Making Use of Local Knowledge and Participatory Monitoring to Engage with Local Communities:
A Case Study of Hunters’ Perceptions of Change in Lefini, Republic of Congo

Sophia Leroy-Puri
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DECLARATION OF OWN WORK

I declare that this thesis, ‘Making Use of Local Knowledge and Participatory Monitoring to Engage with Local Communities: A Case Study of Hunters’ Perceptions of Change in Lefini, Republic of Congo’ is entirely my own work, and that where material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgement given.

Signature

Name of Student Sophia Leroy -Puri

Name of Supervisor(s) Professor E.J. Milner- Gulland
Tim Rayden
Table of Content

Table of Content........................................................................................................... iii
List of Figures .................................................................................................................. v
List of Tables ................................................................................................................... v
List of Abbreviations & Acronyms ................................................................................ vi
Abstract ........................................................................................................................... vii
Acknowledgments........................................................................................................... viii

1 Introduction ................................................................................................................... 1
  1.1 Problem Statement ................................................................................................. 1
  1.2 Project Aims ............................................................................................................. 2

2 Background .................................................................................................................. 4
  2.1 The Need for Local Engagement .......................................................................... 4
      2.1.1 Local Ecological Knowledge and Historical Literature ................................. 4
      2.1.2 The Shifting Baseline Syndrome .................................................................. 5
      2.1.3 Using Participatory Approaches to Measure Abundance & Assess Sustainability 5
      2.1.4 Lefini Reserve ................................................................................................. 6
      2.1.5 Historical Wildlife Presence ......................................................................... 6
      2.1.6 Administration & Conservation Initiatives around the Reserve .................. 7
      2.1.7 Bushmeat Hunting in Lefini .......................................................................... 8
      2.1.8 Previous Biological Surveys of Lefini ............................................................ 9

3 Methods ....................................................................................................................... 10
  3.1 Methodological Approach ....................................................................................... 10
  3.2 Hunter Surveys ........................................................................................................ 10
  3.3 Spatial Data Collection .......................................................................................... 13
      3.3.1 Sapelli ............................................................................................................ 14
      3.3.2 Recces ............................................................................................................ 15
      3.3.3 GPS mapping of hunting camps ................................................................... 17
  3.4 Analysis ..................................................................................................................... 18
4 Results

4.1 Hunters' Perceptions

4.1.1 Perceived Changes in Wildlife Populations Since the 1950s

4.1.2 Perceived Changes in Hunting Effort Since the 1950s

4.1.3 Latest Catch and Average Catch

4.1.4 Perceived Changes in the Presence of Species of Historical Interest

4.1.5 Perceptions about the Future of Hunting in Lefini

4.2 Spatial Distribution

4.2.1 Distribution of Hunting Camps and Hunting Signs

4.2.2 Distribution of Wildlife Signs and Encounter Rates per km

5 Discussion

5.1 Spatial-temporal Differences in Perceptions

5.2 Assessing the Use of LEK and Participatory Monitoring in Lefini & Defining Priorities for the Future

5.3 Prospects for Conservation in Lefini

References

Appendix A - Hunter Survey

Appendix B - Species Identification Cards

Appendix C - Sapelli Interface

Appendix D - Encounter Rates

Appendix E - Encounter Rate Comparison
List of Figures

Figure 2.1 Location of Lefini Reserve, Republic of Congo................................................................. 7
Figure 3.1 Location of the study sites for hunters interviews.............................................................. 11
Figure 3.2 Recce areas and their locations in relation to the study villages ........................................ 16
Figure 4.1 Perceived change in wildlife abundance by age category ................................................... 19
Figure 4.2 Number of hunters who started hunting in each decade and their perceptions of change in wildlife abundance ..................................................................................................................... 20
Figure 4.3 Perceived levels of wildlife abundance at the start and end of the hunting career.............. 21
Figure 4.4 Perceived wildlife presence around the village by sector .................................................... 22
Figure 4.5 Perceived changes in wildlife presence around the village ................................................ 22
Figure 4.6 Perceived changes in the number of local hunters ................................................................. 23
Figure 4.7 Active and non-active hunters’ perceived latest and average catch.................................. 25
Figure 4.8 Last perceived sightings of lion and hyena ........................................................................ 27
Figure 4.9 Distribution of camps and hunting signs ............................................................................. 29

List of Tables

Table 3.1 Profile of interview respondents per sector and age category................................................. 11
Table 4.1 Perceived sightings of species of historical interest .............................................................. 26
Table 4.2 Encounter rates of hunting and wildlife signs..................................................................... 30
**List of Abbreviations & Acronyms**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CARPE</td>
<td>Central Africa Regional Program for the Environment</td>
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<tr>
<td>ExCiteS</td>
<td>Extreme Citizen Science</td>
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<td>LEK/LK</td>
<td>Local Ecological Knowledge/Local Knowledge</td>
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<td>ML</td>
<td>Mbouambé-Léfini</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<td>SBS</td>
<td>Shifting Baseline Syndrome</td>
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<td>WCS</td>
<td>Wildlife Conservation Society</td>
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Abstract

The sustainable use of natural resources requires the engagement of local communities in the conservation process and the alignment of differing perceptions towards a common goal. This study investigates the use of local knowledge and participatory monitoring to engage with resource users in a bushmeat-harvesting system. Interviews were conducted with 30 hunters in two distinct geographical areas around the Lefini Reserve in the Republic of Congo to investigate their perceptions of changes in hunting and wildlife abundance since the 1950s. These perceptions were compared with information from historical literature and data on distribution of hunting and wildlife signs collected using a participatory approach aimed at engaging with hunters and ecoguards. Results showed inter-generational and geographical differences in hunters’ perceptions, in line with historical literature and previous studies in the area, suggesting a decline in wildlife abundance, the extirpation of two major carnivores in the last 30 years and the possible presence of the critically endangered Pennant’s red colobus (*Procolobus pennantii ssp. Bouvieri*). This underlines the use of local knowledge and participatory approaches in engaging with local resource users to inform conservation management in Lefini. Future conservation action should rely on a multi-user strategy providing shared access and benefits for all. However, this is ultimately dependent on the continued support from international organisations and the commitment of national institutions.
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1 Introduction

1.1 Problem Statement

Conservation is a field of conflicting perceptions and realities (Redpath et al., 2013), where differing values and understandings of the natural environment drive not only the use of natural resources, but also research priorities and strategy implementation. Unveiling those perceptions and moving beyond one-sided approaches to conservation are therefore crucial steps towards understanding the complex dynamics underlying social-ecological systems (Berkes & Folke, 1998; Vliet et al., 2015) and implementing adequate conservation strategies, both of which require the use of sound ecological knowledge and engagement with various stakeholders. In a context where the use of resources is not or badly regulated, the concept of ‘tragedy of the commons’ (Hardin, 1968) has often been invoked to explain depletion and motivate ‘fortress conservation’. However, such strategies are of little use less the users themselves perceive the depletion and are willing to act (Burke, 2001). Here, aligning conservationist and resource-user perceptions through local engagement is important at a number of levels; not only does it ensure more transparency and consistency during the research and implementation process, it also guarantees resource users understand the need for conservation and promotes long-term commitment (Redpath et al., 2013).

Engagement can be initiated at a number of levels, for instance through the use of Local Knowledge (LK) or participatory approaches. Traditionally, ecological knowledge has been understood as scientific data collected by experts, foreign to the study area. Nevertheless, the use of qualitative data within the field of conservations is increasingly being recognised as a useful tool (Newing, 2011), which offers an interesting complement to traditional methods by providing a more nuanced understanding of an otherwise simplified system. LK, often combined with the use of historical literature, represents one such method, which has for instance been used to provide historical evidence for ecosystem depletion (Ainsworth et al., 2008; Sáenz-Arroyo et al., 2005). Although care must be taken in using qualitative data to assess sustainability (Jones et al., 2008), such methods can provide a historical background against which to measure change and set appropriate baselines (Mcclenachan et al.,
They can also enable conservationists to recognize the existence of shifting ecological baselines (Pauly, 1995), which may have implications for participatory conservation strategies (Papworth, 2009).

Participatory monitoring represents another approach to engage with local stakeholders and assess sustainability. Where data is scarce or non-existent and field conditions particularly challenging, rendering traditional data collection logistically impractical, participatory monitoring has proven a reliable alternative (Danielsen et al., 2005; Rist et al., 2010). Bushmeat is one such topic where perceptions not only define what we view as right, but where defining levels of sustainability based on accurate trends has proven difficult (Vliet et al., 2015). Tropical environments, which constitute the main focus of bushmeat research, are difficult to survey and many programs in these parts of the world lack systematic data on population trends and harvesting levels. Nevertheless, threats paused by unsustainable levels of hunting, particularly in the Congo basin, are high on the agenda of conservationists (Wilkie & Carpenter, 1998; Milner-Gulland et al., 2003; Fa et al., 2003). Hence, many studies on bushmeat are moving away from pure scientific approaches to data collection to engage local resource users in the research process (Kümpel et al., 2009; Rist et al., 2010; Coad et al., 2013).

In this context, conservation organisations tackling the issue of bushmeat are increasingly seeking to engage with local resource users both in the research and implementation process.

1.2 Project Aims

This study, conducted in collaboration with the Wildlife Conservation Society (WCS), investigates the use of LK and participatory monitoring to engage with local communities and inform conservation management around the Lefini Reserve in southern Republic of Congo. In particular, the study aims to explore perceived spatial-temporal trends in hunting effort and wildlife abundance since the 1950s in two distinct geographical areas of the reserve, and characterise their spatial distribution through local participation. In parallel, the research process aims to provide an insight into the potential of a novel technological tool in engaging with local stakeholders, specifically hunters and ecoguards.
The study aims to answer the following questions:

1. Have the hunters perceived a change in wildlife abundance and hunting effort over the past decades? If yes, what are these changes and do they vary across different generations of hunters or geographical areas?

2. How do hunters’ perceptions compare with historical information on species presence in the area?

3. How do hunters’ perceptions compare with current data on spatial distribution of hunting and wildlife signs in two sampled areas of the reserve?

4. What are hunters’ perceptions in regard to the future of hunting around the reserve?

5. What conclusions can be drawn from these assessments in regards to the ecological state of the area, the use of local knowledge and participatory monitoring, which could inform the future management of the reserve?
2 Background

2.1 The Need for Local Engagement

Sustainable conservation strategies ultimately require the resolution of the human conflicts which underlie the use and management of natural resources (Redpath et al., 2013). This implies recognition of the various perceptions, values and interests underpinning these conflicts (Redpath et al., 2013) and the collaboration of the parties they represent (Milner-Gulland et al., 2003). Thus, engaging with stakeholders at all levels becomes a priority in order to foster trust, transparency and facilitate common action (Danielsen et al., 2003; Redpath et al., 2013). The inclusion of local communities in particular, into the decision-making process and management of natural resources, has been widely recognised as a necessity for the future of conservation (Millennium Ecosystem Assessment, 2005). This recognition has resulted in a shift towards more qualitative sources of data borrowed from the field of social science, which recognise the value of local knowledge (Huntington, 2010; van der Hoeven et al., 2004; Ziembicki et al., 2013; Turvey et al., 2013) and participatory approaches (Danielsen et al., 2005; Rist et al., 2010; Mortensen & Jensen, 2012). Such methods represent useful complements to traditional scientific research, providing powerful insights into socio-ecological systems as well as reliable alternative methods for data collection.

2.1.1 Local Ecological Knowledge and Historical Literature

Various studies have documented the use of local ecological knowledge (LEK) in providing valuable information on changes affecting ecosystems (van der Hoeven et al., 2004; Ziembicki et al., 2013). Coupled with the use of historical literature, they can provide useful benchmarks against which to compare current levels of biodiversity and set appropriate targets (Mcclenachan et al., 2012). They have for instance been used in fisheries to assess sustainability (Sáenz-Arroyo et al., 2005a; 2005b; Coll et al., 2014) by characterizing the decline in fish stocks through variations in catch among different generations of fishers. In China, the use of LEK enabled the characterisation of population trends of freshwater cetaceans over time, corroborating survey data collected independently (Turvey et al., 2013). More recently, interviews have also been used in bushmeat studies to elicit hunters’ perceptions of socio-ecological changes to
their environment (Coad et al., 2013). In such cases, these approaches have been able to provide quick and reasonably accurate snapshots of the situation as well as the socio-ecological changes affecting it. Nevertheless, local knowledge elicited through interviews remains subject to bias (Jones et al., 2008; O’Donnell et al., 2012) and may reveal the existence of ‘shifting baseline syndrome’ (Pauly, 1995; Papworth, 2009).

2.1.2 The Shifting Baseline Syndrome

Defined as ‘changing human perceptions of biological systems due to loss of experience about past conditions’ (Papworth et al., 2009), ‘shifting baseline syndrome’ (SBS) can manifest itself in the form of ‘generational’ or ‘personal amnesia’ and represents a powerful framework for measuring the level of awareness pertaining to changes within a community. Care must be taken in distinguishing actual inter-generational differences in perceptions from mere differences in experience, which do not necessarily represent a lack of awareness. However, failing to recognise the existence of SBS within a community presents a number of risks, which could jeopardise the validity of local knowledge and have wider implication for the implementation of participatory approaches. For instance, lack of awareness can prevent actors from truly engaging in conservation actions, if the need for change is not recognised, and blind conservation implementers to the need for environmental education. However, in order to establish the existence of SBS, biological data to corroborate actual ecological changes in the system are necessary.

2.1.3 Using Participatory Approaches to Measure Abundance & Assess Sustainability

Methods for assessing sustainability are multiple and include data collected using plot sampling, distance sampling, mark-recapture methods, indirect sign counts, presence-absence data and offtake-base methods (Milner-Gulland & Rowcliffe, 2007). The latter has been widely used in the context of bushmeat studies to assess hunters’ catch-per-unit-of effort (CPUE) and incorporates more qualitative techniques such as village or household offtake surveys, hunter follows, interviews and diaries (Kümpel, 2006; Kümpel et al., 2009). Moreover, methods such as hunter reporting of CPUE and hunter interviews have proven equally reliable as professionally carried out surveys in assessing the status of ecological systems (Rist, 2007; Rist et al., 2010), even though the choice of variable to assess levels of CPUE may be subject to bias and should be
considered carefully (Rist et al., 2008). In addition, they also represent useful alternatives to traditional ecological surveys, which can prove logistically impractical and too resource-consuming in tropical environments (Coad et al., 2013). Finally, the use of participatory approaches is a powerful way to engage with local communities (Danielsen et al., 2003), and in the case of bushmeat-harvesting systems with the hunters themselves.

2.1.4 Lefini Reserve

One such bushmeat-harvesting system is the state-owned Lefini Reserve in southern Republic of Congo. Covering an area of 6,300 km², it is situated approximately 200 km north of the capital Brazzaville and is easily accessible by road, with the main N2 running along its eastern boundary (Fig.2.1). Lefini forms part of the greater Batéké Plateaux, a unique landscape of sandy savannah hills interspersed by riverine forest galleries, which stretches from Gabon to the Democratic Republic of Congo (Van de Weghe, 2008). During the rainy season, the heavy rainfalls seep through the sandy soils forming large reservoirs of underground water, which resurface as swamps and rivers, the largest being the Lefini River itself. Geologically, these plateaux belong to the Kalahari basin, which formed millions of years ago and spans all the way to Southern Africa. This helps explain the distinctive habitat of Lefini compared to the rest of the country, and within it the subsistence of typical savannah species (Van de Weghe, 2008; King & Chamberlan, 2013).

2.1.5 Historical Wildlife Presence

Lefini Reserve owes its creation to a decree promulgated in 1951, aimed at preventing the complete destruction of its wildlife and natural habitat, considered unique in Congo (Arrêté n.3761, 1951). Hunting was subsequently banned, except during six months of the year during which local communities retained legal rights to hunt in the reserve. Six years after its creation, the reserve inspired ‘great hope’ and its wildlife was ‘diversified’ and ‘on the track to rehabilitation’ (Blancou, 1957), with ‘several big herds of elephant [...]; many buffalos; hippopotamus in the rivers; numerous southern reedbuck; waterbucks in places; many sitatunga; bush duiker in the savannah, yellow-backed, bay, black-fronted, blue duiker in the galleries; red-river hogs, leopards, spotted hyenas, jackals, hyraxes and forest monkeys, galagos and at least one big troop
of chimpanzee’. Lions were also known to roam the area in the middle of the 20th century and were thought to be more common in Congo than in neighbouring Gabon. In fact, they were most numerous in the Lefini area (Malbrant & Maclatchy, 1949; Maclatchy, 1957). However, the nature of the open habitat and the proximity of the motorized road made the animals vulnerable to opportunist hunters inspiring wishes for a higher degree of protection of the reserve (Blancou, 1957).

![Map of the Lefini Reserve, Republic of Congo](image)

**Figure 2.1 Location of Lefini Reserve, Republic of Congo**

2.1.6 **Administration & Conservation Initiatives around the Reserve**

Originally 4,000 km² at its creation in 1951, the reserve was subsequently enlarged to encompass an area straddling the two banks of the Lefini River to which it owes its name. However, due to the administrative division of the country, the reserve is not governed as a single entity. Following the creation of the Lesio-Louna Reserve on the southern bank to accommodate the establishment of a gorilla sanctuary in 1993, the southern section is currently managed by the John Aspinall Foundation under the tutelage of the State (Mathot et al., 2006). The Lesio-Louna Reserve operates two
checkpoints on the Lefini River manned by a small ecoguard unit, which conducts regular patrols on the southern bank and to some extent on the northern bank directly opposite the sanctuary. The section north of the river, which is the focus of this study, remains under management of the State alone, despite repeated initiatives from WCS to obtain co-management of the area. As a result, conservation efforts of NGOs remain limited to the periphery of the reserve and include the provision of alternative livelihoods to bushmeat and initiatives around sustainable household wood consumption, which receive the financing of CARPE (WCS, 2014; CARPE, 2015). A small, and until recently volunteer, unit of ecoguards has been conducting patrols in a small area in the northern section along the Nambouli River. This unit was recently awarded official recognition by the State, although support remains limited (WCS, 2014).

2.1.7 Bushmeat Hunting in Lefini

The majority of the population living around the Lefini Reserve belongs to the ethnic group Teke, indigenous to the area. Following the instability of the civil war of 1997, the population of the area substantially increased, with a large proportion of people emigrating from Brazzaville (Downer, 1998; Mathot et al., 2006). The village of Mbouambé-Léfini, adjacent to the reserve, saw its population rise from 568 in 1997 to 846 in 1998 and 1538 in 2006, which tremendously increased pressure on the surrounding natural habitat.

Agriculture represents the primary activity for the majority of people around the reserve (Mathot et al., 2006), although to varying degrees, notably in Mbouambé-Léfini where hunting remains an important activity (Detoeuf, 2014). Fish constitutes the main source of protein, meaning the population is not dependent on bushmeat for food. However, while bushmeat hunting for auto-consumption remains limited, the reserve is under great threat from commercial hunting to supply urban markets, in particular Brazzaville (Downer, 1998; Mathot et al., 2006; Detoeuf, 2014). In the village of Mbouambé-Léfini, hunting generates over 100,000 CFA per month (approximately £107) for some hunters, with approximately 200kg of meat hunted per hunter per month (Detoeuf, 2014). Although other villages such as Mpoh present a very different profile, with revenues from hunting less than 20,000 CFA per month per hunter (i.e.
approximately £22) and a monthly catch less than 25kg per hunter, reports on hunter catch and household surveys suggest large-bodied species are getting rarer, while hunters themselves report being tired of having “to run after the game’. This reflects the general trend in the region of the Congo basin, where growing human population and increasing demand from cities have led to dramatic declines in bushmeat species (Wilkie & Carpenter, 1998; Milner-Gulland et al., 2003; Brashares et al., 2011).

2.1.8 Previous Biological Surveys of Lefini

Unfortunately, a lack of systematic biological surveys over time prevents any categorical conclusions on the real impact hunting is having on the wildlife of the area. A handful of recces have been carried out at irregular intervals and provide some information on hunting and wildlife distribution on the reserve (Downer, 1998; Ikoli, 1998; Mathot et al., 2006; Nganga et al., 2006). These indicate the presence of 25 species of animals, including a small population of elephants, an overall low incidence of animal signs and a substantial number of hunting signs. Although recces can be easier to conduct in challenging environments than more systematic approaches such as transects, they do present a number of biases, which prevents the method of providing indices of absolute abundance (White & Edwards, 2000; Kühl et al., 2008). The type and quality of data collected during recces are particularly dependent on the personal skills of the observer, his/her motivation as well as the season and habitat in which they are carried out. The only reliable information to be inferred from recce data is therefore one of relative abundance and distribution, presence-absence data, potential threats or habitat preferences. In this context, turning towards hunters’ perceptions to elicit a better understanding of ecological changes, which have affected the reserve since the 1950s, could prove an interesting tool.
3 Methods

3.1 Methodological Approach

The research outlined here is an initiative aimed at engaging with local stakeholders, specifically village hunters and ecoguards, through the use of LEK and participatory monitoring. In particular, the study aims to use hunters’ perceptions to provide a deeper understanding of the changes pertaining to hunting and wildlife abundance on the reserve, with a view to inform future conservation action. The first step is to investigate inter-generational hunter perceptions of changes in wildlife abundance and hunting effort using semi-structured hunter interviews, and compare these findings with data from historical literature pertaining to the presence of specific species. The second step of the study aims at providing a snapshot representation of the spatial distribution of hunting and wildlife on the reserve using a participatory approach, and compare these findings with interview data.

3.2 Hunter Surveys

Thirty semi-structured interviews targeting hunter communities were conducted to investigate perceived changes in wildlife abundance and hunting effort since the 1950s and potential inter-generational or geographical differences in perceptions. The surveys were conducted in five localities bordering the reserve, four of them on the reserve’s northern boundary (Banga Makombo, Mpol, Edzouala and Okiene) and one on its western edge (Mbouambé-Léfini, hereafter referred to as ML) (Figure 3.1). The villages were selected for their proximity to the reserve, their accessibility and hunting profile based on the knowledge of WCS staff and previous research (Detoeuf, 2014). For the purpose of the research, and given the limited number of respondents, the four villages in the north are considered as one unit to be compared against ML in the south.
The surveys targeted both active and retired hunters, with approximately half of the respondents in each category (Table 3.1). Although every effort was made to obtain a balanced representation of individuals for each generation, respondents were selected on the basis of their willingness to participate, which influenced the representativeness of each age category.

**Table 3.1** Profile of interview respondents per sector and age category. *Numbers in brackets represent counts of active hunters*

<table>
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<tr>
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<th>30-50</th>
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<th>Total</th>
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<tr>
<td>North</td>
<td>2 (2)*</td>
<td>7 (4)</td>
<td>5 (0)</td>
<td>14 (6)</td>
</tr>
<tr>
<td>South</td>
<td>1 (1)</td>
<td>9 (7)</td>
<td>6 (3)</td>
<td>16 (11)</td>
</tr>
<tr>
<td>Total</td>
<td>3 (3)</td>
<td>16 (11)</td>
<td>11 (3)</td>
<td>30 (17)</td>
</tr>
</tbody>
</table>
In ML the survey team comprised the author and her research assistant, a local resident of Congolese nationality employed by WCS. In the north, where most respondents spoke neither French nor Lingala, the team required the help of an additional translator, a local villager previously employed by WCS. Both had an in-depth knowledge of the area and its culture, having lived there most of their lives, and were respected members of their communities, which facilitated contact with the hunters. Both had past or current experience of working as ecoguards, which meant they also had a very good understanding of hunting and of hunters, which made it easier to determine whether the respondents were telling the truth. The hunters appeared to remain open nonetheless, although complete and total honesty from their part is impossible to ensure.

A pilot study was conducted at the start in ML. This enabled the team to identify questions which were unclear and needed reformulating or new ones that arose. It also ensured the research assistants understood the questions well and knew how to translate them accurately.

The research assistants contacted each potential respondent prior to the interviews to ask if they would agree to take part in the survey. Although many hunters were open to discussion, others requested money in exchange for their time; to avoid setting a precedent, reduce social desirability bias and promote openness these individuals were not interviewed. The principles of free prior informed consent were clearly explained to each of the respondents at the start, to which they all were asked to agree for the interview to proceed. The reasons and aims of the study were also clarified to ensure the respondents understood why they had been identified for the interview. It was also made clear to them that, although the survey was conducted in collaboration with WCS, the author was in no way affiliated to the organisation and that neither her nor the research assistants were entitled to divulge their identity, so that their answers would remain anonymous. Despite the potential sensitive nature of the subject, most of them remained open to discuss their hunting activity, except on two particular questions concerning the number of local and outside hunters which many were obviously uncomfortable with. On these two questions respondents tended to remain rather vague and as a results those responses are to be taken cautiously. Overall however, respondents seemed to provide honest responses.
Since most of the respondents were busy with other activities during the day, most interviews were conducted in the late afternoon or evening to minimise disruption. Surveys were conducted in French, Lingala or Teke depending on which language the respondent felt more comfortable with. Interviews were not recorded; rather answers in Lingala and Teke were immediately translated back into French to the author, who was in charge of their transcription. If the respondent felt comfortable enough to use French, the author conducted the interview directly, in which case any question or answer which did not seem clear was immediately double-checked with the research assistants and reformulated in the local language if necessary.

The survey comprised a total of 20 closed and open-ended questions on the topics of wildlife abundance, on the reserve and around the village; sightings of species of historical interest; hunting practices; species hunted; hunting regulations and prospects for the future (Appendix A). Species of historical interest were identified in collaboration with WCS as species which had previously been known to inhabit the area and were thought to have disappeared or become rare. They comprised the lion (*Felis leo*), the hyena (*Crocuta crocuta*), the elephant (*Loxodonta africana cyclotis*), the southern reedbuck (*Redunca arundinum*), the waterbuck (*Kobus ellipsiprymnus defassa*), the chimpanzee (*Pan troglodytes*), Pennant’s red colobus (*Procolobus pennantii ssp. bouvieri*) and Denham’s bustard (*Neotis denhami*). Listed as critically endangered, Pennant’s red colobus has reportedly not been sighted since the 1970s and the species is thought to be potentially extinct in the wild (IUCN, 2015). Images of target species were used for the purpose of identification (Appendix B), including that of the tiger (*Panthera tigris*), known to never have inhabited the area, in order to assess the validity of the responses. Respondents were also encouraged to share any additional comment they considered relevant to the survey.

### 3.3 Spatial Data Collection

Recces were conducted in two sampled areas (using the technology described below) to provide a snapshot of relative abundance and distribution of wildlife and hunting on the reserve, as well as a basis against which to compare interview data. Previous research around the use of a participatory monitoring technique had also been initiated in the area (Tim Rayden, WCS, pers.comm.), which provided a good opportunity to
further investigate its use within the framework of this study. While building on local knowledge of the reserve, the aim was to allow the study to fall within the long-term scope of WCS conservation intervention in the area by facilitating the long-term engagement of the local stakeholders through their direct involvement in all aspects of the research from an early stage. The first recce phase was therefore conducted with the help of two ecoguards and the second with the help of three local hunters, contracted for the occasion.

3.3.1 Sapelli

Data collection was conducted using the Sapelli software operating on Samsung Galaxy Xcover2 smartphones. Developed by the Extreme Citizen Science (ExciteS) research group at University College London (UCL), the software aims to bridge the gap between scientists and non-literate communities by providing user-friendly technology, which enables the recording of spatial data without the need for numeric or alphabetical symbols (Vitos et al., 2013; UCL 1999-2015). Its interface presents a pictorial decision tree, which enables the user to navigate from one category to the next and ultimately record the GPS location of a given sign or characteristic. Decision trees are designed according to the needs of the research, with the additional options for audio and visual recording.

For the purpose of this study, a choice was made to include two main categories (human and wildlife signs), which were further subdivided. Signs to be recorded included snares, camps, machete cuts, trails, discarded cartridges, carcasses, footprints and rubbish for hunting signs; droppings, tracks, trails, call, visual for wildlife signs. However, the level of detail to be recorded for each sign was limited to some extent by the use of untrained individuals and largely by the constraints of the software. This proved particularly problematic when dividing animal species into categories and deciding on appropriate representations for each of them. For instance, the choice was made to group all antelope species into one category, as well as the primates (the complete decision tree can be found under appendix C). This clearly limits the extent of the comparability with prior recce data on encounter rates and interviews.
3.3.2 Recces

The choice of recces as a method for spatial data collection, as opposed to line transects, was based on the limited time available for the research, the participation of previously untrained local individuals and the nature of the habitat. Although line transects can offer indications of absolute abundance they are also more resource consuming, requiring highly trained staff, and are difficult to conduct in dense habitat (Kühl et al., 2009; White & Edward, 2000; Walsh et al., 2001). Recces, while offering less precision, provide more flexibility, particularly since the observer is not restricted to following a straight line. Previous studies conducted in the area (Downer 1998; Ikoli et al., 1998; Mathot et al., 2006; Nganga et al., 2006) agreed on the suitability of recces for this type of environment, so the choice was made to employ a similar method.

A total of 30 recces were conducted in the north of the reserve, along the Nambouli River, and in the south, along the Lefini River (Figure 3.2). The two areas were selected based on their proximity to the villages targeted for the interviews, proximity to rivers and accessibility from outside of the reserve, all of which increased their likelihood of being prime hunting grounds. In addition, the two areas presented an interesting difference allowing for some comparison; the first area was assumed to be under less pressure from hunting given the presence of ecoguards, whereas the second was believed to be more heavily hunted due to its proximity to ML and relative accessibility by boat. The presence of ecoguards in the southern section was not assumed to represent a major deterrent to hunters since their activities are concentrated on the southern bank of the Lefini. The area to be covered and the number of recces were planned according to the time available.
Figure 3.2 Recce areas and their locations in relation to the study villages

The recces were conducted based on the principles outlined by White & Edwards (2000). This implied following a predefined direction using the ‘path of least resistance’ while targeting as many habitat types as possible. The recces were carried out in two teams comprising the author, her research assistant as well as two ecoguards for the first phase and three hunters for the second phase. Departing from a common starting point in the early hours of the day the teams moved away in different directions for a distance of at least 5 km, covering as many vegetation types as possible. Distances were recorded using two Garmin GPSMAP 62 series. 12 recces covering a total distance of 74.6 km were carried out in the northern section of the reserve along the Nambouli River over a period of 7 days; 18 recces covering a total distance of 98.4 km were carried out in the southern section along the Lefini River over a period of 12 days.
Both groups were trained in the use of the software at the start of each phase to ensure consistent data collection throughout, and the initial decision-tree was piloted with the ecoguards and modified according to their comments. Given the nature of the signs to be recorded the presence of the research assistant proved invaluable, both for his identification skills and for ensuring the hunters were recording the signs accurately and not misleading the research team.

3.3.3 GPS mapping of hunting camps

Mapping the distribution of hunting activity in the two areas included navigating the rivers by canoe and recording the GPS location of known hunting camps, presumed to be found along the rivers, using the same GPS units mentioned above. Discussions with the research assistant confirmed that hunting camps along the Lefini were regularly spaced out and represented good predictors of hunting grounds. Once recorded, these locations were therefore to serve as starting points for the recces. In addition, their locations on the riverbanks within the gallery forests would allow the teams to reach the savannah by walking away from them in a relatively straight line, thereby covering two main habitats.

In the northern section of the reserve however, this turned out impossible for a number of reasons. First, hunting camps in the north were located farther up on the plateaux, a fair distance away from the river, which at this point in time was not navigable due to logs and debris obstructing its course. This considerably reduced the area the teams were able to cover during the first phase, as they were left with no choice but to walk from camp to camp. Secondly, and for these same reasons, hunting camps were far less conspicuous than along the Lefini River, where many could easily be spotted from the boat. This, coupled with the harshness of the terrain, rendered the task of locating the camps far more challenging and as a result not all recces in the north had hunting camps as starting points.
3.4 Analysis

Analyses were run using Chi-squared tests to assess differences in perception between categories of hunters. Given the small number of respondents, categories had to be grouped for the analyses to be carried out. Young (≤30) and middle age hunters (31-50) were grouped into one category; while perceived ‘increase’ and ‘stability’ were grouped into another. Often however, the sample size proved too small for the analysis to be carried out and this is indicated in the text. Wilcoxon signed ranked test and Mann Whitney U test were used to assess differences in perception of changes overtime. The Chi square tests were run in Excel version 14.5.4, while the Wilcoxon signed ranked and Mann Whitney U tests were run using the latest version of R studio.
4 Results

4.1 Hunters Perceptions

4.1.1 Perceived Changes in Wildlife Populations Since the 1950s

The majority of respondents (25 out of 30) identified a decrease in wildlife abundance and/or diversity since they started hunting, with only a handful identifying either stability (3) or increase (2). This remains true irrespective of age (Figure 4.1); the difference of perceptions between hunters aged ≤50 and >50 is not significant (Chi squared=0.243; df=1; P=0.41).

![Figure 4.1 Perceived change in wildlife abundance by age category](image)

There is no significant difference between respondents who started hunting before and after 1999 in regards to their perceptions of change (V = 9, n=30, p-value = 0.429), although hunters who identified an increase had all started hunting in the decade 2000-2009, suggesting wildlife populations were particularly low at that time (Figure 4.2). This could be explained by the aftermath of the war that ravaged the country in 1997, following which immigration and hunting increased in the region (Downer, 1998; S. Elenga, WCS, pers. comm.). There is also a slight increase in the number of hunters identifying stable wildlife populations, which could be explained by the fact that individuals who started hunting in the present decade, potentially only in the past couple of years, would have had less time to notice any changes. From a village
perspective, 14 out of 16 respondents in the southern sector described a decrease in wildlife populations, against 11 out 14 in the north. This comparison yielded no significant result (Chi squared=0.149; df=1; P=0.512).

Looking more specifically at levels of abundance shows that individuals who started hunting before the end of the 1990s described wildlife populations at that time as either very abundant or abundant, while 2 of the hunters who started in the decades following 1999 thought the levels to be low (Figure 4.3a). This should reflect the number of individuals who perceived an increase in wildlife populations following 1999 (Figure 4.2). In fact, respondents who started hunting before 1999 perceived a significant decline in wildlife populations over their career (W= 394.5, n=21, p=2.027e-06), while hunters who started hunting after 1999 did not perceive any significant changes (W= 51.5, n=9, p= 0.3213). However, comparing perceived levels of abundance at the end of the hunting career for hunters who stopped hunting before 1999 with those who stopped after 1999 does not yield any significant result (Chi squared=0.04; df=1; p= 0.87) suggesting most hunters perceived levels to be low at the end of their career regardless of the decade in which they started (Figure 4.3b).
Figure 4.3 Perceived levels of wildlife abundance at the start and end of the hunting career. Figure 4.3a shows the number of hunters who first started hunting as a career in each decade and their perceptions of levels of wildlife abundance at that time. Figure 4.3b shows the number of hunters who stopped hunting as a career in each decade and their perceptions of levels of wildlife abundance at that time. The decade 2010-2019 in figure 4.3b includes hunters who are still active. ‘High’ represents either ‘high’ or ‘medium’.

These perceptions are in great part influenced by the views of respondents from the south; in fact, while the group as a whole has perceived a significant change in wildlife abundance ($V = 27.5$, $n=30$, $p$-value = 0.00018) the same cannot be said of hunters in the north ($V = 13$, $n=14$, $p$-value = 0.137) as opposed to hunters in the south ($V = 4$, $n=16$, $p$-value = 0.003). 10 out of 14 hunters in the northern sector still describe very abundant or abundant populations at the end of their career, compared to hunters in the southern sector, where 12 out of 16 hunters describe them as low. Elaborating on these perceived changes, all hunters recall greater numbers of all species, including duikers and monkeys. Many, especially older generations, said big herds of elephants and buffalos were commonplace as well as large groups of red river hog (“heaps of them”), while a couple of hunters aged >50 noted the disappearance of larger carnivores such as lions, leopards and hyenas. Hunters in the north, who perceived numbers had increased or remained stable (3 out of 14), attributed it to the presence of ecoguards in the area, which had provided animal populations with some level of protection.
On the question of wildlife presence around the villages, the respondents as a group were evenly divided. However, comparing north and south shows a significant relationship between sector and perceived presence of wildlife around the village (Chi squared= 1.45; df=1; P=0.002) as illustrated in table 4.1. The species cited as most common around villages in the north were bushbuck, hogs, and smaller mammals such as civets and cane rats.

![Figure 4.4 Number of hunters who perceive wildlife to be present around the village by sector](image)

Both age category (Chi squared 1.418; df=1; P=0.037) and sector (Chi squared=1.909; df=1; P=0.006) show a significant relationship with perceived changes of wildlife around the village (Figure 4.5a and 4.5b). In fact, all hunters aged >50 said wildlife presence around the village had decreased and recalled elephants and buffalos coming to raid their crops. Many of the older hunters in the south also said they used to be able to just step out of their house and take a shot at passing animals.

![Figure 4.5 Perceived changes in wildlife presence around the village in number of hunters per age category (a) and sector (b)](image)
18 out of 30 hunters attributed the general decrease to hunting and the increasing number of guns. One respondent explained that there only used to be one or two .12 calibre guns in each village in his time, adding that today's younger generations also tended to hunt indiscriminately. Seven respondents explained the change with growing numbers of people living and farming in or close to wild habitat, or otherwise encroaching on it; five mentioned the construction of the Imboulou dam further down the Lefini River, which had inundated vast expenses of prime wildlife habitat and forced large numbers of animals to flee; another five thought the animals had become smarter with time and had learnt to avoid humans; a minority (2) did not attribute the change to any particular reason other than luck or God's will, while five did not have an opinion at all on the question. Two respondents had only recently moved to the area and thought wildlife was less abundant than where they used to live.

4.1.2 Perceived Changes in Hunting Effort Since the 1950s

Most respondents were reluctant to give or even estimate the number of hunters living in the village. Maybe as a result, respondents irrespective of age or sector were evenly divided on the question of change in the number of local hunters (Figure 4.6).

*Figure 4.6 Perceived changes in the number of local hunters a) by sector and b) age category at the top. Below are perceived changes in the number of outside hunters c) by sector and d) age category, where 'none' indicates perceived absence of outside hunters.*
Although respondents were generally more open to talk about changes in the number of outside hunters, they remained equally divided on the question (figure 4.6) and there was no significant difference in perception of change between north and south ($V = 8, n= 30, p= 0.152$) or between age categories ($V = 7.5, n= 30, p= 0.423$). Whether individuals had started hunting before or after 1999 did not have a significant impact on their perception either ($V= 3, n= 30, p = 0.345$). In the south, there was no expressed resentment from those who acknowledged the presence of outsiders, as they understood people needed to earn living. However, a total of 16 hunters said there were no outsiders coming to hunt in the area, the majority of them in the north (13). There, respondents explained this with the presence of ecoguards, who acted as a deterrent to most, and although older hunters remembered outsiders coming to the area, they thought people had become increasingly suspicious of each other overtime and now tended to keep their activity secret.

4.1.3 Latest Catch and Average Catch

The list of species mentioned as part of the latest catch (active hunters) and average catch (all hunters) are identical, except for the turaco, francolin, pangolin and porcupine, which were only mentioned once (Figure 4.7). It became obvious that hunters very often did not consider these small species worth mentioning, possibly because many of those were consumed on the spot and rarely made it back to the village. There was no significant difference between active hunters’ latest and average catch (Chi squared= 0.439; df=; P= 0.104) of species most often cited (primates, hogs and bushbuck). The apparent difference between active and non-active hunters average catch could not be confirmed statically due to the small sample size, although as one elder respondent put it, suggesting the decline in catch:” If you did not catch anything back then, you really needed to see someone!” In contrast, two active hunters reported not catching anything on their latest hunt.

Primates (moustached and de Brazza’s monkeys) were cited by more than half of active hunters (10/18) as part of their latest catch, although most of them operated in the south (9/10). There, primates were the only animals cited by more than half the hunters, compared to the hog and the bushbuck, cited by half of active hunters in the north as part of their latest catch (3/6). The small sample size prevents any statistical
testing on active hunters’ latest catch between north and south; however, considering all hunters’ average catch of hog, primates, blue duiker and yellow-back duiker (Figure 4.7d) shows a significant difference between north and south (Chi squared=3.05; df=3; P=0.006). This appears to be due to an overrepresentation of non-active hunters from the north (Figure 4.7c), although it was again impossible to confirm statistically due to the small sample size.

![Figure 4.7](image)

**Figure 4.7** Active and non-active hunters’ perceived latest and average catch, showing by sector a) (top left) active hunters’ latest catch; b) (top right) active hunters’ average catch; c) (bottom left) non-active hunters’ average catch. ‘North’ is yellow, ‘South’ is blue. Figure 4.7d (bottom right) showing active hunters’ latest catch (red) next to active hunters’ average catch (green) and non-active hunters’ average catch (blue) for both sectors. (Active hunters AH= 18; AH north= 6; AH south= 12; non-active hunters NAH= 12; NAH north= 8; NAH south= 4).
4.1.4 Perceived Changes in the Presence of Species of Historical Interest

Perceived changes in the presence of species of historical interest suggests the extirpation of at least two major species, the decline of three and the absence of one, at least from living human memory. The southern reedbuck had never been seen by any of the hunters, while most of them recalled seeing elephants, although 8 of them, including young, middle age and old hunters said they had never seen one (Table 4.1). The second species most hunters recalled seeing was the lion, followed by the hyena.

Table 4.1 Perceived sightings of species of historical interest. Number of hunters who claim having seen the species as a group and by sector compared to the number of hunters who say they have never seen them

<table>
<thead>
<tr>
<th>Species</th>
<th>Sightings</th>
<th>North</th>
<th>South</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>22</td>
<td>9</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Lion</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Hyena</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Denham’s bustard</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Bouvier’s red colobus</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Waterbuck</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>Southern reedbuck</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
</tbody>
</table>

The lion was reportedly seen for the last time at the end of the years 2000-2009, whereas the hyena appears to have disappeared much earlier, at the end of the 1980s (Figure 4.8). Both species were perceived to be abundant in the 1960s and even throughout the 1970s, with 7 out of 11 hunters aged >50 claiming to have seen a lion compared to 5 out of 19 hunters aged ≤50. The difference is more pronounced in regard to hyenas, with 7 hunters >50 and 1 hunter ≤50 recalling seeing the species. While respondents in both sites mentioned lions as a common occurrence, the hyena would seem to have been more prevalent in the north of the reserve (Table 4.1), which appears to be corroborated statically (Chi squared= 0.736; df=; P= 0.06). There, all hunters aged >50 consistently recalled hyenas chasing goats around the villages, adding that “they were everywhere!” Given the hyena’s past abundance, one respondent was clearly intrigued by the fact that he did not see them anymore.
There was no marked age or geographical difference in the number of respondents who claimed to have seen chimpanzees (4 hunters >50 compared to 3 hunters ≤50), but those who mentioned the species said it only occurred in very small numbers. Denham’s bustard had been seen mostly in the south of the reserve, while Bouvier’s red colobus and the waterbuck were exclusively mentioned by hunters in the south, although few of them (4 and 2 respectively) recalled ever seeing the species. Those who had seen the waterbuck described it as a “stupid” animal that “even women could take a shot at”.

4.1.5 Perceptions around the Future of Hunting in Lefini

Although guns were said to have become commonplace, 27 out 30 respondents did not wish their children to become hunters; many clearly expressed their disdain at the idea, stating it was too hard an activity and that they wanted their children to become educated and earn proper jobs instead. Most hunters expressed the desire to do something different with their lives, or at least enable their children to do so, but recognised that until they could earn a living from other activities hunting remained a necessity. The three hunters who whished their children to become hunters were all aged >50 and seemed to have retained an image of hunting as a prestigious and skilled activity where game was plentiful. Nevertheless, they expressed their lack of trust in
the younger generation, stating they wouldn’t actually trust their children with a gun anyway.

All hunters were aware of rules and regulations pertaining to hunting, citing the official hunting season and the restricted access to the reserve as examples. Interestingly, all but one hunter was of the opinion that laws should either remain unchanged or be reinforced. If laws were relaxed they feared that there soon would be nothing left on the reserve for their children and grandchildren to either hunt or see. They also said the laws ensured a minimum of control and restrain from the hunters, although, as a couple of them expressed, the lack of enforcement made trespassing easy.

4.2 Spatial Distribution

4.2.1 Distribution of Hunting Camps and Hunting Signs

Figure 4.9 shows the distribution of hunting camps encountered along the river in the southern sector of the reserve. These represent the main starting points for most hunters accessing the reserve by boat, although this does not exclude the existence of other camps further in. Traveling upriver the hunters explained what the main activities were in each camp (hunting, fishing, farming) and those that were still in use. The map presents a clear displacement in time towards the west of the reserve and away from ML. This is consistent with respondent interviews, which indicated that the establishment of the gorilla sanctuary in the 1990s on the southern bank of the Lefini had increased the distance hunters had to cover from the village, since hunting was no longer permitted in the middle section of the river, in between the two checkpoints.

The hunters indicated that most camps situated between ML and the first checkpoint were inhabited all year round; these were described as either farming or fishing camps. However hunting signs turned out to be most concentrated in that area suggesting that hunting is carried out opportunistically, as illustrated by a couple of snares the team found tied to trees next to a path leading to the fields. A few active hunting camps also remain in the middle section of the river, which according to the hunters belonged to individuals coming in by way of vehicle from villages northeast of ML.
As was expected, camps encountered in the northern section of the reserve were more randomly scattered. All but one were encountered on the southern bank of the Nambouli River, on the opposite side from the ecoguard post. The ecoguards explained that the sensitization programs against poaching conducted in the villages had made the ecoguards’ presence known in the area, pushing people to hunt farther away. Moreover, the presence of villages inside the reserve could also explain the presence of camps on the southern bank.

![Distribution of camps and hunting signs encountered in the northern section (top) and southern section (below)](image)

Figure 4.9 Distribution of camps and hunting signs encountered in the northern section (top) and southern section (below)
4.2.2 Distribution of Wildlife Signs and Encounter Rates per km

There seems to be no obvious relation between the distribution of hunting and wildlife signs encountered, with the exception of primate signs in the southern section: the majority of primate signs were found between the two checkpoints, an area in theory patrolled to some extent; they were less frequent in the west and close to non-existent in the east, closer to ML and in proximity to the farming camps, where most hunting signs were concentrated. This could suggest a strong hunting pressure on the primates, in line with interview responses but could also be the result of the loss of forest galleries following the dam construction.

Table 4.2 presents encounter rates per km for hunting and wildlife signs included in the spatial survey. Given the nature of the data collection, these numbers should be considered with caution and can only pretend to offer an idea of the situation. The southern section shows a higher incidence of hunting signs, as well as antelope, hog and buffalo signs. Elephant signs were more numerous in the north while carnivore and primate sign numbers were comparable in both sites.

<table>
<thead>
<tr>
<th></th>
<th>Hunting</th>
<th>Antelopes</th>
<th>Hog</th>
<th>Buffalo</th>
<th>Elephant</th>
<th>Primates</th>
<th>Cats</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (75)</td>
<td>0.60</td>
<td>0.72</td>
<td>0.66</td>
<td>0.27</td>
<td>0.31</td>
<td>0.29</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>South (98)</td>
<td>0.98</td>
<td>2.43</td>
<td>1.40</td>
<td>0.65</td>
<td>0.15</td>
<td>0.32</td>
<td>0.04</td>
<td>0.21</td>
</tr>
<tr>
<td>Overall (173)</td>
<td>0.79</td>
<td>1.58</td>
<td>1.03</td>
<td>0.46</td>
<td>0.23</td>
<td>0.31</td>
<td>0.03</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Table 4.2 Encounter rates of hunting and wildlife signs. Encounter rates per km for hunting and wildlife signs collected by hunters and ecoguards using Sapelli in the northern and southern section of the Lefini Reserve. Numbers in parentheses represent the total distance covered in each sector and overall. ‘Other’ includes signs of civet, jackal and porcupine.
5 Discussion

5.1 Spatial-temporal Differences in Perceptions

This study set out to first assess hunters’ perceptions of changes in wildlife abundance and hunting effort around Lefini since the 1950s, compare these with historical data on the presence of species of historical interest and offer a picture of the present distribution of wildlife and hunting activity around the reserve. Results suggest varying degrees of both generational and spatial differences in perceptions, which seem to reflect actual differences. General perceptions of declining wildlife populations across all categories of hunters are consistent with previous studies, in which hunters reported having to ‘run after the game’ (Detoeuf, 2014). Interviews also suggest higher levels of abundance prior to the end of the 1990s, pointing to the impact of the civil war on the area’s wildlife which accelerated the proliferation of weapons and drew in large numbers of people, increasing the pressure on the surrounding habitat (Downer, 1998).

The study suggests a more pronounced decrease in wildlife populations in the southern section of the reserve, including around the village of ML. This supports previous findings of higher levels of commercial hunting in ML compared to villages in the north (Detoeuf, 2014). Organised hunts are reportedly commonplace in ML during the open season and the majority of respondents in the south reported taking part in them. These operations, which were already mentioned at the end of the 1990s (Downer, 1998), consist of parties of hunters traveling upriver for up to two weeks at a time and are generally organised by wealthy outsiders or members of the community, in exchange for a rather large percentage of the hunting sales. The apparent absence of big scale hunting in the north, suggested by the perceived absence of outside hunters, could partially explain the lesser decrease in wildlife populations experienced by hunters in that area; simultaneously, hunter interviews suggests the non-negligible impact of the ecoguards’ presence, which seems to have both helped raise awareness and reduce hunting in direct proximity to these villages.
The results also point to some generational differences in regards to perceived wildlife abundance around villages. Older hunters recalled hunting close to the villages, which would logically have become the first areas to get depleted, explaining the shift in perceptions and illustrating central-place depletion. Sightings of species of historical interest were consistent with descriptions in earlier literature (Malbrant & Maclatchy, 1949; Maclatchy, 1957; Blancou, 1957) and further highlight the unique bio-ecological heritage of the area, where typical savannah species were or still are known to occur (King & Chamberlan, 2013).

Data on latest and average catch highlight the great hunting pressure on primates, reinforcing the idea that hunters in the area are ‘hunting down the food chain’ and the argument that Lefini is a highly depleted area (Detoeuf, 2014). In addition, the low incidence of smaller species reported illustrates the risk of underestimating the catch by focusing on species of economical relevance to the hunters (Rist et al., 2008). However, the recce surveys suggest that larger mammals still persist in the area, albeit at low density. Therefore, assessing the ecological sustainability of the reserve by looking at hunters’ catch alone could be limiting.

Spatial data collection presented a distribution of hunting camps different from that described in previous studies (Downer, 1998). Downer described decreasing density of hunting camps as one moved away from ML; this was found to have changed, with a substantial displacement towards the west of the reserve. The establishment of the gorilla sanctuary and the resulting presence of ecoguards are obvious explanations, corroborated by hunters. In addition, the construction of the Imboulou dam approximately 40 km downriver from ML, seems to have played an important role in forcing the animals away from the forest galleries along the river; one respondent clearly remembers how he used to shoot several monkeys a day in the months following the dam's construction, as the animals were fleeing. Travelling upriver from ML, it was easy to notice the devastation caused by the rising waters on the forest galleries for several kilometres. Although the study suggests the positive impact of ecoguards in both sections of the reserve, it also made clear the lack of enforcement capacity demonstrated by the presence of hunting camps and signs further away from the checkpoints. Previous recce data presented low encounter rates overall for wildlife.
signs, consistent with data collected by the hunters and ecoguards, although numbers tended to vary for some signs (Appendix E).

5.2 Assessing the Use of LEK and Participatory Monitoring in Lefini & Defining Priorities for the Future

The overall aim of this study was to assess the potential of LEK and participatory monitoring in providing useful socio-ecological information in the context of conservation action around Lefini and for engaging with local communities, in particular hunters and ecoguards. LEK elicited through hunter interviews were consistent with the picture presented by previous studies on hunting in the area, suggesting that local knowledge can be used as a complement to biological data to inform conservation management. As exemplified by other case studies (Papworth et al., 2009), the existence of shifting baselines and misleading responses due to generational or individual amnesia within these hunter communities remains a possibility, which cannot be dismissed given the absence of independent biological data to corroborate ecological changes. Nevertheless, hunters’ perceptions were consistent with historical literature on species presence, which suggests that the interviews offered reliable information, which could form the basis for future environmental education and further collaboration with the hunter community.

In the absence of inter-generational knowledge transfer, knowledge about the presence of past species can disappear quickly within a community (Turvey et al., 2009), increasing the risk of SBS and reducing the perceived need for conservation programs in younger generations (Papworth et al., 2009). Ensuring that younger generations around Lefini are aware of the past ecological condition of the reserve could therefore be a way to promote conservation in the area. Developing a framework for environmental education by promoting inter-generational dialogue on the subject is an area for future research. This study initiated a good rapport with the hunters; however, more work needs to be done in order to build a trusting relationship with the hunter community. Further research around the cultural norms and practices surrounding hunting in Lefini is important for effective participatory conservation action (Walters, 2014) and would represent a step in the right direction.
Reported sightings of Pennant’s red colobus could have major implications for the long-term survival of the species. Detailed interviews relating to sightings of the species and participatory mapping of its present range, with hunters, is an exciting prospect, which could lead to the development of protection and breeding programs.

Previous studies have shown that participatory monitoring techniques can be as efficient as scientific methods in producing reliable data (Danielsen et al., 2005; Rist et al., 2010). Although data collected with Sapelli remain too uncertain to assess sustainability, the strength of this technology lies in its potential in helping to engage with local communities and foster local management (Danielsen et al., 2003). The ecoguards showed a great interest in the tool; given that they at present benefit from very little support, they viewed Sapelli as a way to demonstrate their efforts on the ground to the authorities. Their patrols have clearly showed some results but they would gain from proper training and logistical support, while the reserve would benefit from having a decent sized and properly trained unit. In this regard, Sapelli presents some advantages as it requires minimum training and its simple interface makes it accessible to a large audience. Since it operates on standard Android phones, its cost is much lower than that of a regular GPS and the battery life longer. Finally, the interface can also be tailored to the specific needs of the ecoguards to incorporate more details concerning the type of data to be collected. This could be an exciting opportunity for designing the optimum interface together with the ecoguards, with a view to standardise the use of Sapelli across the entire area, including Lesio-Louna.

Law enforcement is of course not an end in itself and should be seen within the wider context of resource management. Hunter interviews confirmed that Lefini is an ecosystem that has undergone noticeable changes; however, trying to control these changes by reinforcing ‘fortress conservation’ would be negating the social component of the system and its underlying complexity (Vliet et al., 2015). Therefore, complete exclusion of local communities from within the reserve’s boundaries is not a realistic option; rather, the necessary adaption to change (Vliet et al., 2015) implies that resources should be managed in order to provide shared benefits for all. In this context, the reserve could be divided into zones providing local communities with access to certain areas for the extraction of timber and non-timber forest products, including bushmeat, while the establishment of buffer and core areas would provide protection.
for wildlife and provide a source for sustainable hunting. Engaging the hunters in participatory mapping of these zones, including sites of cultural significance, could be achieved with the use of Sapelli. Within the context of shared resources, other areas could be delineated for tourism. The unique landscape of Lefini makes it an accessible tourism destination for people coming from Brazzaville, and is an asset that should be taken advantage of, while the restricted tourism activity that takes place in Lefini at present would benefit from improved protection and better management.

5.3 Prospects for Conservation in Lefini

Included in this study was the investigation of hunters’ perceptions concerning the future of bushmeat hunting in Lefini. These suggested a wish for stricter law enforcement on the reserve to ensure sustainable wildlife population for future generations. However, the persistent lack of institutional support has so far precluded any attempt in this direction, despite early and repeated calls for a higher degree of protection of the reserve and its wildlife (Blancou, 1957; Downer, 1998). Lefini’s present lack of charismatic species in large numbers has failed to attract a similar attention to that of other parks, more representative of Congo’s archetypal habitats. The extinction of its wildlife could therefore go generally unnoticed. However, given some time and adequate protection, wildlife in Lefini would undoubtedly bounce back as exemplified by the positive effects of regular patrols around the gorilla sanctuary on Lesio-Louna, where the ecoguards have reported a noticeable increase in animal sightings since their arrival (PPG, pers.comm.)

Thus far, Lefini has benefited from international donor support and engagement of international organisations. The recommendations given above are only relevant within the context of continued backing. However, the lack of endorsement from the Congolese authorities puts the reserve at risk of losing this too and do not bode well for the future of its wildlife, as perceptions of what constitutes a priority and warrants saving entrenches international organisations’ ‘unwillingness to pay’ the cost incurred by managing such protected areas in the long-term (Wilkie et al., 2001).
References


37


Appendix

Appendix A – Hunter Survey

Introduction

Hello, I’m a student from a university in England. I’m here to carry out a research project around Lefini for my Masters degree. The aim of the study is to understand how hunting and wildlife abundance have changed over the past decades.

As a hunter or former hunter, you have a very good knowledge of the area and its wildlife, which is why you’ve been identified for this survey. The aim is not to penalize you but to try and form an accurate picture of the ecological state of the reserve which could inform its future development.

I would be very grateful if you had time to answer this survey, however you’re free to refuse. Your name and the information you provide will remain confidential.

Date:
Village:
GPS Location:
Name:
Age:
Person carrying out the survey:

1. Introductory questions
First I am going to ask you some general questions so I can understand your experience as a hunter.

1. How long have you lived in the village?
2. When did you start hunting?
3. Do you still hunt?
   • If yes, did you stop for a while any time and why?
   • If no, when did you stop hunting and why?
4. Is/ was hunting your main occupation?
   If not, what other occupations do you have/did you have?
2. Wildlife

Now I am going to ask you some questions about wildlife in Lefini to get your experience and knowledge about the animals that live here.

5. How would you describe the abundance of wildlife on the reserve today or when you stopped hunting?
   • Lots
   • Enough
   • Few

6. How was it when you started hunting?
   • Lots
   • Enough
   • Few

7. Have you noticed any changes in the number or type of wildlife?
   • What may have caused these changes?
   • What do you think of it?

8. Have you ever seen wild animals close around the village?
   • If yes, what species, and when was the last time you saw them?
   • Has the number and/or the type of animals close to the village changed since you live here?
   • If yes, why?

9. How many times have you seen the following species? When and where was the last time you saw them? (show pictures)
   • Lion
   • Southern reedbuck
   • Waterbuck
   • Tiger
   • Pennant's red colobus
   • Denham's bustard
   • Elephant
   • Chimpanzee
3. Hunting Effort

A. Active hunters
Now I am going to ask you some questions about your hunting experience to better understand the numbers and type of animals hunted in Lefini.

10. How many hunting trips do you usually take per month?
   • Does this vary by season?
   • Is it the same as it has always been since you started hunting?
   • If not, how has it changed and why?

11. When was your last hunting trip?
   • What method did you use?
   • How many animals and what species did you catch?

12. What is the distance you generally walk from your hunting camp?
   • Is it the same as it has always been since you started hunting?
   • If not, how has it changed and why?

13. What is the usual number of days you spent on a hunting trip?
   • Is it the same as it has always been since you started hunting?
   • If not, how has it changed and why?

14. How many animals and what species do you usually catch on a hunting trip?
   • Is this the same as it has always been since you started hunting?
   • If not, how has it changed and why?

15. What is your preferred hunting method and why?
   • Do you use other methods? If yes, why and what are they?

16. Did the arrival of the gorillas on Lesio-Louna affect your hunting? Why?

17. How many hunters live in the village? (0-10; 10-30; 30-50)
   • Did it ever change since you started hunting?
   • If yes, what may have caused these changes and what do you think of it?

B. Non-active Hunters
Now I am going to ask you some questions about your hunting experience to better understand the numbers and type of animals, which used to be hunted in Lefini.

18. How many hunting trips did you take per month?
   • Did this vary by season?
   • Did it ever change throughout your hunting career?
   • If yes, how did it change and why?

19. What distance you walk from your hunting camp?
   • Did it ever change throughout your hunting career?
   • If yes, how did it change and why?
20. How many days would you spend on a hunting trip?  
   • Did it ever change throughout your hunting career?  
   • If yes, how did it change and why?

21. How many animals and what species did you catch on a single trip?  
   • Did it ever change throughout your hunting career?  
   • If yes, how did it change and why?

22. What was your preferred hunting method and why?  
   • Did you use other methods? If yes, why and which ones?

23. Did the arrival of the gorillas on Lesio- Louna affect your hunting? Why?

24. How many hunters used to live in the village when you were hunting? (0-10; 10-30; 30-50)  
   • Did it ever change throughout your hunting career?  
   • If yes, how did it change and why?

4. General Hunting Effort - All Hunters  
Finally I have a couple of general questions about hunting in general and the future.

25. Have you noticed a change in the number of outside hunters since you started hunting?  
   • If yes, when did that change occur?  
   • Where do they/did they come from?  
   • What may have caused these changes and what do you think of it?

26. Would you like your son(s) or grandson(s) to become hunters? Why?

27. Are there any rules or regulations about hunting in the village or on the reserve?  
   • If not, do you think there should be? Why?  
   • If yes, are there any changes you think should be made? Why?

Thank you very much for taking the time to answer this survey! Are there any other comments you would like to make, which you think may be useful?
Appendix B – Species Identification Cards

All picture credits Jonathan Kingdon except Denham’s bustard (By Duncan Robertson (Own Work) Available Online from http://www.biodiversityexplorer.org/birds/otitidae/neotis_denhami.htm [Accessed 31.08.2015]); Tiger (By Captain Herbert (Own work) [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons. Accessed 31.08.2015)
Appendix C – Sapelli Interface
Representation of the Sapelli interface and images used in the study:
1) Wildlife/Hunting Signs; 2) Ungulates/Primate/Cat/Bird/Elephant/Other; 3) Antelope/Buffalo/Hog; 4) Visual/Heard/Signs; 5) Options for photograph; 6) Option for audio recording; 7) Hunting signs: Hunting camp/Snare/Cartridge/Path or machete cut/Footprints or rubbish/Dead animal; 8) Recording of GPS location
### Appendix D – Encounter Rates

<table>
<thead>
<tr>
<th></th>
<th>Hunting</th>
<th>Antelopes</th>
<th>Hog</th>
<th>Buffalo</th>
<th>Elephant</th>
<th>Primates</th>
<th>Cats</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Signs North</strong></td>
<td>45</td>
<td>54</td>
<td>49</td>
<td>20</td>
<td>23</td>
<td>22</td>
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<td>9</td>
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<tr>
<td>North (75)</td>
<td>0.6</td>
<td>0.72</td>
<td>0.66</td>
<td>0.27</td>
<td>0.31</td>
<td>0.29</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Number of Signs South</strong></td>
<td>96</td>
<td>239</td>
<td>138</td>
<td>64</td>
<td>15</td>
<td>31</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>South (98)</td>
<td>0.98</td>
<td>2.43</td>
<td>1.4</td>
<td>0.65</td>
<td>0.15</td>
<td>0.32</td>
<td>0.04</td>
<td>0.21</td>
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<tr>
<td><strong>Total Number of Signs</strong></td>
<td>141</td>
<td>293</td>
<td>187</td>
<td>84</td>
<td>38</td>
<td>53</td>
<td>6</td>
<td>30</td>
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<tr>
<td>Overall (173)</td>
<td>0.79</td>
<td>1.58</td>
<td>1.03</td>
<td>0.46</td>
<td>0.23</td>
<td>0.31</td>
<td>0.03</td>
<td>0.17</td>
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</tbody>
</table>

*Table showing recce encounter rates and number of signs encountered for each category in both sectors. Numbers in bracket indicate the distance covered.*
Appendix E – Encounter Rate Comparison

<table>
<thead>
<tr>
<th></th>
<th>Hunting</th>
<th>Antelopes</th>
<th>Hog</th>
<th>Buffalo</th>
<th>Elephant</th>
<th>Primates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 Study (North)</td>
<td>0.51</td>
<td>0.2</td>
<td>0.79</td>
<td>0.56</td>
<td>1.49</td>
<td>0.02</td>
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<tr>
<td>Present Study (North)</td>
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<td>0.72</td>
<td>0.66</td>
<td>0.27</td>
<td>0.31</td>
<td>0.29</td>
</tr>
<tr>
<td>2006 Study (South)</td>
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<td>2.04</td>
<td>0.07</td>
<td>0.38</td>
<td>0.05</td>
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<tr>
<td>Present Study (South)</td>
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<td>2.43</td>
<td>1.4</td>
<td>0.65</td>
<td>0.15</td>
<td>0.32</td>
</tr>
<tr>
<td>2006 Study (Overall)</td>
<td>0.51</td>
<td>0.26</td>
<td>1.4</td>
<td>0.3</td>
<td>0.9</td>
<td>0.03</td>
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<tr>
<td>Present Study (Overall)</td>
<td>0.79</td>
<td>1.58</td>
<td>1.03</td>
<td>0.46</td>
<td>0.23</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Table showing the encounter rates of the present study compared to the 2006 study (Nganga et al., 2006). Most common signs reported north of the Lefini River were those of hog, yellow-back duiker and sitatunga. Antelope signs were aggregated to match the categories of the present study.