed signs of anthropic activities. The environment does not have a very high

species diversity but it does have two primate species (observed in small groups), the green monkey and Campbell's monkey. This was the only place where the latter species was observed. Two species of carnivore were noted in this habitat, the serval and the African clawless otter. In total the mangrove has 10 species of mammals.

Beaches

The ecological value if sand beaches for carnivores is not known. However of the six species of mammals recorded from this environment, five are carnivores including again the serval and the African clawless otter.

3.7.4.5 Cogon River

Opportunistic observations along the Cogon River led to the identification of two more IUCN threatened species. The hippopotamus (*Hippopotamus amphibius*), considered as Vulnerable, was seen at less than one km from the Sangarédi airport.

The red colobus (*Procolobus badius*), considered *Endangered*, was seen along the river about twenty km north of the center of the town of Sangarédi.

Direct observations of chimpanzee (*Pan troglodytes verus*), Campbell's monkey (*Cercopithecus campbelli)* and green monkey (*Chlorocebus sabaeus*) were also made. In spite of anthropic pressures along the river, there are still some riparian forests with a definite ecological value for several threatened mammals.

3.7.5 Species of conservation concern

The species of concern considered below are those listed as threatened or near threatened according to the IUCN as well as those listed as threatened, vulnerable or in peril in the *Monographie Nationale de la diversité biologique de la Guinée* (Bah *et al*., 1997).

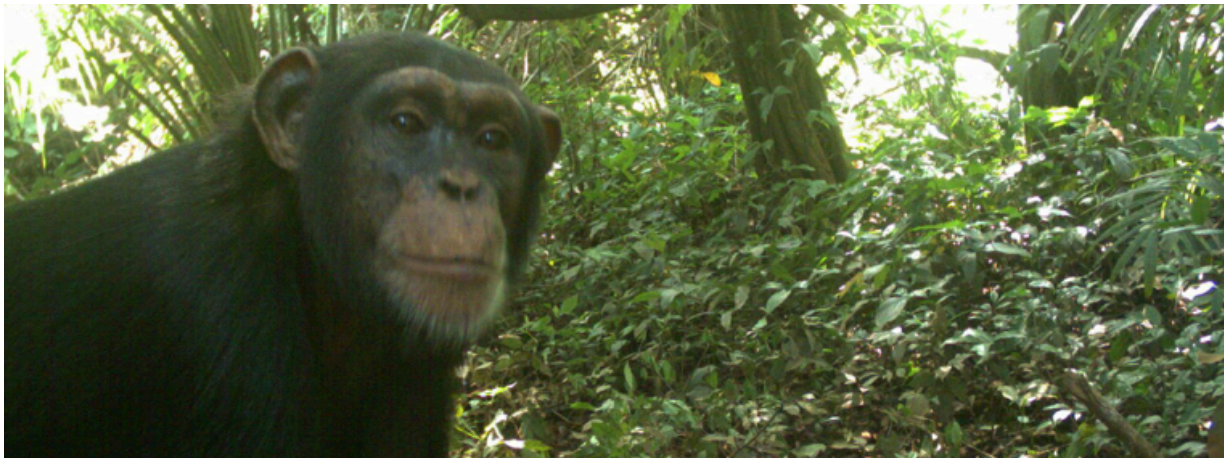
3.7.5.1 According to the IUCN

According to the IUCN criteria, the chimpanzee (*Pan troglodytes verus*) is considered *Endangered* whereas the hippopotamus (*Hippopotamus amphibius*) and the sooty mangabey (*Cercocebus atys*) are considered *Vulnerable*. The African golden cat (*Caracal aurata*) is classed as *Near Threatened*.

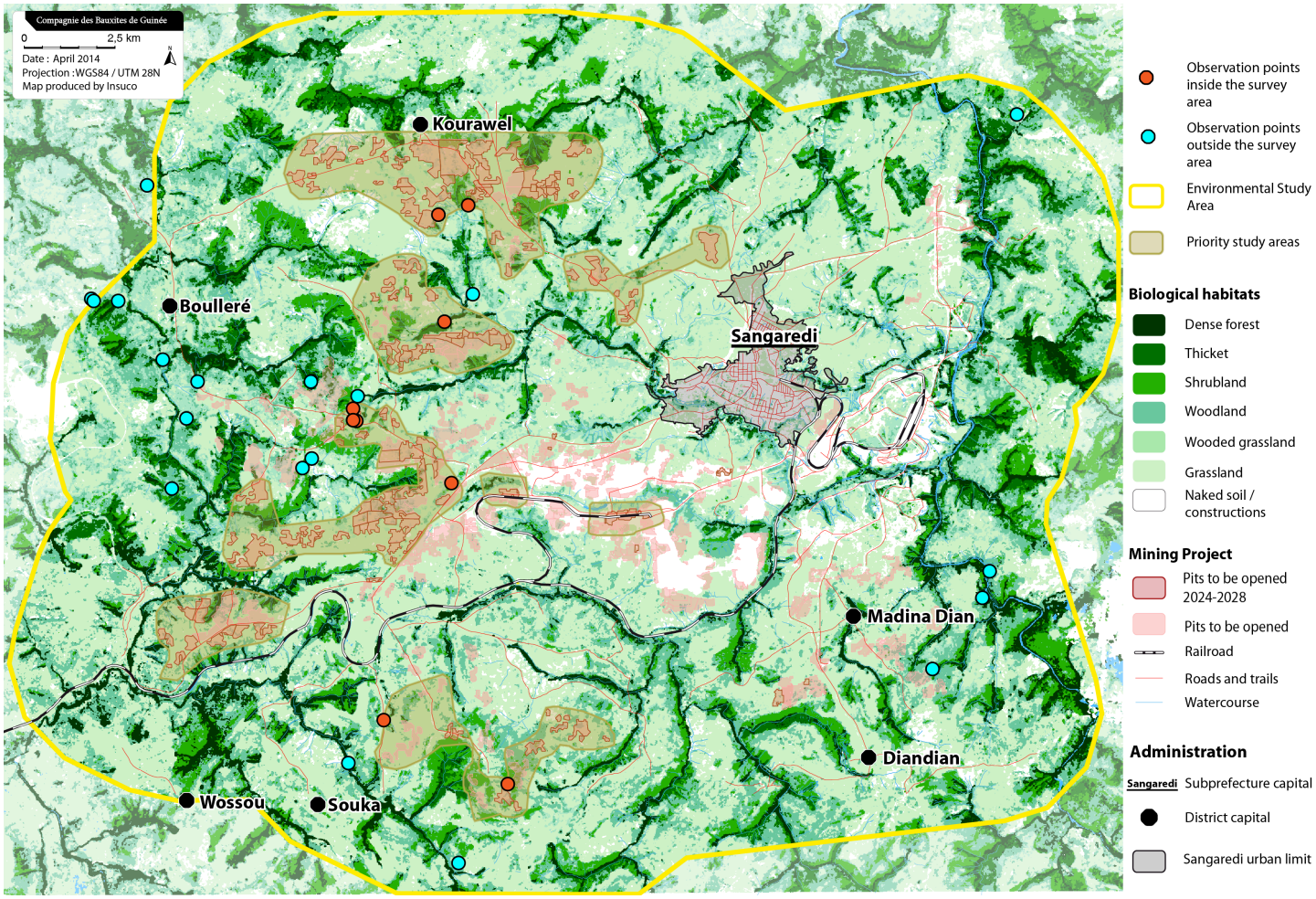
Chimpanzee

The subspecies *verus* is distributed throughout West Africa, from Senegal to Nigeria (Oates et al., 2008a in IUCN, 2013). Guinea is considered one of the countries harboring viable chimpanzee populations (Kormos and Boesch, 2003). Even so, losses of habitat and hunting pressure on the species continue to increase, and the declines in population may be difficult to revers (Oates et al., 2008a in IUCN, 2013). Map 3-20 presents the direct and indirect observation points of chimpanzees in the Study Area. This species was observed mainly in woodland and dense forest. Nests within the Study Area were preferentially in the following species: *Erythrophleum guinensis* (43 %), followed by *Daniellia oliveri* (19 %), *Parkia biglobosa* (14 %) and *Elaeis guineensis* (7 %). The use of the oil palm for nest construction is considered typical of the chimpanzee populations in West Africa (Ndiaye et al., 2013).

Photo 3-21 Chimpanzee



Map 3-20 Chimpanzee direct and indirect observations



Hippopotamus

The hippopotamus is present in more than 35 African countries, but it is not common in West Africa where it is most at risk since it is distributed in small groups over 19 countries (Lewison and Oliver, 2008 in IUCN, 2013). Opportunistic observations were made of this species on the Cogon River in the Study Area, east of Sangarédi. A group of four individuals was also seen on the Cogon about 20 km downstream from Sangarédi.

Photo 3-22 Hippopotamus

Sooty mangabey

The subspecies *atys* found in Guinea does not have a large distribution. In addition to Guinea it is noted in Senegal, Guinea Bissau, Sierra Leone, Liberia and Ivory Coast (Oates et al., 2008b in IUCN, 2013). It has a variety of habitats, but primarily forests. It was observed only once in a gallery forest near Boulléré.

African golden cat

This species is one of the least well known of the African cats. It is infrequently observed in its natural habitat and is considered rare. It is probably in decline because it is threatened with loss of habitat and large prey items, particularly in West Africa (Henschel et al., 2008 in IUCN, 2013). The species was seen twice in the same camera trap in the gallery forest in zone 7 of Sangarédi. Information on this species is sparse, but many observations of it are in forests along watercourses (Nowell and Jackson, 1996; Ray and Butynski in press, cited by Henschel et al., 2008 in IUCN, 2013). This was the first time it was observed in Boké prefecture.

3.7.5.2 According to the Monographie Nationale

In the *Monographie Nationale sur la diversité biologique de la Guinée* (Bah et al., 1997) the red-flanked duiker (*Cephalophus rufilatus*), the common warthog

(*Phacochoerus africanus*), the red river hog (*Potamochoerus porcus*), the African clawless otter (*Aonyx capensis*), the Campbell's monkey (*Cercopithecus campbelli*) and the chimpanzee (*Pan troglodytes*) are considered threatened. The crested porcupine (*Hystrix cristata*) is considered vulnerable. Finally the African golden cat (*Caracal aurata*) is considered in peril.

Red-flanked duiker

Reported as rarely encountered by the local hunters of the Study Area, the IUCN specialists consider that this species can tolerate heavy hunting pressure and is still present in most of its historical range (IUCN SSC Antelope Specialist Group, 2008 in IUCN, 2013). The species is not common and was noted in shrubland, thickets and woodland, the latter preferentially.

Common warthog

This artiodactyl is widely distributed in Sub-Saharan Africa. It is present in more than 35 countries (Cumming, 2008 in IUCN, 2013). It was often noted during the inventories, in particular in gallery forest and woodland.

Red river hog

The species is widely distributed and common in West Africa and Central Africa where it is present in about 15 countries (Querouil and Leus, 2008 in IUCN, 2013). The species was found frequently, only in grassland.

African clawless otter

This otter varies from common to rare, with populations considered stable in 29 out of the 35 countries where it is present (Rowe-Rowe, 1990, 1995; Nel and Somers, 2002; cited by Hoffmann, 2008 in IUCN 2013). Its abundance seems linked to the availability of crabs (Rowe-Rowe and Somers, 1998 cited by Hoffmann, 2008 in IUCN, 2013).

The species, predominantly aquatic, is rarely found far from watercourses. According to Van Niekerk et al. (1998, cited by Hoffmann, 2008 in IUCN, 2013),

fresh water is an essential habitat for this species and it is present in marine habitats (mainly rocky coasts) only if there is access to freshwater nearby. The African clawless otter was noted at Kamsar only and in particular on the sandy coastal beach on the west side of Taïdi Island. A few tracks of the species were seen between the mangrove and the rice fields.

Crested porcupine

This species has a wide range. It is found in a variety of habitats from Italy to North Africa to Sub-Saharan Africa, where it is present in thirty-odd countries (Grubb et al., 2008 in IUCN, 2013). This porcupine was only observed in fallow land not burned for more than two years both in Kamsar and Sangarédi.

3.8 Birds

3.8.1 Introduction

Although still limited, knowledge about West African birds has improved during the 21st century. Guinea, for example has been fairly well studied by Ron Demey (Demey and Rainey, 2004, 2006; Demey, 2006). However the only study on the birds of Kamsar and Sangarédi was that of Demey (2006) who inventoried the region of Boulléré and of Kamsar in May 2005.

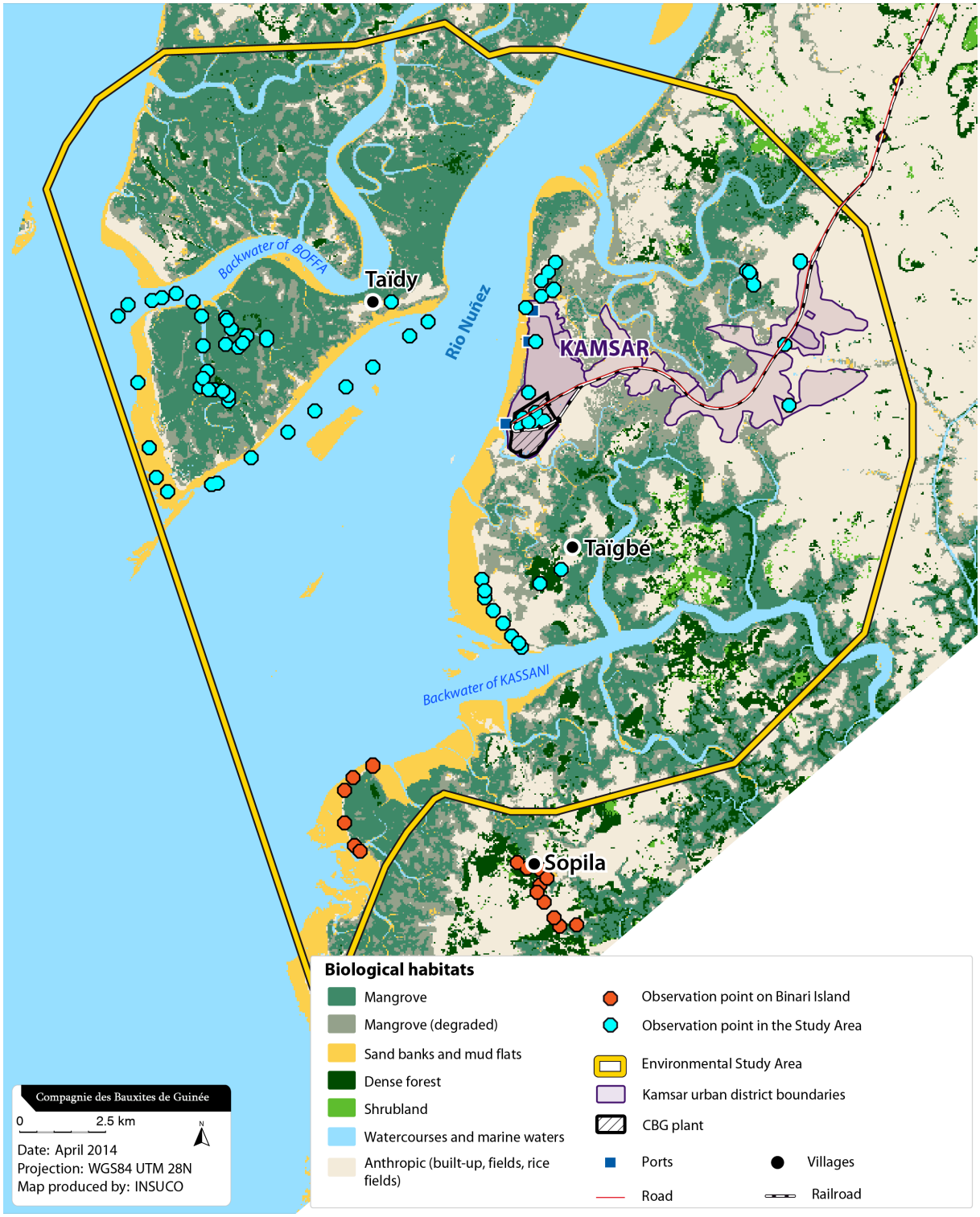
The complete reports on the fieldwork for birds are presented as appendices (Annexes 3-6 and 3-7).

3.8.2 Birds of Kamsar

3.8.2.1 Introduction

Inventories of birds at Kamsar were undertaken between November 11 and 16, 2013, at the beginning of the dry season. Several sites were inventoried during this study (Map 3-21), including Kamsar, the Island of Binari and Sopila to south (reference area), Taïgbé, Kassimakoro and Taïdi. The sites included diverse habitats, such as beaches, mud flats, forests and degraded habitats. The inventories covered the majority of habitats in the Study Area so as to maximize the identification of the bird species using them.

Map 3-21 Bird observation points at Kamsar



3.8.2.2 Inventory methodology

The birds were identified visually (binoculars and telescopes) and/or by their songs or calls during circuits through the habitats within the inventoried sites. Field guides were used for identification and if a particular species could not be identified, photographs were taken for later study. In dense forest visual observation was difficult given the density of the vegetation cover. In these environments, birds were identified more by their songs and calls. The circuit was recorded on a GPS. Some birds caught by the camera traps for the mammal survey, were added to the inventory.

As mentioned earlier, a maximum of habitat types were inventoried in the different sites so as to maximize knowledge of bird use of the territory. These habitats were defined according to the classification suggested by Royal Botanic Gardens (KEW), based on White's (1983) classification (see Section 3,2). The description of these habitats can be found in the sections on habitats and vegetation (3.2 and 3.3).

For Kamsar, the aquatic birds, notably the migratory congregatory species were particularly important and particular efforts were made to survey them visually.

3.8.2.3 Analysis

The findings were compared against internationally recognized criteria, notably those that are used to describe Important Bird Areas (Fishpool and Evans 2001). This assesses the importance of a site based on criteria for threatened species, species representativeness in different plant biomes and congregatory species. The thresholds in Wetlands International (2014) were used to identify which congregatory species surpassed 1% biogeographic totals and would thus potentially qualify the site as an Important Bird Area. All results are reviewed in the context of national and regional avifaunas.

3.8.2.4 Results

In total, 132 species of birds were identified in the Study Area. The list of these 132 species is in Rainey et al. (2014) (Annexe 3-7 of the present study). By combining these species with those identified by Demey in 2006, 195 species are now known from the Kamsar subprefecture, representing approximately 29% of Guinea's avifauna. Twenty-eight Palearctic species were identified during this study.

The following tables show the species inventoried for each of the main sites studied. Table 3-21 shows the total number of species by site and Table 3-22 the number of congregatory birds.

Table 3-21 Number of bird species from sites inventoried at Kamsar

	Binari	Taïgbé	Kassimakoro	CBG plant	Sopila	Taïdi
Number of species	32	66	94	32	47	21

Table 3-22 Estimates of congregatory bird species by habitats at Kamsar

Species	Taïgbé	Sopila	Taïdi
	12/11/2013	15/11/2013	16/11/2013
Phalacrocorax lucidus	2		
Phalacrocorax africanus	2		
Tigriornis leucolophus			1
Egretta gularis	1	1	2
Egretta garzetta	3		
Ardea cinerea	7		1
Ardea goliath			1
Pandion haliaetus		1	

Species	Taïgbé	Sopila	Taïdi
Haliaeetus vocifer		1	
Gypohierax angolensis	1		7
Haematopus ostralegus	3	7	
Charadrius hiaticula	2 600	330	
Charadrius alexandrinus	2		
Charadrius marginatus	2	110	
Pluvialis squatarola	850	19	
Calidris canutus	420	140	
Calidris alba	355	1 630	
Calidris minuta		30	
Calidris ferruginea	230	760	
Limosa limosa		1	
Limosa lapponica	250	1 020	
Numenius phaeopus	960	380	1250
Numenius arquata	160	1	
Tringa totanus	150	4	11
Tringa nebularia	1	1	
Actitis hypoleucos	12	4	
Arenaria interpres	1	6	
Gelochelidon nilotica	120	160	
Sterna maxima	3	1	10
Sterna hirundo	2	5	
Sterna albifrons	70	60	50
Chlidonias niger		8	

3.8.2.5 Species of concern

The species considered below are those that have been surveyed in the Study Area and are either:

- considered as threatened according to the IUCN Red List, that is either *Vulnerable*, *Endangered* or *Critically Endangered*;
- species seen for the first time in Guinea; or
- species with restricted ranges.

Threatened species

Two species considered *Endangered* according to the IUCN are present:

- **Hooded Vulture** *Necrosyrtes monachus*. This species was observed at four site at Kamsar, including coastal and degrade sites. See section 3.8.3.6 for a photograph of this species.
- **African white-backed vulture** *Gyps africanus*. This species was observed at Taïgbé. See section 3.8.3.6 for a photograph of this species.

Two species identifed as *Near Threatened* according to the IUCN are present:

- **Black-tailed godwit** *Limosa limosa*. An individual was observed at the beach at Sopila.
- **Eurasian curlew** *Numenius arquata*. Observed at three site,including a flock of 160 individuals at Taïgbé.

New species for Guinea

Two species not previously observed in Guinea were found:

- **African Mourning Dove** *Streptopelia decipiens*. This species was observed in Kassimakoro and Ketapa. This species was also observed in Sangarédi (see report). Closest previous observations are from northern Guinea-Bissau and southern Senegal (Borrow & Demey 2010).

- **Subalpine Warbler** *Sylvia cantillans*. This species was observed at Kassimakoro on 13 November. This is the first observation of this species in Guinea. Closest previous observations are from northern Guinea-Bissau and southern Senegal (Borrow & Demey 2010).

Species with restricted ranges

No restricted-range species were identified during this study, although Turati's Boubou *Laniarius turatii*, which is known only from Guinea, Sierra Leone and Guinea-Bissau was found at Sopila.

3.8.2.6 Habitat assessment

Congregatory species

Counts were made of a number of congregatory waterbirds (Table 3-22). Sanderling *Calidris alba* was counted in numbers (1,630 individuals) which exceed the 1% biogeographic population total (1,200 individuals). Four other species had numbers that were close to the 1% biogeographic total:

- Ringed plover *Charadrius hiaticula* 2,600 counted, 2,800 1% total;
- White-fronted Plover *C. marginatus* 110 counted, 120 1% total;
- Whimbrel *Numenius phaeopus* 2,590 counted, 2,500 1% total;
- Gull-billed Tern *Gelochelidon nilotica* 160 counted, 170 1% total (Wetlands International 2014).

Biome species

Nine Sudan-Guinea (SG) Savanna biome species are now known from the site, 26% of the total of 35 known from Guinea (Robertson 2001, Borrow and Demey 2010). This indicates that this site is of moderate importance for birds of this biome. These species are generally found in grassland and wooded grassland. Combined with data from Demey (2006), 17 Guinea-Congo (GC) Forest biome species are known from Kamsar. This is 10% of the approximately 168 GC biome species known from

Guinea (Robertson 2001, Borrow and Demey 2010) suggesting it is of low importance for this biome.

3.8.2.7 Conclusions

The Kamsar sous-prefecture is of relatively high importance for birds in international terms. The large numbers of waterbirds counted indicate that this site is of international importance for birds, including *Calidris alba* that surpasses the 1% biogeographic total and three species that are close to their 1% totals (Wetlands International 2014). In addition there is the presence of two *Endangered* species and a good representation of Sudan-Guinea Savanna biome species.

It qualifies as an Important Bird Area (IBA) (Fishpool and Evans 2001) on the basis of internationally important numbers of waterbirds, because of the threatened species and the Sudan-Guinea Savanna biome-restricted species found here. In addition, It has mangrove and inter-tidal habitats which are important for many species and it is bordered on the south by the Rio Kapatchez Ramsar site.

Photo 3-23 Royal tern, Sandwich tern, common tern, bar-tailed godwit, and dunlin

3.8.3 Birds of Sangarédi

3.8.3.1 Introduction

This bird study in Sangarédi subprefecture took place from November 16 to 22, 2013. This period is at the beginning of the dry season and corresponds to the beginning of the northern European winter. Fifteen Palearctic migratory species were identified in the Study Area. Demey (2006) had found only three Palearctic species, because his surveys were in May when these migrants are practically absent. The number of migratory species recorded is fairly low.

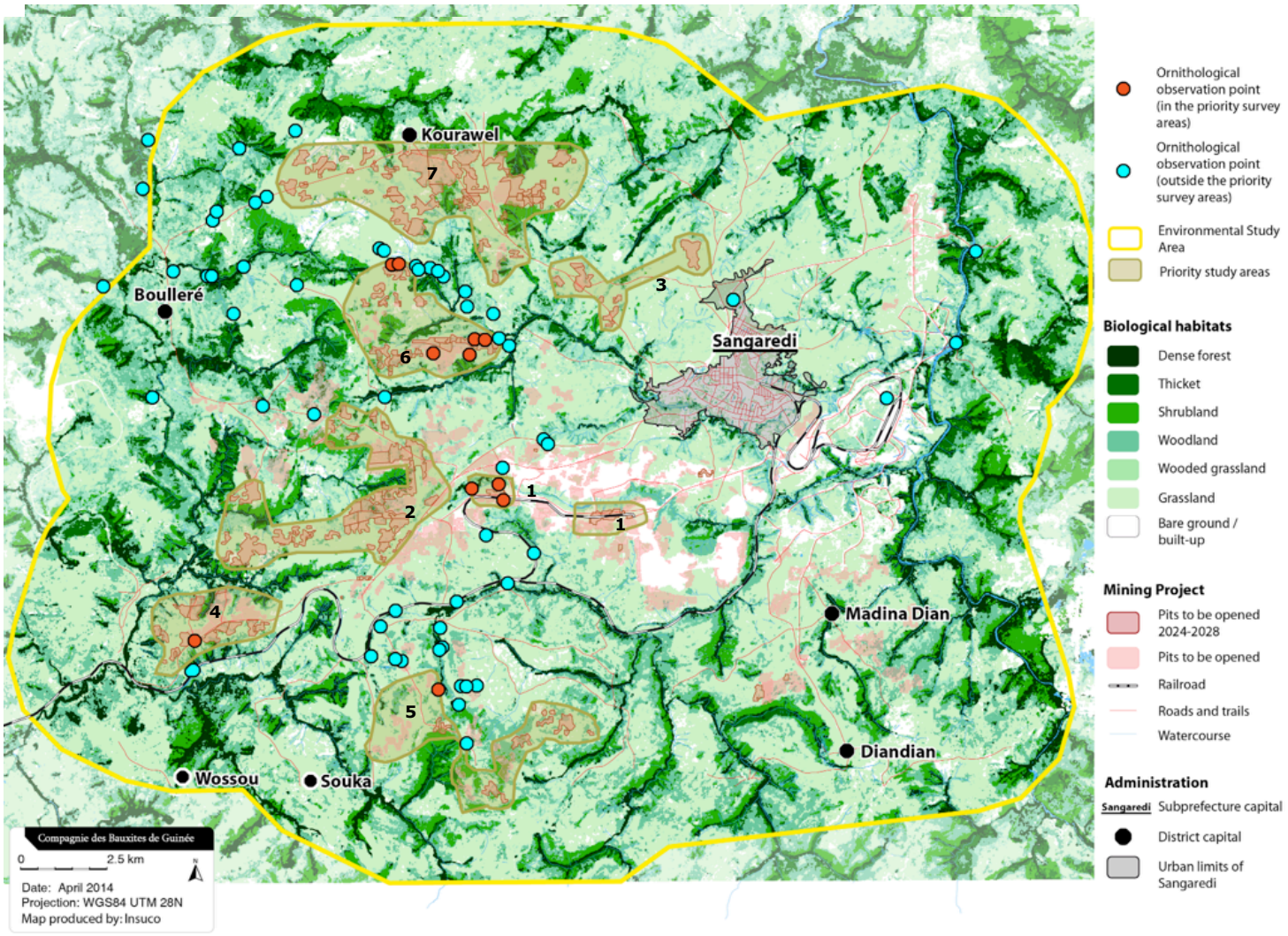
Six sites were inventoried (Map 3-22) for this study. They were composed of diversified habitats including grassland formations (including bowés), wooded grassland formations and forests degraded by anthropic activities. The inventories covered the majority of habitats found in the Study Area so as to maximize the identification of birds using them.

3.8.3.2 Inventoried sites

Five of the six sites inventoried are located in the potential CBG expansion zone for bauxite production. These are sites 1, 4, 5, 6 and 7 (Map-22). The sixth site is Boulléré, considered as a reference site (see Section 3.1). During the site inventories, observations of birds close to these sites were also noted as to identify the largest number of bird species using the Study Area.

Access to several areas was difficult given the presence of long and dense grasses. Access is easier after burning. The Study Area included few flooded grasslands and marshy areas and this is reflected in the number of species noted from these habitats. Access to forest was also not easy, and the bird diversity in this habitat maybe b different than the one found in this study.

Map 3-22 Bird observation points at Sangarédi



3.8.3.3 Habitats

As mentioned earlier, a maximum of habitat types were inventoried in the different sites so as to maximize knowledge of bird use of the territory. The analysis of bird observations is based on 11 habitats. These habitats were defined according to the classification suggested by Royal Botanic Gardens (KEW), based on White's (1983) classification (see Section 3,2). The description of these habitats can be found in the

sections on habitats and vegetation (3.2 and 3.3). Within the context of this study an additional habitat type was added to White's (1983) classification based on the particularities of birds: the aerial habitat. When a bird was observed flying above a habitat without necessarily using it, it was associated with this aerial habitat.

3.8.3.4 Inventory methodology

The birds were identified visually (binoculars and telescopes) and/or by their songs or calls during circuits through the habitats within the inventoried sites (sites 1, 4, 5, 6, 7 and Boulléré). Field guides were used for identification and if a particular species could not be identified, photographs were taken for later study. In dense forest visual observation was difficult given the density of the vegetation cover. In these environments, birds were identified more by their songs and calls. In case of doubt the vocalizations were recorded for later comparison with the recordings by Chappuis (2000).

The circuits were recorded on a GPS and shown on Map 3-22. Some birds caught by the camera traps for the mammal survey, were added to the inventory. However the seven species captured by the cameras had also been observed in the Study Area by the bird study team.

3.8.3.5 Results

In total 183 bird species were identified from the Study Area, including 75 new species for the subprefecture. Of this total, 108 species are in common with those identified by Demey in 2006.

The list of the 183 species is in Rainey et al. (2014) (Annexe 3-6 of the present study).

Table 3-23 shows the number of species inventoried for each of the sites studied.

Table 3-23 Number of bird species by sites at Sangarédi

Site inventoried	Site 1	Site 4	Site 5	Site 6	Site 7	Environs des sites	Boulléré
Number of species	6	78	102	79	103	82	90

Combined with Demey (2006), a total of 215 species are known from the survey area, approximately 32% of the avifauna of Guinea. According to Avibase (http://avibase.bsc-eoc.org/checklist.jsp?region=gn&list=clements), there are 729 species in Guinea. The *Monographie Nationale sur la diversité biologique* (Bah *et al.*, 1997), reports 518 species.

The most diverse site was found to be site 7 with 103 species observed, followed by site 5 with 102 species and then Boulléré with 90 species.

The species found in each habitat are summarized in Table 3-24. A species can be found in more than one habitat, thus the total number of species in all habitats is greater than the total number of species found during this study. Woodland supports the most diverse avifauna (88 species) and grassland also supports a relatively diverse bird community (52 species). The list of species found in each habitat is in Rainey et al. (2014) (Annexe 3-6 of the present study).

Table 3-24 Number of species found in each habitat type in this study at Sangarédi

Habitats	Bowal	Grassland	Wooded grassland	Shrubland	Thicket	Bushland	Woodland	Dense forest	Wetland	Aerial	Village, town
Number of species	24	52	52	7	10	19	88	32	10	31	13

Of the total species found in the present study, 14 are Sudan-Guinea (SG) Savanna biome species. Combined with those found by Demey (2006) there are 17 SG biome species known from the subprefecture, 49% of the total of 35 known from Guinea (Robertson 2001, Borrow and Demey 2010). This indicates that this site is of high importance for birds of this biome. Most of these species are found in grassland and wooded grassland.

On the other hand, 22 are Guinea-Congo Forests (GC) biome species. Combined with those from Demey (2006) there are now 23 GC biome species known from Sangarédi. This is 14% of the approximately 168 GC biome species known from Guinea (Robertson 2001, Borrow & Demey 2010). Most of these species were found in degraded forest, wooded grassland, thicket and bushland.

In view of the relatively high diversity of habitats, species typical of dense forest such as red-tailed greenbul *Criniger calurus* and grey-headed bristlebill *Bleda canicapillus* as well as species of bowal such as tour-banded sandgrouse *Pterocles quadricinctus* and chestnut-backed sparrow lark *Eremopterix leucotis* were observed.

3.8.3.6 Species of concern

The species considered below are those that have been surveyed in the Study Area and are either:

- considered as threatened according to the IUCN Red List, that is either *Vulnerable*, *Endangered* or *Critically Endangered*;
- species seen for the first time in Guinea;
- species with restricted ranges; or
- species whose presence in the Study Area represents a significant range extension.

According to the IUCN *Red List*, there are 18 threatened species in Guinea (IUCN, 2013) and according to the *sur la diversité biologique* (Bah et al, 1997), there is one vulnerable species, 27 species and 2 genera in peril. Three species considered in peril on the *Monographie Nationale* list were observed during this study: *Gypohierax angolensis*, *Gyps rueppellii* and *Circaètes cinereus.* However the *Monographie Nationale* list must be considered with reserve since some errors slipped in. For example, for birds *Gyps bengalensis* is listed as in peril whereas this species only occurs Southeast Asia.

Threatened species

Four threatened species were observed during this study, three considered *Endangered* and one considered *Vulnerable* according to the IUCN.

Hooded vulture *Necrosyrtes monachus*

This *Endangered* vulture species was the most commonly observed of the three vulture species in this study. Over 30 individuals could be seen in Sangarédi town each day and almost all villages seemed to have a pair of these birds. It was less commonly seen away from human habitation. It can be found in 40-odd African countries, mainly associated with populated areas, although it also frequent grasslands, wooded or not, forest edges and coastal areas. It is mainly necrophagous but it also eats insects. The species nests year round but mainly between November and July in West Africa (BirdLife International 2012. *Necrosyrtes monachus* in IUCN, 2013). The nest, that seems to be re-used yearly by this vulture is not placed on the top of a tree, unlike most vultures. It is located in the fork of an acacia, a palm, an ebony tree, a baobab or other tree.

Photo 3-24 Hooded vulture

© H. Rainey

African white-backed vulture *Gyps africanus*

Twenty-six individuals were seen soaring in a flock with Hooded and Rueppell's Griffon Vultures.

Birds in this flock came down to sit in trees near Hamdallaye village, possibly near a carcass although this was not observed. The habitat in this area was mostly grassland or wooded grassland with some trees and bowal nearby. No other observations were made of this species. A local herder indicated that people lived alongside vultures without conflict.

The necrophagous species, considered as *Endangered*, is also found in close to 40 African countries. It frequents wooded grassland with a preference of environments with acacia trees. It nests in large trees in loose colonies (BirdLife International 2012. *Gyps africanus* in IUCN, 2013), often along a watercourse. These are vultures that tend to stay away from towns and villages and that are often found in association with herds of large mammals and intensive livestock ranches. In West Africa this vulture nests year round with a peak between October and June (http://www.oiseaux.net/oiseaux/vautour. africain.html).

Photo 3-25 African white-backed vulture

© H. Rainey

Rueppell's griffon vulture *Gyps rueppellii*

Three individuals were seen in the same flock as the White-backed Vultures. No other observations were made of this species. This necrophagous species is considered *Endangered*.

It is found in nearly 30 African countries, frequnting open habitats with acacias, grasslands and mountainous areas. It generally nests in colonies on ledges of cliffs or escarpments BirdLife International 2012. *Gyps rueppellii*. in IUCN, 2013). In the north of Cameroon the species nests in trees (http://www.oiseaux-birds.com/fiche-vautour-ruppell.html).

Photo 3-26 Rueppell's griffon vulture

© H. Rainey

Beaudouin's snake eagle *Circaetus beaudouini*

A single individual of this species, considered *Vulnerable* was seen in site 7.

The species, found in fewer than 20 African countries, has a preference for grasslands and cultivated lands. This snake eagle is found in a narrow Sub-Saharan band oriented east-west and including the north of Guinea (BirdLife International 2012. *Circaetus beaudouini* in UICN, 2013). It is generally solitary and reproduces between November and March. The nest is built at the top of a large tree such as an acacia, euphorbia or afzelia. It is presumed that it feeds primarily on snakes, like the other species of this genus. A diet completed by lizards and small mammals and even birds and insects occasionally (www.oiseaux.net/oiseaux/ circaete.de.beaudouin.html).

Discussions are underway for a new assessment of the status of this species that could pass from *Vulnerable* to *Endangered*.

Birds not previously observed in Guinea

African mourning dove *Streptopelia decipi*

This species was observed at site 5. It was also observed in Kamsar (Rainey and Soumah, 2014 – Section 3.8.2.5). Closest previous observations are from northern Guinea-Bissau and southern Senegal (Borrow and Demey 2010).

This species is considered to be of Least Concern by the IUCN. It has a large range and is present in about 35 African countries (BirdLife International 2012. *Streptopelia decipiens*. in IUCN 2013).

Rufous-naped lark *Mirafra africana* putatively ssp. *batesi*

The species, present in fewer than 30 African countries is considered of Least Concern by the IUCN (BirdLife International 2012. *Mirafra africana*. in UICN, 2013).

Within the context of this study it is the likely, but not certain observation of a subspecies (*M. a. batesi*) that had not yet been recorded from Guinea. A different subspecies *M. a. henrici* is known from the grasslands of the Mont Nimba region and

the Pic de Fon in Guinea (Keith et al. 1992, Demey and Rainey 2004). The individual, observed on a bowal at an altude of about 250 m was apparently paler, with less black on the wings than *M. a. henrici*, and the two-note calls were typical of *M. africana*. However the coloration of the plumage of this species can vary according to the ground where it is found.

The closest confirmed population of the most similar subspecies *M. a. batesi* is in Nigeria (Borrow and Demey 2010) and it is possible that it is this subspecies. However, there is currently insufficient knowledge of this population to confirm its taxonomy.

Photo 3-27 Rufous-naped lark

© H. Rainey

Banded martin *Riparia cincta*

One banded martin was observed flying over grassland in a flock of other swallow species, some distance from wetland habitat where it might typically be observed. This species had not previously been confirmed in Guinea. It is known from surrounding countries and as a typically mobile species in the swallow family Hirundinidae, it is remarkable that it had not previously been observed within the country.

Species of restricted range

No restricted-range species were identified during this study, although Turati's boubou *Laniarius turatii*, which is known only from Guinea, Sierra Leone and Guinea-Bissau was common

Species with range extensions

Six species with significant range extensions were observed.

Grey-throated Rail *Canirallus oculeus*

Two individuals were recorded at two separate sites by camera traps in scrubby degraded forest. This species was previously known from the *Guinée Forestière* region and from Sierra Leone (Borrow and Demey 2010).

African crake *Crex egregia*

A single individual was seen on a bowal close to the main road on the track to site 7. This species was previously known from the *Guinée Forestière* region and from Sierra Leone (Borrow and Demey 2010).

Blue-headed wood dove *Turtur brehmeri*

This species was observed in site 5. This species was previously known from the *Guinée Forestière* region and from Sierra Leone (Borrow and Demey 2010).

Yellow-throated tinkerbird *Pogoniulus subsulphureus*

This species was observed in forest in Zone 5. This species was previously known from the *Guinée Forestière* region and from Sierra Leone (Borrow and Demey 2010).

Black-winged bishop *Euplectes hordeaceus*

This species was found widely across the study area in breeding plumage. Demey (2006) identified a bishop *Euplectes* sp., but was not able to allocate it to a species. Given that in non-breeding plumage, the bishops are very difficult to identify, it is likely that the individuals observed by Demey (2006) were this species.

Red-collared widowbird *Euplectes ardens*

At least two individuals and probably at least four were seen in dense farmbush in site 4. This species was previously known from the *Guinée Forestière* region and from Sierra Leone (Borrow and Demey 2010).

3.9 Reptiles

3.9.1 Introduction

The reptiles of West Africa have been the subject of two relatively recent general publications: one on snakes (Trape and Mané, 2006) and the other on turtles, crocodiles and lizards (Trape et al., 2012). Chirio (2012) carried out a more specific study on the reptiles of the Sangarédi area. Finally, another recent study on the reptiles of the *Guinée Forestière* (Böhme *et al*., 2011) presents a list of species known from the country.

The complete reports for the fieldwork for reptiles are included as appendices (Annexes 3-8 and 3-9).

3.9.2 Reptiles of Kamsar

3.9.2.1 Inventoried sites and habitats

For the present study, the inventories for reptiles in the Kamsar area took place between October 19 and 24 2013, at the end of the rainy season and beginning of the dry season.

Ten sites were summarily inventoried and are shown on Map 3-23. They sites were composed of diversified habitats including forest, mangrove and anthropic formations according to White's classification (1983).

The present text does not include the marine crocodiles and turtles discussed in detail in another report (Weir, 2013 Annexe 3-2).

Map 3-23 Reptile observation points at Kamsar

Each of the ten sites included a variety of habitats as detailed on Table 3-25.

Table 3-25 Habitats of inventoried sites for reptiles at Kamsar

Inventoried site	Forest	Mangrove	Anthropic formation (rice fields, lowlands, plantations)	Anthropic formation (villages, built-up)
SK1		x		x
SK2	x	x	x	x
SK3		x		
SK4				x
SK5				x
SK6				x
SK7		x		x
SK8	x		x	
SK9	x		x	x
SK10		x	x	

3.9.2.2 Inventory methodology

The inventory took place during the day and the night by prospecting the different habitats by visual observation of the reptiles. Additionally, villagers were made responsible for the collection of reptiles (especially snakes) killed or found dead. The villagers of Taïdi, Taïgbé and Sopila were sensitized to this harvest. Captured specimens were preserved in alcohol to be given later to a member of the field team for identification.

3.9.2.3 Results

Table 3-26 shows the 15 species of reptiles identified in the Study Area. Including the three species of marine turtles, the species of freshwater/brackish water turtle and the West African Nile crocodile, discussed in the section on marine mammals, turtles and crocodiles (Section 3.4), the number of reptile species in the Study Area becomes 20.

Table 3-26 Distribution of reptile species at Kamsar by sites studied

Species		SK 1	SK 2	SK 3	SK 4	SK 5	SK 6	SK 7	SK 8	SK 9	SK 10
Latin name	**French name**										
Pelusios castaneus	Péluse de Schweigger		x							x	x
Agama agama	Agame des colons	x			x						
Chamaeleo gracilis	Caméléon gracile			x				x			
Hemidactylus albivertebralis	Gecko à ligne claire	x									
Hemidactylus angulatus	Gecko commun africain		x								
Hemidactylus mabouia	Gecko des maisons	x									
Trachylepis affinis	Mabouya du Sénégal		x	x		x		x			x
Trachylepis perroteti	Mabouya de Perrotet		x			x	x		x		
Varanus niloticus	Varan du Nil		x						x	x	
Philothamnus irregularis	Philothamne irrégulier										x
Thrasops occidentalis	Thrasops occidental		x								
Toxicodryas blandingii	Boïga de Blanding		x								

Species		SK 1	SK 2	SK 3	SK 4	SK 5	SK 6	SK 7	SK 8	SK 9	SK 10
Naja nigricollis	Cobra cracheur à cou noir		x								
Lycophidion albomaculatum	Lycophidion tacheté	x									
Psammophis sibilans	Psammophis sifflant		x							x	

[1] This table does not include the marine and brackish water species discussed in Weir (2013) (Annexe 3-2) namely thrre species of marine turtles (grren turtle, hawksbill turtle, and olive ridley), the West African Nile crocodile and the Nile softshell turtle.

It can be noted on Table 3-26 that more than half of the species surveyed were on Taïgbé Island (SK 2), which is understandable given that this site included the four targeted habitats in the Study Area and that the villagers there collected several species. On the other hand, *Trachylepis affinis* is found in most of the inventoried sites, taking into account its anthropophilic nature.

Table 3-27 presents the distribution of the species of reptiles based on the habitats inventoried. The anthropic formation is the richest in terms of species with 11 of the 15 species surveyed for this study present. It should be noted that species noted in captivity (*Pelusios castaneus*) and those collected by the villagers (*Thrasops occidentalis*, *Toxicodryas blandingii* and *Naja nigricollis*) are not associated with specific habitats since their capture location is not known.

Table 3-27 Distribution of reptiles at Kamsar by habitat[1]

Species	Mangrove	Forest	Anthropic formation (rice fields, lowlands, plantations)	Anthropic formation (villages, built-up)
Pelusios castaneus				
Agama agama				X
Chamaeleo gracilis		X		x
Hemidactylus albivertebralis				X
Hemidactylus angulatus		X		X

Species	Mangrove	Forest	Anthropic formation (rice fields, lowlands, plantations)	Anthropic formation (villages, built-up)
Hemidactylus mabouia				X
Trachylepis affinis	X		x	
Trachylepis perroteti				X
Varanus niloticus	X		X	
Philothamnus irregularis			x	
Thrasops occidentalis				
Toxicodryas blandingii				
Naja nigricollis				
Lycophidion albomaculatum		X		X
Psammophis sibilans	X		X	
Total	3	3	4	7

[1] This table does not include the marine and brackish water species discussed in Weir (2013) (Annexe 3-2) namely thrre species of marine turtles (grren turtle, hawksbill turtle, and olive ridley), the West African Nile crocodile and the Nile softshell turtle.

Table 3-28 compares the results of the reptile species surveyed during the fieldwork with the species collected by the villagers. The collection by the villagers added three species of reptiles (or 20% of the total species surveyed) to the general list of species from the Study Area, all collected on Taïgbé Island.

Table 3-28 Comparaison between reptile species surveyed during fieldwork and those collcted by villagers

Species	Fieldwork	Collection by villagers
Pelusios castaneus	X	X
Agama agama	X	
Chamaeleo gracilis	X	
Hemidactylus albivertebralis	X	
Hemidactylus angulatus	X	

Species	Fieldwork	Collection by villagers
Hemidactylus mabouia	X	
Trachylepis affinis	X	X
Trachylepis perroteti	X	
Varanus niloticus	X	
Philothamnus irregularis	X	X
Thrasops occidentalis		X
Toxicodryas blandingii		X
Naja nigricollis		X
Lycophidion albomaculatum	X	
Psammophis sibilans	X	X
Total	**12**	**7**

Böhme et al. (2011) reports that there are 128 reptile species in Guinea of which 7 turtles, 30 lizards, 88 snakes and 3 crocodiles. The *Monographie Nationale sur la diversité biologique* (Bah et al., 1997) lists 140 species but does not present the list of the species.

Chirio (2012), during an inventory of reptiles southeast of Sangarédi had found 74 species of reptiles during three missions spread out over six months between September 6 2010 and March 4 2011.

The reptiles of the Kamsar area seem at first glance to be not very diversified with only 20 species in the Study Area (including marine turtles and crocodiles), however these are only very partial results and longer work in the area would certainly have resulted in more species, particularly among the snakes. Snakes are difficult to observe and capture during such a short mission.

3.9.2.4 Biogeography of the species found

Among the species of reptiles from the Kamsar area are species of wide distribution that are of the Sudan-Guinea Savanna biome: *Pelusios castaneus*, *Chamaeleo gracilis*, *Hemidactylus angulatus*, *Trachylepis affinis*, *T. perroteti*, *Varanus niloticus*, *Philothamnus irregularis*, *Naja nigricollis* and *Psammophis sibilans*.

Agama agama and *Hemidactylus mabouia* also have a wide distribution and very anthropophilic and follow humans into natural habitats.

Only two species, *Hemidactylus albivertebralis* and *Lycophidion albomaculatum*, have a more reduced distribution and they are endemics of the most western part of West Africa.

Finally two snake species identified during the inventories in the Kamsar region have definite forest affinities. One (*Toxicodryas blandingii*) is found in the forests of West Africa as well as Central Africa. The other one (*Thrasops occidentalis*) is endemic to the West African forests from the south of Senegal to the west of Ghana.

The savana biome species are thus largely in the majority in the Study Area but some typically forest species are present coming in through the gallery forests in the area.

3.9.2.5 Species of concern

None of the species presented on Table 3-27 are listed as Critically Endangered, Endangered or Vulnerable according to IUCN criteria. *Hemidactylus albivertebralis* (white-lined half-toed gecko) is classed as Data Deficient but its status will be revise soon (unpublished data).

In the *Monographie Nationale* (Bah et al., 1997), the West African mud turtle (*Pelusios castaneus*, under the name *Pelosis niger*) and the Nile monitor (*Varanus niloticus*) are considered threatened while the common bush snake (*Philothamnus irregularis*, under the name *Elaps irregularis*) are considered vulnerable.

None of the species of reptiles identified is endemic to Guinea and none is new to science.

Photo 3-28 White-lined half-toed gecko *Hemidactylus albivertebralis*

© L. Chirio

3.9.3 Reptiles of Sangarédi

3.9.3.1 Inventoried sites and habitats

The inventories for reptiles in the Sangarédi region for this study took place from October 24 to November 1 2013, at the end of the rainy season and the beginning of the dry season.

Twenty sites were inventoried (Map 3-24). They were composed of diversified habitats (Table 3-29) including dense forest, woodlands, bushland, thickets, shrubland, grassland, wooded grassland, aquatic and wetland vegetation and anthropic formations (according to White, 1983). For more details on the composition of these vegetation types, see the sections on habitats (3.2) and vegetation (3.3).

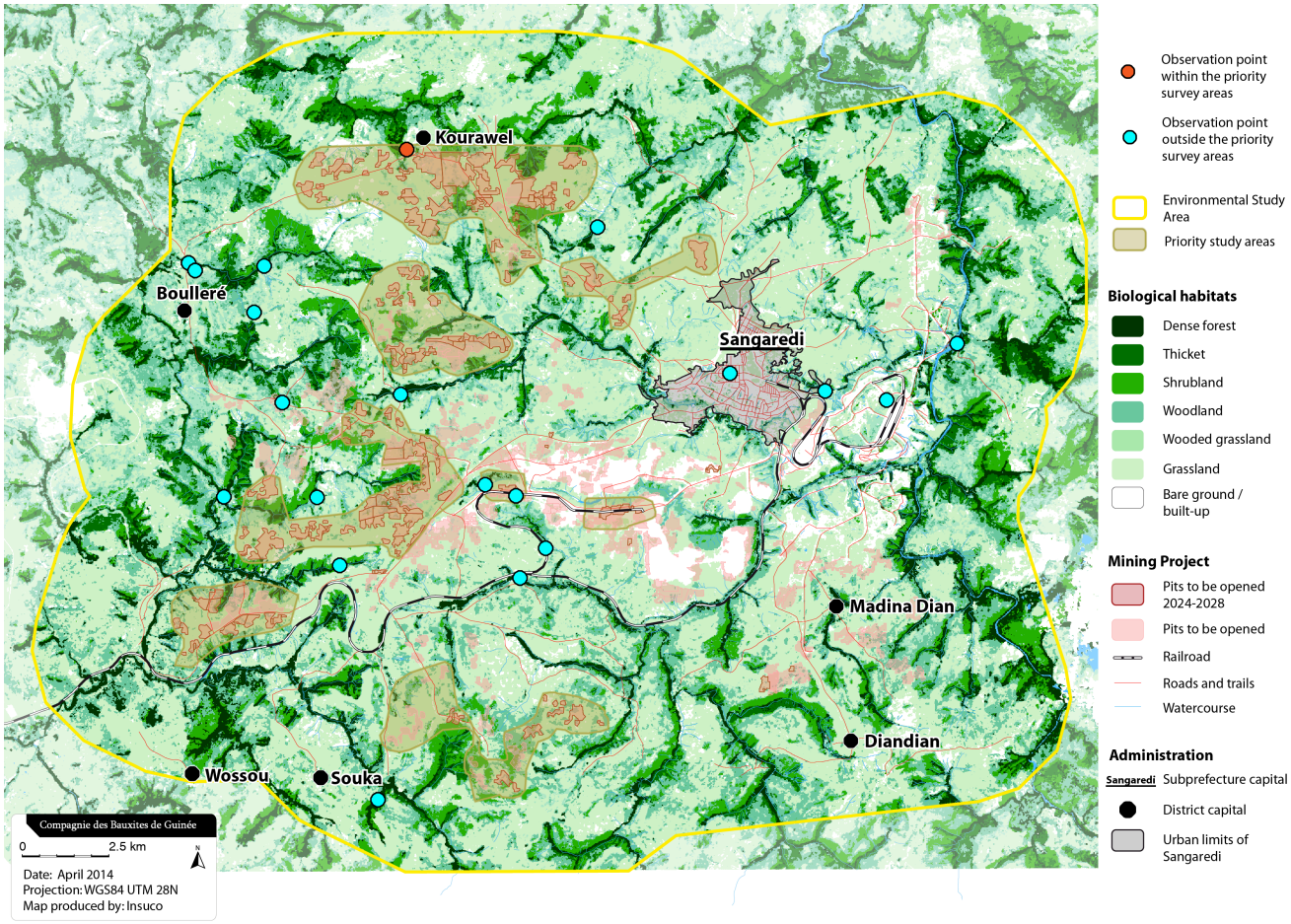
Table 3-29 shows the habitats found in each of the 20 sites inventoried.

Table 3-29 Habitats[1] of the sites inventoried for reptiles at Sangarédi

Inventoried sites	DF	W	BT	S	G	WG	AW	A
SS1				x				x
SS2	x				x		x	
SS3					x	x		
SS4	x					x	x	
SS5								
SS6	x	x		x	x			
SS7	x						x	
SS8				x	x	x	x	
SS9	x	x	x			x	x	x
SS10	x					x	x	
SS11		x		x		x		
SS12	x							
SS13	x	x				x	x	
SS14	x	x						
SS15						x		
SS16	x						x	
SS17	x						x	
SS18	x		x		x		x	
SS19	x	x				x	x	
SS20	x			x	x	x		

[1] Abreviations used on this table for habitats: DF (dense forest); W (woodland); BT (bushland and thicket); S (shrubland); G (grassland); WG (wooded grassland); AW (aquatic and wetland vegetation); A (anthropic).

Map 3-24 Reptile observation points at Sangarédi



3.9.3.2 Inventory methodology

The inventory took place during the day and the night by prospecting the differents habitats by visual observation of the reptiles. Additionally, villagers were made responsible for the collection of reptiles (especially snakes) killed or found dead. Captured specimens were preserved in alcohol to be given later to a member of the field team for identification.

3.9.3.3 Results

Distribution of reptiles at inventory sites

Table 3-30 shows the distribution of the reptiles in terms of the 20 inventory sites.

Sites SS9, SS13, SS15 and SS18 are those where villagers participated in the collection of reptiles, Site SS9 northeast of Boulléré has the highest species diversity (20) followed by Site SS13, near Korawel, with 6 species. At SS13, half of the species noted were collected by villagers whereas at SS18, it was all of the species. The approach of using village collectors thus allows for a more complete understanding of the reptile diversity of an area. For the present study, this led to 8 more species on top of the fieldwork total of 29, or about 22% of the species found.

Distribution of species by habitat

Table 3-31 shows the 37 species of reptiles identified in the Study Area by habitat type. The observations from the Boulléré sites are included in this table. The eight species collected by the villages are not associated with any habitat since their place of capture is not known.

Besides the anthropic formations, the environments with the highest diversity are the dense forest and the wooded grassland with 10 and 13 species each respectively. These two habitats include 22 of the 29 species found in the field.

The dense forest that forms some very shaded galleries along the watercourses permits some species characteristic of the *Guinée Forestière* to make it into the Study Area. The wooded grassland associates species characteristic of grasslands with tree climbing species, accounting for the high biodiversity.

Table 3-30 Distribution of reptiles in the 20 sites inventoried at Sangarédi

Latin name	Presence of the species in the sites inventoried (SS1 to SS20)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Pelomedusa subrufa olivacea		x						x	x	x										
Kinixys nogueyi									x											
Osteolaemus* cf. *tetraspis				x						x						x				
Agama africana	x		x						x											x
Agama agama	x																			
Agama boensis		x	x					x	x											
Chamaeleo gracilis						x				x										
Chamaeleo senegalensis				x					x					x						
Hemidactylus angulatus									x											
Hemidactylus kundaensis													x*							
Hemidactylus mabouia	x																			
Trachylepis affinis							x		x			x							x	
Trachylepis perroteti	x							x	x											
Varanus exanthematicus								x												
Varanus niloticus				x			x									x	x		x	x
Cynisca* cf. *oligopholis																		x*		

Latin name	Presence of the species in the sites inventoried (SS1 to SS20)																			
Python sebae				x																
Crotaphopeltis hippocrepis															x*					
Crotaphopeltis hotamboeia									x											
Dasypeltis confusa									x											
Dipsadoboa unicolor													x*							
Philothamnus irregularis									x		x								x	
Philothamnus pobeguini																			x	
Philothamnus* cf *semivariegatus																		x*		
Dendroaspis poplylepis									x											
Naja nigricollis						x			x											
Grayia smithi									x				x							
Boaedon fuliginosus				x																
Boaedon lineatus									x*				x*					x*		
Afronatrix anoscopus										x			x							
Natriciteres variegata																		x*		
Psammophis elegans									x		x									
Psammophis lineatus									x											
Psammophis sibilans									x				x							x
Bitis arietans						x			x						x					

Latin name	Presence of the species in the sites inventoried (SS1 to SS20)																			
Causus maculatus									x*											
Echis jogeri			x																	
Total	**4**	**2**	**3**	**5**	**0**	**3**	**2**	**4**	**20**	**4**	**1**	**1**	**6**	**1**	**2**	**2**	**1**	**4**	**4**	**2**

*Species with asterisks were only collected by villagers.

Table 3-31 Distribution of species of reptiles at Sangarédi by habitats[1]

Latin name	French name	Habitats where observed							
		DF	W	BT	S	G	WG	AW	A
Pelomedusa subrufa olivacea	Péloméduse roussâtre	x						x	
Kinixys nogueyi	Cinixys de Noguey	x							
Osteolaemus* cf. *tetraspis	Crocodile nain d'Afrique de l'Ouest	x						x	
Agama africana	Agame des forêts					x	x		x
Agama agama	Margouillat								x
Agama boensis	Agame de Boé					x	x		
Chamaeleo gracilis	Caméleon gracile	x	x				x		
Chamaeleo senegalensis	Caméléon du Sénégal	x	x						
Hemidactylus angulatus	Gecko commun africain								x
Hemidactylus kundaensis	Gecko de Kunda								

Latin name	French name	Habitats where observed							
Hemidactylus mabouia	Gecko des maisons								x
Trachylepis affinis	Mabouya du Sénégal	x							x
Trachylepis perroteti	Mabouya de Perrotet			x	x	x			x
Varanus exanthematicus	Varan de savane						x		
Varanus niloticus	Varan du Nil	x						x	
Cynisca* cf. *oligopholis	Amphisbène à peu de dents								
Python sebae	Python de Séba	x							
Crotaphopeltis hippocrepis	Hétérure fer-à-cheval								
Crotaphopeltis hotamboeia	Hétérure commune	x						x	x
Dasypeltis confusa	Mangeur d'œufs confondant		x	x			x		
Dipsadoboa unicolor	Dipsadoboa unicolore								
Philothamnus irregularis	Philothamne irrégulier		x	x			x		
Philothamnus pobeguini	Philothamne de Pobegine		x						
Philothamnus* cf *semivariegatus	Philothamne tacheté								
Dendroaspis poplylepis	Mamba noir						x		
Naja nigricollis	Cobra cracheur à cou noir				x	x	x		x
Grayia smithi	Couleuvre aquatique de Smith							x	
Boaedon fuliginosus	Boaedon des maisons						x		x
Boaedon lineatus	Boaedon ligné								

Latin name	French name	Habitats where observed							
Afronatrix anoscopus	Couleuvre des ruisseaux	x						x	
Natriciteres variegata	Couleuvre des marais variable								
Psammophis elegans	Psammophis élégant		x	x	x		x		
Psammophis lineatus	Psammophis ligné						x		x
Psammophis sibilans	Psammophis sifflant			x	x	x	x		
Bitis arietans	Vipère heurtante		x	x			x		
Causus maculatus	Causus maculé								
Echis jogeri	Echide de Joger					x			
Total		10	7	6	4	6	13	6	10

[1] Abreviations used on this table for habitats : DF (dense forest); W (woodland); BT (bushland and thicket); S (shrubland); G (grassland); WG (wooded grassland); AW (aquatic and wetland vegetation); A (anthropic).

On the other hand, the shrubland formation is the poorest habitat in reptile species. The heavy brush cover restricts the presence of species of open areas and the woody plants not tall enough for the tree climbing species.

The reference site, Boulléré, has a high reptilian diversity since 23 of the 37 species of the Study Area are found there, This high diversity is also linked to the survey effort, since four sites (SS9 to SS12) were visited near the village and two species were collected only by the villagers. In the inventory, seven species were found only in the Boulléré area. The area studied outside of Boulléré this includes 30 species.

Among the species found in the Study Area, ten have a very wide range on the whole continent south of the Sahara, either because they are very anthropophilic and they have followed people with the conversion of natural environments (*Agama agama*, *Hemidactylus mabouia*) or because they have very broad ecological requirements (*Pelomedusa subrufa olivacea*, *Varanus niloticus*, *Crotaphopeltis hotamboeia*, *Dendroaspis polylepis*, *Naja nigricollis*, *Boaedon fuliginosus*, *Psamophis lineatus* and *Bitis arietans*).

Seventeen species occur both in West Africa and Central Africa or beyond (*Kinixys nogueyi, Chamaeleo gracilis, Hemidactylus angulatus, Trachylepis affinis, T. perroteti, Varanus exanthematicus, Python sebae, Crotaphopeltis hippocrepis, Dasypeltis confusa, Dipsadoboa unicolor, Philothamnus irregularis, Grayia smithi, Boaedon lineatus, Natriciteres variegata, Psammophis elegans, P. sibilans* and *Causus maculatus*).

A large majority of these species (31) are typical of the Sudan-Guinea Savanna biome, representing 84% of the species found. Three species only are characteristic of the Guinea-Congo Forest biome, or 8% of the species found.

Diversity and relative importance of different groups of reptiles

Among the 37 species identified in this study, snakes wehre the most diversified group with 21 species (57% of the total), followed by lizards with that are represented by 12 species (32%) of the total, turtles with two species (5% of the total, and finally crocodies and amphisbaenians each represented by only one species (3% of the total).

Eleven reptile species were identified for the region of Kamsar (6) and Sangarédi (5) for the RAP 41 study (Wright et al., 2006) in the Boké prefecture, whereas Chirio (2012) had found 74 species in a study southeast of Sangarédi.

Böhme et al. (2011) reports that there are 128 reptile species in Guinea of which 7 turtles, 30 lizards, 88 snakes and 3 crocodiles. The *Monographie Nationale sur la diversité biologique* (Bah et al., 1997) lists 140 species but does not present the list of the species.

3.9.3.4 Species of concern

Theatened species according to the IUCN

Among the species of reptiles identified in the Study Area, the Kunda half-toed gecko *Hemidactylus kundaensis*, still little known, is classed in the *Critically Endangered* category by the IUCN (2013). It is the only reptile in Guinea in that category. The species seems to be endemic to Guinea. It was observed at four places in the remnant forests of the Fouta Djallon (Chirio, L., 2013).

The amphisbaenian Cassine River worm lizard (*Cynisca oligopholis*) is classified as *Endangered*, and the West African dwarf crocodile (*Osteolaemus* cf. *tetraspis*) is classified as *Vulnerable*.

Species listed in the Monographie nationale

The African savannah monitor lizard (*Varanus exanthematicus*) is on the list of threatened species of the *Monographie nationale sur la biodiversité biologique de la République de Guinée* (Bah et al., 1997), and the Nile monitor (*Varanus niloticus*) are considered threatened while the common bush snake (*Philothamnus irregularis*, under the name *Elaps irregularis*) is considered vulnerable. However the species mentioned in this *Monographie* must always be considered with reserve. *Varanus sebae*, a non-existant species is considered threatened. The *Monographie* was probably referring either to *Varanus niloticus* or to *Pithon sebae*.

Photo 3-29 Kunda half-toed gecko *Hemidactylus kundaensis*

© L. Chirio

Photo 3-30 *Cynisca oligopholis*

© L. Chirio

Photo 3-31 West African dwarf crocodile

© S. Dufour

Endemic species or restricted range species

Five species have a range limited to West Africa (*Osteolaemus* cf. *tetraspis*, *Agama africana*, *Chamaeleo senegalensis*, *Philothamnus* cf. *variegatus* and *Afronatrix anoscopus*), roughly from Senegal to Nigeria. Three species have a distribution limited to extreme western Africa (*A. boensis*, *Philothamnus pobenguini* and *Echis jogeri*), roughly from the south of Senegal to Guinea and western Mali only. The amphisbaenian *Cynisca oligopholis* and the gecko *Hemidactylus kundaensis*, finally appear to be endemics of the Sangarédi subprefecture.

Species new to science or Guinea

Osteolaemus cf. *tetraspis* was confused until now with *Osteolaemus tetraspis* of Central Africa. Recent DNA analyses (Eaton et al., 2009 ; Shirley et al., 2014) show that the West African populations are a distinct species. *Cynisca oligopholis* is a

burrowing species described from the south of Guinea Bissau. The specimens collected during this survey belong to a related taxon that is probably distinct. *Cynisca* cf. *oligopholis* was identified recently from the gallery forests of Sangarédi (Chirio, 2012). *Philothamnus* cf. *variegatus* is a non-described species confused untill now with *Philothamnus variegatus* whose distribution extends to Central, East and South Africa (Trape, pers. comm.).

Photo 3-32 Joger's carpet viper *Echis jogeri*

© L. Chirio

Echis jogeri – this species had not been previously inventoried during preceding work in the region of Sangarédi (Chirio 2012). It belongs to a genus that is frequent in desert and Sahrarian zones and is here at the limit of its range. Its range is

limited to the north of Guinea and the west of Mali. Its hemolytic venom is very virulent and it is a very dangerous snake for humans.

3.10 Amphibians

3.10.1 Introduction

Inventory work on amphibians was done during the months of October, November and December 2013 in different habitats, including dense forest, anthropic formations, grassland and wooded grassland. The inventories allowed the identification of 27 amphibian species in total. The 10 species found in the Kamsar Study Area also occur in the Sangarédi Study Area, where, of the 27 species found, *Phrynobatrachus pinto*i is considered *Endangered* according to the IUCN criteria. Three species are considered *Vulnerable* at the national level ((Bah et al., 1997). Only one species is endemic to Guinea: *Phrynobatrachus pintoi*, observed at Sangarédi. The studies enabled the identification of eight new species for the Sangarédi Study Area. The complete report on the fieldwork is presented in Annexe 3-10.

There is a growing consensus in the scientific community that amphibians during the last decades have undergone a catastrophic decline in different parts of the world (Houlahan et al., 2000; Semlitsch, 2005; Lips et al., 2005). Stuart et al. (2004) state that the number of amphibian species is decreasing at a more rapid rate than that of most mammal and bird species. Amphibians form one of the threatened taxonomic groups among the vertebrates.

According to Bakarr et al. (2001), the loss of biodiversity from Guinea to Togo is mainly due to human activities, the most important being slash and burn agricultures, bush fires, mining and forest harvesting. Even though it has not yet been demonstrated in Africa, it has been shown that climatic changes and certain fungi (*Batrachochytrium dendrobatidis*) can also be responsible for the loss of biodiversity of amphibians (Penner et al., 2013).

The sensitivity of amphibians to environmental changes manifests itself by changes in the numbers of populations of some species, by the composition of their communities, by the change of their sex from pesticide use and by a modification of their diphasic life cycle (Rödel, 2000b; Ernst and Rödel, 2005; Pineda et al., 2005;

Rödel, pers. comm.) and consequently their numbers and diversity is often a good indicator of the quality of the natural environment.

According to Mittermeir *et al.* (1999), the forest ecosystem of *Haute Guinée* (forest zone extending in the west from Dahomey Gap to Sierra Leone), forming a complex of great biological diversity is considered one of the priority areas for the conservation of world biodiversity because of its high rate of endemism. Guinea, an integral part of this ecosystem, has a remarkable amphibian diversity. As an illustration, Greenbaum and Carr (2005) have identified 22 amphibian species in the Parc National du Haut Niger, whereas in the Fouta Djallon, Hillers et al. (2008a) have found 25 species. In the *Forêt Classée du Pic de Fon* (Simandou Mountains region), Rödel and Bangoura (2004) found 33 species, and based on statistical analysis concluded that the region could have 50 to 60 amphibian species. However, among all the geographic regions known to date at the national level, the most important and diversified from the herpetological perspective is the region of Mount Nimba where earlier studies showed the presence of 66 amphibian species (Angel, 1950; Guibé and Lamotte 1958a, b, 1963; Schiøtz, 1967; Lamotte and Ohler, 1997; Rödel, 2000a; Rödel et al., 2004).

On the other hand, data on the amphibians of the Boké region are rare or not yet published. The only existing data on the anuran composition of this region are in the report of Hillers et al. (2006 in Wright et al., 2006) where the authors inventoried 26 species of amphibians exclusively during the dry season.

3.10.2 Methodology

3.10.2.1 Inventory period

The amphibian inventories took place over two distinct periods. The first period extended from October 21 to 31 2013, whereas the second period went from November 20 to December 6 2013 (at the interface of the wet and dry seasons: October to December).

3.10.2.2 Inventoried sites

Thirty-six sites were inventoried in the Project areas, including six sites in the Kamsar Study Area (Map 3-25) and 30 in the Sangarédi Study Area (Map 3-26). Annexe 1 in the report of Doumbia and Camara (2014) (Annexe 3-10), presents the coordinates of each of these sites and contextual data including the date and times of visits and the habitat type.

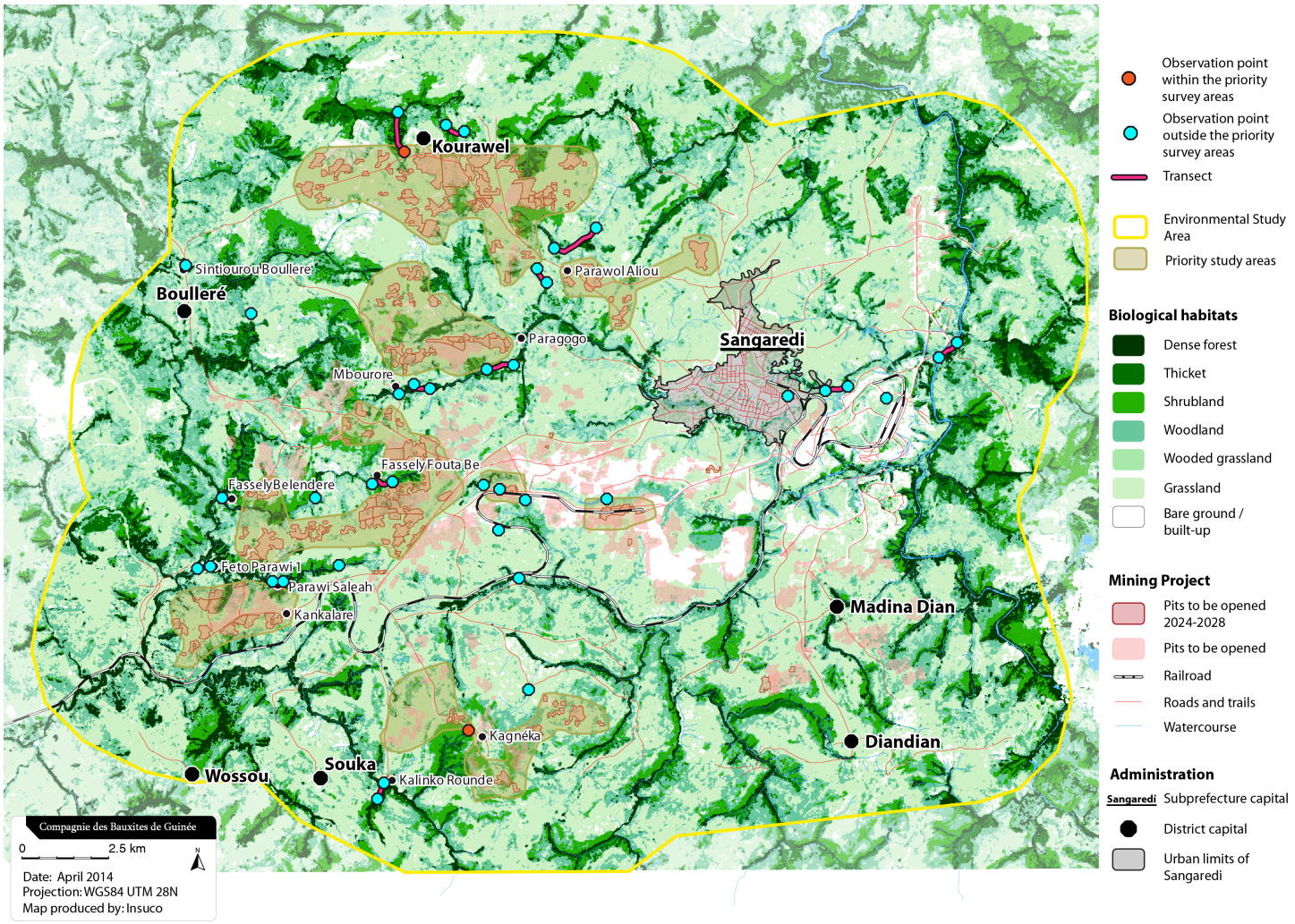
The site names are based on the period of the inventories. For the first period, the sites are labeled KAM (for Kamsar) or SAN (for Sangarédi) followed by a number. For the second period, the sites follow the same approach (KAM or SAN) but followed by a letter rather than a number.

Photo 3-33 *Astylosternus occidentalis*

© J. Doumbia

Map 3-25 Amphibian observation points at Kamsar

Map 3-26 Amphibian observation points at Sangarédi



3.10.2.3 Habitats

The classification of habitats inventoried is based on White (1983), and their description is found in the sections on habitat (3.2) and vegetation (3.3).

The inventoried sites were composed of diverse habitats including, at Kamsar forests and anthropic formations, and, at Sangarédi, grasslands and wooded grasslands on top of the first two.

3.10.2.4 Fieldwork

The random collection method (searching in all directions) proposed by Heyer et al. (1994) and Rödel and Ernst (2004) with direct observations (including the capture of individuals) associated with acoustic observations (listening for specific calls) was used for sampling the amphibians. Given the ecological requirements of amphibians, meaning in general a strong correlation between their presence and wet environments, they were looked for especially in those habitats where ponds, watercourses, lowlands, rice fields and marshy areas were found, or those environments with high humidity in the ground and the air. In these environments, rocks and dead tree trunks are turned over to find and capture the hidden amphibians. In addition, brush, high dense grasses, litter (dead grasses and leaves), burrows, and the canopy and leaves of trees and shrubs were explored. Also, wet cavities of tree and shrub trunks were examined.

During the first period of the study, corresponding to the end of the rainy season and consequently allowing the maintenance of a certain humidity on the ground and temporary ponds, the searching was carried out in diverse habitats. However, during the second period, the searching targeted specifically the remaining wet areas.

During this second period, the watercourses in the different habitats were searched. They were followed going from the downstream part and working upstream searching for amphibians and the geographic coordinates, at the beginning and end of the search were recorded with a GPS when the distance was more than 200 m (annexe 1 of the Doumbia et Camara, 2014, report). For a distance of less than 200 m, a single GPS point was taken.

The investigations took place during the day from 9:00 and 18:00 and at night from 19:00 to 23:00. When it was impossible to identify the amphibians by their call, they were captured if the environment allowed it. They were then identified to the

species level with the aid of a field guide for amphibian and reptile identification in West Africa (Rödel, not published). Specimens whose identification were in doubt were photographed and a sample of their DNA taken for later analysis at the Herpetology Department of the Berlin Museum of Natural History. However no new species was discovered.

It should be noted that among the individuals collected, the taxonomy of the genus *Arthroleptis* is not yet resolved although several specialists are working on it. Based on morphological characteristics, there could be more than one species in this genus.

The binomial names of species for this study are based on Frost (2013).

3.10.3 Results

3.10.3.1 Kamsar

Ten species and 77 individuals were found in the Kamsar Study Area. Table 3-32 shows the distribution and relative importance of these species in relation to habitat types. At Kamsar there are some remnants of the original dense forest, for example in the degraded village forests of Taïgbé and Binari islands. The anthropic formation includes, among others, the fields in semi-urban areas, cultivated land and lowlands. In general, amphibians are absent from mangrove and environments with high salinity. The ten species observed are distributed more or less equally between the two types of habitats inventoried. This distribution can be explained by the fact that the species found are not tied to a particular habitat and that they are typical of disturbed areas. The low number of inventoried species is mainly related to anthropic pressures on the habitats and the rarity of freshwater in the environments visited.

Hoplobatrachus occipitalis is the most abundant species with 25 individuals including 22 observed in the anthropic formation.

Table 3-32 Distribution of amphibians at Kamsar by habitat

Family	Species	Number of individuals in dense forest	Number of individuals in anthropic formations	Total number of individuals observed
Bufonidae	*Amietophrynus regularis*		6	6
	Amietophrynus maculatus	1	1	2
Dicroglossidae	*Hoplobatrachus occipitalis*	3	22	25
Hyperoliidae	*Hyperolius occidentalis*	12		12
	Hyperolius picturatus	2		2
	Hyperolius spatzi	8	1	9
Ptychadenidae	*Ptychadena bibroni*	2	4	6
	Ptychadena mascareniensis	3	9	12
	Ptychadena pumilio		1	1
	Ptychadena tournieri		2	2
Total	**10**	**31**	**46**	**77**

During the RAP 41 study (Hillers *et al.*, 2006), 17 species were identified in the Kamsar region, for ten days of fieldwork. The difference in terms of amphibian diversity between the present study and the RAP 41 study can be related in part to the inventory effort that was higher in the RAP 41 study (ten days) than in the present study (four days). All of the species from Table 3-32 had already been

noted in the RAP study except for *Hyperolius picturatus*. This species is thus new for the Study Area that now has 18 species of identified amphibians.

Table 3-33 shows the distribution of species in relation to the six sites inventoried, the status of these species according to the UICN criteria and of the *Monographie nationale de la diversité biologique de la Guinée*, as well as the level of endemicity (either endemic to Guinea or the *Haute Guinée* forest system). It is apparent from this table that the sites inventoried on the islands of Taïgbé and Binari are the richest in terms of species present. These two sites have freshwater ponds as well as temporary watercourses in the forests. Five species were found at KAM-1, a site in the semi-cultivated area belonging to CBG just to the northeast of the plant.

A single species was seen at KAM-2, made up of a rice field on the edge of mangrove. The low diversity can be explained by the fact that rice fields close to mangroves have relatively brackish waters, not favorable for amphibians, and the fact that there was no night inventory at this spot.

Site KAM-1 and KAM-5 were visited during the first study period whereas the site KAM-A was visited in the second period (Map 3-25). As mentioned earlier the coordinates for these sites are given in Annexe 1 of the Doumbia and Camara (2014) report (Annexe 3-10).

Table 3-33 Distribution, status and endemicity of amphibians at Kamsar by site

Site	Location	Number of species by site	Species	IUCN[1]	MN[1]	Endemicity	
						Guinea	Forests of *Haute Guinée*
KAM -1	Kamsar cité	5	*Amietophrynus regularis*	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Ptychadena mascareniensis	LC	NE		

Site	Location	Number of species by site	Species	IUCN[1]	MN[1]	Endemicity	
						Guinea	Forests of *Haute Guinée*
KAM -2	Kamsar cité	1	*Hoplobatrachus occipitalis*	LC	NE		
KAM -3	Taïgbé	8	*Amietophrynus regularis*	LC	NE		
			Amietophrynus maculatus	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena mascareniensis	LC	NE		
			Hyperolius picturatus	LC	VU		
			Hyperolius occidentalis	LC	NE		
			Hyperolius spatzi	NE	NE		
KAM -4	Kamsar	3	*Amietophrynus maculatus*	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena bibroni	LC	NE		
KAM -5	Taïdi	4	*Hoplobatrachus occipitalis*	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Ptychadena mascareniensis	LC	NE		
			Hyperolius spatzi	NE	NE		
KAM-A	Sopila (Binari)	6	*Hoplobatrachus occipitalis*	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena mascareniensis	LC	NE		

Site	Location	Number of species by site	Species	IUCN[1]	MN[1]	Endemicity	
						Guinea	Forests of *Haute Guinée*
			Hyperolius picturatus	LC	VU		
			Hyperolius occidentalis	LC	NE		
			Hyperolius spatzi	NE	NE		

[1] LC (Lesser Concern); NE (Not Evaluated); VU (Vulnerable)

Species of concern

No species of amphibian found at Kamsar is considered as threatened according to the IUCN criteria (Table 3-33). The *Monographie nationale de la Guinée* (Bah *et al*., 1997) considers *Hyperolius picturatus* as a vulnerable species.

No species is endemic to Guinea but the distribution of *Ptychadena tournieri* is limited to the forest ecosystem of *Haute Guinée*.

3.10.3.2 Sangarédi

Twenty-seven species and one genus (*Arthroleptis* spp.) were found in the Sangarédi Study Area. Table 3-34 shows the distribution and relative importance of these species in relation to the habitats inventoried. During the RAP 41 study (Hillers et al., 2006), 12 species were found in the region of Boulléré. All of these species except for one (*Ptychadena tellinii*) were found in this study. This study brings 13 new species for the region of Sangarédi, noted by an asterisk on Table 3-34. The total number of species for the Study Area thus passes to 28.

This difference in terms of diversity of amphibians between the present study and the RAP 41 study can be related, among other factors, to the inventory effort that was notably higher in the present study, 17 days compared to 6 days for the RAP 41 study.

Of course, the dense forests, including the gallery forests and associated watercourses, as well as the anthropic formations that include cultivated lowlands (rice fields, and orange, avocado and mango plantations) on the edge of watercourses are the most diversified environments in terms of amphibian presence (26 and 17 species respectively) and relative abundance. In fact, Edward et al. (2010) and Giam et al. (2011) state that forest environments, including gallery forests potentially constitute an important biodiversity reservoir.

For a total of 406 individuals observed, 81% were observed in dense forest and 16% in anthropic formations. The most abundant species is *Hoplobatrachus occipitalis*, which by itself accounts for 22% of all individuals observed. As expected, grasslands and wooded grasslands had a low diversity and abundance of amphibians as these formations were relatively drying out during the inventories. It is recognized in any case that several species of amphibians that may occur in grasslands and wooded grasslands during the rainy season migrate towards the waterbodies in the galley forests or the lowlands during the dry period (Rödel et al., 2004). Consequently inventories during the rainy season in these grassland formations and in the habitats in general of the Study Area would lead to higher amphibian diversity then.

For example, *Ptychadena retropunctata* is a frog that is generally found in grassland formations during the rainy season. It is not characteristic of dense forests and is reported as living at elevations of from 400 to 800 m in Guinea, Sierra Leone and Ivory Coast. However during this study *Ptychadena retropunctata* was captured specifically in dense forests. Additionally, an interesting point, the species was found at elevations below 100 m.

Table 3-34 Distribution amphibians at Sangarédi by habitat

Family	Species	Number of individuals in dense forest	Number of individuals in anthropic formations	Number of individuals in grassland	Number of individuals in wooded grassland	Total number of individuals observed
Arthroleptidae	*Arthroleptis* spp.	64	8		3	75
	Astylosternus occidentalis	3				3

Family	Species	Number of individuals in dense forest	Number of individuals in anthropic formations	Number of individuals in grassland	Number of individuals in wooded grassland	Total number of individuals observed
	*Leptopelis bufonides**				1	1
	*Leptopelis viridis**	1				1
Bufonidae	*Amietophrynus maculatus*	2				1
	Amietophrynus regularis	2	2	4		8
Diroglossidae	*Hoplobatrachus occipitalis*	82	8			90
Hyperoliidae	*Hyperolius concolor**	6	1			7
	*Hyperolius lamottei**	3	1	2		6
	*Hyperolius nitidilus**		8			8
	Hyperolius occidentalis	29	2			31
	*Hyperolius picturatus**	1				1
	*Hyperolius spatzi**	2	10			12
Phrynobatrachidae	*Phrynobatrachus francisci*	1				1
	Phrynobatrachus gutturosus	2				2
	Phrynobatrachus natalensis	5	2			7
	*Phrynobatrachus pintoi**	8				8
	Phrynobatrachus tokba	41	4			45
Pipidae	*Pseudhymenochirus merlini**	17	6			23
Ptychadenidae	*Ptychadena aequiplicata**	9	2			11
	*Ptychadena bibroni**	5	1			6

Family	Species	Number of individuals in dense forest	Number of individuals in anthropic formations	Number of individuals in grassland	Number of individuals in wooded grassland	Total number of individuals observed
	Ptychadena longirostris *	6	1			7
	*Ptychadena mascareniensis**	7	2			9
	Ptychadena oxyrhynchus	1				1
	Ptychadena pumilio	11	5			16
	Ptychadena retropunctata	10	1	2		13
	Ptychadena sp.	1				1
	Ptychadena tournieri	9		1		10
Ranidae	*Hylarana albolabris**	2				2
Total	**30**	**329**	**64**	**9**	**4**	**406**

*New species for the Study Area

Table 3-35 shows the distribution of species in relation to the 30 sites inventoried, the status of the species according to the IUCN criteria and of the *Monographie nationale de la diversité biologique de la Guinée*, as well as the level of endemicity (either endemic to Guinea or the *Haute Guinée* forest system).

Sites SAN-6 to SAN-15 were visited during the first study period whereas the sites SAN-A to SAN-T were visited during the second period.

Sites SAN-A (Kourawel), SAN-M (Fassaly Belonderé), SAN-N (Fassaly Foutabhé) and SAN-S (N'Dounssy), all in gallery forest and all inventoried in the dry season have the greatest amphibian diversity with 14, 9, 12 and 12 species respectively.

Sites SAN-7 and SAN-13 are in grassland formations, including a bowal, inside the zone currently mined by CBG. They only have a single species each. It should be noted that there were no sources of water close to these sites.

The presence of *Phrynobatrachus pintoi* on sites SAN-A and SAN-S, in gallery forest, confirms the work of Hillers et al. (2006) and Hillers et al. (2008b) according to which the Sangarédi area and the gallery forests present constitute the habitat for this species during the dry season.

Table 3-35 Distribution, status and endemicity of amphibians at Sangarédi by sites

Site	Location	Number of species by site	Species	IUCN[1]	MN[1]	Endemicity	
						Guinea	Forests of *Haute Guinée*
SAN-6	Mbouroré		*Arthroleptis* spp.	?	NE		
			Amietophrynus regularis	LC	NE		
		6	*Ptychadena aequiplicata*	LC	NE		
			Ptychadena longirostris	LC	NE		
			Hyperolius occidentalis	LC	NE		
			Pseudhymenochirus merlini	LC	NE		
SAN-7	Mine Sangarédi	1	*Ptychadena retropunctata*	DD	NE		
SAN-8	Forêt près de la Mine	4	*Arthroleptis* spp.	?	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Hyperolius spatzi	NE	NE		
SAN-9	Sinthiourou village		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
		5	*Leptopelis viridis*	LC	NE		
			Ptychadena aequiplicata	LC	NE		
			Hyperolius lamottei	LC	VU		x
SAN-10	Sangarédi		*Arthroleptis* spp.	?			
			Phrynobatrachus natalensis	LC	NE		

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
		6	*Ptychadena aequiplicata*	LC	NE		
			Hyperolius concolor	LC	VU		
			Hyperolius spatzi	NE	NE		
			Hyperolius lamottei	LC	VU		x
SAN-11	Sinthiourou-Boulléré	2	*Arthroleptis* spp.	?			
			Leptopelis bufonides	LC	NE		
SAN-12	Sinthiourou		*Phrynobatrachus gutturosus*	LC	NE		
		3	*Hyperolius lamottei*	LC	VU		x
			Pseudhymenochirus merlini	LC	NE		
SAN-13	Sangarédi	1	*Hyperolius lamottei*	LC	VU		x
SAN-14	Sangarédi		*Arthroleptis spp.*	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena pumilio	LC	NE		
		4	*Ptychadena aequiplicata*	LC	NE		
SAN-15	Sangarédi		*Hyperolius* sp.	?			
		2	*Hyperolius spatzi*	NE	NE		
SAN-A	Kourawel		*Arthroleptis* spp.	?			
			Phrynobatrachus tokba	LC	NE		x
			Phrynobatrachus gutturosus	LC	NE		
			Phrynobatrachus pintoi	EN	NE	x	
			Amietophrynus maculatus	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Astylosternus occidentalis	LC	NE		x
			Ptychadena bibroni	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena aequiplicata	LC	NE		
			Ptychadena mascareniensis	LC	NE		

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
			Ptychadena retropunctata	DD	NE		
			Hyperolius occidentalis	LC	NE		
		14	*Pseudhymenochirus merlini*	LC	NE		
SAN-B	Kourawel		*Arthroleptis spp.*	?	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena aequiplicata	LC	NE		
			Ptychadena retropunctata	DD	NE		
			Hyperolius occidentalis	LC	NE		
		7	*Pseudhymenochirus merlini*	LC	NE		
SAN-C	Parawol Aliou		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
			Phrynobatrachus natalensis	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena mascareniensis	LC	NE		
			Ptychadena retropunctata	DD	NE		
		7	*Hyperolius occidentalis*	LC	NE		
SAN-D	Parawol Aliou		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
		3	*Hoplobatrachus occipitalis*	LC	NE		
SAN-E	Paragogo		*Arthroleptis* spp.	?	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena longirostris	LC	NE		
		5	*Ptychadena retropunctata*	DD	NE		
SAN-F	Paragogo		*Arthroleptis* spp.	?	NE		
		2	*Ptychadena pumilio*	LC	NE		

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
SAN-G	Kagnaka		*Arthroleptis spp.*		NE		
			Phrynobatrachus tokba	LC	NE		x
			Hoplobatrachus occipitalis	LC	NE		
		4	*Ptychadena tournieri*	LC	NE		x
SAN-H	Kagnaka		*Arthroleptis spp.*	?	NE		
			Phrynobatrachus tokba	LC	NE		x
		3	*Hoplobatrachus occipitalis*	LC	NE		
SAN-I	Route kagnaka		*Arthroleptis* spp.	?	NE		
			Amietophrynus regularis	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena pumilio	LC	NE		
			Hyperolius sp.	?	NE		
		6	*Hyperolius spatzi*	NE	NE		
SAN-J	Kankalaré		*Phrynobatrachus tokba*	LC	NE		x
			Hoplobatrachus occipitalis	LC	NE		
		3	*Ptychadena pumilio*	LC	NE		
SAN-K	Sinthiourou Saléah 1		*Arthroleptis* spp.	?	NE		
		2	*Phrynobatrachus tokba*	LC	NE		x
SAN-L	Fèto Parawi		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus natalensis	LC	NE		
			Hylarana albolabris	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena mascareniensis	LC	NE		
		7	*Ptychadena longirostris*	LC	NE		
SAN-M	Fassaly Bélendéré						
			Phrynobatrachus tokba	LC	NE		x

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
			Amietophrynus maculatus	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Ptychadena aequiplicata	LC	NE		
			Ptychadena mascareniensis	LC	NE		
			Ptychadena longirostris	LC	NE		
			Ptychadena retropunctata	DD	NE		
		9	*Hyperolius occidentalis*	LC	NE		
SAN-N	Fassaly Foutabhé		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
			Phrynobatrachus natalensis	LC	NE		
			Phrynobatrachus francisci	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena pumilio	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Ptychadena longirostris	LC	NE		
			Ptychadena retropunctata	DD	NE		
			Hyperolius concolor	LC	VU		
		12	*Hyperolius occidentalis*	LC	NE		
SAN-O	Fassaly Foutabhé		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
			Ptychadena tournieri	LC	NE		x
			Ptychadena longirostris	LC	NE		
			Ptychadena retropunctata	DD	NE		
		6	*Hyperolius concolor*	LC	VU		
SAN-P	Kalinko Roundé		*Arthroleptis spp.*	?	NE		

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
			Phrynobatrachus tokba	LC	NE		x
			Astylosternus occidentalis	LC	NE		x
			Ptychadena pumilio	LC	NE		
			Ptychadena tournieri	LC	NE		x
			Ptychadena mascareniensis	LC	NE		
		7	*Hyperolius occidentalis*	LC	NE		
SAN-Q	Mine /Sangarédi		*Amietophrynus regularis*	LC	NE		
			Ptychadena tournieri	LC	NE		x
		3	*Ptychadena retropunctata*	DD	NE		
SAN-R	Mine /Sangarédi		*Arthroleptis* spp.	?	NE		
			Phrynobatrachus tokba	LC	NE		x
			Amietophrynus regularis	LC	NE		
			Hoplobatrachus occipitalis	LC	NE		
		5	*Hyperolius concolor*	LC	VU		
SAN-S	N'Dounssy		*Phrynobatrachus tokba*	LC	NE		x
			Phrynobatrachus natalensis	LC	NE		
			Phrynobatrachus pintoi	EN	NE	x	
			Hoplobatrachus occipitalis	LC	NE		
			Ptychadena bibroni	LC	NE		
			Ptychadena mascareniensis	LC	NE		
			Ptychadena sp	?	NE		
			Ptychadena oxyrhynchus	LC	NE		
			Hyperolius picturatus	LC	VU		
			Hyperolius occidentalis	LC	NE		
			Hyperolius spatzi	NE	NE		
		12	*Pseudhymenochirus merlini*	LC	NE		
SAN-T	Mine /Sangarédi		*Hoplobatrachus occipitalis*	LC	NE		

Site	Location	Number of	Species	IUCN[1]	MN[1]	Endemicity	
			Ptychadena bibroni	LC	NE		
			Ptychadena mascareniensis	LC	NE		
			Hyperolius nitidilus	NE	NE		
		5	*Pseudhymenochirus merlini*	LC	NE		

[1] LC (Lesser Concern); NE (Not Evaluated); VU (Vulnerable); EN (Endangered) DD (Data Deficient)

Species of concern

According to IUCN and the Monographie nationale

*Phrynobatrachus pinto*i is considered *Endangered* according to the IUCN criteria. Three species are considered vulnerable in the *Monographie nationale de la biodiversité biologique de la Guinée* (Bah et al., 1997). They are *Hyperolius picturatus*, *H. concolor* and *H. lamottei*.

According to endemicity

One species, *Phrynobatrachus pintoi*, is endemic to Guinea. Four species are restricted to the forest ecosystem of *Haute Guinée*: *Astylosternus occidentalis*, *Phrynobatrachus tokba*, *Hyperolius lamottei* and *Ptychadena tournieri*.

Photo 3-34 *Hyperolius lamottei*

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3.11 Bushmeat

3.11.1 Introduction

This section deals with a subject that includes biological aspects but also social ones (Chapter 5).

In the majority of West African countries, and in particular in Guinea, the relationships between human population growth, hunting and consumption of bushmeat are complex and are a function of social, economic, ecological and geographical factors, among others. In these countries, bushmeat is more than a source of food proteins; it has become a source of revenue for rural and urban populations. A frequently noted indirect impact of industry developments, and in particular large scale mining in remote locations, is an increase in wildlife harvesting pressure, often due to better access to areas with more wildlife, consequence of opening new roads.

Hunting, bushmeat consumption and commercial networks have not been well documented in Guinea and only a few studies have been carried out mostly in the central and southern part of the country: Ziegler (1996), Dufour (2002), Colyn et al. (2005), Dia (2005), Dufour (2006), Brugiere and Magassouba (2009), Dufour (2013). No information is available for the northern part of Guinea where the Study Area is located.

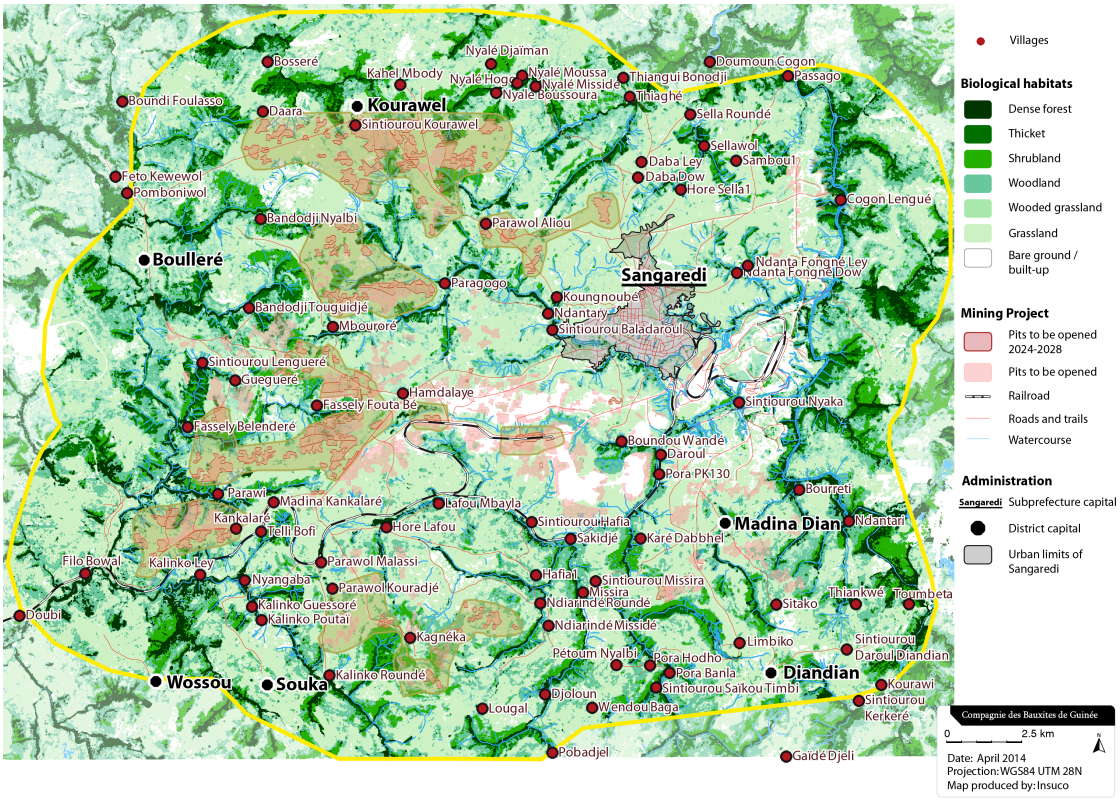
For some forty years, the town of Sangarédi, with a population on the order of 53,600 residents (Insuco, 2013) has been the center of regional development due mainly to the mining activities of a single company, CBG, activities that have created numerous direct and indirect jobs. Although of course, nothing tangible is known of the use of the wild animals of the region before the arrival of CBG, it is more than probable that since then the increase of the population has shaped it to some degree.

This short study of hunting and bushmeat consumption and commercial networks was carried out from November 25 to December 7 2012 in the context of a planned increase in CBG's bauxite production rate and new areas to be mined.

3.11.2 Methodology

To determine the hinting practices in the rural environment and the commercial networks for bushmeat in the urban environment, two teams worked in parallel in the field. One team conducted semi-structured interviews with 15 hunters from 10 villages spread out in the Study Area (Map 3-27). Two groups of hunters were also interviewed. The other team identified and monitored 11 participants in the bushmeat network in Sangarédi.

Map 3-27 Villages around Sangarédi



The study was conducted within some important constraints. Fieldwork coincided with the rice harvest, which limited the availability of people to talk to during village visits which were conducted over such a short period that it was difficult and largely impossible to pre-arrange visits to suit people's availability. Probably the biggest constraint of all though was hunter's willingness to talk openly about their hunt and their captures. They were rather vague about the range of animals they targeted, mainly because there are religious-based interdictions around the consumption and pursuit of some species (pigs and moneys notably), but also because some animals are protected under Guinean law, hunted outside the permitted hunting season or their sale is forbidden. For example in Guinea, the hunting period is from December 15 of a year to finish April 30 of the following year and the exchange, sale or commercialization of bushmeat, in any form, is prohibited. In Sangarédi, the bushmeat trade is largely conducted covertly because of fear of sanctions by "*Eaux et Forêts"* agents. Consequently, a relationship of confidence has to be established between the interviewer and the interviewee, before the latter would be willing to reveal information. Relation that depends on a number of factors, takes time and was not always fully achieved in the limited fieldwork period.

3.11.3 Results

3.11.3.1 Historical and social aspects of hunting

The main ethnic group of the Sangarédi region comes from the Fouta Djallon and consists of *Peuls* that have migrated from the Labé region. Hunting is a tradition among the *Peuls* and despite the advent of modern tools, often Western, hunting in the Sangarédi region still seems to respect a certain ritual between the family of the hunter and the owner of the forest. A preoccupation with the rational use of the fauna should be a daily concern of the communities but unfortunately this is not the case.

Several hunters around Sangarédi prepare their hunt by first protecting themselves from evil spirits and to increase their hunting success. As Singleton (1982) brings up, this practice is common and implies a fundamental social element in the hunt, that is the faunal resources are not *res nullius* (meaning without owners and that

anyone can appropriate them). However this is not the perception of all hunters since some of them believe that the animals belong to all. These practices have a considerable impact on who can hunt and how an individual becomes a hunter and they are not protected from changes.

Forty years ago the rural population around Sangarédi was much smaller, the agricultural territory more restricted, natural environments were more abundant and supporting a more diverse and plentiful fauna. At that time, the hunting forays out into the bush was riskier due to the presence of relatively dangerous animals such as the buffalo (*Syncerus caffer*) and leopard (*Panthera pardus*). Hunting equipment was also different, or not so easily available. Also at that time, under the totalitarian regime of Sékou Touré, any person, without apparent reason could be considered as a counter-revolutionary, especially someone in possession of a firearm (Kamara, 2012).

With the sole exception of one occasional hunter who claimed to be self-taught, all the others interviewed said that they had learnt their craft from a relative, typically their father, but uncles and elder brother were also mentioned. Their education covered the basics such as learning animal tracks, how to conceal oneself and how to shoot. After a certain period of practice, which may be several years, the novice is eventually taught the hunting secrets, such as the ritual verses, talismans and preparatory washes for themselves and their equipment made from certain plants and the ink washes of Koranic text, knowledge required before venturing out for a successful hunt in the bush.

In the not so distant past, a certain type of hunting fetish made from the horn of the bushbuck, (*Tragelaphus scriptus*), was one of these secrets. It appears to have fallen increasingly out of favor because it is considered incompatible with contemporary Islamic practice: belief that fetishes, talismans and amulets have any power goes against true belief and the sovereignty of Allah.

For most hunters interviewed, a semantic difference exists between the two Pulaar terms for a hunter, *waino* and *duna*. *Grosso modo*, the first is a confirmed hunter who has learned the hunting secrets, whereas the second is an occasional hunter who owns a shotgun and uses in an opportunistic way.

With time, things change. Today, there are different reasons for learning to hunt. Even if the new apprentice conforms to certain ancient rituals, he may be simply stimulated by the attraction of profit. Certain animal species that used to be relatively ignored before for consumption can now have a significant value at the market.

Finally, hunting is also a question of aptitude and willpower. Owning a gun to scare predators or pests from a farm is one thing, but running after game with dogs or waiting in ambush at night in a tree waiting for a prey is another. This is an important methodological aspect because the hunting pressure on a resource cannot simply be tied to the fact an individual owns a gun.

Table 3-36 gives an indication of the number of hunters in the villages visited. Although this is to take with a certain reserve, the results suggest that in the Sangarédi region about 10% of the men over 15 years are hunters, including all categories: confirmed hunters, occasional hunters and trappers.

Table 3-36 Number of hunters and trappers per village

Village	Men over 15 yrs.[1]	Number of confirmed hunters	Number of occasional hunters	Trappers	Total
Parawol Kouradjé et Parawol Malassi	138	13	4	ND	**17**
Paragogo	112	14	2	4	**20**
Parawol Aliou	63	3	ND	1	**4**
Kourawel	76	8	ND	ND	**8**
Nyalé Boussoura	27	4	7	0	**11**
Mbouroré	58	7	ND	7*	**7**
Kankalaré Hacoudé	2	0	1	1*	**1**

Village	Men over 15 yrs.[1]	Number of confirmed hunters	Number of occasional hunters	Trappers	Total
Bouleré	359	7	5	1	**13**
Kagnaka	51	4	ND	5	**9**
Facely Belenderé	50	4	ND	2	**6**
Total	**936**	**64**	**19**	**21**	**96**

[1] Population of the villages from INSUCO, 2013.

*Hunters already included in another category

3.11.3.2 Hunting techniques

Several hunting techniques are used in the Sangarédi region. Some hunters specialize in one technique or two and a few can end up mastering them all.

Hunting at night with a light

This method is widely practiced and is thought by most hunters to be the most efficient of all techniques, though some who use dogs disagree. The lamp is generally fixed on the head of the hunter to leave him free with his movements. According to hunters this technique is used year round but is mainly done from May to end November, during the rainy season when sounds of movement are quieter in the bush. Dark nights, without a moon, are of course preferred for this type of hunting. This type of hunting is done mainly in the bowal/forest ecotone and in gallery forests with favored game spots, such as drinking places and fruiting trees targeted.

Ambushing

Another popular hunting technique, ambushing can be done on the ground, in a simple hide, or preferably in a tree to minimize dispersion of smells on the ground

and gains a wider field of view on the environment nearby and hence increases chances of success. Typically the hunters install themselves near a water hole, fruit trees or trails used by the game. Certain species are attracted by using blocks of salt often mixed with earth from termite mounds and special plant ingredients according to the acquired experience of the hunter. Mineral supplements, such as used by farmers to give to their animals, are also used. They may also hunt close to where farmers distribute these minerals to their herds. This technique is used especially towards the full moon, favoring better night vision for the man, both during the beginning of the rainy season and in the dry season.

Hunting with dogs

Whereas the preceding two hunting methods seem mainly to be practiced by well trained or initiated hunters, hunting with dogs is generally an activity of youth (unmarried young men) who may also be occasional hunters. At Gagnaka (Map 3-27), an interview with four young practitioners (14 to 20 years) revealed some facets of this activity that may make it especially accessible to the younger generation. Only one of them owned two dogs but as the others often went hunting with them, they were able to borrow them and go out on their own. Perhaps most surprisingly they didn't always go out with a gun but had a technique of getting monkeys that the dogs had chased up a tree down and killed, something which was also reported at Boulléré. The patas monkey (*Erythrocebus patas*) seems to be targeted for this hunt that does not require a firearm. With firearms the same technique is used for warthogs (*Phacochoerus africanus*) and red river hogs (*Potamochoerus porcus*). Eating these three animals is proscribed for Muslims and there is some stigma attached to hunting and handling their carcasses. However their capture implies financial incentives that are not negligible. This hunt is practiced year round, rather at the beginning and the end of the day.

Collective hunting

This type of hunting is carried out mainly in the dry season, when animals concentrate in the gallery forests. Several or a few hunters who ay come from several villages, post themselves at strategic points while waiting for the beater and

dogs move the game towards their positions. The captures are split between the beaters and hunters, according to various formulas. The meat of those animals whose consumption is forbidden by Islam may be sold and the profits are also distributed. This type of hunting is done more frequently during special occasions such as village festivities (as at the end of Ramadan) or when food is scarce.

In some villages, such as Paragogo it was said that they hadn't held a collective hunt for 5-6 years because there were no longer enough animals and in Boulléré this opportunity is left to the youth. In any case, during the 1960s, this form of hunting was carried out at a large scale since it could involve from five to ten villages and could go on for three to four days. The hunts were done for various reasons, because there was damage to crops from baboons, other monkeys or pigs, or because of loss of livestock from the presence of leopards and hyenas.

Trapping

Trapping, essentially done by snares (neck or leg cable snares), is relatively little done in the villages visited and is sometimes complementary to the hunting activities of a confirmed hunter. At Boulléré, only one or two people carried out this form of hunting because according to an interviewee, this technique involved knowledge that he did not possess. In other villages where hunting with snares is practiced, this technique was part of the basic teaching for apprentice hunters.

The use of this technique tends to be avoided during the dry season because of the risk of capturing errant livestock searching for food at this season. Or, it is used in environments where the risk of capturing livestock is limited such as in dense parts of the gallery forests, near watercourses.

Hunting calendar

In the villages visited, there are really no full-time hunters. Hunting is complemented by other activites, in particular agriculture. Table 3-37 shows the variations in hunting techniques used related to the agricultural calendar.

Table 3-37 Calendar of hunting techniques and agricultural activities

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Season	Dry				Rains						Dry	
Rice Farming		Clearance & Burning				Sowing & Weeding			Harvest			
Hunting at night												
Ambushing												
Hunting with dogs												
Collective hunting												
Trapping												

3.11.3.3 Harvest levels

To understand hunting pressure it is important to combine sociological data with harvest rates but collecting the latter in a very short time frame is no easy task. During interviews, hunters were asked about the species and numbers of animals they had killed. In an attempt to standardize the reporting period, they were asked about their kills within the 2013 rainy season (however the understanding of the length of the rainy season varied according to the person questioned). Some hunters were also asked about their success in the preceding dry season. However given the time that had passed since that period and the responses that seemed somewhat imaginary, the results were not taken into account.

Table 3-38 presents the results of the harvest rates during the rainy season only, all hunting techniques combined and this based on the most reliable interview data, that is 20 hunters spread out in five villages near Sangarédi. It also presents an estimation of the biomass of the harvested species.

Ungulates represent the majority of the harvested biomass. Within this group, the bushbuck and red river hog represent the major part.

Among the rodents, the crested porcupine constitutes the biggest part of the harvested biomass.

Table 3-38 Synthesis of captures and estimates of biomass

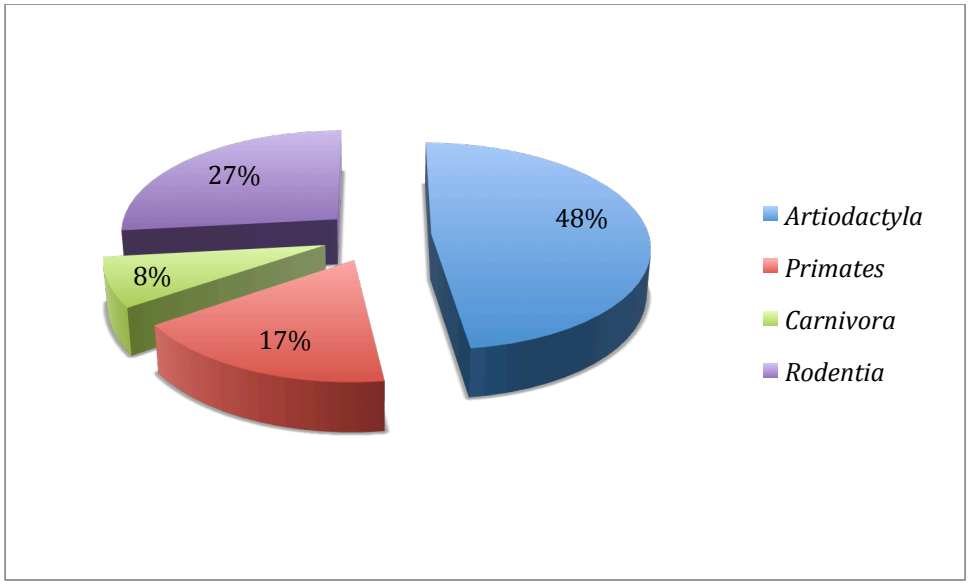
Order/Species	English name	French name	Number	Average weight (kg)[1]	Average biomass take (kg)
Artiodactyla			68		3,043
Cephalophus rufilatus	Red-flanked duiker	Céphalophe à flanc roux	9	10	90
Cephalophus niger	Black duiker	Céphalophe noir	1	20	20
Philantomba maxwelli	Maxwell's duiker	Céphalophe de Maxwell	12	8	96
Tragelaphus scriptus	Bushbuck	Guib harnaché	27	48.5	1,309.5
Phacochoerus africanus	Common warthog	Phacochère commun	3	82.5	247.5
Potamochoerus porcus	Red river hog	Potamochère d'Afrique	16	80	1,280
Primates			25		140
Chlorocebus sabaeus	Green monkey	Singe vert	1	5.75	5.75
Erythrocebus patas	Patas monkey	Patas	11	12.25	134.75
C. sabaeus et *E. patas*	Green and Patas monkey	Singe vert et Patas	8	-	-
Primates *spp.*			5	-	-
Carnivora			11		127
Civettictis civetta	Civet	Civette d'Afrique	7	13.5	94.5
Genetta spp.	Genet	Genette	1	2.25	2.25
Canis spp.			3	10.07	30.22
Rodentia			38		237

Order/Species	English name	French name	Number	Average weight (kg)[1]	Average biomass take (kg)
Thryonomys swinderianus	Greater cane rat	Aulacode	12	6,65	79.8
Lepus spp.	Hare	Lièvre	4	3	12
Sciuridae			8	0.75	6
Hystrix cristata	Crested porcupine	Porc-épic à crête	6	19.5	117
Atherurus africanus	African brush-tailed porcupine	Athérure africain	8	2.75	22
TOTAL			142		

[1] Average weight according to Kingdon, 1997.

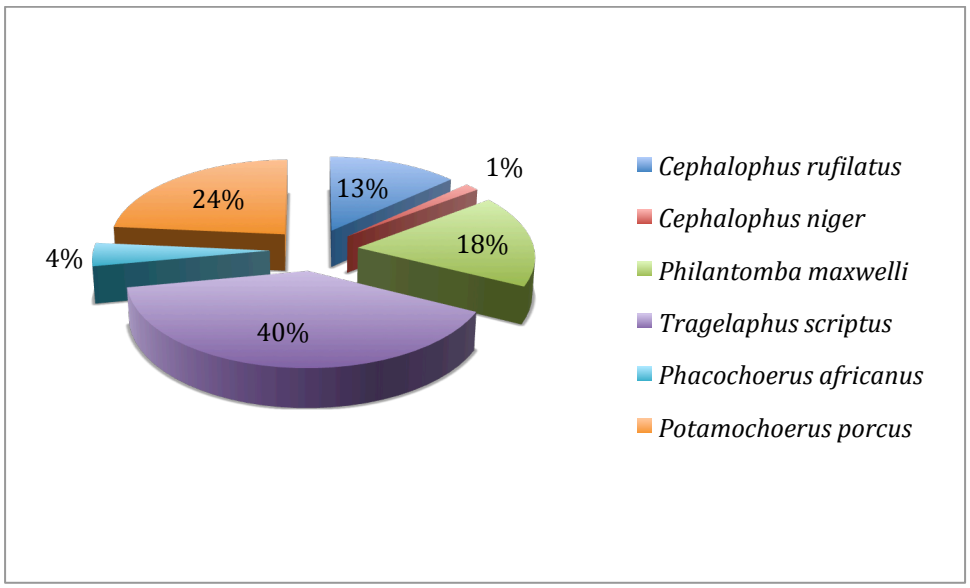
The species most often caught are artiodactyls (48%) followed by rodents and primates. Carnivores only constitute a low percentage (Figure 3-5).

Figure 3-5 Representation of catch number in percentage by order



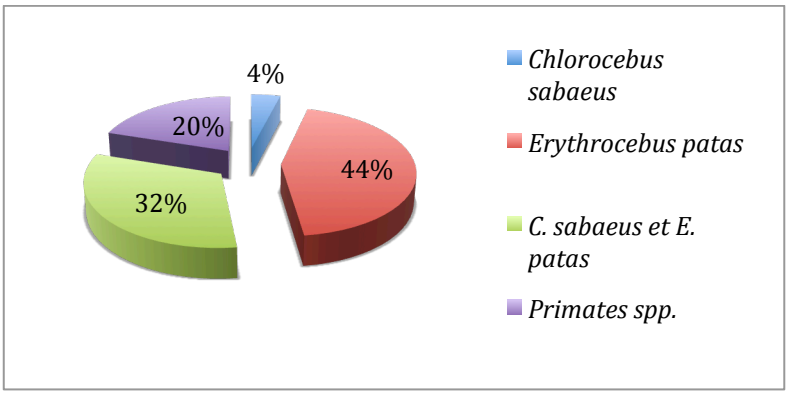
Among the ungulates, the bushbuck is most often captured (40%). The duikers represent 43% and the bush pigs 28% (Figure 3-6).

Figure 3-6 Representation of ungulate number caught in percentage by species



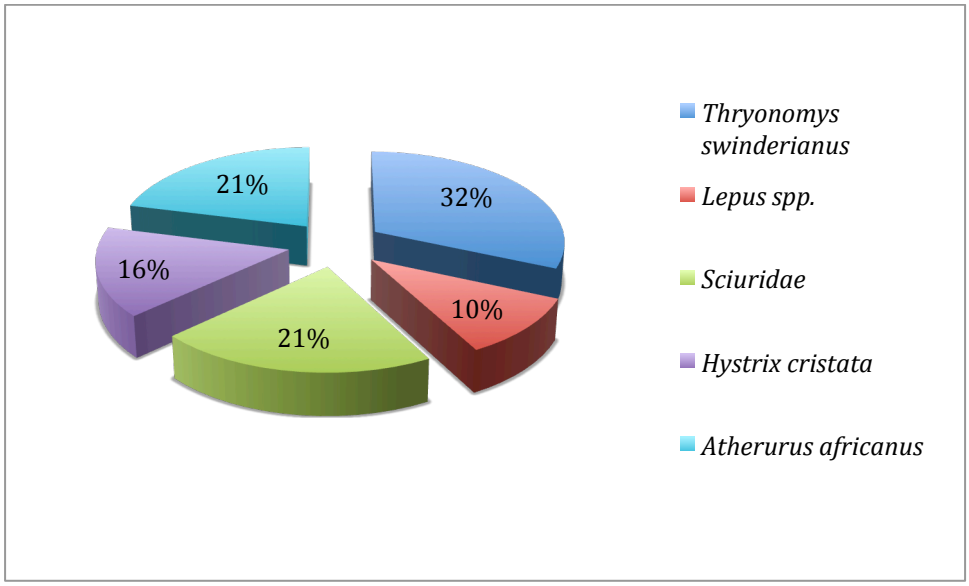
Among the primates, the patas monkey constitutes the majority of the captures but in 20% of the cases it was not posible to determine the species caught (Figure 3-7).

Figure 3-7 Representation of primate number caught in percentage by species



As to the rodents, the most frequently captured is the greater cane rat (*Thryonomys swinderianus*) (Figure 3-8).

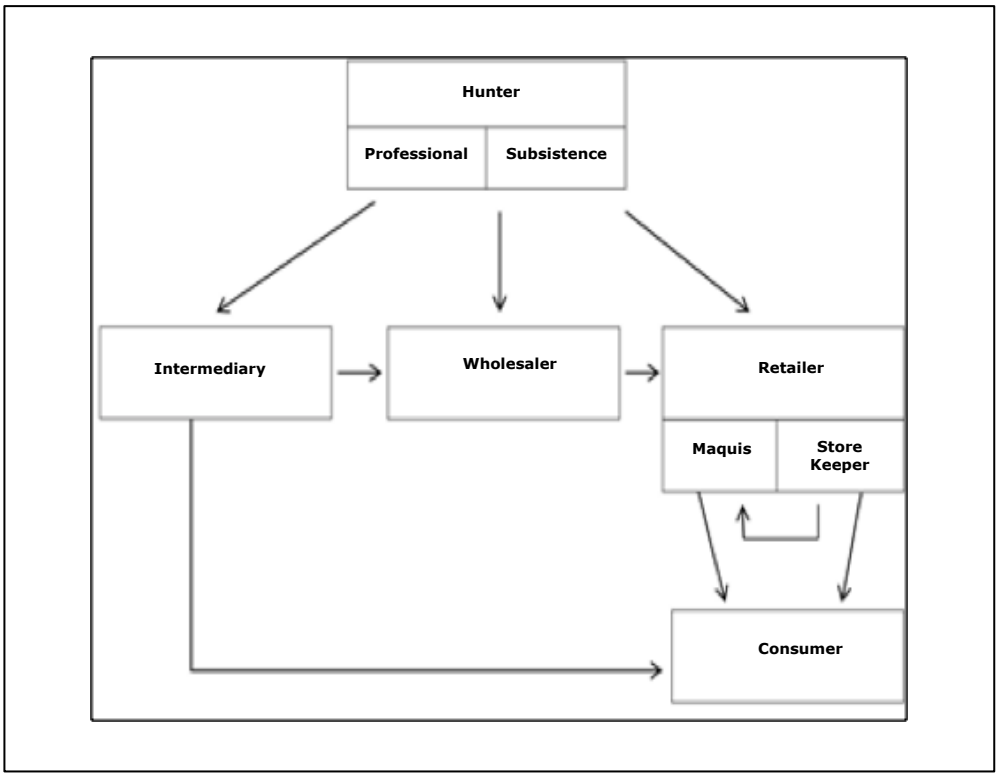
Figure 3-8 Representation of rodent number caught in percentage by species



3.11.3.4 Use of harvested animals

Some species are eaten or sold in the village. Others, because of the restrictions of Islam are sold, generally in Sangarédi to consumers not having these restrictions. Finally a few particularly prized species are sold in the village or the town.

Figure 3-9 Diagram of the bushmeat network (from Dufour, 2013)



In-village consumption

Smaller game, such as hares (*Lepus* spp.), mongoose (*Herpestidae* spp.), francolins (*Francolinus spp.*) and stone partridges (*Ptilopachus petrosus*) are generally consumed within the household. Larger or perhaps just more appreciated species such as porcupines (*Hystrix cristata* and *Atherurus africanus*), cane rats (*Thryonomys swinderianus*), duikers (*Cephalophinae* especially *Philantomba maxwelli* and *Cephalophus rufilatus)* and bushbucks (*Tragelaphus scriptus*) can also be sold. These are either sold in piles of values such as 2,000, 5,000 or 10,000 GNF (7,000 GNF corresponded to one American dollar at the time of this study) or by weight, which is probably mainly for the larger species. The bushbuck was said to be sold at 15,000 to 20,000 GNF per kilo and the weight of an adult varies between 25 and 80 kilos.

Although the consumption of monkeys and bush pigs is forbidden by Islam, times change and young hunters from two villages report that they have sold their mat to young villagers like themselves. In one of the villages, one informant offered this meat as charity (sadaga, an Islamic term for alms) to pregnant women and impoverished elders. Although these examples show that these consumption proscriptions are nuanced, most of the carcasses of these animals are actually sent on to be consumed by non-Muslims.

Out of village consumption

Hunters who kill animals that are nominally not consumed in their villages, have several options to profit from their success. The people they sell to are with only a few exceptions, typically described as *forestières*, a generic term to describe the women from the *Guinée Forestière* who are largely Christian or animist

In places such as Facely Belenderé beside the highway joining Sangarédi to Boké and Gagnaka (Map 3-27), which has some passing traffic of Chinese workers heading to the GAC concession, have the privilege of being able to expose their fresh meat to passers-by. This latter village also has the advantage of being close to CBG operations to the northeast where it is known that some employees can buy their meat.

At Boulléré, there is a weekly market regularly visited by the women from the *Guinée Forestière* that favors the hunters by allowing the marketing of their fresh meat in situ. As to other villages, they have to depend on the visits of the *forestières* or send their meat to Sangarédi.

The majority of hunters, especially the younger ones, have contacts in Sangarédi with one or two women from the *Guinée Forestière* ready to buy monkeys and bush pigs. They can receive up to 60,000 GNF for a large male patas and from 80,000 to 300,000 GNF for a bush pig, depending on its size.

However as mentioned above, the hunters of villages near the national road or the CBG installations are advantaged. Without having to go log distances, with its attendant costs, they can sell a patas monkey for sums between 20,000 and 45,000 GNF.

Besides buying fresh meat, the women of the *Guinée Forestière* willingly buy dried and smoked meat, eventually to sell it in Conakry, this can be advantageous of the hunter as he can sell a wider variety of animal species in this form.

However, the hunters are noting a decrease in the faunal resource. Some even go as far as Guinea Bissau to come back with dried meat, symptomatic of this decrease.

Species of special hunting interest

The informants specified that some species were hunted to be sold or used, in whole or part, for purposes other than human consumption. For example the jackal (*Canis spp*.) supposedly has therapeutic virtues for the treatment of rheumatism, the serval (*Leptailurus serval*) is sought after for its skin and the colobus monkey for its heart, of medicinal value.

In addition, the skins of certain species that are commonly hunted may be sold to leather workers and the horns of Maxwell's duiker are used as a medical talisman.

3.11.3.5 The bushmeat trade in Sangarédi

The 11 sellers of bushmeat identified during the period devoted to this study were rather vague as to the quantities and the origins of the animals they obtained. However, some established a relationship of confidence with the field team. Given the nature of their commerce, the bans concerning the sale of bushmeat and the restrictions of Islam on monkeys and bush pigs, the sellers generally did not have a storefront. Figure 3-9 gives a representation of the network.

The few results obtained (Table 3-39) can be summarized as follows:

- 45 animal carcasses identified (44 mammals and one reptile), 43 were destined for consumption and two were skins of animals destined for other uses (colobus and civet);
- Of the 43 animals destined for consumption, 22 were received fresh and 21 smoked;

- Though the site of provenance were not always well defined, it is clear that 11 of the 21 smoked animals were received in two consignments of 5 and 6 animals respectively. The arrival of one of these from Missira on a Friday suggests the possibility that it came in with vehicles returning from the Thursday market at Missira, 34km to the east (straight line distance). There is a distinct possibility that the cited provenance is actually a collection/shipping point.
- Though not localized, three smoked animals were said to have come from two villages in Gaoual Prefecture to the north/north-east of Sangarédi. Logically this prefecture is a likely source of dry meat for Sangarédi traders because transport links via the town provide the most convenient route through to Conakry;
- Bambaya, 25 km (straight line distance) and located on the road to Télimélé, which is an important transport axis to the east, is again another likely dry meat source direction;
- Without surprise, the fresh meat comes from places much closer to town and all within a 20 km radius; and
- Finally of the 45 carcasses, 32 were destined for the market in Conakry implying that certain of the fresh carcasses received in Sangarédi before being shipped to Conakry.

Although these data can only give a glimpse of the Sangarédi bushmeat market, it is also possible to present the results in terms of biomass and species noted in the market. Table 3-39 presents these results, along with the nature of the carcasses, their final destination and the purchase prices.

Table 3-39 shows that the bushmeat market in the Sangarédi maquis is composed primarily of primates and bush pigs, whereas Table 3-38 shows that the majority of the biomass captures by hunters is composed of antelopes (mainly bushbuck). This is related to the fact that most of the residents of the subprefecture of Sangarédi are Muslims. Consequently all the meat from antelopes and other animals whose consumption is permitted by Islam are eaten or sold in situ in the villages or in Sangarédi without necessarily passing through the large bushmeat market. It is

therefore not surprising that in the maquis, meat of monkeys and bush pigs dominates and that the market aims primarily for the capital, where all ethnic groups and religions combined, the demand for bushmeat exists.

In total during the 18 days devoted to the bushmeat market studies, 1,358.5 kg of carcasses were found. It should be noted that the sums of the kilos of meat on Table 3-39 give only 769.5 kg. This difference comes from the fact that bushmeat is often presented in an aggregate composed of several species, this explaining why certain carcasses are not entered into Table 3-39. However the complete table of results in an appendix of the Manvell (2014) report (Annexe 3-11 of this ESIA) shows that these aggregate sums come to 589 kg.

Without counting these last 589 kg, it should be noted that on Table 3-39, 683 kg of the total biomass (762.5 kg) is composed of bush pigs, or about 84% of the biomass on the market.

Table 3-39 Species, weight, destination and price of carcasses on the market

Order	Species	English name	French name	Weight (kg)	Nature of the meat	Destination	Purchase price (GNF)
Primates	*Erythrocebus patas*	Patas monkey	Patas	4	Fresh	Sangarédi	45 000
	Chlorocebus sabaeus	Green monkey	Singe vert	3	Fresh	Sangarédi	40 000
	Papio papio	Guinea baboon	Babouin de Guinée	7	Smoked	Conakry	30 000
	Chlorocebus sabaeus	Green monkey	Singe vert	4	Smoked	Conakry	15 000
	Erythrocebus patas	Patas monkey	Patas	8	Smoked	Sangarédi	25 000
	Chlorocebus sabaeus	Green monkey	Singe vert	2,5	Smoked	Sangarédi	10 000
	Erythrocebus patas	Patas monkey	Patas	X	Smoked	Conakry	X
	Chlorocebus sabaeus	Green monkey	Singe vert		Smoked	Conakry	X
	Papio spp.	Baboon	Babouin		Smoked	Conakry	X
	Erythrocebus patas	Patas monkey	Patas		Smoked	Conakry	X
	Chlorocebus sabaeus	Green monkey	Singe vert		Smoked	Conakry	X
	Papio papio	Guinea baboon	Babouin de Guinée		Smoked	Conakry	X
	Erythrocebus patas	Patas monkey	Patas	50	Fresh	Conakry	180 000
	Papio papio	Guinea baboon	Babouin de Guinée		Smoked	Conakry	X
	Chlorocebus sabaeus	Green monkey	Singe vert		Smoked	Conakry	X
	Erythrocebus patas	Patas monkey	Patas		Smoked	Conakry	X
	Colobus polykomos	Western pied colobus	Colobe à camail	0.7	Skin	Sangarédi	X

Order	Species	English name	French name	Weight (kg)	Nature of the meat	Destination	Purchase price (GNF)
Suidae	*Potamochoerus porcus*	Red river hog	Potamochère d'Afrique	37	Fresh	Conakry	70 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	22	Fresh	Conakry	105 000
	Potamochoerus porcus	Common warthog	Potamochère d'Afrique	15	Fresh	Sangarédi	50 000
	Phacochoerus africanus	Common warthog	Phacochère commun	28	Fresh	Sangarédi	65 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	60	Fresh	Conakry	250 000
	Phacochoerus africanus	Common warthog	Phacochère commun	28	Smoked	Conakry	60 000
	Phacochoerus africanus	Common warthog	Phacochère commun	50	Fresh	Conakry	230 000
	Phacochoerus africanus	Common warthog	Phacochère commun	37	Fresh	Conakry	150 000
	Phacochoerus africanus	Common warthog	Phacochère commun		Smoked	Conakry	X
	Phacochoerus africanus	Common warthog	Phacochère commun		Smoked	Conakry	X
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique		Smoked	Conakry	X
	Phacochoerus africanus	Common warthog	Phacochère commun	25	Fresh	Conakry	50 000
	Phacochoerus africanus	Common warthog	Phacochère commun	35	Smoked	Conakry	105 000
	Phacochoerus africanus	Common warthog	Phacochère commun	12	Fresh	Sangarédi	50 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	73	Fresh	Conakry	150 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique		Smoked	Conakry	X
	Phacochoerus africanus	Common warthog	Phacochère commun		Smoked	Conakry	X
	Phacochoerus africanus	Common warthog	Phacochère commun	80	Fresh	Conakry	140 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	60	Fresh	Conakry	200 000
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	28	Fresh	Conakry	
	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	52	Fresh	Conakry	

	Potamochoerus porcus	Red river hog	Potamochère d'Afrique	41	Fresh	Conakry	
Squamata	*Varanus niloticus*	Nile monitor lizard	Varan du Nil	1	Fresh	Sangarédi	2 000
Carnivora	*Civettictis civetta*	Civet	Civette d'Afrique	4	Fresh	Sangarédi	18 000
	ND	Mongoose	Mangouste	3	Fresh	Sangarédi	12 000
	ND	Mongoose	Mangouste		Smoked	Conakry	X
	Civettictis civetta	Civet	Civette africaine	0.5	Skin	Sangarédi	x
Rodentia	*Cricetomis spp.*	Giant pouched rat	Cricétome	1.300	Fresh	Sangarédi	7000

3.11.4 Bushmeat and conservation concerns

Table 3-40 presents the total list of the species identified from the hunters and from the bushmeat maquis in Sangarédi. In total, 14 species were noted. Four mammals were only identified to the genus level: *Genetta*, *Canis*, *Lepus* et *Cricetomys*.

All of these species were noted during the study on medium and large mammals and their status is detailed in Section 3.7. Among these species only the Western pied colobus is considered *Vulnerable* according to the IUCN criteria.

Table 3-40 Species from hunters and the bushmeat maquis in Sangarédi

Latin name	English name	Information source	IUCN(1)	National(2)	Prot.(3)	CPS
Primates						
Cercopithecidae						
Chlorocebus sabaeus	Green monkey	I	LC	VU	-	-
Erythrocebus patas	Patas monkey	I	LC	-	-	-

Latin name	English name	Information source	IUCN[1]	National[2]	Prot.[3]	CPS
Colobus polykomos	Western pied colobus	M	VU	EN	-	√
Papio papio	Guinea baboon	M	NT	-	-	√
Carnivora						
Viverridae						
Civettictis civetta	Civet	I, M	LC	-	-	-
Genetta spp.	Genet	I	-	-	-	-
Canidae						
Canis spp.		I				
Cetartiodactyla						
Bovidae						
Cephalophus niger	Black duiker	I	LC	EN	IP	√
Cephalophus rufilatus	Red-flanked duiker	I	LC	EN	PP	-
Philantomba maxwellii	Maxwell's duiker	I	LC	EN	PP	-
Tragelaphus scriptus	Bushbuck	I	LC	-	PP	-
Suidae						
Phacochoerus africanus	Common warthog	I, M	LC	EN	-	-
Potamochoerus porcus	Red river hog	I, M	LC	EN	PP	-
Lagomorpha						
Leporidae						
Lepus spp.	Hare	I	LC	VU	-	-

Latin name	English name	Information source	IUCN[1]	National[2]	Prot.[3]	CPS
Rodentia						
Thryonomyidae						
Thryonomys swinderianus	Greater cane rat	I	LC	VU	-	-
Hystricidae						
Atherurus africanus	African brush-tailed porcupine	I	LC	-	-	-
Hystrix cristata	Crested porcupine	I	LC	VU	PP	-
Muridae						
Cricetomys spp.	Giant pouched rat	M	LC	-	-	-

I : Species noted during intereviews with hunters.

M : Species noted on the bushmeat market in Sangarédi.

3.11.5 The game industry and legislation

Hunting in Guinea is authorized and regulated by the *Code de protection de la faune et réglementation de la chasse* that stipulates that:

- subsistence hunting is authorized on the entire territory when it is done in accord with the legislation in effect and except in areas where it is forbidden (protected areas, urban environment) (Art. 32, 63, 66);
- subsistence hunting is subject to the holding of a small game permit (Art. 144);
- hunting is subject to a period of opening and closing (Art. 72 – 82);
- recreational or sports hunting targeting partially protected species is subject to a special authorization (Art. 47 et 56); and

- the holder of a hunting permit is free to eat the game but its commercialization is forbidden (Art.124).

The results of this study show, as have shown prior studies (Ziegler, S., 1996; Dufour, S., 2002; Dufour, S., 2006; Brugière et Magassouba, 2009; Dufour *et al*., 2013), that the legislation is not respected at all.

3.11.6 Conclusion

The region including the projected expansion area for the extraction of bauxite, and up to around 20 km in a direct line around the town of Sangarédi, is the one where hunters obtain fresh meat for their personal consumption or for its sale in the villages and the maquis of Sangarédi. In Sangarédi, this meat is dominated by three species, two bush pigs (common warthog and red river pig) and a monkey (patas monkey). This meat is mainly destined for the bushmeat market in Conakry and is smoked before being sent.

As to smoked meat that enters the national market while passing through Sangarédi, which is an important crossroads for this trade, it comes from much farther, up to 48 km in a straight line from Sangarédi, according to the surveys undertaken. That being said, the supply zone is certainly large and may even extend to Guinea Bissau.

The interviews with the hunters show that the captures are dominated by a species adapted to environments modified by humans, the bushbuck. The absence among the captures, of species such as the waterbuck (*Kobus ellypsiprimnus*) and the yellow-backed duiker (*Cephalophus sylvicultor*) is noted. These results are representative of a wild fauna whose populations have been particularly impoverished.

Within the context of a human population of Muslim faith, religion that proscribes the consumption of primates and pigs, the fact that these two groups are captured in non-negligible proportions is an additional indicator of the rarefaction of other species of the wild fauna on the one hand, and a hunting activity with a commercial orientation on the other hand, as is done in other regions of Guinea. In the Fouta

Djallon, a region generally similar form the ecological and ethnic perspectives, following 14 months of hunting monitoring, the pigs represented only 19% of the artiodactyl captures, in the context of strongly developed commercial hunting (Dufour, 2013).

The different studies on hunting and the trade in game undertaken in Guinea these 20 last years have all shown that hunting is becoming more and more oriented towards the commercial aspects and without any respect for the legislation in effect, with as an immediate consequence an overexploitation of the large and medium fauna (Ziegler, 1996; Brugière and Magassouba, 2009; Dufour, 2002, 2006, 2013). Dufour (2002, in Colyn et al., 2005), in three villages adjacent to the *forêt classée de Diécké*, found that this was translated in the animals harvested by a high proportion of small game such as rodents (29 %, 30 % et 77 % of the captures) and small carnivores (7 %, 7 % et 12 % of the captures), whereas the large game, in particular the ungulates, represented 4 %, 20 % and 39 % of the total captures.

The results of the studies in the Sangarédi region, in having 27% of the captures as rodents and 8% as carnivores according to the hunters, is a strong indication of the rarefication of the game through overexploitation.

3.12 Firewood and charcoal

3.12.1 Introduction

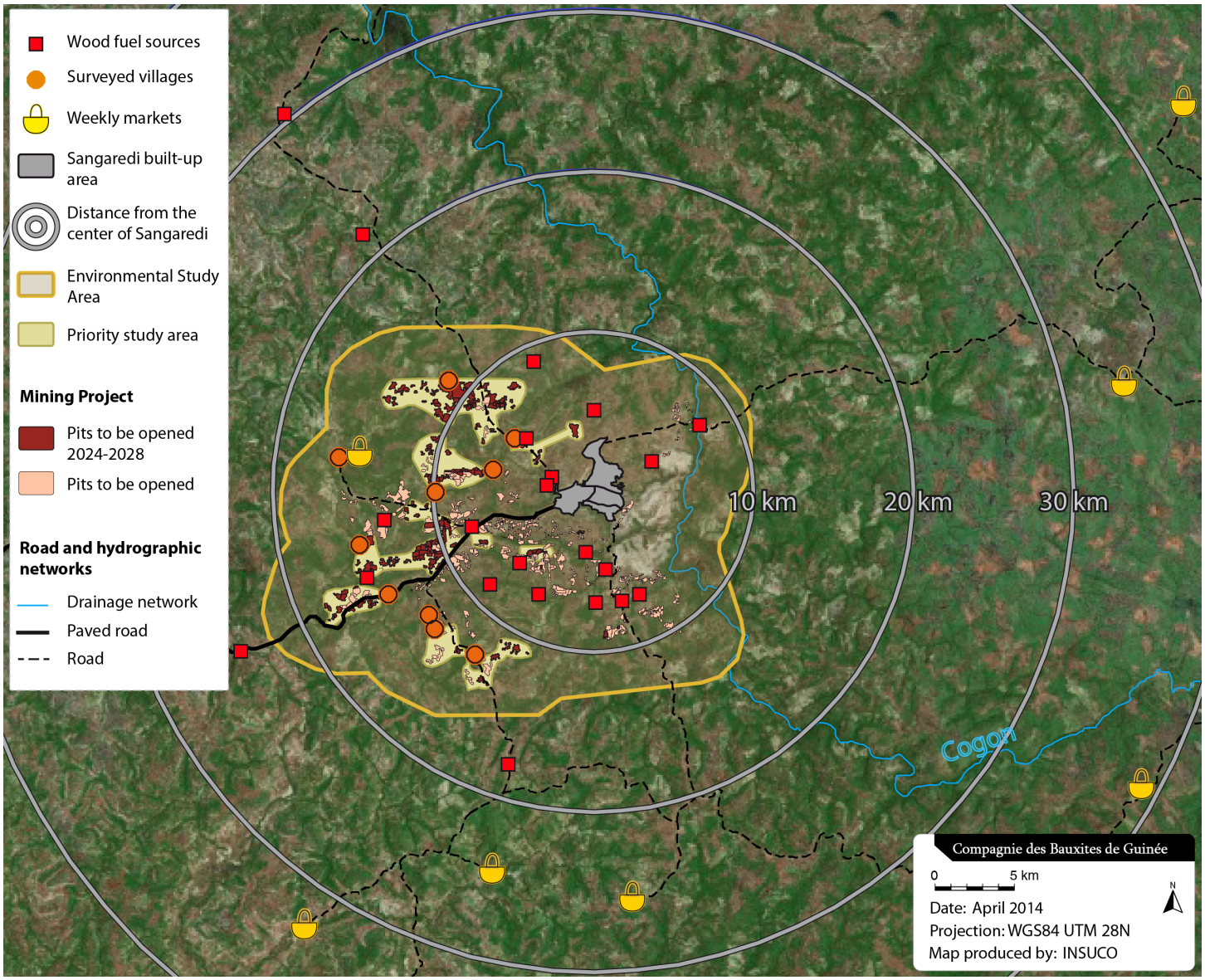
This section deals with a subject that includes biological aspects but also social ones (Chapter 5).

Each town or village has an impact on its immediate environment. These impacts depend on several factors such as the size of the population, the needs in natural resources and the spatial distribution of these resources. Sangarédi, with a population in the order of 53,600 residents in 2013 (INSUCO, 2013), has its own particularities in this regard. For some forty years, the town has been the center of regional development due mainly to the mining activities of a single entity, CBG, activities that created numerous direct and indirect jobs. The mining activities have transformed the landscape and the possibilities of access to the nearby hinterland reduced because of the establishment of exclusion zones. CBG now is considering extending its operations to about 18 km from the center of Sangarédi. This section deals with a resource that is particularly exploited in the expansion zone of the CBG Project, wood-energy (firewood and charcoal). The field data were collected between November 25 and December 7 2013. The complete report on the fieldwork for firewood and charcoal is presented as an appendix (Annexe 3-12).

3.12.2 Methodology

To gain an understanding of the use of woodfuel (including its origin and the consumption pattern in the town), semi structured and often opportunistic interviews were conducted with people supplying woodfuel to Sangarédi in 10 villages close to and in the zones that might eventually be mined (Map 3-28).

Map 3-28 Villages of interviews with woodfuel producers



In parallel, 108 randomly selected households in the town of Sangarédi were interviewed concerning their needs and use of woodfuel according to the seasons (see Annexe 3-12 for more details on methodology). The location of these households and their preferences is shown on Map 3-29.

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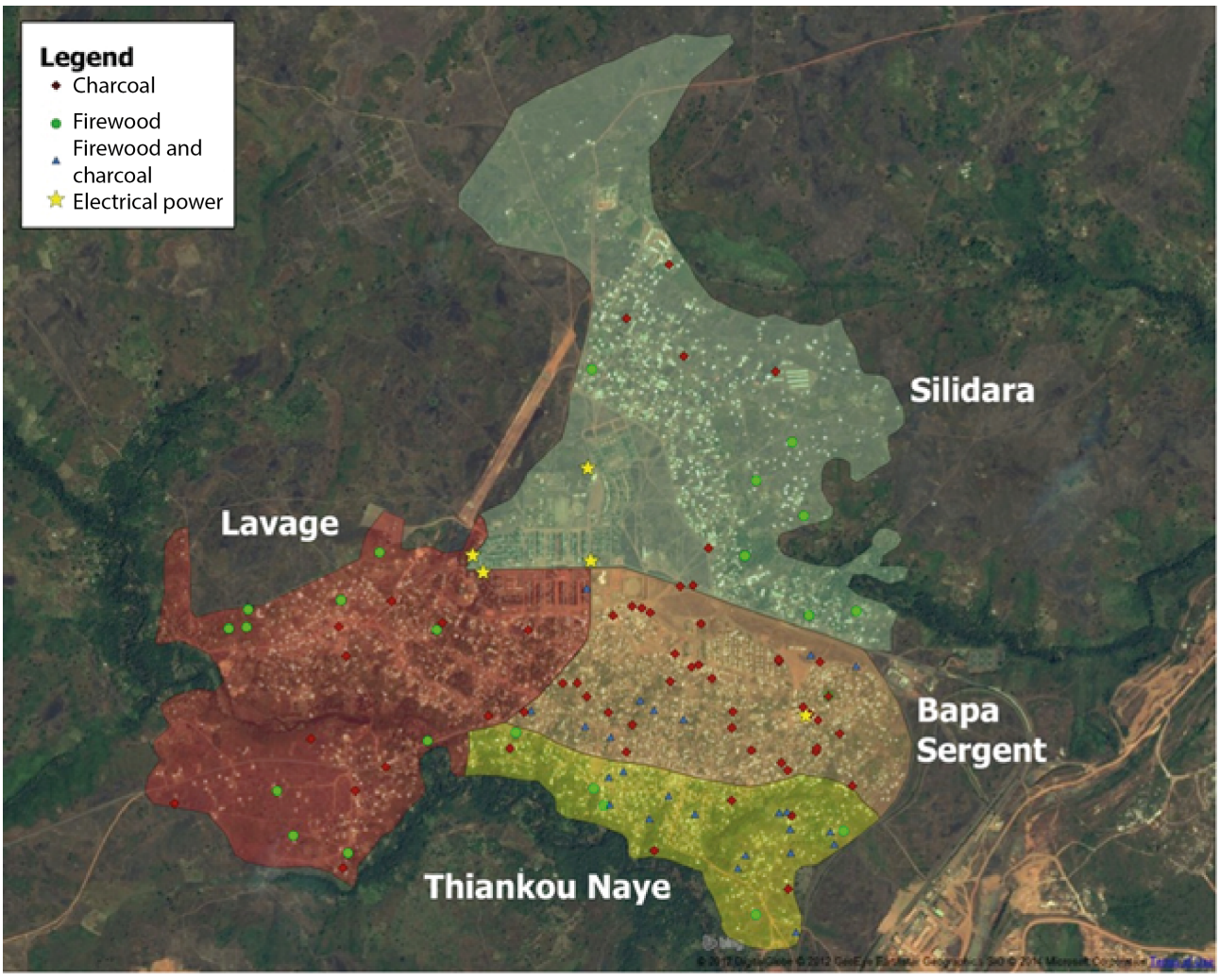
Map 3-29 Location of Sangarédi households according to their fuel choices



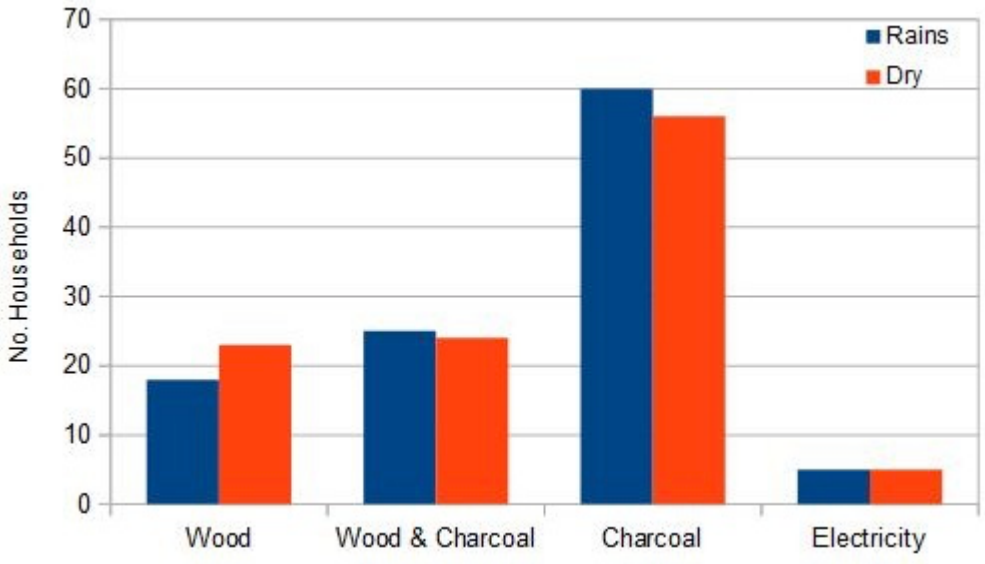
3.12.3 Results

3.12.3.1 Demand and consumption of woodfuel

Choice of energy

Woodfuels are the most frequently used energy source consumed by households in Sangarédi for cooking, with charcoal predominant, followed by a mixture of charcoal and wood and then wood on its own. The data indicate some seasonal changes in woodfuel choices, with a small switch to more charcoal in the rainy season and a return to more firewood in the dry season (Figure 3-10)

Figure 3-10 Household cooking fuels in Sangarédi

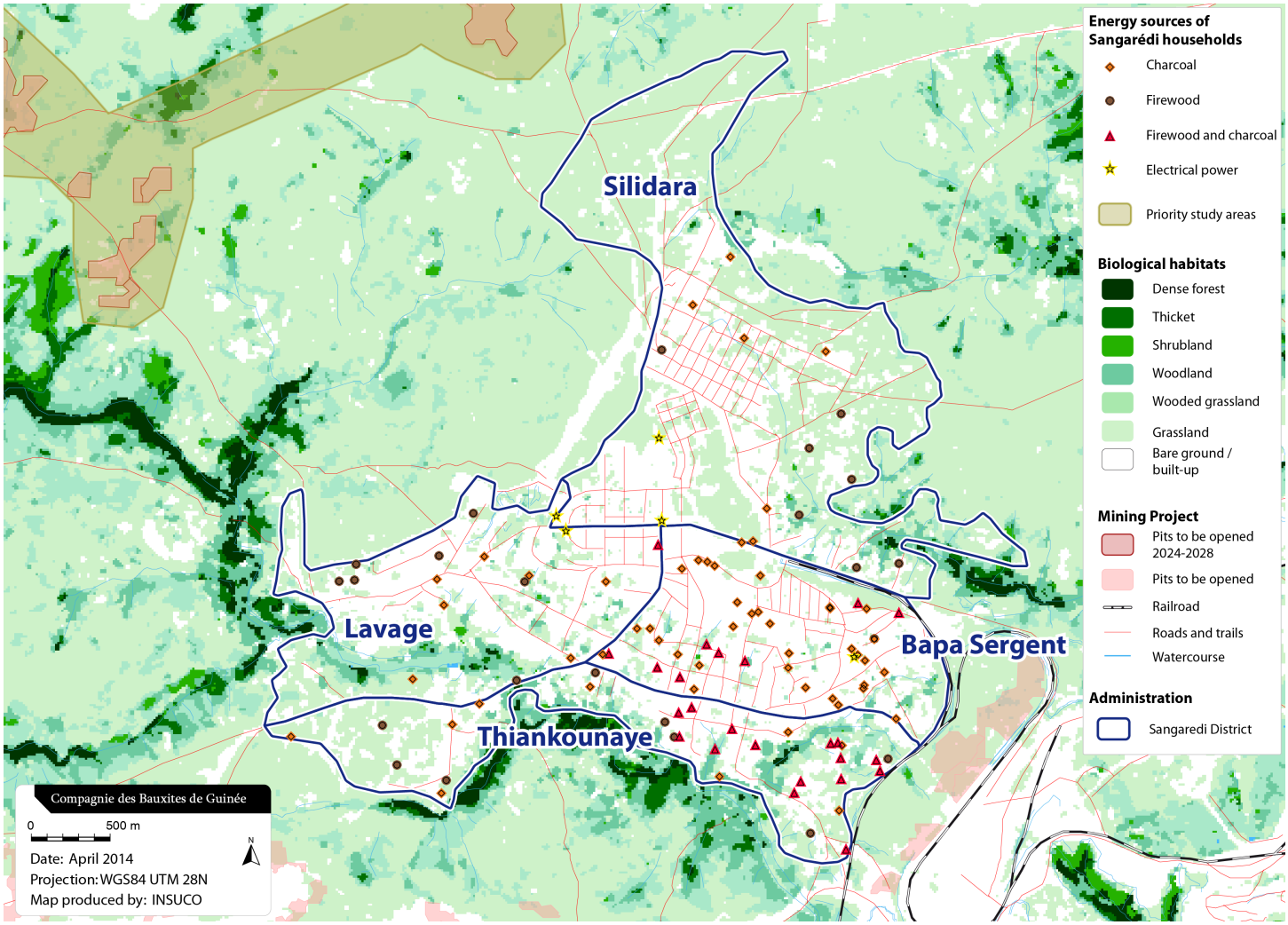


Several factors can influence the choice of woodfuel. Some maintain that charcoal does not dirty their cooking pots and other simply consider that is more enjoyable to use charcoal, probably because it burns more cleanly than firewood. One person interviewed, who uses both forms of energy, cooks sauces with charcoal and prepares rice using firewood.

On the other hand, several respondents said they used firewood because it is less expensive to buy or they can collect it themselves. As can be seen on Map 3-30, the

households that use firewood tend in general to be towards the limits of the town, hence closer to potential harvesting areas.

Map 3-30 Energy sources of households in Sangarédi



Electricity users are located in the area supplied by CBG in the center of town. This electrical option is not available to everyone, on the one hand because of the associated costs but also because its availability is limited in most of the town.

In conclusion, the data suggest that several factors can influence the choice of cooking energy, some of which are more subtle than merely the cost.

Table 3-41 indicates the type of stoves people are using with their fuel choices. All charcoal users use a traditional metal stove, but to what extent the price of this is a barrier to adopting this fuel is not known. Three informants who declared they only used charcoal, also said they had three stone stoves, which suggests that they are also occasional woodfuel users. Perhaps they use it when charcoal is scarce or for special cooking occasions, such as when the number of guests is high. As to improved cooking stoves (ICS) only thee informants reported them.

Table 3-41 Types of cooking stoves in Sangarédi

STOVE TYPE(s)	No.	%
Three Stones	14	13
Traditional Metal Stove	55	51
Other (incl. electricity & one ICS)	7	7
Three Stones + Metal Stove	30	28
ICS + Traditional Metal Stove	1	1
ICS + Three Stones	1	1

Woodfuel sources

All of the informants save six declare that they buy their woodfuel. The six exceptions live on the periphery of town and use wood they harvest themselves.

Table 3-42 shows where informants get their woodfuel, whether they harvest it or bought it. These data refer only to the rainy season.

Table 3-42 Woodfuel acquisition locations

Source Location	No. house-holds	%
In Town: Limania	29	66
In Town: Thiankou Naye	28	
In Town: Other	11	
In & Out-of-Town	7	7
Out-of-Town	28	27

Table 3-42 clearly shows that there are two major centers for acquiring woodfuel within the town, the large Sunday market in Thiankou Naye and the central daily market at Limania. Over a third of the informants get the woodfuel outside of town. There is thus a diffuse network for acquiring woodfuel in the hinterland that is was not possible to capture in this study.

Woodfuel purchasing patterns

Table 3-43 indicates the reported frequencies of woodfuel purchases, which though obviously related to household consumption patterns, nevertheless shows that many households are making frequent purchases

Table 3-43 Woodfuel purchasing frequency

Woodfuel Purchasing Unit	No. of Households	Purchasing Frequency		
		Min.	Max.	Median
Bundle of firewood	18	1 day	7 days	3 days
Sack of charcoal	42	3 days	1 month	8.5 days
Sachet of charcoal	14	1 day	2 days	1 day

Ethnographic studies of markets have often revealed the importance of dyadic relationships between traders and buyers (Traeger, 1981). Given the regularity of woodfuel purchases, these might be thought to exist in Sangarédi. However, replies to the question "do you always buy from the same vendor and why" suggest this is no in the majority of cases (N=82/96) and the main reasons given are the seller is not always available and for reasons of sale price.

These responses indicate that in Sangarédi, the buyer may turn to a number of vendors and the market for woodfuel is fairly open, that is to say there are fairly few constraints to selling, except for controls by the *Eaux et Forêts* agent at the entrance to town.

Enquiries outside of town, in the neighboring villages, show that there are several resellers (that buy in large quantities and sell by the unit). This phenomenon of course has some importance in determining the sales price of woodfuel.

Woodfuel prices

The standardization of woodfuel sales units is an important in determining the sales prices. For example, the firewood bundle can vary according to the quality of the wood and the size of the bundle. For charcoal, that is generally sold in sacks of standard size, thus of a determined volume, the purchase tends to select a heavy bag, that would give a better energy output. This tendency is widespread in Africa (Girard, 2002).

The surveys brought out certain data on the price tendencies between seasons.

For charcoal, 64% of the informants (N=27/42) indicated a decrease in prices during the rainy season on the order of 12 to 20%. Others did not notice a difference in price.

The price of a sack of charcoal is between 15,000 and 30,000 Guinean francs (GNF) in the rainy season and between 10,000 and 22,000 GNF during the dry season. BERCA-Baara-BERD (2003) reported a sales price of 3,000 GNF per sack.

The price for a sachet of charcoal remains stable through the year (1,000 GNF/unit).

In spite of the response of certain persons interviewed that, for reasons unknown, maintain that the sales price is stable through the year, it is noticeable that the prices go up during the rainy season. On the one hand the transport is more problematic given the state of the roads, and the rural producers spend more time on agricultural activities.

The cost of a firewood bundle seems to remain stable through the year, varying from 5,000 to 15,000 GNF per unit, but the number of informants is too small to conclude to a real tendency. In 2003, according to BERCA-Baara-BERD, the price of a bundle varied from 500 to 1,000 GNF.

Woodfuel consumption

The data presented in Table 3-44 on the daily frequency of use of cooking stoves does not allow making an estimate of the quantity of woodfuel used in Sangarédi.

Table 3-44: Daily stove use frequencies

Cooking Frequency	Rains No.	Dry No.
Once a day	33	33
Twice a day	58	58
Thrice a day	12	12

The quantity of woodfuel consumed depends on several factors including of course the number of persons and the nature of the food to be prepared. It also depends on the customs and habitats of the villagers. In towns, cooked food sold on the street is an important element in the diet of people, in particular for those of limited means who see it as a savings in the cost of preparation (Tedd *et al.*, 2003).

The hypothesis of a simple relation between the consumption of woodfuel and the size of a household is untenable. For example, old research on the consumption of woodfuel in the towns of Pita and Labé, in Guinea, showed that the larger the family the more efficient the use (LaFramboise, 1984). Whereas it might be tempting to estimate the woodfuel consumption in Sangarédi on the basis of an average consumption per capita (there are some averages per capita for Pita, Labé and Conakry (LaFramboise, 1984; World Bank, 1994)), the data collected in this study suggest that unless there was a more complete study on the variability of woodfuel consumption in time and space, any estimate would be unrealistic. In addition, there are other consumers of woodfuel in town, whose consumption is unknown.

3.6 Other types of urban woodfuel users

As a complement to the data collected among the households, certain preliminary information was collected from other urban users.

Bakers

In order to achieve an adequate temperature in their ovens, bakers tend to use firewood of certain trees—*bani* (*Pterocarpus erinaceus*) and *koura* (*Parinari exelsa*) were mentioned in particular. They appear to have specialist supply channels for this. As the three bakers visited were producing between 360 and 720 loaves a day, there are presumably other similar sized operations catering to local bread demand.

Aluminum Casters and Blacksmiths

These two artisanal industries, which are found particularly around the Thiankou Naye market are reliant upon charcoal to melt/heat their respective metals. It is likely that they have particular charcoal quality demands.

Street food producers

As mentioned above, street food offers interesting economies of scale for consumers. Though they very often use the same cooking technologies as households, studies elsewhere have shown that they can consume twice as much energy (cited in Tedd et al. 2003). These kitchens use firewood in particular, perhaps because they can manage their consumption better.

Brickmakers

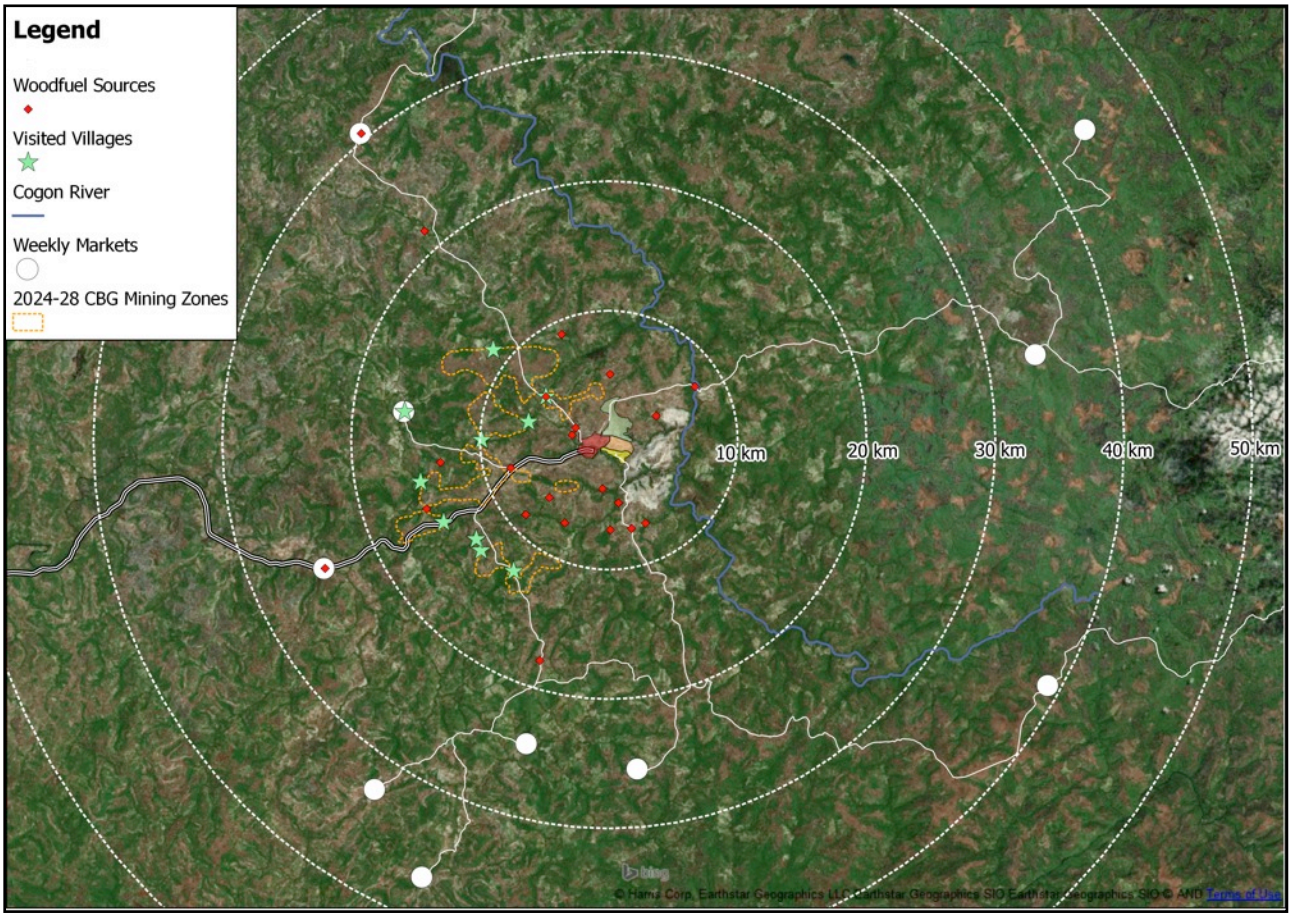
Several people in the Sangarédi hinterland reported that brick-makers from the town exerted a particular pressure on their woodfuel resources.

3.12.3.2 Rural production and distribution of woodfuel

Production areas

Map 3-31 provides a preliminary overview of Sangarédi's woodfuel supply area. This information was obtained from a variety of sources: questionnaire responses, discussions with transporters, woodfuel traders and bakers in the town as well as from chainsaw operators and charcoal producers based or operating in the countryside.

Map 3-31 Woodfuel supply zone for Sangarédi



One can note on this map that several geographic and geomorphological factors can influence the presence or accessibility of woodfuel out of town. For example a large part of the territory is occupied by bowal (in pale brown on the map), thus not offering any potential for wood harvesting, whereas the mining areas currently in use are inaccessible. On the other side, the Cogon River is probably an important natural barrier to the access of potential harvest areas east of Sangarédi, since only a single bridge, close to town, gives access to it.

The configuration of the road network is another significant geographical factor shaping the accessibility of the hinterland's woodfuel resources. For example the woodfuel sources the farthest out from Sangarédi are along roads. The one to the

north, Djan-Djan, is along an unmade road that in recent years has become more frequented because of a Russian mining concession in this direction. It is also the location of a weekly marketplace and therefore attracts traders from the town, which provides regular transport opportunities.

Tinguinlinta is another location far away, there is also a weekly market place and it has the great particularity of being located along the main paved road linking Sangarédi to Boké. One cannot help but notice the piles of firewood and sacks of charcoal alongside it, available for buyers using this well-supplied road.

Several sites in the hinterland are nevertheless accessible by robust 4x4 vehicles that can be used as woodfuel transports as long as the value of the wood exceeds in an acceptable way for the vendor, the cost of the transport. Of course, given the weight, the volume and the value of the woodfuel transported, it is more profitable to transport charcoal. It is not surprising to note that firewood generally comes from areas closer to Sangarédi than the charcoal, except of course when large trucks can lead to an economy of scale for the transport of firewood.

The geography of the woodfuel footprint of Sangarédi can be described in terms of three zones spreading out from the town and going to the hinterland (Map 3-31). The first zone is a belt only a few kilometers wide around the town's edge where some townsfolk as well as the inhabitants of the hamlets within this area exploit firewood resources. In the second zone, spreading out to a radius of roughly 10 km from the town center is a zone of mixed firewood and charcoal exploitation. In the third zone, exploitation becomes more dispersed and charcoal production dominates.

4.2 Firewood harvesting and trade

Around Sangarédi, with the exception of some permanent gardens and tree crop plantations, much of the farmable landscape is rotated between short periods under annual crops, especially rice and sorghum, and longer periods under bush fallow during which time woody vegetation re-establishes itself to some extent. Field clearance for the annual crops takes place around March to May and produces large

quantities of dead wood, available for the villagers but also allowing the export of surplus bundles to Sangarédi.

At Parawol Molassi, it was reported that this exportation in 2013 was an important source of revenue for households in the period between crops, when the reserves of the preceding season were emptying. The importance of this source of revenue for the poorer households was observed in several West African countries (Beck and Nesmith, 2001).

Informants in Mbouroré said that the bundle of wood composed of *bani* and *koura* (species used in bakers ovens as mentioned earlier) could be sold for double the price of a normal wood bundle.

Charcoal production and trade

During fieldwork, several informants noted since 2000 approximately, a substantial increase in the demand for charcoal in Sangarédi. This phenomenon has also been reported elsewhere in *Guinée Maritime*, in the region of Boffa for the same years (Leciak, 2006). On the other hand, for household energy, a larger role for charcoal compared to wood is noticed as the population of the town increases (Barnes *et al*., 2004).

Technical knowledge and social contexts

In Senegal, Ribot, (1998) noted that technical knowledge to construct charcoal kilns acted as an important entry barrier. In the Sangarédi region several producers acquired their experience by stays outside the country (in Senegal in particular), in the context of Coranic studies elsewhere in Guinea or from the presence of foreigners that came to practice this trade in their village. The knowledge is then passed on from person to the other in the villages.

Tenure considerations in charcoal production

Different relations exist between the owner of piece of land and the charcoal producer.

According to informants at Parawol Aliou and Mbouroré ten years ago the charcoal production activity was fairly free and it wasn't necessary to ask the owner of the land a special permission to practice it. However it is now the standard and owners and producers must come to an understanding, unless of course the producer is also the owner. The understanding is easier when the producers are members of the family of the owner.

In general some form of payment is discussed between the producer and the owner. The producer can pay in bags of charcoal, in cash or in a combination of both, according to the wishes of the owner.

The agreement of an owner is not necessarily given without some demands regarding the exploitation of the trees. Sometimes the owner may want to cut the trees to use the land a different way. For example at Parawol Aliou, a charcoal producer cut a variety of species for certain owners that wanted to plant cashew trees (*Anacardium occidentale*). In the last ten years there has been an important increase in cashew plantations in the region, increase that corresponds to the increases in charcoal production in the same period.

Kilns

Kiln sizes vary in relation both to the amount of time producers are prepared to wait before they can realize their profits and the amount of suitable wood in the vicinity. Generally producers work on their own, though sometimes they may seek help for some of the various tasks required (collecting wood, transporting it to the site, surveying the kiln and sorting and bagging it). One means of speeding up production is to call upon the services of a chainsaw operator, but costs are fairly high and rarely within the reach of the purse of the small producer.

The largest kiln reported for the region is supposed to have produced 270 bags of charcoal, six year ago. The producer says that it would utopic for him to make a kiln of that size now because of the rarity of large trees in the area where he operates. Now, the largest kilns produce from 200 to 250 bags of charcoal although smaller kilns (less than 50 bags) are more common. Some producers prepare small kilns, on the order of 10 bags, during the low season to round off their revenues. The operations involved in producing 10 bags of charcoal, from harvesting the wood to

packaging the product can take 5 to 15 days depending on the time devoted to this activity and the time required to harvest the wood.

Apart from a few producers who only do this, most producers do it in complement to other activities that generate revenues. This makes it even more difficult to describe an average producer and the average production. Table 3-45 illustrates the result of the discussions with six Charcoal producers from Parawol Aliou. It shows the great variability in terms of numbers of kilns and bags produced according to the informant.

Table 3-45 Annual charcoal production figures for six producers in Parawol Aliou (2013)

No. kilns made in 2013 Rainy season	No. kilns in 2013 Dry season	Typical kiln size made (Sacks)	Total Possible Sack Production for Year
2	3	100-150	500-750
2	0	20-30	40-60
3	3	30-40	180-240
5	3	80-180	640-1440
7	4	60	660
1	2	100-150	300-450

Just as urban consumers are aware of different charcoal burning qualities, rural producers are conscious that certain tree species provide different qualities of charcoal. Three species in particular are well known for producing good charcoal: *bani (Pterocarpus erinaceus), karma fassa (Combretum glutinosum)* and *tchellen (Prosopis africana)*. These three species are known to coppice (Bellefontaine, 1997), but *bani* is slow growing, unlike *karma fassa*, Wurster (2010). In other situations these species are not available near the kilns, and a range of alternate species are used

The charcoal market does not seem to reflect the intrinsic value of the tree species used, since the bags are sold by volume and it is rather difficult for a consumer to identify a species from a piece of charcoal. This does not mean that producers make their charcoal from any species. For example certain fruit trees or species important for traditional medicine or taboo are left aside.

Selling charcoal

The price obtained by the producer for the charcoal production depends on where and how the sale is organized. Of course producers near the paved road (Sangarédi-Boké) seem to be at an advantage since the transport cost is reduced and that the numerous passers-by represent a good clientele. In more remote areas, the choice is to make the buyers come to the kilns (sale price 10,000 to 15,000 GNF per bag) or put the bags on the Sangarédi market (price from 18,000 to 20,000 GNF per bag). The second option, that may bring in more revenue, however implies that the procurers has to pay the transport cost to town and whether a savings can be realized depends on the economy of scale, depending in part on the volume transported. Also, the Eaux et Forêts agents at the entrance to town may impose a fee or even confiscate the bags. By selling the charcoal at the kiln site, the producer shifts the risk to the buyer.

3.12.3.3 Plant species used for charcoal

Table 3-46 presents the plant species used for the preparation of charcoal and some that are sometimes avoided by producers for different reasons, including their therapeutic uses and their food value. It is the synthesis of interviews with 14 charcoal producers. The Pulaar names given by the producers allowed the association, with reserve, to Latin names based on the works of Carrière (2000). A common Pulaar name can correspond to several distinct species. The Pulaar names *tiouko* (*Lannea acida*, *L. barteri*, *L. velutina*), *nonko* (*Ficus ovata*, *F. saussureana*, *F. polita*, *F. sur*, *F. thonningii*) and *boilé* (*Uvaria chamea*, *U. sofa*, *Artabotrys velutinus*), given by the informants are examples.

In Table 3-46 only those species likely present in the area (all but three have been found by the KEW Gardens team) and whose Pulaar name corresponds to a single

species according to Carrière (2000), war retained. It must be emphasized that this Latin name – Pulaar name association has been undertaken with reserve. Some of the Pulaar names could not be associated with any species. When the informants did not specify that the species was not a favorite one, the species are listed as used without preference. It is apparent from this table that the species that seem to have the highest harvest pressure for charcoal production are *Pterocarpus erinaceus* and *Combretum glutinosum*, with respectively 12 and 7 mentions.

Table 3-46 Plant species used for charcoal production

Latin name	Pulaar name	French name[1]	Number of times the species is mentioned as preferred by producers	Number of times the species is mentioned as used without preference by producers	Number of times the species is mentioned as avoided by producers
Pterocarpus erinaceus	Bani	Palissandre du Sénégal	10	2	
Daniellia oliveri	Tiéwé (ou tiéri)	Saucissonnier	1	2	2
*Combretum glutinosum**	Kamafassa	Combretum gluant	4	3	
Combretum micranthum	Kankaliba	Kinkéliba		1	
Parkia biglobosa	Nété,	Néré	1	3	3
Parinari excelsa	Koura	Prune du Japon	2	3	1
Erythrophleum africanum	Téli		1	2	1
Hymenocardia acida	Pélitoro	Cœurs-volants	2	3	
Prosopis africana	Tiélèn	Faux ébénier	1	1	
Trema orientalis	Tieké			1	
Markhamia tomentosa	Kafawandou	Kasounkaress		1	1
Bombax costatum	Loukoun	Kapokier		1	2
Dalium guineense	Méko	Tamarinier noir		3	1
Sorindeia juglandifolia	Sandji bombo		1	1	

Latin name	Pulaar name	French name[1]	Number of times the species is mentioned as preferred by producers	Number of times the species is mentioned as used without preference by producers	Number of times the species is mentioned as avoided by producers
Mangifera indica	Mango	Manguier		3	
Lophira lanceolata	Malanga	Azobé de savane	1		1
Spondias mombin	Talé (ou tyalè)	Prunier mombin			1
Albizia zygia	Maronaye (ou maronai)			1	
Piliostigma thonningii	Barké			1	
Holarrhena floribunda	Eindhama (ou endhamma)	Holarrhène florifère		1	
*Lecaniodiscus cupanioides**	Sataga		2		
Anisophyllea laurina	Kansi			1	
Detarium senegalense	Boto	Petit détar			1
Margaritaria discoidea	Kéeri,		1		
*Schrebera arborea**	koulététaya			1	

[1]There is no official list of French names for plants of the African continent. For the majority of species there is no name at all. However when a simple web search allowed it ,one of the French names is indicated in the table. Othrwise only the Pulaar and Latin names are used.

*Species not found by the Kwe Gardens team for the present study.

Species of concern

Among the 25 species noted in Table 3-46, none is currently considered as threatened according to IUCN criteria. One is classed as *Data Deficient*: *Mangifera indica* (IUCN, 2013). The status of the 24 other species has not yet been determined by the IUCN specialists (IUCN, 2013).

In the *Monographie nationale* (Bah et al., 1997), *Spondias mombin* and *Bombax* sp. Are considered as threatened whereas *Combretum micranthum*, *Parkia biglobosa*, *Lophira lanceolata* and *Hymenocardia acida* are considered vulnerable.

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