Vulnerability to crop-raiding: an interdisciplinary investigation in Loango National Park, Gabon

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Abstract

Human-wildlife conflict is a major threat to long-term wildlife survival and to subsistence communities' livelihoods in developing countries, particularly near protected areas. In this thesis, I use an interdisciplinary approach based on a threefold vulnerability framework to examine the specific issue of crop-raiding in Loango National Park, Gabon. First, I investigate the context of conservation at the study site, and how this limits, or intensifies, conflict over wildlife. People in Loango have an understanding of sustainability that shares common ground with modern conservation principles. However, local people resent and resist current conservation practices, which exclude local communities, threaten local environmental entitlement and thus exacerbate institutional vulnerability to crop-raiding. Next, I examine biophysical vulnerability to crop-raiding and find that elephants cause the most crop damage in Loango. Crop-raiding by elephants, when considered at the scale of the study site, follows a seasonal pattern which probably results from elephants' use of water points. However, field isolation and surrounding forest types render some fields more vulnerable than others. Farmers use diverse deterrent methods to limit raids, but none seem effective. The lack of efficacy of deterrents stems from lack of access to labour, driven by rural exodus, which prevents their successful implementation. State mitigation strategies exist but are inadequate and ineffective. Demographic changes also make farmers increasingly vulnerable to poverty, which ultimately increases social vulnerability to crop-raiding. The consequences of crop-raiding, which span from increased food and economic insecurity to social marginalisation, create a negative spiral of vulnerability to poverty and to crop-raiding. Ultimately, spatial and social isolation are the main factors driving vulnerability to crop-raiding in Loango, and both need to be addressed. Vulnerability proves to be a very appropriate analytical framework for the holistic investigation of crop-raiding, and I recommend its use in future research on human-wildlife conflicts and in conservation.

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Table of contents

List of figures

List of tables

Glossary

List of terms

Canton: Administrative division of regions in Gabon

Conservateur**:** National Park Warden

Écogarde: National Park ranger

La Haute: Study zone including Ntchonimbani, Iloupi and all the villages in Loango National Park

New fields: fields cleared in 2009

Old fields: Fields cleared in 2008

Regroupement: Group of settlements considered as an administrative unit and equivalent to the western view of a village

Chef: Chief of a group of settlement that can be a village, a *regroupement* or a *canton*

Terroir villageois: Multi-use zone in which local communities can carry out subsistence activity

List of abbreviations

ANPN: National Agency of National Parks

CENAREST: National Centre for Technological and Scientific Research

DFC: Directorate of Fauna and Hunting

FAO: Food and Agriculture Organization

IRAF: Institute for Agroforestry Research and part of CENAREST

MEF: Ministry of Forestry Economy, Waters and Fishing

NGO: Non-Governmental Organisation

WCS: Wildlife Conservation Society

WWF: World Wildlife Fund

Statement of copyright

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« Il ne faut jamais baisser les bras quand il s’agit de ses rêves. Il faut se battre jusqu’au bout, quitte à aller dans le mur»

Chapter 1 – Introduction

This thesis presents an interdisciplinary and holistic investigation of the most common form of human-wildlife conflict, and one of the most pressing conservation challenges in Africa: crop-raiding. I use the term human-wildlife conflict as any interaction between humans and wildlife that results in negative impacts for human or wildlife populations (Knight 2000; Conover 2001; Madden 2004). While the term "human-wildlife conflict" is now criticised for promoting the idea of human and wildlife as "conscious antagonists" (Peterson et al. 2010: 2), it has been used extensively in the literature to define various aspects of wildlife damage management (biological, socio-cultural and institutional), and, as such, is well suited to express the multidimensional structure of crop-raiding issues as analysed in this thesis. I, therefore, used this particular term to be consistent with the literature and to avoid confusion. However, not all interactions between wildlife and human are negative, as I describe in Chapter 3.

Crop-raiding affects both rural community subsistence, particularly in developing countries, and the survival of endangered species, particularly large mammals (Barnes 1996; Hill, Osborn and Plumptre 2002; Sitati, Walpole and Leader-Williams 2005; Woodroffe, Thirdgood and Rabinowitz 2005). Crop-raiding, like other forms of human-wildlife conflict, often results in retaliation killing, harassment or displacement of pest species, and, ultimately, more complex ecological effects, such as trophic cascades, that result from local extinctions (Saj and Sicotte 2001; Woodroffe, Thirdgood and Rabinowitz 2005; Treves et al. 2006). People near protected areas engage in increasingly destructive activities, such as deforestation, in the hope that these will prevent animal excursions outside the protected area boundary (Woodroffe, Thirdgood and Rabinowitz 2005; Hartter, Goldman and Southworth 2011), or engage increasingly in poaching to compensate for the economic loss incurred through crop-raiding (Wilfred and Maccoll 2010). Finally, like other forms of human-wildlife conflict, crop-raiding can be fuelled by, and undermine, the relationships between conservation managers, protected areas and local people, impeding local conservation efforts (Hill 1998; Nyhus, Tilson and Sumianto 2000; Osborn and Hill 2005).

Although crop-raiding lies at the interface between humans and wildlife, most studies to date have concentrated on only one aspect of the problem – either humans or wildlife – but rarely on both. Studies investigating the biophysical aspects of crop-raiding focus on crop-loss and the landscape factors that render farms vulnerable (e.g., Hoare 1999; Chiyo et al. 2005; Sitati, Walpole and Leader-Williams 2005; Tweheyo, Hill and Obua 2005; Barnes et al. 2006; Rode et al. 2006). Those focusing on local communities explore crop-raiding from the farmer's perspective, including how crop-raiding affects farmer's attitudes towards wildlife and conservation (e.g., De Boer and Baquete 1998; Hill 1998; Gillingham and Lee 2003; Hill and Webber 2010). Another common research theme in crop-raiding is the investigation of mitigation strategies. These latter studies have provided largely ambiguous results at best, and,

more commonly, proof of the practical ineffectiveness of most traditional deterrent methods (e.g., Osborn and Parker 2002; Osborn and Hill 2005; Sitati and Walpole 2006; Graham and Ochieng 2008; Hill and Wallace 2012). While most studies on crop-raiding have included some aspects of the human dimensions of crop-raiding, it was not until 2007 that the impact of crop-raiding on farmers' food and economic security was assessed in detail, by Kaswamila, Russell and McGibbon (2007), in a study in Tanzania. Two other studies from Uganda then followed: Barirega et al. (2010) looked at the effect of crop-raiding on farmer's food security, while Hartter, Goldman and Southworth (2011) investigated household responses to resource scarcity more generally, including scarcity due to conservation and crop-raiding.

Despite the extensive literature devoted to crop-raiding, few studies have attempted to disentangle the links between the different aspects described above (notable exceptions are Naughton-Treves 1997, 1998; Naughton, Rose and Treves 1999; Hill 2000; and the compilation of knowledge in Woodroffe, Thirdgood and Rabinowitz 2005). However, even these few exceptions did not provide an integrated framework that could be used systematically in future research, or to compare studies. Osborn and Parker (2003) and Dublin and Hoare (2004) offered some perspectives on the various aspects of crop-raiding that should be integrated, but their work is more a review of existing knowledge than an actual framework of investigation. The exceptions are Naughton-Treves (1997, 1998) and Naughton, Rose and Treves (1999), who initiated the use of the concept of "vulnerability" in crop-raiding research. Naughton-Treves (1997) referred to vulnerability as the degree to which farmers are at risk of crop damage, combined with individual ability to cope with damage. Later, Naughton, Rose and Treves (1999) reviewed the literature on crop-raiding and developed the concept of vulnerability further to include individual and collective coping strategies (e.g., scattering fields geographically to spread the risk of food shortage or sharing the labour of guarding fields from crop-raiding animals). However, their proposed analysis (see Naughton-Treves and Treves 2005) is limited to theory and the case study used as an illustration does not, in fact, use the vulnerability concept described by the authors.

When looking for a framework to analyse human-wildlife conflict, I first considered the concept of resilience. Resilience, which aims to connect human societies and nature, focuses on how systems can absorb shock while remaining functional (Adger 2000; Folke 2006). This concept has attracted a great deal of attention in the last few years and has been of particular interest in sustainable science (Walker et al., 2002; Walker et al. 2004; Turner II 2010). Theoretically, resilience could be of great use in the study of human-wildlife conflict, as understanding how human can adapt and absorb crises caused by wildlife depredation is central to wildlife damage management. However, two major factors led me to rule out resilience as a possible framework of analysis in this particular case. First, at the theoretical level, resilience

focuses on how systems can adapt and evolve over time. However, at the empirical level observing the transformation and adaptation of human societies requires long-term data set when I collected data only over a 12 months period. Second, my observations in the field suggested that the community under study lacked various aspects of resilience (e.g. inability to cope and recover from repeated damage to crops, etc…), and it seemed to me problematic to conduct an analysis through the lens of a quality that was lacking. However, when reading about resilience, particularly the article from Fraser, Mabee and Slaymaker (2003) and Turner II (2010), I discovered a parallel and complementary concept, vulnerability, which seemed straight away relevant to my data. I, therefore, decided to use the concept of vulnerability instead.

According to Hogan & Marandola (2005), vulnerability science promotes links between the natural and social sciences. Thus, I believe this framework can be effective in the study of human-wildlife conflict. Vulnerability science, which has developed significantly since Naughton-Treves's work, is described by Cutter (2003: 6) as helping to "understand those circumstances that put people and places at risk, and those conditions that reduce the ability of people and places to respond to environmental threats". Initially, vulnerability was mostly defined, and considered, through the risk-hazard approach, which focuses solely on the biophysical aspect of risk (Cutter 1996). However, the concept then diversified to include social vulnerability, which represents the inability of people to cope with, and recover from, risk (e.g., Cutter 1996; Cutter et al. 2003; Cannon, Twigg and Rowell 2003). Cutter (1996: 534) defines the causes of social vulnerability as "the underlying social conditions that are often quite remote from the initiating hazard or disaster event". Perhaps for this reason, the social dimension of vulnerability is employed consistently in studies focusing on food security and poverty (e.g., Watts and Bohle 1993; Kamanou and Morduch 2002; Dudley et al. 2008).

Blaikie et al (1994: 8-9) provided one of the first integrated visions of vulnerability as "the characteristic of a person or a group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature and society". Following this, researchers have used and expanded the concept and processes of vulnerability in diverse fields, resulting in three major themes summarised in Figure 1.1: (1) the notion of institutional vulnerability focused on a particular place or region that represents the political and institutional contexts; (2) risk exposure representing the biophysical aspect of risk; and (3) vulnerability as a social condition which underlies the inability to cope and absorb crisis at the social level (Watts and Bohle 1993; Blaikie et al. 1994; Cutter 1996, 2003; Carter 1997; Adger et al. 2003; Cannon, Twigg and Rowell 2003; Turner et al. 2003; Birkmann 2006; Cutter and Finch 2008). Thus, vulnerability is now an interdisciplinary and integrated framework that includes institutional/political, biophysical and

social domains, making it ideal for the study of crop-raiding. I used this three-dimensional approach to vulnerability to assess the issue of crop-raiding in Loango National Park, Gabon and to provide an integrated framework for the study of crop-raiding and of human-wildlife conflict more generally.

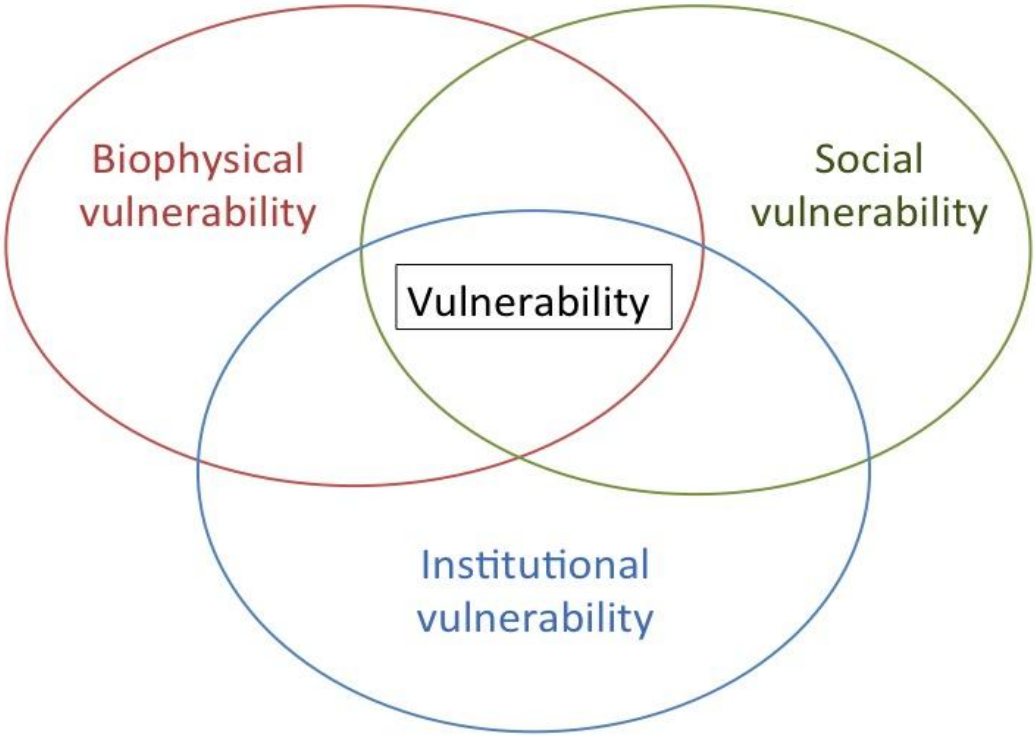

Figure 1.1: Three-dimensional approach to the vulnerability concept.

Protected areas are often implemented as top-down conservation strategies, excluding local populations from the decision-making process (Adams 2004; Adams and Hutton 2007). In both developing and industrialised nations, conservation regulations and protected areas hinder farmers' ability to protect themselves against raiding animals (see the numerous case studies in Woodroffe, Thirdgood and Rabinowitz 2005) and conservation can therefore participate in institutional vulnerability. As a result, farmers often cite crop-raiding as the major reason for disliking protected areas and conservation (De Boer and Baquete 1998; Webber, Hill and Reynolds 2007). Hence, conservation has turned human-wildlife conflict, like crop-raiding, into human-human conflict, and political conflict between people and institutions over wildlife (Newmark et al. 1994; Knight 2000; Madden 2004; Perez and Pacheco 2006; Treves et al. 2006; Adams and Hutton 2007).

Local communities express their side of this conflict as frustration due to restricted access to resources, lack of control over wildlife, and feelings of inequality, where people think animal welfare and survival are considered more important than their own welfare and survival (Kottack 1999; Naughton, Rose and Treves; Lee and Graham 2006; Holmes 2007; Kaimowitz and

Sheil 2007). These sentiments can evolve into both unobtrusive subversion of conservation efforts (e.g., Holmes 2007), or direct acts of sabotage against conservation projects, like burning conservation workers' houses (Campbell 2002). Even successful integrative conservation projects, such as the Community Areas Management Programme for Indigenous Resources in Zimbabwe (CAMPFIRE; Van der Wittenboren (1999), cited in Hill, Osborn and Plumptre 2002) or mountain gorilla-based tourism in East Africa (Madden 2006), are increasingly hampered by human-wildlife, and concomitant human-human, conflicts. Therefore, following the description of the methods I used (Chapter 2), I begin by presenting my study in its broader context of wildlife conservation in Gabon and Loango (Chapter 3).

Next, I investigate biophysical vulnerability to crop-raiding in terms of the offending species, the spatio-temporal distribution of damage and the factors affecting the degree of crop damage (Chapter 4). Many different wildlife species act as crop-raiders worldwide, with varying levels of impact in different local contexts. For example, insects can cause severe damage to manioc in Africa and South America (Bellotti et al. 1994) and birds and rodents cause significant losses to fruit and grain worldwide (Somers and Morris 2002; Stenseth et al., 2003). In Africa, mammals, including rodents, wild pigs, antelopes, primates and elephants (*Loxodonta africana)*, are often blamed for damage to various crops (Lahm 1996; De Boer and Baquete 1998; Naughton-Treves 1998; Hill 2000; Gadd 2005; Sitati, Walpole and Leader-Williams 2005; Tweheyo, Hill and Obua 2005). In Gabon, Lahm (1996) described cane rats (*Thryonomys swinderianus*) and elephants as the two most damaging species nationwide, and elephants as the worst crop-raider in the region where my study site is located. Patterns of crop-raiding are affected by many factors, of which the best predictors of the level of crop-raiding are the distance from the forest edge in forested habitat, distance from protected area boundaries, the availability and ripening of preferred crops for a given pest, and the number of neighbouring fields (Naughton-Treves 1998; Hill 2000; Chiyo et al. 2005; Sitati, Walpole and Leader-Williams 2005; Tweheyo, Hill and Obua 2005; Linkie et al. 2007). In Gabon, Lahm (1996) and Barnes (1996) suggested that the distribution of wet habitats (e.g., swamps), and of secondary forests, may explain elephant distribution and crop-damage, but their conclusions are not based on systematic surveys in different habitats.

Despite the existing knowledge of crop-raiding patterns, many gaps remain in our understanding. Most studies of crop-raiding have acknowledged the importance of site-specific context in factors affecting the pattern and intensity of crop damage (e.g., Lahm 1996; Naughton-Treves 1998; Naughton, Rose and Treves 1999; Hoare 2000; Hill, Osborn and Plumptre 2002). Since our current knowledge largely comes from studies focusing on very few countries and locations, mostly in East Africa, and/or areas with very high human density, such as in Uganda, important parameters still need to be investigated and tested (Humle 2003). For

example, most scholars agree that increases in human-wildlife conflict are a direct consequence of human population growth and encroachment into wild areas (Siex and Struhsaker 1999; Sillero-Zubiri and Switzer 2001; Hill, Osborn and Plumptre 2002; Humle 2003; Osborn and Hill 2005; Anthony, Scott and Antypas 2010). Gabon, however, presents the opposite case, as it is characterised by very low human densities (< 0.2 inhabitant/km^2 at the study site: Laurance et al. 2006a) and extensive forest coverage (70-80 % of the country is forested: Laurance et al. 2006b). However, the level of crop damage seems to be high and I investigate the possible causes of this in Chapter 4.

I then investigate the use of individual and institutional mitigation strategies against crop-raiding in Loango National Park, which are important to understand both the social and institutional vulnerability to crop-raiding (Chapter 5). As for crop-raiding, the existing literature on traditional deterrent methods comes mostly from studies in East and Southern Africa (e.g., Kenya: Sitati and Walpole 2006; Graham and Ochieng 2008; King, Douglas-Hamilton and Vollrath 2011; Zimbabwe: Osborn and Parker 2002), which differs considerably in habitat and species composition to Central Africa. Therefore, it is unknown whether these previously studied deterrent methods are similar to, and similarly (in)effective to, those in more forested areas, for example. In Gabon, Lahm (1996) suggested that deterrent methods were mostly ineffective, but her study was based strictly on interviews, and therefore on people's perceptions of effectiveness rather than on actual effectiveness, and should be viewed with caution. When strategies at the level of the individual fail, the government may offer measures to limit crop damage or mitigate its negative consequences. Usually, these solutions involve killing raiding animals in an attempt to prevent further raids or compensating farmers financially (e.g., for bears (*Ursus sp.*) damage: Garshelis et al. 1997; Karamanlidis et al. 2011). However, these measures are rarely implemented or successful in alleviating the costs of crop-raiding for farmers in Africa (Barnes 1996; Lahm 1996; Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2003).

Finally, the literature reveals that rural communities rely heavily on farming for subsistence and can be greatly affected by crop-raiding, particularly in developing countries. For example, crop-raiding may deprive farmers of food supplies and income, threatening their food and economic security (Kaswamila, Russell and McGibbon 2007; Barirega et al. 2010; Hartter, Goldman and Southworth 2011). Crop-raiding also causes increased labour, and threats to health or education, through increased time spent guarding fields, leading to reduced sleep and increased levels of stress (Naughton-Treves 1997; Hill 2000; Hill 2004; Gadd 2005; Osborn and Hill 2005; Ogra 2008). However, the importance of these indirect consequences has received little attention to date (Thirdgood, Woodroffe and Rabinowitz 2005). In extreme situations, crop-raiding can even result in the abandonment of fields and villages by farmers (Naughton, Rose

and Treves 1999; Sitati, Walpole and Leader-Williams 2005; Treves et al. 2006), or in injury or death to people attempting to protect their fields (Nyhus, Tislon and Sumianto 2000). Despite this broad knowledge, nowhere in the literature did I find an analysis of how the negative consequences of crop-raiding affect farmers' abilities to combat and cope with crop-raiding effectively in the future. Therefore, I explore how crop-raiding, and the need to prevent crop-raiding, affects farmers' livelihoods and their ability to prevent further crop-damage in Chapter 6. Coupled with this, I investigate which coping strategies they employ to limit the negative effects of crop-raiding, and whether these strategies are successful, therefore providing an overview of the social vulnerability to crop-raiding in Loango.

My final chapter (Chapter 7) reintegrates the three aspects of vulnerability explored during the course of the thesis. By highlighting the main aspects of importance for vulnerability to crop-raiding in Loango and in Gabon, I provide management guidelines at both individual and institutional levels. Finally, I discuss the effectiveness of interdisciplinary studies, and of vulnerability as a theoretical framework, for the investigation of crop-raiding, human-wildlife conflicts, and conservation research.

Chapter 2 – Methods

2.1 Study Site

2.1.1 Geographic and natural characteristics

The study took place in Gabon in Central Africa (Fig. 2.1). Gabon is 75-80 % rainforest, harbours many threatened species and has been preserved from excessive exploitation, leading to its international recognition as a reservoir of biodiversity (Lahm 1996; Laurance et al. 2006b). Within Gabon, I conducted my study in the northern sector of Loango National Park (Figs. 2.1, 2.2). The climate is equatorial with temperatures ranging 19-31 °C and mean annual rainfall of 2200 mm (Head et al. 2011). The climate is divided into two wet seasons (February-April and October-December), a long dry season (May-September) and a short dry season (December-January) (Blaney et al. 1999; Laurance et al. 2006a; Head et al. 2011). The area is characterised by a wide variety of habitats including savannah, swamp, lagoon, coastal forest, and permanently and seasonally inundated lowland forests in various stages of succession (Laurence et al. 2006a, Head et al. 2011). This diversity of habitat supports a high density of forest elephants, many primate species including western lowland gorillas (*Gorilla gorilla gorilla*), chimpanzees (*Pan troglodytes*), two species of mangabey (*Cercocebus albigenas* and *C. torquatus*), three species of guenon (*Cercopithecus cephus, C. nictitans* and *C. pogonias*), buffaloes (*Syncerus caffer nanus*), red river hogs (*Potamocherus porcus*), several species of antelope and duiker (*Tragelaphus spekii gratus, Cephalophus silviculto, Cephalophus rufilatus, Philantomba monticola*), and many aquatic species (e.g., hippopotamus (*Hippopotamus amphibius*), manatees (*Trichechus senegalensis*), whales (*Megaptera novaeangliae)*, turtles (e.g., *Dermochelys coriacea)* and crocodiles (e.g., *Mecistops cataphractus*)).

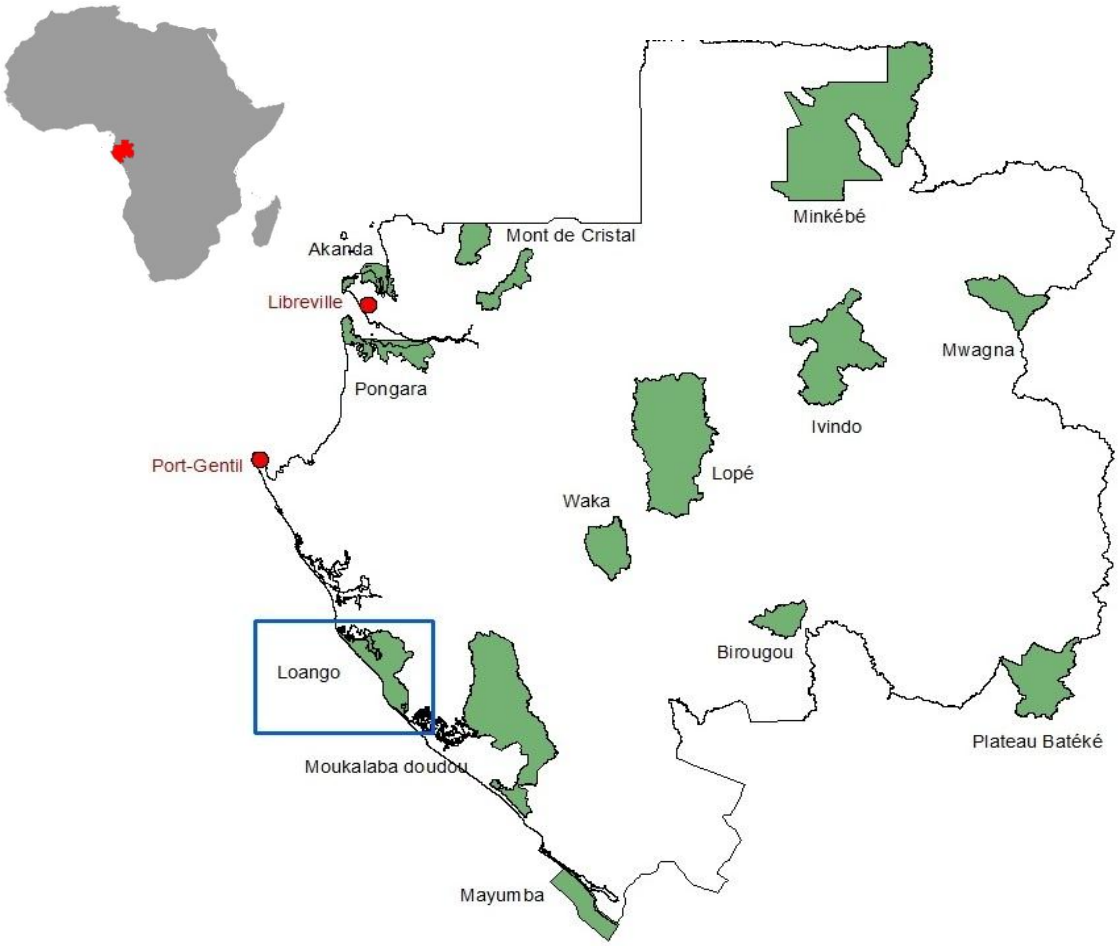

Figure 2.1: Map of Africa with Gabon in red, and a map of Gabon with National Parks in green. Loango National Park is framed in blue and red dots are the major cities of interest for my study. Map created based on data from the World Resources Institute, downloaded from http://www.wri.org/publication/interactive-forestry-atlas-gabon on 15th May 2012.

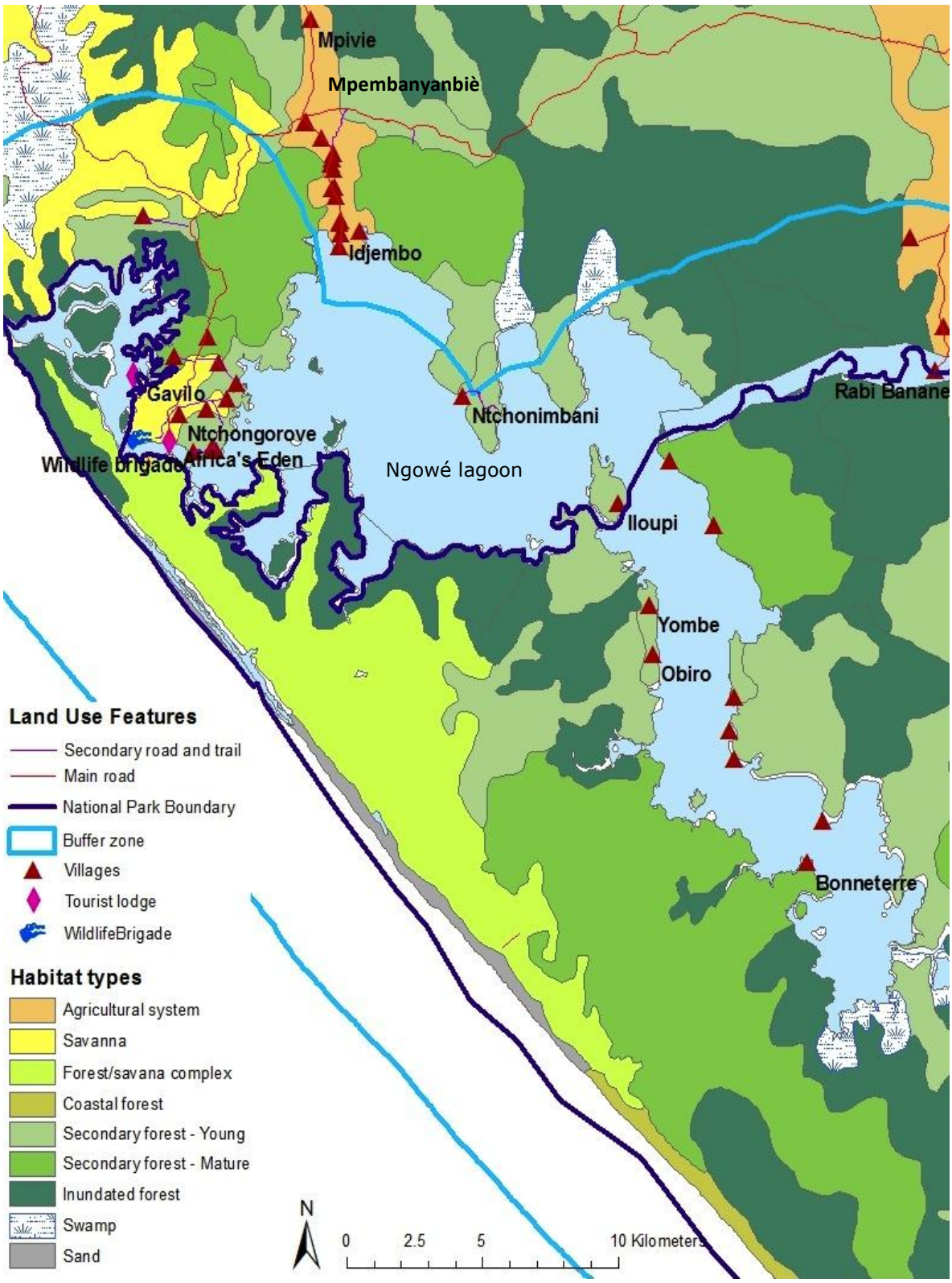

Figure 2.2: Northern part of Loango National Park, including the study site which included all *regroupements* except Mpivié and Rabi. Based on data provided by the Wildlife Conservation Society and personal observations.

2.1.2 People of Loango

The population of Loango is comprised of people belonging to two major ethnic and linguistic groups: the Pounou (or Bapounou) and the Myéné (Pourtier 1989a). While the Ngowé (also called Ngubi, Pounou group) seem to predominate, a large number of Nkomi people are present at the study site, and almost all people speak Nkomi (Myéné group) in addition to their natal language. These Nkomi come mostly from Oumboué and Port-Gentil, the nearest town and city, following work opportunities or arriving through marriage (Blaney et al. 1999). The minority ethnicities represented are: Eshira, Loumbou (or Baloumbou), Bavarama and Vili of the Bapounou group, and Bakota of the Batéké group (Pourtier 1989a; Blaney et al. 1999).

Local residents are distributed among eight official "*regroupements"* (Fig. 2.2). *Regroupements* are constituted of several settlements, referred to locally as villages that can be several kilometres apart (up to 6 km at the study site). *Regroupements* are the result of the French colonial administration's active "*regroupement scheme"*, which aimed to group scattered settlements along transportation routes (Pourtier 1989a; Laurance et al. 2006b). The nine villages present inside the park, which are all located on the edge of the Ngowé lagoon, are officially grouped into three *regroupements*: Obiro, Yombé and Bonneterre. All the other villages on the lagoon edge were originally temporary fishing camps but are now permanent settlements. Five other *regroupements* and one village are located in the periphery of the park: Ntchongorové, Idjembo, Ntchonimbani, Mpivié, Rabi and Iloupi. It is unclear which of the five other *regroupements* in the periphery are in the buffer zone and which are not. The buffer zone is defined as the area contiguous to the National Park and which is at least 5 km wide (ANPN 2009). In the park management plan 2009-2014 (ANPN 2009: 22), all *regroupements* are listed as "in the periphery" but the map included in the document suggests that only Ntchongorové, Iloupi and Rabi belong to the actual buffer zone. Locally, people refer to the villages in the park, Ntchonimbani and Iloupi, as "*la Haute"* (the upper lagoon), and I use this term in this thesis. My study focused on villages in Ntchongorové, Idjembo and *la Haute*, which I refer to as the three study zones.

Villages constituting *regroupements* usually include one to a dozen or more houses where members of the same extended family live. In local culture, as in Sanderson (2001), the extended family constitutes several generations of both consanguinal and affinal kin; although several unrelated friends are often also present and some larger villages constitute a grouping of more than one family group. Thus, the distribution and social structure of villages is highly influenced by kinship. Only natives of the *regroupement* have access to land or have the right to fish, and incomers must request an authorisation from the "*Chef de village"* or *"Chef de regroupement"* (local leaders), who then allocates land for cultivation and sometimes

construction or give fishing rights. Villagers know where their family territory is and ensure that their land remains unoccupied by others. Each family decides the location of their field within the family land or some not as yet allocated land. Once land has been "*travaillé"* (cleared), the land belongs to the worker and their family and becomes transmissible family land. Natives can also lend or give family land to an incomer without the need of agreement from the *chef* or village. While this cultural heritage is followed in rural areas, the "*droit de propriété coutumier*" (customary property right) is not clearly legally recognised by the Gabonese administration.

Most people in the study area depend mostly on subsistence activities, including farming, fishing, hunting, palm wine production, traditional medicine and handicraft. A socio-economic survey I carried out for the entire the study site reveals that 95 % of households in the park, 100 % in Idjembo and Ntchonimbani and 35 % in Ntchongorové depend mostly on subsistence activities (see section 2.2 for details of data collection). All households practicing fishing, palm wine production, traditional medicine and handicraft also farmed. Livelihood strategies are based on a portfolio of activities structured around a gender division of labour. Women carry out farming, traditional medicine, handicraft and domestic activities while men are in charge of providing sources of protein through fishing and hunting or providing cash through wage labour. Source of wage labour in the area include tourism, conservation and research, oil exploitation, forestry, phone company, state employment for education, health and wildlife management, owning and driving a taxi and the tenancy of shops and bars. Other sources of income come from pensions or the rental of properties. Even households benefiting from wage labour often engaged in complementary subsistence activities for food and/or an additional source of income.

The human population density in the study area is very low, with < 0.2 inhabitants per km² (Laurance et al. 2006a). The population has declined drastically in the last 20 years due to rural exodus by the younger generations, resulting in a rapid increase of the average age of the remaining population (Blaney et al. 1999). Blaney et al.'s survey in 1999 estimated that 33 % of the population was over 55 years old, with many villages having 50-100 % of the population older than 55 (Blaney et al. 1999). My data show that 19 of 38 (50%) of the farmers I interviewed at the study site, and for which I was given an approximate age, were over 50 years old, but there were large differences between *regroupements* (see section 2.2 for details of data collection methods). Only 37.5% farmers are over 50 years old in *la Haute*, compared to 64 % in Ntchongorové and 60% in Idjembo (Fig. 2.3). While elders always have a field, or at least a "*jardin*" (a very small field), the youth are reluctant to engage in farming. As in western countries, farming is considered an old-fashioned activity and young people prefer to seek a modern way of life in urban centres. In contrast, people who have spent their entire life in cities often return to their family land and start farming at retirement.

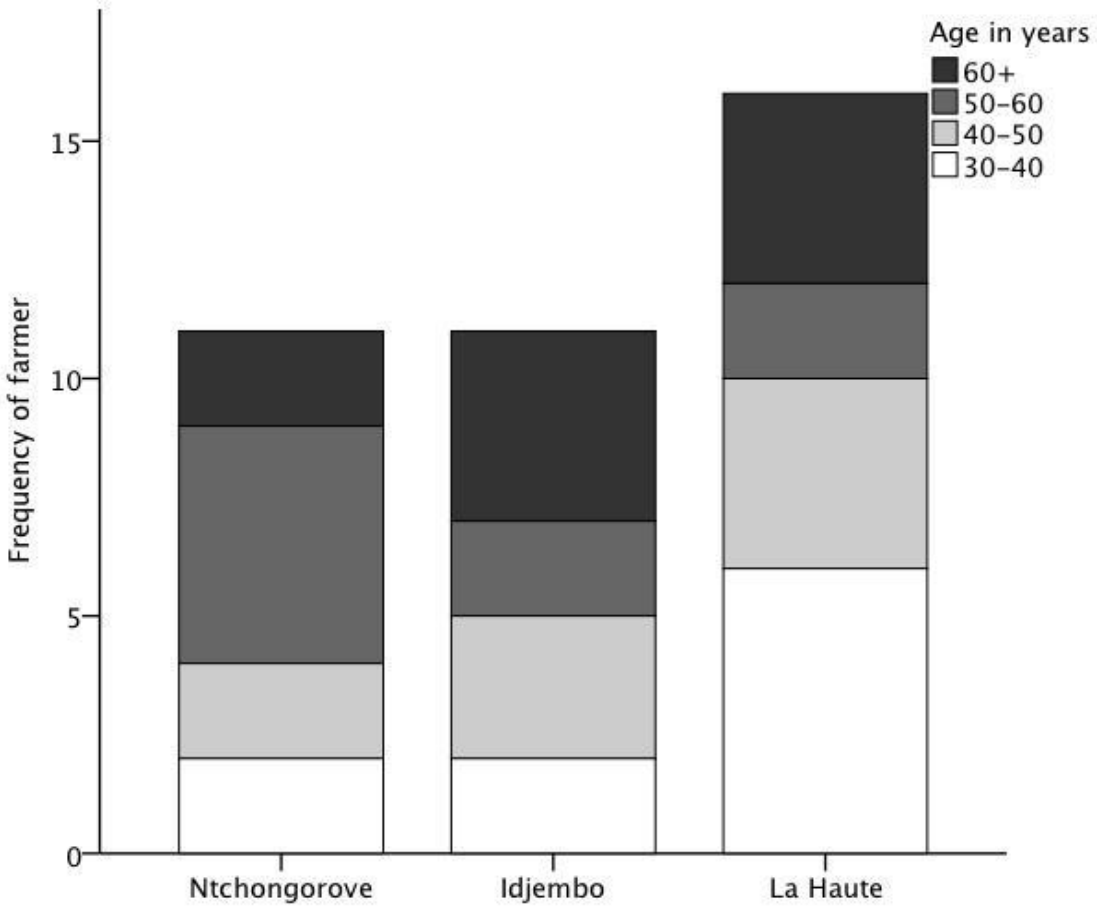

Figure 2.3: Distribution of farmers' ages in the three study zones.

The absence of infrastructure in many *regroupements* probably exacerbated rural exodus in the past (Blaney et al. 1999), and the presence of a school in Idjembo and a new school in Ntchongorové may have slowed the process down to some extent. Employment in tourism and conservation also slowed population decline in Ntchongorové. Blaney et al. (1999) suggest that the presence of employment through oil and forestry companies also slowed down rural exodus (Blaney et al. 1999), but this differs between *regroupements*. Park data, and mine, suggest an increase of the population in Ntchongorové between 1999 (Blaney et al. 1999) and now (ANPN 2009; personal observations) where tourism is flourishing, and a decline everywhere else.

2.1.3 Agricultural practices

As mentioned in the previous section, farming in Gabon is mostly a woman's activity. Only four men engaged in agriculture at the study site and this was always related to a lack of a female partner or relative capable of farming. Most women in sub-Saharan Africa are expected to provide food for the household even when men engage in wage labour (Bryson 1981). It seems

that this expectation goes further in Loango and that fields represent the ability of a woman and a wife to provide food for her family, and, therefore, shape her value as wife and a mother (Chapters 5 and 6). Women I worked with in Loango have a strong sense that they should provide non-protein food for their children in order to be a good parent. When Gabonese women farmers visit relatives, or attend ceremonies such as weddings, they are expected to contribute village produce in the form of manioc, or bananas. The act of giving food to others is closely linked to social relatedness in Loango, as in other societies in Africa, and allows for the creation or maintenance of social networks (e.g., Bahuchet 1990, Chapter 6). Furthermore, in polygamous marital systems, such as the traditional Gabonese system, the value of each wife in comparison to her co-wives potentially affects her status within the family, at least in relation to the shared husband (see also Chapters 5 and 6). Farming therefore has implications beyond the strictly productive function as it helps to structure domestic organisation and is of great importance in women's identity and sense of purpose.

Farming at the study site is limited to the production of crops and no farmers possessed livestock apart from few chickens. In addition, I never saw, or heard of, farmers killing their chickens for food, nor did I witness villagers collecting eggs. On one occasion I observed a porcupine, which was bought at a market, and a goat kept as pets. The farmer declared that she kept these animals for pleasure and not for consumption. The porcupine eventually escaped and the goat was sold but neither were replaced during the study. The lack of livestock farming is common in Gabon and results from the absence of a livestock farming culture due to the predominance of hunter-gatherer societies in the past and the prevalence of tsetse flies which carry and spread sleeping sickness (trypanosomiasis) (Magnagna Nguema 2005). Furthermore, the inadequacy of the transport and market systems does not facilitate or allow for the easy transportation and sale of products. There is therefore no real incentive for farmers to invest in livestock farming (Magnagna Nguema 2005). The easy access to fishing grounds and the perceived high level of depredation by pythons, leopards and other small predators probably accentuated this in Loango. People regularly blamed pythons for the disappearance of dogs, cats and chicken, another form of human-wildlife conflict, and two farmers said that predation would impede any trial of livestock farming.

Agriculture is small-scale, subsistence based and on a slash and burn basis with rotational fallow cultivation. During my study, farmers said that they left their fields fallow for 10-20 years before using the same site again. However, previous records at the study site suggest that farmers tend to clear *new fields* from the forest rather than using fallows (Blaney et al. 1999; Le-Duc Yéno 2006). Most farmers possess more than one field, including at least one from previous years that still provides food ("*old field*"), and one cleared during the current year ("*new field*") (Fig. 2.4). Fields are generally located less than 2 km from the village, but may be

up to 8 km away. The mean field size is 5404 m^2/woman/year (range 680-18260 m^2), which is comparable to previous studies in the area (mean of 3600-8300 m^2/woman/year – Blaney et al. 1999 and Le-Duc Yeno et al. 2006). Agricultural activities are centred on the long dry season (May-September) for the creation of *new fields*. After clearing, *new fields* are burned and planted immediately before the first rains (September-October), then weeded twice in the year (December-January and April-May). Men clear the forest to create *new fields* during the dry season, but women perform all the other activities, from planting to cooking and selling produce (Pourtier 1989a; Lahm 1993 ; Blaney et al. 1999; Le-Duc Yeno et al. 2006).

The most important crops for local people are, in decreasing order of importance: manioc (*Manihot esculenta*), banana (*Musa sp.*), tarot (*Colocasia esculenta*) and sweet potato (*Ipomoea batata*), and manioc is the predominant species and the most important food and cash crop. Other crops grown include pumpkin (*Curcurbita sp.*), aubergine (*Solanum sp.*), peanut (*Arachis hypogaea*), sugar cane (*Saccharum officinarum*), roselle (*Hibiscus sabdariffa*), chilli pepper (*Capsicum frutescens*), papaya (*Carica papaya*), pineapple (*Ananas comosus*), avocado (*Persea americana*), mango (*Mangifera indica*) and lemon, grapefruit, and orange (*Citrus sp.*). While manioc, banana and taro are mostly grown over extended areas, the other crops are generally planted in small gardens around habitations. The root crops (manioc, potatoes and taro) do not have a precise harvest time but are collected when needed and can be stored underground effectively (for up to three years in the case of manioc). Thus, Pourtier (1989a: 204) describes the field as the household “granary”. Bananas provide one bunch a year, which is harvested when ripe. Other less important food crop species are harvested when needed or ripe but, as they are not grown in large numbers or over extended areas, their harvest does not represent a peak of activity in the year.

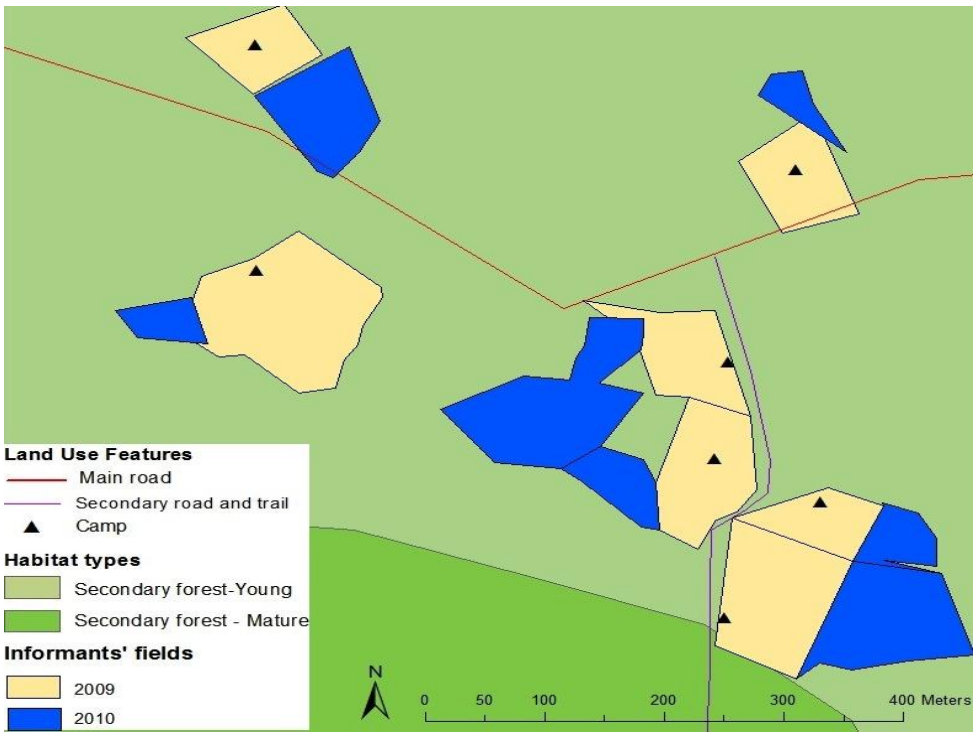

Figure 2.4: Example of the spatio-temporal distribution of fields for farmers from Idjembo in Mpembanyanbiè. Contiguous fields of different ages belong to the same farmer.

2.2 Data collection and analysis

2.2.1 Sample selection

From March to June 2009, I carried out a pilot study to test the feasibility of the study, various methods and to estimate logistical needs. My observations during the pilot study suggested a gradient of crop-raiding frequency and pest species increasing with the distance to the centre of the village, which coincides with the lagoon edge. In Ntchongorové, it was clear that the further a field was from the centre of the village, the more exposed it was to crop-raiding and to larger pest species (e.g., elephants entirely devastated the field that was furthest away from the centre of the village). Therefore, for the investigation of crop-raiding patterns, I used random stratified sampling to select farmers in both Ntchongorové and Idjembo, based on the location of the 2008 plantations and with distance from the centre of the village as the stratification criteria. In Idjembo, there was a shift in plantation location pattern between 2008 and 2009. In 2009, 95 % of farmers in Idjembo created their fields in the same location – Mpembanyanbiè – about 8 km from the village (Fig. 2.5). According to farmers, the allocation of plots of land in Mpembanyanbiè was based on a first come, first served strategy, although one of the local leaders assigned some plots arbitrarily. Because field distribution did not seem to follow any particular pattern (such as village neighbours or kinship), I assumed that the random sample

selection for fields in 2009, and based on 2008 fields, was still random. To investigate the pattern and extent of crop-raiding, I selected 10 farmers each from Ntchongorové and Idjembo. This represents 31 % of the 32 farmers in Ntchongorové and 58 % of the 17 farmers in Idjembo, which is comparable with, or higher than, sample sizes in previous studies of crop-raiding (e.g., Sekhar 1998; Hill 2000; Pérez and Pacheco 2006). In *la Haute*, because of the very low number of farmers and because villages are very scattered, I included as many households as possible distributed as follow: 10 of 11 families of farmers in the park, 5 out of 6 in Ntchonimbani and 3 out of 4 in Iloupi. I selected the same farmers to investigate the social aspects of crop-raiding as those whose fields I selected for the biological investigations described above.

Of the households I selected in my study (N = 38), 30 (79%) said that they received an income from agriculture, 14 (37%) carried out subsistence fishing in addition to farming (of whom 9 households said that they derived an income from it), and 3 (8%) also practiced traditional medicine. Farming or fishing was the first source of income for 26 of 38 (68%) of the selected households, with differences in the proportions between regroupements (Table 2.1). Households in *la Haute* relied more on fishing than farming while households in Ntchongorové relied more on other sources of income although farming was still the women's main activity. Only four households reported farming to be their sole subsistence activity, while 20 complemented farming with other sources of income.

Table 2.1: Primary source of income for households of the farmers included in the study (N = 38)

Primary source of income		**Farming**	**Fishing**	**Others***	**Traditional medicine**
Regroupement	**$N_{households}$**				
Ntchongorové	10	3	0	5	2
Idjembo	10	7	1	1	1
Ntchonimbani	5	3	2	0	0
Iloupi	3	0	3	0	0
Park	10	2	5	3	0
Total	**38**	**15**	**11**	**9**	**3**

* Others include: wage labour, rental of properties, pensions and relatives sending money

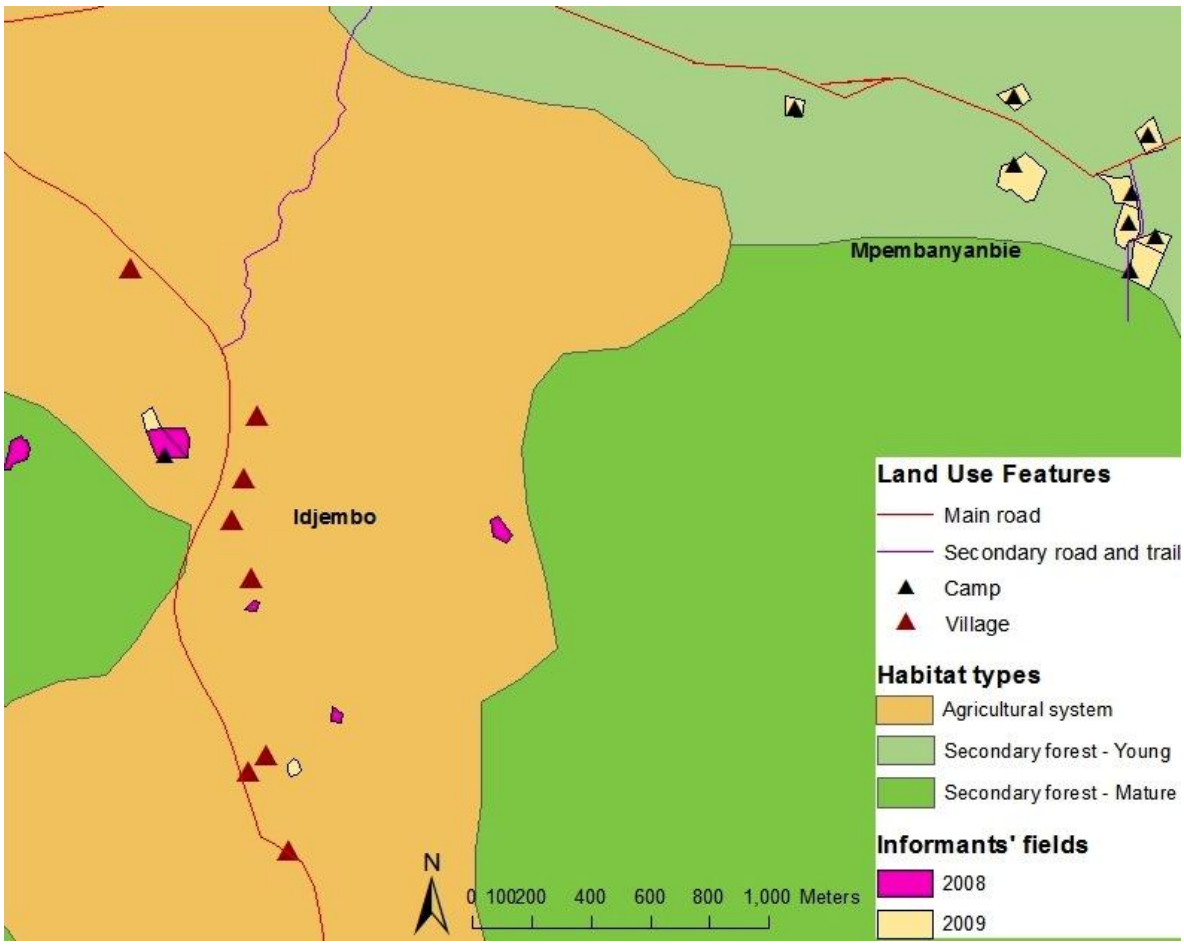

Figure 2.5: Map of the spatial distribution of fields cleared in 2008 and 2009 in Idjembo and Mpembanyanbiè.

2.2.2 Data collection and analyses

Because the methods used for monitoring crop-raiding are only relevant to Chapters 4 and 5, I describe them there. Here, I describe the methods used for the investigation of the social aspects of crop-raiding as I use the results throughout the thesis. I carried out data collection from October 2009 to November 2010 in four *regroupements* in the periphery of the park – Ntchongorové, Idjembo, Ntchonimbani and Iloupi – and in all three *regroupements* inside the park. Villages in *la Haute* were difficult and expensive to reach so I only monitored them three times.

To investigate the social and institutional aspect of crop-raiding I used a combination of participant observation, an ethnographic journal and semi-structured interviews (Emerson, Fretz and Shaw 1995; Bernard 2005; Drury, Homewood and Randall 2011). My ethnographic journal is based on observations made during the periods in which I used participant observation and during interviews. This combination of qualitative and more structured approaches gave me the opportunity to crosscheck information between group and individual perceptions (Milton 1996;

Hill, Osborn and Plumptre 2002; Treves et al. 2006; Drury, Homewood and Randall 2011). To undertake participant observation, I lived among my informants in Ntchongorové (Fig. 2.2) for the duration of the study. I chose this *regroupement* because the stakeholders involved in conservation (local communities, NGO, wildlife and park authorities and ecotourism companies) were all present. By living with my informants, I was able to become a *de facto* member of the community and in many ways transcend problems that arise when discussing sensitive issues with informants who might otherwise have thought my allegiance was more to local authorities than to them. In addition, I took part in a workshop held in Libreville by the Food and Agriculture Organisation (FAO), which aimed to offer guidelines for the resolution human-wildlife conflicts in Gabon. This workshop helped to develop my understanding of how state agencies understand and manage rural communities' problems in relation to wildlife. The advantage of using multiple methods including participant observation was confirmed during my study, when informants who were honest during informal conversations, even when I was openly taking notes and/or recording them, avoided discussions about sensitive issues during my official interview with them. As suggested by Drury, Homewood and Randall (2011), I also found participant observation extremely valuable in highlighting contradictions between what people said and did or what people said at different times during the study. In addition, participant observation proved valuable in that it allowed me to record values and opinions of individuals whose voices were not always heard during interviews. Finally, I used qualitative methods as they are known to be effective to capture processes (Murray 2002).

During the pilot study, it appeared that local people, and especially elders, relied heavily on narrative discourse. They were also very embarrassed when they did not understand, or did not know the answer to, a question. In such cases, they provided a random answer, the answer they believed I was expecting, or ended the interview by starting another activity or leaving. I therefore considered that semi-structured interviews, which are more flexible and allow informants to express their own understanding in their own words (Drury, Homewood and Randall 2011), were the most appropriate approach. I carried out these interviews at the end of my study, i.e., from September-December 2010. Waiting until the end of the study to conduct the interviews had two advantages. First, I was able to take the time necessary to be integrated into the community and be trusted by local people and other stakeholders to ensure maximum honesty during interviews. Second, I was able to adapt and improve my interviews thanks to the ethnographic material collected during the previous months.

I agreed a time and place for interviews in advance with farmers and conducted interviews in their house or field, depending on their activity on our arrival. I originally intended to interview farmers individually. However, this proved difficult as I was rarely able to isolate farmers in a setting that allowed for an interview, and most of the time their friends, husband or

other relatives were present. Men often participated actively in discussions and interviews even when not invited to do so, so I do not separate interviews by gender. Most of the interviews should, therefore, be considered as household or small-scale group interviews. When possible, I recorded the various opinions of the participants separately, while focusing my attention on the farmer that I had intended to interview. Some debates resulted in women leaving or being completely quiet. In such cases, I attempted to continue the interview with the women at a later stage. I had very little opportunity to conduct interviews in *la Haute*, so I did so opportunistically with members of the household who were present at the time of my visits. Because cultural and socio-economic factors are known to shape people's perceptions of wildlife and conservation (Hill, Osborn and Plumptre 2002; Madden 2004; Treves et al. 2006), I collected the following data during interviews: age class of the interviewee(s), ethnicity, household size, sources of household income and people's degree of dependence on agriculture for subsistence.

I conducted three different types of interviews for different topics of investigation. First, I conducted 27 interviews with farmers in the periphery of the park (11 in Ntchongorové, 10 in Idjembo, one in Mpivié and five in Ntchonimbani), and 12 in the park. All of the farmers interviewed were the ones whose fields were monitored for crop damage (section 2.2.1). I also included the five local leaders in farmer interviews as they discussed their households' problems with crop-raiding even though they themselves were not always farmers. Interviews aimed to assess the following (Appendix – Interview Guide 1):

- Their farming practices and their perceptions of historical and current characteristics of crop-raiding
- Their experience with deterrent methods and the efficacy of such methods
- The factors influencing crop-raiding
- The consequences of crop-raiding

To investigate people's perceptions and values concerning nature, its preservation and conservation, I questioned both farmers and non-farmers. Non-farmers included the five local leaders mentioned earlier, the four wildlife authority representatives in the area, four of the five employees of the local conservation NGO (one of whom was from Ntchongorové), two tourism managers (both working for one of the tourism companies in the area) and 10 tourism employees (working for two different tourism companies). I could not interview the managers of the main tourism company present in the area because they stopped their activity unexpectedly before the interview period started. I interviewed employees of the tourism companies, many of whom are from the area, opportunistically during the last two months of the study. Interviews focused on the following (Appendix – Interview Guide 2):

- Whether they value nature in general, or particular species, and why
- What they think about nature preservation and conservation
- Whether or not they think local communities or themselves receive benefits from wildlife and wildlife-related activities including conservation
- Their relationships with local communities, park authorities, NGOs, the ecotourism industry and research teams as relevant

I will develop the local understanding of nature preservation further in Chapter 3, but I want to take this opportunity to differentiate between the two understandings of conservation, as expressed by conservation actors and local communities at the study site. The local view sometimes found in Africa, in which humans belong to and depend on nature, has been described in the literature as "Indigenous Environmental Ethics" (Kelbessa 2005), or as "Non-anthropocentric African Environmentalism" (Behrens 2010). In both cases, authors move away from the nature-culture dualism often used as a basis for conservation thinking, and which suggests a separation between humans and nature that has been criticised as inadequate in contemporary environmental discourse (Descola 1996; Neumann 1997). I therefore use “Local Environmental Ethics”, adapted from Kelbessa (2005), to refer to the current conceptualisation of nature used by local people. However, the idea of the need to protect nature in Loango has been introduced to local communities under the term “conservation”. Local people therefore use the term conservation to describe both the concept of nature preservation and to discuss conservation practices. To avoid misunderstandings, I use nature “preservation” and “preservation principle” to express the concept of nature protection, and “conservation”, “conservation approach” and “conservation practice” to refer to the state-centric and science-based approach to modern conservation.

Finally, I carried out interviews with local authorities and conservation stakeholders (as described above) focusing on the following (Appendix – Interview Guide 3):

- Their relationships with local communities and conservation management in the area
- The impact of conservation on local communities and the impact of crop-raiding on conservation
- The past and future development of conservation management in the area

Where possible I conducted interviews in French, which is the national language and my first language. When informants did not speak French, my local research assistant, Kharl Rémanda, conducted interviews in the local language. Kharl is a 21 year-old man who grew up in Libreville, the capital city, and came back in his village of origin, Idjembo, in search of a job

opportunity in 2002. I met him when we both worked for a research project in Loango National Park in 2006-2007. I hired him because I thought he would be efficient in collecting systematic data, as he did in the past, and as he had, to my knowledge, no antagonistic relationships with anybody in the area. Kharl is a relative of the head of Idjembo and is consanguinal or affinal kin to most of the farmers we worked with. As he was younger than all farmers, villagers generally considered him as a "son". I did not feel that women farmers were inhibited by his presence or were embarrassed to answer him, probably because of his age and kin relationships with the farmers, even though he was a man. In addition, people did not seem to find it awkward that a man was working on, and asking questions about, women's activity. The reason for this is probably that research assistantship is a wage labour activity, and therefore considered to be a man's activity.

To record data during interviews I took written notes but I also recorded all interviews with an audio recorder so that I could obtain more details during transcription with Kharl. Although I have a basic knowledge of Nkomi, I asked Kharl to translate ideas and concepts during interviews in local language so that I could ask appropriate follow-up questions. During the first few months of the study, I trained Kharl in how to translate people's answers as accurately as possible so as not to lose subtleties in people's answers. Kharl's participation in the study was far more than translation, however. He also helped me to shape the methods we used to monitor crop-raiding so that it would be logistically feasible and we had many debates around the meaning of people behaviour and answers, the true signification of one word over the other and his interpretation of village meetings, etc.... For the purpose of this thesis, I translated quotes from French to English myself and I have taken great care to preserve people's meaning while providing quotes that are understandable and in correct English. While double translation is always problematic, I believe we maintained people's meaning at all steps of the translation process and I am confident that the level of interpretation inherent to any translation did not denature the quotes used in the thesis.

I coded and analysed ethnographic field notes and qualitative data such as open-ended interviews using the ethnographic software package NVivo 8. I pre-coded ethnographic data by themes during the writing process in the field and re-coded them in more detail using NVivo at a later stage. I also pre-coded interviews by theme during the transcription phase and recoded them more finely using NVivo. I used the same themes (nodes) to code ethnographic material and interviews to be able to visualise links between the two sets of data.

2.2.3 Research authorisations

2.2.3.1 Ethics

This project was approved by the Research Ethics and Data Protection Committee of the Department of Anthropology, Durham University. During the pilot study, and at the beginning of the main study period, I approached all villagers in the selected *regroupements* and villages. I explained the project, and anticipated outcomes, to the villagers and considered their oral agreement to be part of the study as consent. A written consent form was not appropriate as many villagers and farmers are illiterate and/or do not speak either French or English. When people agreed to take part, I emphasised that they were completely free to participate or not, and also free to withdraw at any time without providing any explanation. While meeting with farmers, it became quickly evident that they all wanted to be included in the study and expected me to come to monitor their fields regularly. I therefore explained to each farmer that I would select some farms for regular monitoring but that those farms will represent them all in future reports.

The major ethical issues related to my study are the potential lack of anonymity for informants and the observation of illegal activities. Some of my informants are in a unique position and may therefore be easily identifiable in any reports. To circumvent this issue I group my informants in various ways. I use "stakeholder" as defined by Freeman (1984: 46, cited in Mitchell, Agle, & Wood, 1997) as "any group or individual who affects or is affected by the achievement of the organizations' objectives". I use the term "conservation stakeholders" to include national authorities through their local representatives, conservation NGOs, ecotourism operators and local communities. I use "conservation actors" to refer to these stakeholders but excluding local communities, as local communities do not take part in conservation management in Loango (Chapter 3). "Officials" refers to the state representatives of wildlife authorities including the "*Agence Nationale des Parcs Nationaux*" (ANPN – National Agency of National Parks) and what was the *"Ministère des Eaux et Forêt"* (MEF – Ministry of Water and Forests) at the time of the study (Chapter 3). I use "local leaders" and "local representatives" to refer to *Député* (equivalent to Member of Parliament in the UK), *Chef de Canton, Chef de regroupements* or *Chef de villages*. I use "local leader" when I refer to their position as a political figure nominated by the citizens. I use the term "local representative" when I refer specifically to their position as representative of the community to other institutions. Protecting the anonymity of my informants was my priority and I did not use any information for any purpose without having their prior agreement to do so. Finally, when I came across any material that I considered too controversial, such as the report of illegal activities hidden from the authorities, I did not use it in

the study. Similarly, when informants asked me to not quote them, which happened once, I did not use the material concerned.

2.2.3.2 Legal authorisations

To carry out research in Gabon, I first needed to obtain a research permit, which requires collaboration with a Gabonese researcher. I therefore established a partnership with Mr Steeve Ngama, a researcher at the "*Institut de Recherche Agronomiques et Forestières"* (IRAF – Institute for Agroforestry Research) at the "*Centre National de la Recherche Scientifique et Technologique"* (CENAREST – National Centre for Technological and Scientific Research) in Libreville. Mr Ngama was of great support during the administrative phases of the project. He also joined our team in the field for a week to gain training in anthropological research at the theoretical and empirical levels.

The second step of the process was to obtain a long-stay visa to carry out 12 months of fieldwork. It proved difficult to establish the exact process for this. After several failed attempts to obtain the appropriate visa, during both the pilot study and the beginning of the fieldwork, I was obliged to leave Gabon from 20th January 2009 to 24th March 2010, and to leave my field site from 10th January until 6th April. This period, although frustrating, was very informative regarding the administrative and legal context of the research. However, because this happened at the beginning of my fieldwork, I was unable to leave my still untrained assistant in charge of the project, resulting in a lack of data during these 3 months.

Chapter 3 – Concepts of conservation in Loango

3.1 Introduction

Conservation is a Western concept centred on the need to protect natural habitat and biodiversity (Adams and Hutton 2007). In the past, conservation practices tended to exclude local communities completely, an approach referred to as "fortress conservation" (Adams and Hutton 2007). More recently, scholars have expressed the view that conservation practices derived from the natural sciences can impoverish human populations in and around protected areas. For example, conservation can limit access to key resources, disenfranchise local authorities or prevent the use of previously established coping mechanisms against resource scarcity, and, in the worst cases, alienate communities from their ancestral land (Igoe 2006; West, Igoe and Brockington 2006; Adams and Hutton 2007; Dudley et al. 2008; Springer 2009). While not all conservation approaches exclude local people, most conservation regulations impose and modify the institutional arrangements that mediate local people's access to natural resources. In the case of crop-raiding, for example, the legislation that protects some crop-raiding species, such as elephants, prevents farmers from killing problem animals, as they did in the past (Hill 1998; Osborn and Hill 2005). Similarly, government regulatory agencies legally control access to distributed resources, which may act as fall-back resources during times of duress (Naughton-Treves 1997; Ellis and Allison 2004). Such conservation strategies act on what Leach, Mearns and Scoones (1999: 233) refer to as "environmental entitlement", and which they define as "alternative sets of utilities derived from environmental goods and services and over which social actors have legitimate effective command and which are instrumental in achieving well-being". This notion of environmental entitlement is an extension of work by Sen (1981, 1984) and Gasper (1993) on the role of entitlement in relation to poverty and famine. Central to this work is the idea that institutions and relations between institutions, formal or informal, frame people's access to resources and to opportunities that are central to their well-being. By changing opportunities to access and use resources, conservation has the potential to undermine environmental entitlement and to maintain or exacerbate livelihood problems.

The imposition of conservation regulations often generates conflicts between local communities and conservation actors. These conflicts highlight different, and sometimes opposing, values, perceptions and expectations associated with wildlife and its protection (Akama 1996; Strang 1997; Escobar 1998; Hill 2004; Bosak 2008). These values also shape attitudes, norms and behaviour in wildlife management (Rokeach 1973; Bright, Manfredo and Fulton 2000; Manfredo and Dayer 2004; Manfredo 2008). If opposing values and perceptions are at the root of conflicts, then understanding differences can guide conflict resolution (Hill, Osborn and Plumptre 2002; Manfredo 2008; Treves 2008). Other scholars emphasise the importance of the quality of relationships between stakeholders and the inclusion of local communities in

decision-making processes related to natural resource management (Lewis 1996; Madden 2004; Treves, Wallace and White 2009). For example, Newmark et al. (1993) show that positive local attitudes towards conservation are linked to more frequent visits by park employees in villages in Tanzania. They also suggest that informal contact between park employees and local people, such as park employees shopping in local shops, is important in breaking down mistrust and building positive attitudes. In support of this, several recent studies show that conservation projects that include local community participation in decision-making processes are as efficient as, or more efficient than, fortress conservation (Hayes 2006; Waylen et al. 2010; Persha, Agrawal and Chhatre 2011). However, including local communities in conservation management is not an easy task, as institutional dynamics depend on the quality of relationships between actors, negotiations and the importance of power relationships (Lewis 1996; Leach, Mearns and Scoones 1999). Differences in access to power influence how people express their concerns and needs as well as the final decision-making process. It is, therefore, crucial to understand the diversity of views of nature and its preservation, and to evaluate the quality of conservation stakeholder relationships for the analysis of crop-raiding.

This chapter address how nature preservation and conservation is perceived and managed in Loango. In the first section, I describe the historical context of wildlife management and conservation, and how this has influenced local attitudes towards, and uses of, wildlife today. I then explore conservation, how it is managed and whether local community views are included. Next, I describe local people's current attitudes towards, and understanding of, nature preservation and conservation. Finally, I investigate local opposition to conservation, how this opposition is expressed and managed, and the implications it has for people and conservation.

3.2 Use of nature in Gabon: A historical perspective

3.2.1 Historical use of nature

The local history of trade and hunting is of major importance if we are to understand how the local vision of nature, and its preservation, has developed in Loango. I summarise key stages of the history of conservation and the use of natural resources in Gabon and the study site in Figure 3.1.

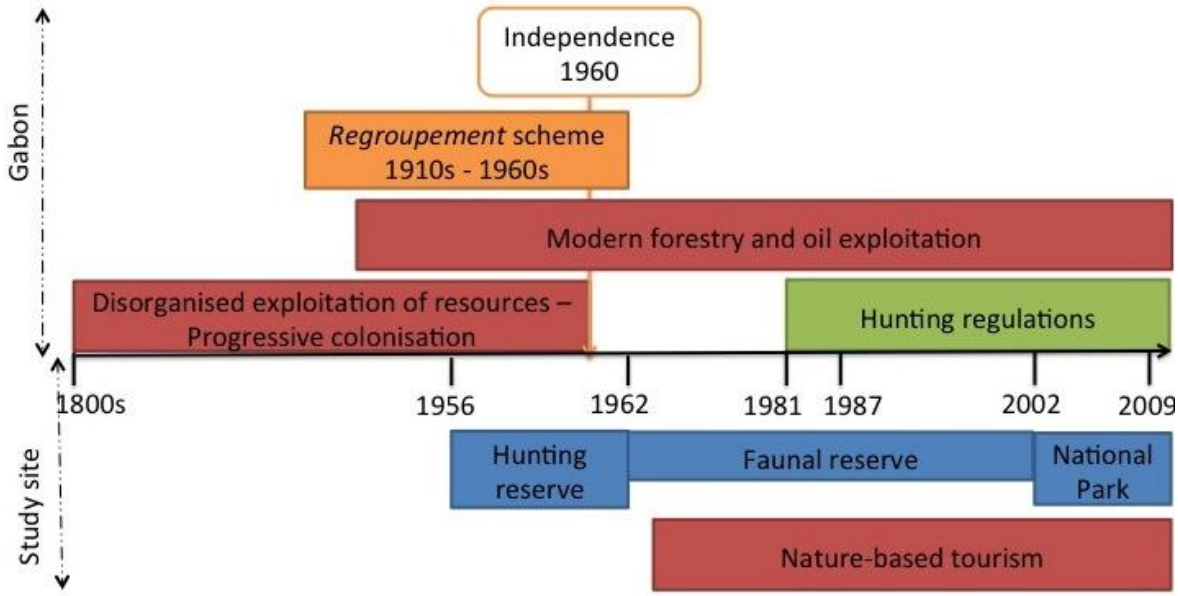

Figure 3.1: Key stages structuring the use and conservation of natural resources in what is now Loango National Park, Gabon. Red boxes represent exploitation of the resources, orange boxes represent state organisation and policy, the green box represents wildlife regulations, and blue boxes represent the protection status of what is now Loango National Park. Time is not to scale.

Coastal communities such as those found in Loango have been in contact, and had commercial relationships, with Europeans for centuries. There was an important trade for African products in Gabon, including wood and ivory, from the 16th to the 19th centuries (Pourtier 1989a; Gray 2002). During that period, Westerners introduced the use of guns, which are more efficient than traditional hunting methods. They provided guns, or traded them with Gabonese communities, to obtain access to goods such as ivory or animal skins. In addition, explorers and naturalists such as Paul du Chaillu hunted wild game for scientific observation (cited in Pourtier 1989a). Trade with Westerners rapidly led to the depletion of many resources. In 1863 Paul du Chaillu (cited in Pourtier 1989a: 69) described the people of the coastal areas of the Fernan Vaz, which neighbours Loango, as societies in crisis, as a consequence of the decline of trade with Europeans due to local resource depletion, and the cessation of the slave trade. As early as 1865, Griffon du Belay (cited in Pourtier 1989a: 65, translated from French) wrote that:

> [The] *Gabonese exploited their resources and acted as brokers between Europeans and the tribes from the interior of the country. However, it is essentially a destructive business. Riparian forests are depleted of precious timber. You need to go very far to find red timber in sufficient quantity, even further for ebony, and as far as elephants are concerned, their number has dropped significantly.*

When French colonisation put the boundaries and governance structures that foreshadowed the creation of contemporary Gabon in place, the forestry, and, later, oil industries developed with

very little regard for wildlife conservation (Pourtier 1989a). From the mid-1950s, a new system of wildlife management began under the French colonial regime, with increasing control over resource exploitation. Wildlife reserves were created, including Loango, but, according to local informants, these were nothing more than hunting reserves where colonialists and foreigners hunted game, including elephants and apes, for trophies. Conservation for environmental reasons only reached the remote areas of Gabon at the beginning of the 1980s, with the prohibition of big game hunting by the state (Fig. 3.1). It is striking that, while local communities always hunted for subsistence, sport hunting and market hunting (now referred to as the bushmeat trade), and the means to hunt efficiently with guns, are a product of Western influence. As one informant said:

> *We need to tell the truth. It is the whites who came with that. We didn't know commercial hunting before. We killed animals to eat only. It is whites who created poaching when they brought us business. After that, it started, the business, and we needed to make money.*

While Westerners introduced new forms of hunting, the rural exodus that took place under the *regroupement* scheme of the colonial regime, and the national government after independence in 1960, created or accelerated the demand for bushmeat in urban centres. A similar process occurred in other African countries (Asibey and Child 2002). Over time, it seems that local communities moved from a subsistence to a cash economy under the influence of Westerners.

Tourism, also introduced by Westerners, has been part of the activities in the north of Loango National Park since the 1970s. The first tourism activities combined trophy hunting, sport fishing and nature viewing. During my fieldwork, local villagers often referred to the time when two expatriate hunters, known as Guizard and DiCroquet, took white tourists into the hunting reserve. According to local informants, this provided moderate employment opportunities to local people until the late 1970s. The two expatriate hunters were also important for farmers as they killed animals that raided cultivated fields. Farmers recalled how the hunters brought tourists into the fields to shoot raiding animals, sometimes camping for several days. As a rule, the meat was left to be shared by the local community, while the tusks were taken as trophies by visiting hunters.

3.2.2 Conservation before the National Parks

3.2.2.1 State conservation

Regulations concerning wildlife use were implemented progressively in Gabon. Reserves for the management of fauna and hunting were created as early as 1956 (Van de Weghe 2007, Fig. 3.1). Loango National Park includes a former hunting reserve that became a faunal reserve in 1962, and became part of an "*Aire d'exploitation rationelle*" (approximately translated as Area of Sustainable Exploitation) (Van de Weghe 2007). This reserve allowed hunting with a professional hunting guide under the control of representatives of the "*Direction de la Faune et de la Chasse*" (DFC – Directorate of Fauna and Hunting) of the MEF (Brugiere 1999). In 1981, the Gabonese government passed a law prohibiting the killing of elephants and buffaloes, defined as "big game hunting", and hunting activities have been regulated by the *Code Forestier* since 1987 (Decree n°189/PR/MEFCR from 4th March 1987, Fig. 3.1). This classifies dozens of species, such as gorillas, as fully protected, and others as partially protected. Fully protected species cannot be hunted, while partially protected species can be hunted under a quota system, with hunting permits and a hunting season. While nature conservation was a clear interest for Gabon's ruling elite, the animal-centred approach taken criminalised the subsistence activities that were an everyday part of local people's lives and identities, in a similar manner to that described for other countries (e.g., Kenya: Akama 1996; Pakistan: MacDonald 2004).

Since the beginning of the 1980s, the conservation strategy in Gabon has been characterised by a transition from a state of low or no control by the state over the use of wild resources, to a strong top-down and increasingly coercive approach. The power of the state in relation to conservation is highly centralised and hierarchical (Fig. 3.2). Compliance is monitored by the MEF, referred to as *"Ministère de l'Economie Forestière, des Eaux et de la Pêche"* (Ministry of Forestry Economy, Waters and Fishing) since 2010, mostly through the DFC, now the "*Direction Générale de la Faune et des Aires Protégées*" (General Directorate of Fauna and Protected Areas).

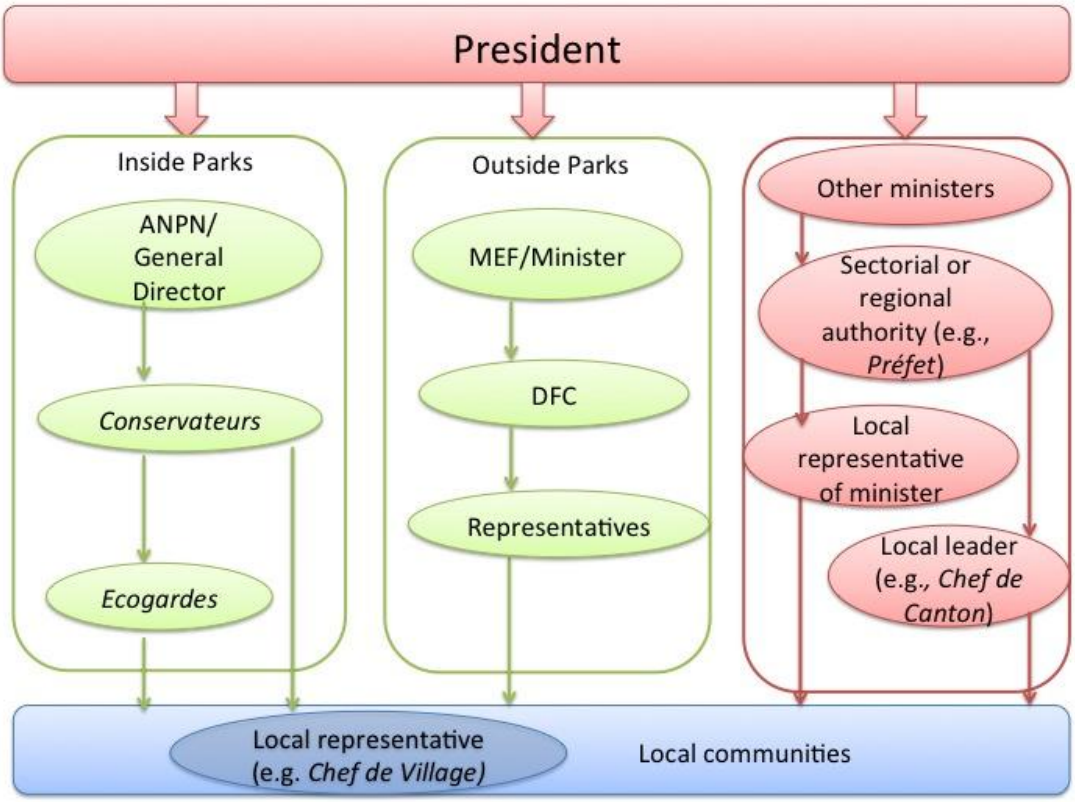

Figure 3.2: Structure of institutional power surrounding natural resource management in Gabon. Red represents political and administrative power, green, authorities in charge of wildlife and conservation, and blue, citizens and their representatives.

3.2.2.2 The local form of nature preservation

From a local perspective, protection of natural resources existed before these regulations. During interviews, 5 of 38 (13%) of informants spontaneously referred to their ancestors regulating the use of wildlife through local leadership. Local authorities agreed, with one saying:

Conservation is not new for our people. It is just the way it is done that is new

According to one local leader I interviewed, local leaders were in charge of defining hunting and fishing zones that were protected by magic, so as to keep some areas free of exploitation. Leaders shifted the extraction zone intermittently to ensure resource renewal. Anybody who violated the prohibition of hunting or fishing in a forbidden zone was cursed and punished by magic forces.

3.2.3 The creation of the National Parks system

3.2.3.1 The myth of pristine nature

In August 2002, the Gabonese government announced the creation of 13 National Parks at the Earth Summit in Johannesburg, following consultation with, and under the impetus of, international conservation NGOs the Wildlife Conservation Society (WCS) and the World Wildlife Fund (WWF) (Van de Weghe 2007), and following Mike Fay's "Megatransect". Fay, a conservation biologist, crossed the Democratic Republic of Congo and Gabon forests by foot to undertake a biological inventory. His adventure was recorded by a team from National Geographic and featured in the documentary "Gabon: The last Eden". The documentary features wild forests, free of humans, and portrays nature as untouched, including wild elephants and naïve chimpanzees. The main reference to humans is the discovery of a poaching camp, which is burnt quickly by the team, and oil and forestry exploitation. Behind the magnificence and intensity of the images, particularly for wildlife amateurs such as myself, the message is clearly that these hundreds of square kilometres of nature need to be preserved from human influence. Parks were therefore designated for the most part, if not exclusively, through the biological evaluation of priority areas for biodiversity conservation (Van de Weghe 2007). This suggests that the creation of National Parks in Gabon is grounded in the perception of pristine nature, underlain by an idea of nature untouched by humans (Adams and Hutton 2007). For example, the name of the largest tourism company in Loango is "Africa's Eden", reflecting the name of the National Geographic documentary. This notion of pristine forest is also pervasive in descriptions of Gabon in both the conservation literature and general discourse. In many cases, these assumptions are linked to notions of the forests as sacred and unique, as described in this extract from Pourtier (1989a: 148, translated from French):

> *We do not enter the forest without being filled with an obscure and sacred feeling of touching the mystery of nature that existed before humans, abundant and confusing, rooted in the dawn of time.*

The spirit of sacred nature evokes a special imperative of protection, as exemplified in Adams and McShane (1996: 208-209):

> *With huge areas relatively untouched by man, and thousands of rare animals at play and unafraid in the forest, not only in the north-east but in unpopulated areas across the country, Gabon begins to sound like wild Africa come to life. Gabon thus elicits the expected and age-old response from some conservationists:*

Dr Thomas E. Lovejoy, Assistant Secretary at the Smithsonian Institution, says, "The entire country should be declared a National Park".

However, historical records contradict this ideal of pristine nature. If we are to believe Griffon du Belay (Section 3.2.1), the coastal forests suffered from heavy exploitation and resource depletion as early as 1865. Moreover, Pourtier (1989b) shows that most regions of Gabon were inhabited until 1940 (Fig. 3.3a). Finally, an investigation of the distribution of forest concessions across time show that by 1997 most of the Gabonese territory was included (Fig. 3.4). This clearly demonstrates that Gabonese forests are not the pristine habitat the conservation discourse envisages, even where human settlements are currently absent. If anything, idealised, but imaginary, pristine forests were created artificially by the colonial *regroupement scheme*, and the subsequent rural exodus, which concentrated people around travel routes and emptied entire tracts of land of human settlements (Fig. 3.3b).

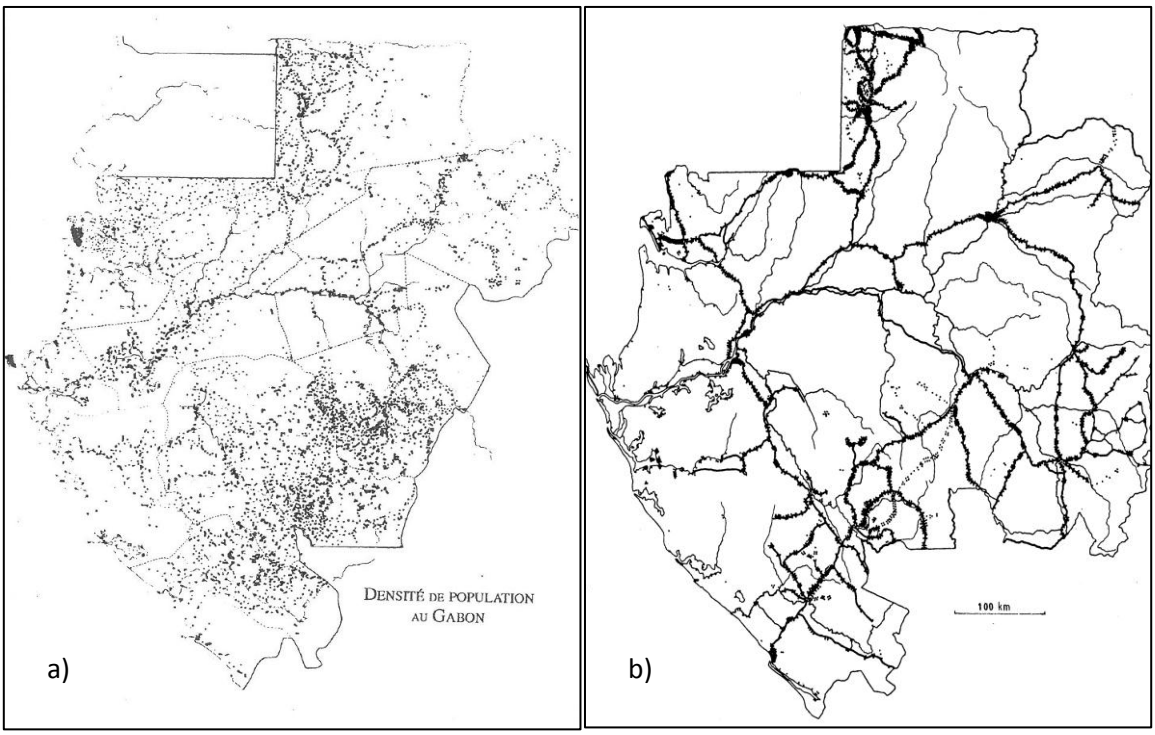

Figure 3.3: Distribution of human populations in Gabon in (a) 1940 and (b) 1970. Source: Pourtier 1989b (116-117).

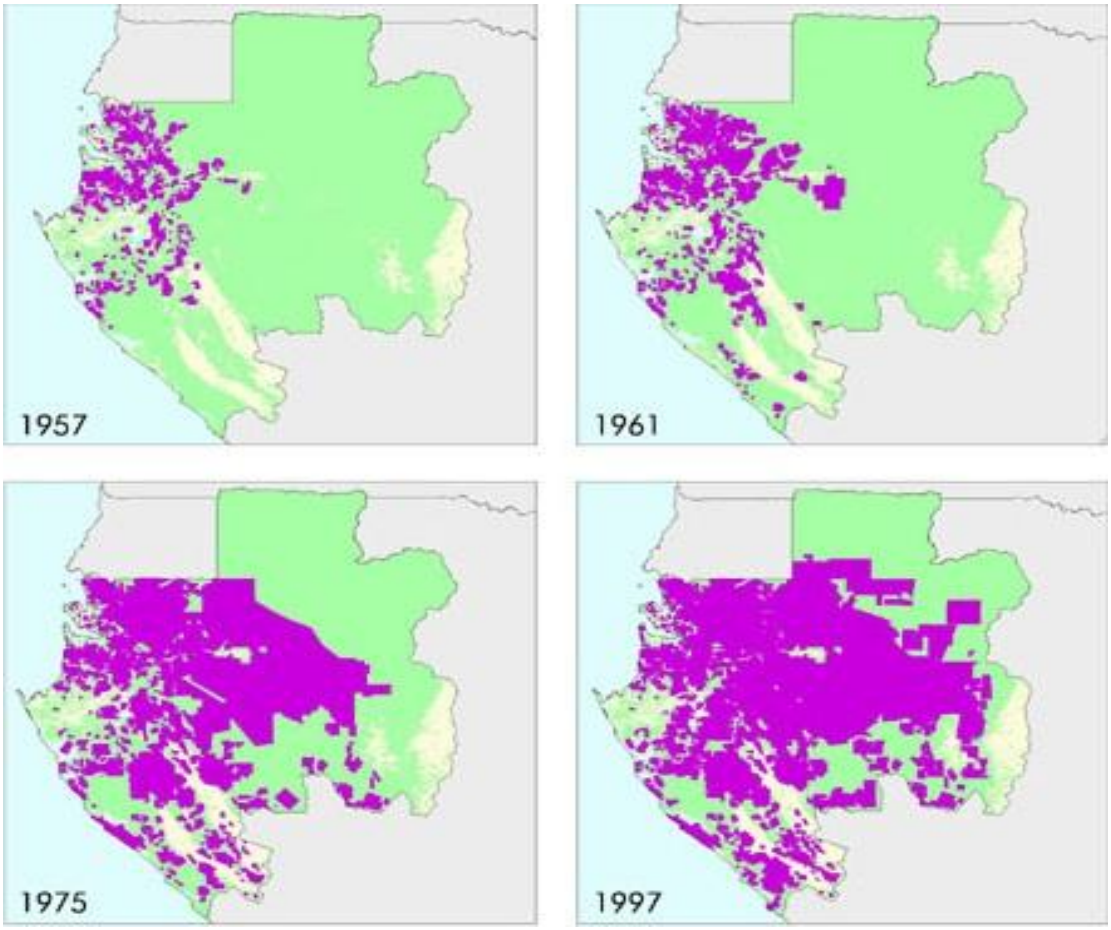

Figure 3.4: Cumulative cover of forest concessions in Gabon from 1957 to 1997. Pink areas represent forest concessions, green are forested areas, yellow are other types of vegetation. Source: Collomb et al. (2000).

3.2.3.2 The imposition of National Parks: Loango as an example

The National Parks were created with two main objectives. The first reflected the need to protect biodiversity, as conceived by the international community. The second was to develop an eco-tourism economy to provide income to sustain conservation, foster rural development and decrease Gabon's dependence on oil and wood exports. ANPN originally appointed two *"conservateurs"* (National Park Wardens) to Loango National Park. Since 2010, only one *conservateur* has been in charge of the park, assisted by a "*conservateur assistant"*. Twenty-one "*écogardes"* (park rangers) are divided into two teams, one for the northern and one for the southern section of the park. However, due to technical and financial constraints, the first group of trained *écogardes* from ANPN were not present and active in the northern part of the park until 2009.

In 2001, a collaboration between Africa's Eden, the NGO working locally, MEF and the *conservateur* was created and referred to as Operation Loango (Van de Weghe 2007). This collaboration served as the park administration and supported research projects (e.g., the Great

Ape Habituation Project in collaboration with the Max Planck Institute for Anthropology). Operation Loango officially terminated in January 2010, when administrative and financial difficulties in the tourism company precluded further funding. This collaboration included almost all sources of institutional power – the state through its national and local representatives, scientific expertise and tourism – but excluded local communities. This is still the case today. Currently, conservation is run by the Gabonese authorities (box 1 in Fig. 3.5) and international NGOs (box 2), which work in collaboration and also support independent research (arrows marked A). Current tourism activities are independent of conservation activities but provide informal support to authorities and should provide funds through park fees (box 3 and arrows marked B). Tourism in Loango comprises three tourism operators. The first is Africa's Eden and the second, Gavilo Lodge, focuses on sport fishing. A third, local, tourism operator, based outside the park but using the park for safaris, started activities during my study period.

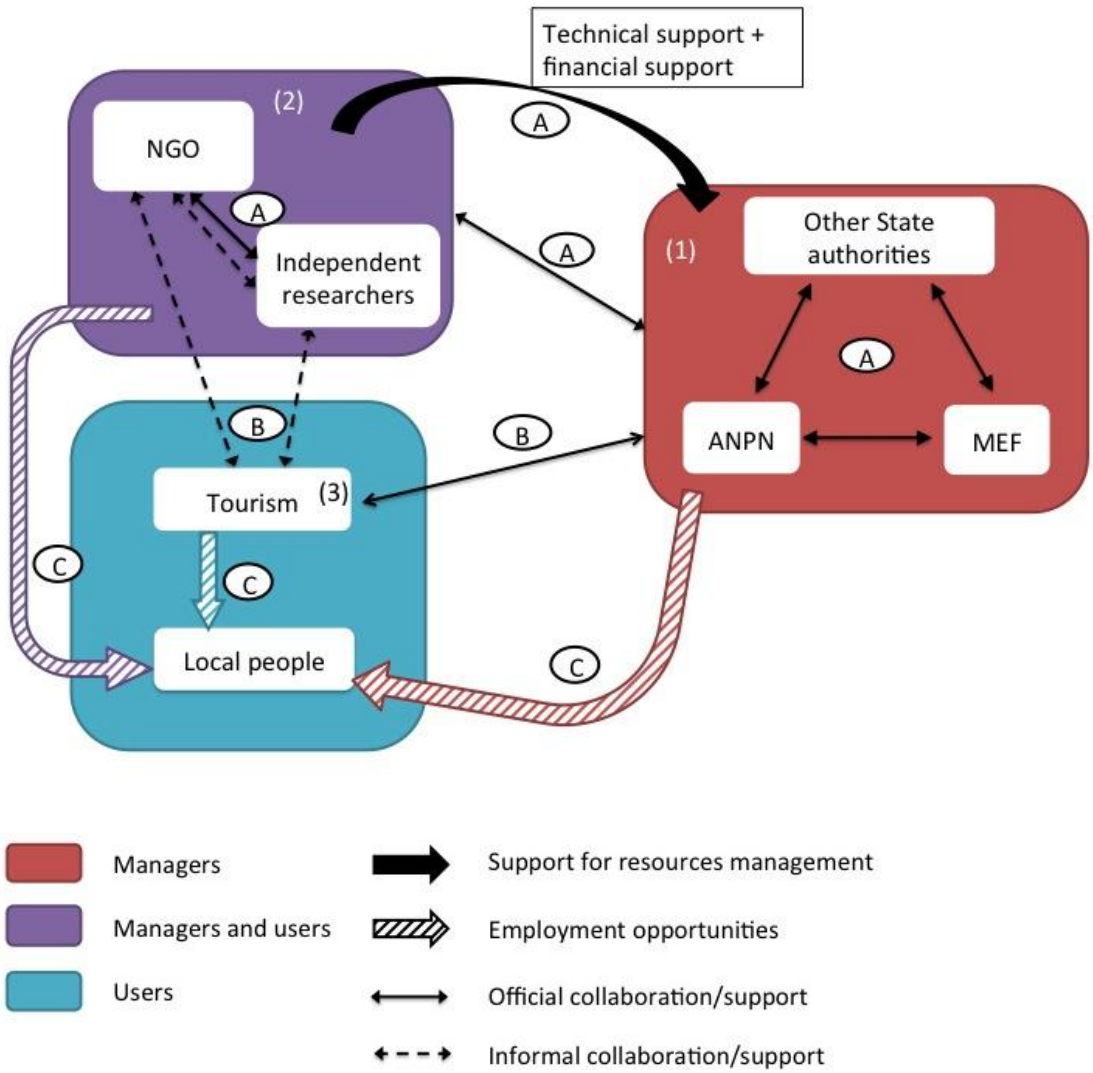

Figure 3.5: Conservation stakeholder relationships in Loango National Park, based on my own analysis. Numbers and letters are discussed in the text.

National Parks were imposed on local communities by the state following the Western model of conservation. ANPN states on its website that socio-economic surveys were carried out prior to the creation of parks, to limit their negative impact on communities (ANPN 2012). A draft of the 2009-2014 management plan for Loango National Park, to which I had access (ANPN 2009), suggests that local community representatives were present at two meetings where decisions were made concerning the future management of the park. It also states that public audits were carried out with local people to identify key challenges and issues in 2003. However, this contradicts what I was told by local people, who said that they were not consulted in any way about management strategies, either before or during the creation of the park, as exemplified in the quote below. This confusion around consultation suggests that parks have been imposed on local communities, whether directly or by lack of proper inclusion, regardless of the extensive literature devoted to the need to effectively involve local communities in the early stages of conservation actions (e.g., Adams and McShane 1996; Lahm 1996; Peters 1999). One local leader said:

> *Apparently, the area has been taken to make a National Park. We don't know how they chose a place like that, without asking the people to whom the place belongs.*

Through the creation of the park, ANPN gained proprietorship over the land which is now controlled by the *conservateur.* S/he is in charge of determining access to the park and the validity of land claims through familial relationships, although it is unclear what levels of relationship are considered valid. While the policy supposedly follows the kin-based, customary land-tenure system (see Chapter 2), local leaders, who were previously in charge of land allocation, have effectively lost control over the land inside the park boundaries. New conflicts have arisen as a consequence of this transfer of power. For example, a member of the community returned to an old family camp inside the park to farm and fish when he retired. However, the park authorities did not consider the camp as belonging to anybody, as it had been abandoned for decades when the park was created and mapped. When the villager claimed the camp, park officials declared his action illegal and asked him to leave. His status was still in abeyance at the end of the study. Several villagers inside the park complained that the park did not consider their customary rights with reference to that particularly case. We can expect similar tensions to arise in the future if conditions of land access and land tenure are not clarified and agreed by all parties.

After the creation of the park, most conservation activities focused on biological monitoring of the park. For example, a survey that lasted several years aimed to map and assess the biodiversity of the park. Wildlife-based research received a great deal of support from

Operation Loango, but no surveys of human communities, local livelihoods or perceptions of biodiversity conservation were undertaken during this period. In 2008, the NGO working in Loango north carried out a socio-economic survey in the park; a survey that had in fact already been carried out by WWF, according to Blaney et al. (1999). This survey aimed to map areas of activity for the villages inside the park and to re-classify these areas as "*terroirs villageois"* (village multi-use zones), in which communities could maintain subsistence activities (ANPN 2009). While this survey could, in theory, be classified as including local communities, it did not provide communities with a platform of expression or any power in relation to the data collected or what the data would be used for. Indeed, one of the survey members told me that the team struggled to "do their job" because villagers kept complaining about crop-raiding and were reluctant to discuss any other topics. The survey clearly did not aim to record local views and issues, but rather to collect data according to the conservation actors' priorities, which were to define clear areas dedicated to human activities. Finally, due to the technical and logistical support provided by Operation Loango, the local wildlife brigade carried out education sessions about the National Park and the legislation with people from the *regroupements* in the park and the periphery. However, apparently these sessions did not include any consultation of, or collaboration with, local communities. Instead, conservation actors described them as "education campaigns", which stressed control over, rather than inclusion of, local communities' views and needs. These examples quite clearly demonstrate that behind the discourse of consultation, conservation in Loango neither facilitates consultation with local people nor their inclusion in decision-making processes.

3.3 Community subsistence and conservation

3.3.1 Contrasting views of livelihood

On paper, the subsistence activities of local communities in Loango are protected by legislation and included in the park management plan. As mentioned earlier, the management plan proposes the creation of *terroirs villageois* within which local communities will be able to continue their traditional subsistence activities (ANPN 2009). In theory, these activities will be regulated through a contract, defined in collaboration with local communities. This contract aims to ensure that local communities' current and future needs, in terms of subsistence and sustainable use of natural resources, are fulfilled. Any extractive activities other than "subsistence based" and "traditional" activities following a sustainable ethos will be forbidden. However, it is unclear what is considered subsistence-based or traditional, and by whom.

Neumann (1997) warns us that the use of the term "traditional" is dangerous as it is imbedded in a Western notion of "non-western primitivism", which precludes changes for the society under its constraints. Similar trends occur in Loango. When conservation actors use the term "subsistence", they often convey a sense of non-market economy, as market economy is construed as leading to over-exploitation of resources. According to this interpretation, farming and fishing should be carried out mostly, if not solely, for household consumption, which is rather restrictive in a society where cash is needed for most aspects of life. The presence of tourism and conservation in Loango lead to a daily display of expatriates and technology (e.g., high technology mobile telephones, cameras, Global Positioning Systems), a tourist lodge with permanent electricity and running water, numerous cars, quad bikes and boats. It seems naïve to believe that these communities will happily pursue a "traditional" way of life, when development in all its forms is within sight daily. Similarly, the creation of new villages and camps will be forbidden in the park unless it follows "rural" criteria, which are undefined in the management plan (ANPN 2009). A clash between development and conservation emerges in the specific context of Loango as exemplified by the following quotes. One informant living inside the park said:

> *The people from water and forest tell us to use lianas, ropes and cans to protect our field. But that is completely archaic. We cannot move forward with that.*

Another informant living in the buffer zone believed that conservation prevents local development purposely:

> *There are rumours that people from conservation are scared to make a proper road. They are scared that more people will come and do illegal activities in the park. I say it is dangerous, people live here, you shouldn't condemn them.*

Conceptualisation of sustainable livelihoods at different spatio-temporal scales also leads to misunderstanding between conservation actors and local communities. On one side, conservation actors consider conservation challenges at a global scale, and embed local conservation within the global context of biodiversity loss. Conservation actors generally make decisions and conduct research to plan the long-term management of natural resources. For example, the NGO working in Loango surveyed fish-catch to evaluate the sustainability of subsistence fishing in the Ngowé lagoon. From the conservation perspective, this study facilitates quota-setting, which in turn should allow local communities to practice sustainable fishing that could increase livelihood security in the long run. The views of local people inside the park, however, differ consistently from those of the NGO. Local people question the emergency of conservation needs in a place where basic human needs, such as access to food or drinking

water, are not always fulfilled, and where animals and the forest seem to be abundant. Some fishermen believe research is another way in which conservation actors exercise control over their livelihood. Some express severe frustration because they consider that conservation actors should control the intensive fishing with trawlers they believe occurs at the entrance of the lagoon, rather than the dozen small-scale fishermen in the park. The aims of conservation actors do not address the current concerns of the local communities and do not share their priorities. Hence, communities feel that conservation does nothing to protect their livelihoods.

Despite these differences, a large majority of conservation actors acknowledge the need to work with local communities, and all the actors interviewed believe conservation can help local livelihoods in both the short and long term. In addition, most actors, especially these of Gabonese origin, empathise with community issues and acknowledge that poverty remains the main challenge to communities' support for conservation. However, the reactions of some conservation actors suggest a less definite position. In a few cases, I heard conservation actors saying that illegal fishermen deserved to go to jail, although this would lead to increased poverty for the fisherman's family. Similarly, I once heard a conservation actor call all villagers poachers. Poaching is a grey area and definitions of poaching can vary both between groups (for example conservationists vs. fishermen) and within groups, according to the methods used, the poacher's origin and the aim of poaching (subsistence vs. commercial) (Hampshire et al. 2004; Bell, Hampshire and Topalidou 2007). The bushmeat market is undoubtedly flourishing in some parts of Gabon (e.g., Coad et al. 2010), and is certainly a threat to wildlife conservation, as it is elsewhere in Africa (Bennett et al. 2007). In Loango, however, most conservation actors claim that subsistence hunting by communities is not a direct threat to wildlife or the park. Different individuals within the same categories of actor can therefore hold divergent views of local people's impact on wildlife. Different individuals also expressed contradictory opinions over time, shifting from empathy towards farmers to anger when faced with proof of hunting, for example. These anecdotes tell us that while conservation actors view collaboration with local people as necessary, they can hold ambivalent, and even contradictory, opinions and feelings regarding local people and local people's relationship with nature.

3.3.2 Differing priorities

For most farmers, crop-raiding represents the main challenge to subsistence and to support for conservation, as acknowledged by the management plan (ANPN 2009: 22). However, crop-raiding is mentioned just once in the management plan, and no actions are included to survey or tackle this particular problem. When asked if crop-raiding resolution was on the institution agenda, an employee from ANPN in Libreville replied:

Of course it is, but first, we need to implement law enforcement and make the park run. Then we are seriously concerned about the impact of global warming and invasive species. Human-wildlife conflicts will definitely be tackled, but in the future.

This statement is problematic, as it clearly highlights the fact that local communities' problems are not seen as a priority by ANPN. In line with this, discussion with the newly appointed *écogardes* revealed that they did not receive any form of introduction to the management of relationships with local communities, the record of crop-raiding events and crop loss, or possible conflicts during their training. Their training, provided by a conservation NGO, and their description of duties suggest that *écogardes* are mainly considered, and consider themselves, as conservation police[1].

The lack of priority accorded to crop-raiding by ANPN is surprising, as wildlife officials seem to see it as a pressing issue at the national and local level. Most conservation actors in contact with people at the study site said that crop-raiding was their major topic of discussion and source of conflict with local communities. The Director of Fauna and Hunting in Libreville classed crop-raiding, and human-wildlife conflict more generally, as his major issue of concern when we met in 2009. In 2010, the MEF even organised a workshop for the management and resolution of human-wildlife conflict, in collaboration with the FAO, to draw up guidelines to mitigate these conflicts. Despite the obvious call for management of these conflicts, actions in the field remain very rare. The local authorities mostly blamed lack of funds and logistics for this lack of action. The local NGO manager stated that there was insufficient time or money left to work with local communities, due to the need to organise, and support, research and conservation. Logistical constraints are serious in Loango, as communities are scattered and difficult to reach, requiring a dedicated budget and staff to work with them. Ultimately, and despite the widespread recognition that local communities need to be better integrated, the meagre resources allocated to conservation in Loango favour support for natural science research, law enforcement and the questionable education campaigns, over what local people see as a priority.

3.3.3 The failure of local representation

The management plan 2009-2014 (ANPN 2009) proposes the creation of a consultative committee to voice local communities' concerns and perspectives. This committee should

[1] During a post-research visit in November 2012, the écogardes told me that they now recorded villagers' complaints and crop-raiding incidents officially during their missions.

include the *Préfet,* the *Chef de Canton*, a representative of the regional council, the *conservateur*, two representatives of the MEF, representatives of NGOs, tourism operators and representatives of local associations. In this list, the only local representative is the *Chef de Canton*. A new *Préfet*, which is the regional state representative, is appointed every 3-5 years and is not necessarily from the local area. As the regional council representative, the *Préfet* is located in the closest town, which is in another canton and belongs to neither the park nor its buffer zone. Because communities are neither homogenous nor spatially cohesive, representatives with regional oversight cannot understand and protect the interests of diverse groups adequately. *Chefs de regroupements* and *chefs de villages,* who are the first level of local representation, as they are appointed directly by village members in each locality, are missing from the proposed committee[2]. It appears that, by including representatives from associations, the management plan aimed to include the interests of local farmers and fishermen. During interviews, some conservation actors claimed they helped local communities to have their voice heard by supporting the creation of associations. However, local people suggest that this is not the case. The system of associations seems to be ineffective or non-existent in Loango (see Chapter 5), and may not provide the expected platform of representation. It is, therefore, unlikely that local communities' voices will be successfully represented within the planned committee.

Conservation stakeholders in the field have not yet put together the consultative committee. The Gabonese administrative structure is characterised by a strong top-down approach, which does not necessarily facilitate, or even allow, bottom-up feedback. During the workshop in Libreville for example, the MEF minister's representative clearly stated that only a top-down approach should be considered. The institutional framework under which the village committee will be created and integrated is currently under development by the group assigned to draft the new management plan. We can, therefore, hope that it will provide a real integration of local voices and needs. However, in the field, the lack of actions to support the establishment of a local committee thus far remains important, even when taking into account how ill-equipped local authorities and NGOs are.

[2] During a post-research visit in November 2012, it appeared that despite what was described in the proposed management plan, *chefs de regroupements* and *chefs de village* are included in the consultative committee.

3.4 Local understanding of nature preservation

3.4.1 Appreciation of nature

3.4.1.1 Attitudes towards nature

Attitudes are defined as the evaluation of a particular object with some degree of favour or disfavour (Allendorf 2006; Manfredo 2008). Manfredo (2008) described the two main components of attitudes as explicit and implicit. Explicit attitudes are those expressed as the result of a conscious cognitive process and are often given in answer to a direct question. Implicit attitudes are more difficult to measure or understand, but refer to "evaluations that are automatic and that function without a person's awareness or ability to control them" (Manfredo 2008: 79). In this section, I focus on explicit attitudes expressed during interviews when I asked informants what they thought about the preservation of nature and conservation in Loango. This question was sometimes too vague and general for interviewees to understand it. When the farmers were confused by my open question, I asked specifically whether they thought it was good to live in and preserve nature (for example, the forest, the lagoon, and animals living in them) and whether conservation and the National Park were "a good thing", "a bad thing ", or neither for the area (see appendices for details of interviews). While the use of " a good thing" and " a bad thing" may look misleading or meaningless in an academic context, the use of this vocabulary fitted the way in which people in Loango express themselves and allowed people to understand my question easily. My idea behind this line of questioning was first to differentiate between views of nature preservation and conservation practices, and second to understand whether people's first feeling towards it was positive or negative. When people answered "it is good but …" or "it is good if it does not …" I considered their attitude to be positive. If their first answer was "it is not a good thing …" or " it is a bad thing …" I considered it as negative. Most farmers in Loango had a positive attitude, with 55 % clearly valuing nature preservation and/or conservation (Fig. 3.6). Five farmers did not answer the question (13 %), perhaps out of fear of providing an inappropriate answer. Another three (8 %) were ambiguous, so I classified them as unclear. By comparison, all tourism employees and all conservation actors displayed a positive attitude towards conservation and nature preservation.

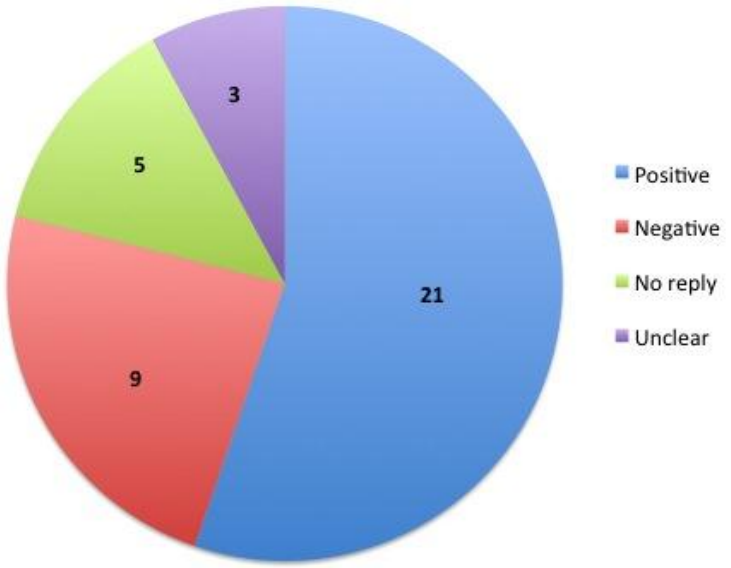

Figure 3.6: Farmers' attitudes towards conservation in Loango.

The literature suggests that attitudes can greatly vary between groups of individuals. For example, Newmark et al. (1993) showed that villagers who received more frequent visits from park staff displayed more positive attitudes towards conservation and protected areas employees in Tanzania. Allendorf (2006) showed that younger people tended to be more favourable to conservation than older people and that educated people showed less support for conservation than less educated people. Hill (1998) showed that women were less likely to support conservation than men in the Budongo Forest in Uganda. Thus, I tested for differences between *regroupements*, between *regroupements* inside the park and those in the periphery, and by age class, but none of these factors influenced farmers' attitudes in Loango (Table 3.1), which suggest that attitudes are quite homogenous across the study site. However this lack of significance may also result from the small sample size so I also provide frequencies in Table 3.2.

Table 3.1: Results of Pearson Chi-Squared tests examining the link between attitudes towards conservation and possible influencing factors. (N = 33)

Test	X^2	df	p-value
Zones (Idjembo, Ntchongorové and *la Haute*)	2.88	4	0.577
Park vs. Periphery	1.630	2	0.443
Age class (30-40, 40-50, 50-60 and 60+ years)	6.55	6	0.365

Table 3.2: Frequencies of respondent displaying positive, unclear or negative attitudes towards nature preservation or conservation for different possible influencing factors.

Attitude		Positive	Unclear	Negative
Factors				
Zones	Ntchongorové	6	2	2
	Idjembo	6	1	3
	La Haute	9	0	4
Conservation	Park National	7	0	2
	Periphery	14	3	7
Age Class	30-40	7	0	1
	40-50	5	1	2
	50-60	6	0	3
	60+	3	2	3

Of the 21 farmers who expressed positive attitudes, all specified that nature preservation was a good thing when it did not lead to suffering, which mostly related to crop-raiding, as exemplified by the following quotes:

Not to hunt them if they don't come in my field, it is good.

Conservation should be a good thing in theory, if animals did not eat our food.

In these 21 cases, 14 had had their fields damaged by elephants in the past few months and 8 had lost more than 50 % of their fields to crop-raiding in the last two years. It may seem surprising to find positive attitudes in farmers suffering from crop-raiding but this result is consistent with previous studies. De Boer and Baquete (1998) found that 88 % of local people had a positive attitude towards conservation in Mozambique, including those suffering from crop-raiding. Similarly, Infield and Namara (2001) in Uganda and Arjunan et al. (2006) in India recorded positive attitudes towards nature preservation and National Parks, despite a generalised negative attitude towards conservation practice in both cases. In Loango, conservation was also considered positively if it provided some benefits to people and as long as animals stayed in the park. This last statement is similar to Hill's (1998) study in Uganda which showed that although people supported elephant conservation, they also had a "not in my backyard" attitude.

Opponents of nature preservation and conservation all emphasised loss of livelihood, through limited access to resources and crop-raiding, as the main reason for disliking nature preservation and/or conservation. This finding is congruent with other studies. For example, Naughton-Treves (1998) and Hartter, Goldman and Southworth (2011) show that crop-raiding was the main reason cited for disliking protected areas in Uganda, and De Boer and Baquete (1998) show a similar result in Mozambique. Allendorf (2010) in Nepal and Arjunan et al. (2006) in India also show that limiting access to resources leads to negative attitude toward parks.

3.4.1.2 Why is nature important?

Values are defined as the spectrum of orientations towards an object, here wildlife, that guide the interpretation and use of that object (Kellert 1996; Manfredo 2008). Kellert (1996) constructed a typology of values associated with wildlife (Table 3.3), and emphasised that values are influenced and moderated by the cultural specificities of the society under investigation. As his work focused on the American public, some of the values he described may be absent in other cultural contexts. However, in this section, I have used Kellert's typology descriptively as a tool to identify key values associated with nature by people in Loango.

Table 3.3: Typology of wildlife values.

Value	Definition
Utilitarian	**Practical and material exploitation of nature**
Naturalistic	**Direct experience and exploration of nature**
Ecologistic-scientific	Systematic study of the structure, function and relationship in nature
Aesthetic	**Physical appeal and beauty of nature**
Symbolic	Use of nature for language and thought
Humanistic	Strong emotional attachment and love for aspects of nature
Moralistic	Spiritual reverence and ethical concern for nature
Dominionistic	Mastery, physical control and dominance of nature
Negativistic	Fear, aversion and alienation from nature

Source: Kellert 1996. Values identified in this study are in bold

Local people in Loango expressed mainly utilitarian, naturalistic and aesthetic values of wildlife and its preservation during interviews. In only one case did a woman say she would be pleased if all animals were extirpated. This particular farmer, however, did not eat meat and did not associate animals with any positive values, with the exception of fish. Of the 21 individuals who had positive attitudes towards nature, 13 did so for utilitarian reasons, and in all cases

respondents associated nature with access to resources, whether they be natural or anthropogenic (e.g., employment). Farmers valued nature preservation and/or conservation mostly because it ensured access to meat and fish over time. Informants mentioned the neighbouring lagoon (the Nkomi lagoon, also called Fernan Vaz), which has been overfished in the past, leaving neighbouring fishermen now struggling to survive. Three farmers valued conservation because it brings development and sources of employment to the area (arrows marked C in Fig. 3.5). The limited number of people valuing employment through tourism is probably a reflection of mass redundancies in 2009-2012, when many people lost their job at Africa's Eden. In comparison, all the current tourism employees, who benefit directly from employment, valued conservation mostly for its impact on income and local development. Employees and ex-employees of tourism companies believed that wage labour improved their livelihood over fishing or farming. However, it is important to bear in mind that tourism employees are mostly young people who consider farming and fishing to be an out-of-date life-style.

In 7 cases people referred to values in terms of transmission to future generations. Almost all of these informants emphasised a desire to maintain the environment in its original form for future generations. For example:

> *The children we give birth to, they have to see what their grandparents have left for them, elephants or antelopes.*

> *If we don't protect, soon we will be ignorant as to what a crocodile or an elephant was.*

Hill (1998) shows similar tendencies in Uganda, where respondents considered it important to maintain nature for their descendants. Both farmers and non-farmers in Loango mentioned the need for their children to have the opportunity to "see" wild animals in the future. When I asked farmers what exactly they meant by "see" animals, most gave answers that combined the consumption of animals with the need to preserve the forest and its original fauna. In doing so, they showed an interest in authenticity and completeness, which suggests sensitivity to aesthetics and naturalism. Another three respondents expressed a sense of beauty, among which two said that it was important for them that they could enjoy animal viewing with their children, in a similar way to tourists, as exemplified in the following quote:

> *Protecting animals is important. I can show them to my son. We can take pictures and have memories.*

Allendorf (2006) shows a similar tendency in Nepal, where respondents living around protected areas expressed ideas of beauty and nature as a recreation. In her study, aesthetic and recreational values significantly influenced people's positive attitudes towards conservation. Through tourism, local people in Loango realised the potential attraction that their natural heritage holds. Several informants said they were very proud that tourists travelled so far to discover their place. It is unclear, however, how much of the aesthetic values is the result of the decades of conservation and tourism presence in the area, and how much was initially part of the local values. Conservation actors suggested that education campaigns were successful in changing people's perceptions and behaviour, which may explain this form of aesthetic. Hill (1998) raised a similar issue in her study of attitudes towards elephants in Uganda, where she questioned whether the non-utilitarian values expressed were intrinsic local appreciations or the results of decades of conservation education.

Finally, 2 informants valued the park because they believed it protects them from "invaders" who might steal "their resources". This sentiment is connected to a sense of place and entitlement to local resources. Wildlife authorities recalled two occasions when villagers complained about illegal activities conducted by "non-local" people in the park. Thus, the legislation imposed on local communities to protect their environment provides them with official, albeit invisible, boundaries, protecting them and their resources against intruders, who are distant "others" as also described by Bell, Hampshire and Tonder (2008).

3.4.1.3 Local environmental ethics

I have described above how local communities value the preservation of their natural heritage. In many cases, informants expressed their pride in how their ancestors had preserved their environment in the past. They explained that a National Park was created in Loango because they, the local community, had managed their resources efficiently in the past. For example:

> *Our grandparents conserved and we do too. If the park came here, it is because they saw we still had animals. There are places where even seeing a bird or a monkey is difficult. But here, every evening at 6pm monkeys come to say hello.*

Thus, local people express their past and present ability to use local resources sustainably. The old form of protection put in place by informants' ancestors, and that I described in section 3.2.2.2, is proof for local people that their community aimed to, and succeeded in, maintaining their natural resources over time. Some local leaders also declared that in the past communities hunted only for consumption, not for trade. This image of indigenous people living in harmony with nature strongly resembles the concept of the ecologically noble savage, which has been

heavily debated for its veracity and its use in conservation discourse (Redford 1991; Neumann 1997; Hames 2007). Hames (2007) discuss how this ideal of harmony with nature is now used by some indigenous groups to gain, or reclaim, ownership and political control over resources in the conservation context. It might be that this emphasis on local sustainability expressed by people in Loango is a strategy aimed at being included in a group, namely conservation actors, from which they feel alienated.

As I described earlier, historical records suggest that resource depletion occurred in Loango more than 100 years ago. This contrasts with statements, such as that by Mr Lovejoy (see section 3.2.1), which suggested that the entire country should be considered a National Park in 1996. If true, this suggests that, when freed from the intensive trade led by Europeans, local communities' use of natural resources allowed animal populations to recover, rather than leading to depletion. When I raised this with several foreign conservationists, they replied that the preserved state of the environment in Loango, and in Gabon in general, was mostly, if not exclusively, a result of the low human density in Gabon. In other words, foreign scientists and conservationists assume that Gabon's preserved nature is not due to the action of local communities, but in spite of it. This conservation discourse is supported by several authors such as Redford (1991), Silitoe (2003) and some of the micro-economic studies discussed in Hames (2007), stating that the preservation of natural resources by indigenous communities is a side effect of low population, lack of technology and low access to markets. In opposition to local people, conservation actors in Loango do not associate local people with the concept of the noble savage. Rather, they tend to see them as destructive. As proof, several conservation actors refer to local over-exploitation of resources as one of the main threats to the park.

3.4.2 Local knowledge of conservation

3.4.2.1 Knowledge of the regulations

Farmers in Loango have little knowledge of the legislation framing new conservation practices in the park and its periphery. Most of the farmers interviewed in the periphery of the park knew there was a protected area, but many of them still associated it with the old hunting reserve, and/or did not know its precise location or limits. As an example, people from Idjembo believe they are in the buffer zone, while the map suggests they are not. In the periphery of the park, 13 of 27 farmers knew about the park from rumour only, or because they witnessed people being fined, having their nets confiscated or being imprisoned for not respecting the law. The rest knew of the park from the MEF representatives. People associated conservation and the park with "we shouldn't kill animals anymore", a sentence that sometimes sounded like a slogan in

farmers' discourse, but did not necessarily underlie more detailed knowledge. For example, people were aware that some species are partially or entirely protected, but they were not sure which ones. This lack of knowledge is problematic as it leads to resentment based on erroneous beliefs. As an example, the park regulations allow local people access to the inhabited areas of the park to harvest traditionally-used resources. For this, the *conservateur* first needs to give his consent to the request. Then, local people are checked for weapons and escorted by *écogardes* who ensure that no illegal activities are carried out. Thus, while access to the park is now under close scrutiny, people are not, in theory, prevented from entering the park and collecting renewable resources. However, one informant stated:

> *Before we were going to the Louri* [a lagoon between the village and the ocean now in the National Park] *to collect crabs and oysters. Now we can't go there anymore.*

Community members from inside the park were much more aware of new laws associated with the National Park and of the park boundaries than those living in the periphery. Only 3 of 12 respondents stated that they had no knowledge of the regulations at all. This is to be expected, as these communities are the ones most targeted by conservation efforts, and they have, as a consequence, been in more regular contact with conservation actors. Conservation in the park is also associated with heavy fishing restrictions. Local people described these fishing regulations more precisely to me than they did hunting regulations, which suggests that either conservation actors apply fishing regulations more than hunting regulations, or that people in the park are more likely to remember fishing regulations than hunting regulations as fishing is their main subsistence activity.

3.4.2.2 Knowledge of conservation actors

Local people have a limited and often inaccurate knowledge of the conservation actors in the area. As a general rule, people mistake ANPN and MEF representatives for one another, associate conservation with white expatriates, and do not have a precise understanding of who does what. In 31 of 39 interviews, farmers claimed not to know any of the actors (listed as MEF, ANPN, NGO and tourism) except the MEF representatives, and/or they did not know what their respective responsibilities and activities were. This is to be expected, as MEF representatives represented the authorities in relation to wildlife management, both inside and outside the park, until very recently, when ANPN became functional. None of the farmers knew what ANPN was, who the representatives were, or what their responsibilities were. Similarly, 9 of 12 of respondents in the park said that they knew nothing about the NGO and their activities,

although 100 % had taken part in either the socio-economic survey or the fish-catch study carried out by the NGO. In the periphery, only two respondents said that they knew the NGO at all, and both were local leaders.

Several villagers believed the park was created by or for the "whites". This was especially true for informants over 60 years old, for whom conservation has always been associated with whites. During an interview, one of the eldest women living in Ntchongorové responded as follows (the dashed lines indicate my questions):

> *Do you know the park? No*
>
> *Do you know the reserve* [the old name of the park]*? Yes I know there is a reserve. This is where people are told not to go and kill the animals.*
>
> *Who told you about it? It is because of the whites who work there. Before we could go and harvest oysters and crabs. Now we can't go there anymore because it is the reserve.*
>
> *Who prevents you from going there? I don't know. Is it not the whites working in Loango?*

Because local authorities were, and still are, financially and logistically ill-equipped, tourism and NGOs have a strong influence over conservation development in the area, as is the case in most parks in Gabon. NGOs and tourism companies are typically run locally by "whites" and possess expensive equipment. During the study, the white expatriate local NGO manager was replaced with a Gabonese manager, but this was not explained to local people. From the local people's perspective, this is essentially a matter of "whites" driving cars, boats or quad-bikes on a daily basis, escorting "whites" into the park, from where locals are excluded. This situation changed slightly when the *conservateur*, who is Gabonese, spent more time in the area with his own car and driver. In addition, with the initiation of anti-poaching patrols by the écogardes, who are all Gabonese, conservation is becoming less "white". However, money and expensive equipment were still strongly associated with conservation by local people during my study.

3.4.2.3 Causes of limited knowledge

Responsibility for the modest knowledge displayed by the local community is shared between stakeholders. First, work or travel constraints prevent local people from attending meetings when they occur. For example, women have less access to sources of knowledge than men, because their relentless work routine leaves them with less time to attend meetings. As an

example, men, rather than the women farmers I worked with during the study, attended the village meeting I organised in Idjembo at the end of the study. Women explained their absence by their need to work in their fields or process food, not allowing them to spare time for a meeting. Some of them sent their husband, son or another male relative to attend on their behalf. This pattern is consistent with that reported for Uganda by Hill (1998), who suggests that women have lower access to external sources of information than men. In Loango, the fact that fishermen, who are mostly men, are more aware of regulations than farmers, who are mostly women, also supports this hypothesis. It is, therefore, not surprising that farmers are not aware of new legislation, even when stakeholders claim to have organised a meeting or education campaigns.

Second, the lack of knowledge of conservation actors also reflects the lack of information provided to local communities by other more powerful stakeholders, including state representatives. During interviews, local people said that conservation actors did not take the time to present themselves, their duties and activities clearly to the area. I noticed personally that of several researchers who were active in the park during my study, including a research project that has been present in the area for several years, most made no attempt to explain their work to the local community. The long-term project visited some villages in the park once, after a hunter was found in the research area, threatening the safety of the research team. Moreover, as described earlier, the NGO managers changed from expatriate to Gabonese during the study, but the new manager did not use the opportunity to organise a meeting and inform local people.

Third, local representatives may not always broadcast information to the wider community. One of the local leaders had been in contact with most of the stakeholders in the past, but failed to convey the results of these interactions to the rest of the *regroupement*. It is unclear why local leaders do not always broadcast information in Loango, but some of them blamed the difficulty of reaching people when villages are scattered, as they are at the study site. This lack of communication is not uncommon, and Idrissou et al. (2011) describe a similar problem in a case study in Benin. They analysed a conflict between conservation actors and local communities over a relocation program which led to the failure of a community-based conservation project. In this dispute, conservation actors criticised local representatives for not informing the populations they represented during meetings. In Loango in particular, but also in Gabon in general, the entire administrative process is hierarchical and centralised by the state. Therefore, it seems logical for conservation stakeholders to follow local civil procedure, which is to go through local representatives. Conservation actors should nonetheless be aware of, and wary of, individual power relationships and local constraints in their area to ensure that all members of communities affected by regulations are reached. Finally, the lack of knowledge

displayed by local people can reveal a subtle form of resistance, which I detail in the following section.

3.5 Ignorance as a form of resistance

Subtleties in farmers' discourses about conservation suggest that their lack of knowledge may reflect a passive form of resistance. Holmes (2007), in his review of resistance to conservation, explains that resistance, rather than direct conflict, is generally used when (1) resistors fear violent repression, (2) the social distance between resistors and oppressor is such that no channel of communication is available, or (3) resistors are neglected in terms of power relationships and thus feel that they have limited ability to change things. All the three cases are possible in Loango, as people have been arrested and put in jail for retaliating against elephants following crop-raiding, which is experienced locally as a form of violent repression. Through the analysis of various case studies, Holmes (2007) shows that a combination of everyday acts of resistance can lead to the failure of contested conservation projects or actions. Idrissou et al. (2011) also report passive resistance and hidden conflicts as the starting point of a series of open conflicts that ultimately led to the failure of a community-based project in Benin.

In Loango, several informants expressed a form of disdain in response to exclusion from conservation and conservation actors. They first displayed this indifference as an overt lack of interest in learning more about conservation. Some informants commented:

> *I don't care about your park. What does your park do for us?*

> *Water and forest* [MEF]*, they come. Then, when we tell them about our problems, they just reply that elephants are our brothers. They don't care about us, we don't care about them.*

As a result of what is seen as a lack of concern from conservation actors, farmers respond with similar indifference towards what matters for the people they perceive to be excluding them or ignoring their concerns. Proctor (2008: 22) reinforces this point in his discussion of the production of ignorance, where he refers to this form of resistance as "virtuous ignorance", which allows political engagement with powerful actors:

> *If knowledge is power (which it sometimes is but not always), then to dismantle certain kinds of power may require the reintroduction of bodies of ignorance – hence impotence – in that realm.*

In addition, farmers' lack of interest in conservation regulations and practice may allow them to continue performing illegal activities in good faith, and by doing so, to protect their livelihood against a perceived threat. This is congruent with Holmes's (2007) review, which shows that the continuation of banned practices is the most common form of everyday resistance. Similarly, Bell, Hampshire and Topalidou (2007) showed that subsistence poaching in Greece, which is ultimately a refusal to follow fishing regulations, can be understood as a form of resistance.

This form of opposition, however, is often unrecognised by conservation actors who consider illegal activities only in terms of the benefit they provide to the offender. This is true in Loango, where conservation actors fail to interpret local people's transgressions as acts of resistance, instead blaming them on lack of education, poverty, and economic incentives alone. For example, one official stated:

> *We, intellectuals, we understand links between nature, animals and human. We know. But for our people it is difficult because they do not see that.*

Holmes (2007) shows that non-recognition of the symbolic resistance behind the perpetuation of banned practices leads to the reinforcement of coercive conservation strategies, rather than to better inclusion of people's needs. In Loango, conservation actors' opinions diverge. Some, mostly expatriates, recognise that villagers do not always abide by the law and conclude that law enforcement should be one of the top priorities of the park for the near future. In fact, *écogardes* training and anti-poaching patrols were both under rapid development during the study. Some other informants, mostly Gabonese, suggested that education is efficient and that it will eventually lead to a spontaneous stop in illegal activities in the long term.

Direct and open conflicts are rare in the Loango community's responses to disagreement of any kind. Interestingly, resistance fits a pattern of behaviour considered appropriate among the villagers. Several informal conversations with villagers revealed that it is seen as inappropriate to say "no" openly to someone asking for a service, or to oppose somebody straightforwardly, particularly in public. In several cases, I witnessed people, in both a professional and personal context, promising to help someone or to do something, without then doing so. My assistant, who is from the area, explained this to me as:

> *He just did not want to say he could not or did not want to do it. So he just did not come, the result is the same.*

Similarly, an official said:

> *When we don't hear from our hierarchy, it just means it is a no.*

In this context, the fact that farmers do not abide by conservation regulations, using ignorance as an excuse to go on practicing forbidden activities, reinforces the idea that people in Loango use a passive form of resistance in line with the cultural expression of refusal.

A MEF representative told a story that also suggests the use of passive resistance as contestation. The story, as he recounted it, took place in another area of Gabon where crop-raiding by elephants is also a serious problem. A MEF representative was invited to dinner in one of the villages. The head woman of the household served the representative with a plate of only dry manioc, while other guests had access to meat, fish and diverse other carbohydrates. If we are to believe the narrator, the woman was very pleasant and polite for the entire meal but the representative was overtly humiliated. According to the narrator, the woman wanted to express that she suffered from food shortage as a result of the legislation imposed on her, and enforced by the representative. Because she could not express this openly, and she did not feel she was listened to, she used a non-confrontational method to show that she was prevented from obtaining food. This example is wholly in line with Holmes (2007: 187), who writes:

> *In order to avoid confrontation, resistance must not contest directly the formal modes of oppression, which would invoke repression, but appear to conform to the dominant power, containing the resistance in the culturally specific symbolism of acts.*

In this context, the use of the image of the noble savage by local people can be re-examined in the light of resistance as an opposition to the perception of marginalisation from conservation.

While open conflict is an uncommon response in Loango, many informants still used the discourse of direct opposition during interviews. Many stated that they would keep killing elephants that “stole” their food, and which came “to remorselessly eat the fruit of somebody else’s work”. Similarly, several informants stated they would hand their children over to the authorities so that the authorities would realise how hard it is to feed a family.

> *If the elephants finish everything, we are all going to move out to his* [the MEF representative's] *house. I will rest for a change and every day ask him for food. We will see then. It will make him feel dizzy* [the need to feed everybody].

The people who mentioned such intentions often stated that their recurring complaints to the MEF representatives were ignored. With increasing frustration due to the repeated inaction of authorities, it seems likely that acts of resistance can intensify or escalate into open conflicts. As an example, I witnessed one open conflict between villagers and the local NGO. The conflict arose during a village meeting to discuss the NGO’s request for land to build a research centre. Resentment towards the NGO erupted suddenly during the meeting, with outbursts stemming

from the years during which the NGO had failed to engage in genuine interactions with the local people of that *regroupement.* It appears that, following years of limited or no official interaction, villagers expressed their frustration as soon as a channel of communication opened. This suggests that the lack of open conflict in Loango may well result, at least partially, from the lack of opportunity to engage with likely opponents.

3.6 Conclusion

Most people in North Loango show favourable attitudes towards the preservation of their natural heritage. Local environmental ethics are grounded in a local understanding of sustainable resource management that includes utilitarian, naturalistic and aesthetic values. These views are not static, but adapt to new trends introduced by other stakeholders and to societal changes. While local people consider employment as conferring added values to wildlife, this economic aspect does not appear to be the main reason to value wildlife and nature. Because the local environmental ethics emphasise sustainable resource management, common ground and interests could easily be found between stakeholders if they were to engage genuinely with each other.

Resistance to conservation is undoubtedly present in Loango, and should be recognised, as it expresses a pervasive resentment towards conservation and conservation actors. I believe that the absence of open conflict in Loango is symptomatic of a lack of engagement between groups and does not suggest appeased interactions. Despite the lack of tangible conflicts, frustration is present and may develop into uncontrolled conflicts in the future, as the failure of other projects should remind us (e.g., Benin: Idrissou et al. 2011). While often considered negative, some scholars suggest that conflicts might be unavoidable in the process of sharing viewpoints, and represent a window of opportunity to clarify disagreements, work through misunderstandings and solve existing tensions (Lewis 1996; Leach, Mearns and Scoones 1997; Peterson, Peterson and Peterson 2005). The same authors suggest that conflicts can lead to innovation and a deeper understanding of the issues at stake. Peterson, Peterson and Peterson (2005: 766) write: “An emphasis on argument legitimizes and facilitates change, whereas an emphasis on consensus further legitimizes continuity or stability”. According to these authors, an argumentative model of management “fosters interdisciplinary conversations”, leading to the creation of “scientifically sound but socially legitimate” policy (Peterson, Peterson and Peterson 2005: 765). In Loango, the lack of communication channels leads to repressed or uncontrolled conflicts, and thus precludes the adaptive and inclusive management described by Peterson,

Peterson and Peterson (2005). Therefore, conservation in Loango may well be scientifically sound, but it is currently failing to be socially legitimate.

Chapter 4 – Biophysical vulnerability to crop-raiding

4.1 Introduction

In the tropics, home of the highest biodiversity globally, crop-raiding is perhaps the most common and significant form of human-wildlife conflict (Naughton-Treves 1998; Sitati, Walpole and Smith 2003). A diversity of pests damage crops in Africa, including elephants (e.g., Lahm 1996), hippopotamus (e.g., Lahm 1996), wild pigs (e.g., Lahm 1996), antelopes (e.g., Kagoro-Rugunda 2004), rodents (e.g., Drazo et al. 2008), birds and insects (e.g., Naughton-Treves and Treves 2005). Elephants receive a great deal of blame for damage to crops and are, in reality, known to cause extreme hardship to subsistence farmers (Barnes 1996; Lahm 1996; Nyhus, Tislon and Sumianto 2000; Sitati, Walpole and Leader-Williams 2005). Primates are equally problematic where they occur, and baboons, for example, cause serious loss to farmers in Africa (Naughton-Treves 1998; Hill 2000; Sillero-Zubiri and Switzer 2001; Tweheyo, Hill and Obua 2005; Madden 2006). Rodents are blamed for damage to standing crops and granaries (Lahm 1996; Naughton-Treves 1998). While systematic surveys of rodent damage are scarce in Africa, particularly in the Central African region (but see Arlet and Molleman 2007 in Cameroon, and Drazo et al. 2008 in the Democractic Republic of Congo), people report that rodents can cause heavy damage, sometimes causing more damage and loss than larger mammals (Lahm 1996; Naughton-Treves 1997; Arlet and Moleman 2007). In Tanzania, for example, rodents alone lead to a loss of US$ 40 million annually (FAO 2002, cited in Drazo et al. 2008). The debate regarding whether rodents damage more than elephants is not new, but comparative data for Africa are scarce.

A diversity of factors limit or exacerbate crop-raiding. For example, farms damaged by elephants in the past are more likely to be raided again in Kenya (Sitati, Walpole and Smith 2003), while increasing distance from the field to the forest edge, increasing number of fields between the field and the forest, and increasing distance to protected areas all decrease the risk of crop-raiding (Naughton-Treves 1998; Hill 2000; Kagoro-Rugunda 2004; Linkie et al. 2007). By contrast, proximity of the field to permanent water points, increased rainfall (Smith and Kasiki 2000; Barnes et al. 2006; Linkie et al. 2007), increased forest cover on field edges (Nyhus, Tilson and Sumianto 2000), and crop composition and maturity (Hill 1997; Hill 2000; Linkie et al. 2007) can lead to an increase in crop damage. Ecological conditions, the spatio-temporal distribution of farms, land-tenure systems and agricultural practices also shape patterns of crop-raiding. The specific natural environment and the diversity of pest species, as well as the political and social circumstances, make each situation unique in its needs and the options available to counter wildlife raids (Hoare 2001; Osborn and Parker 2003). As mentioned in Chapter 1, Pourtier (1989a) and Lahm (1996) suggest that the rural exodus led to increasing damage to crop in

Gabon, while increase in human density is the driving force elsewhere (e.g., Nyhus, Tilson and Sumianto 2000).

To mitigate crop-raiding, site-specific data are required to understand patterns of crop-raiding and factors affecting its pattern and magnitude (Osborn and Parker 2003). Most existing studies of crop-raiding have focused on countries in East Africa, while data from West and Central Africa are scarce (see, for example, Hoare 2000 for a list of human-elephant conflict studies in Africa). The situation in Central African countries such as Gabon may be very different from that in East Africa. Agriculturalists in Gabon farm in a landscape dominated by wild areas, whether forest or savannah, and use shifting cultivation. The consequence is a high fluidity of the spatio-temporal distributions of both farms and crop-raiding incidents. Very few studies have tackled the issue of crop-raiding in a systematic and comparative way in Gabon. Lahm (1996) conducted a nationwide survey, which provides a list of major pest species and a comparison between regions based mostly on interviews with farmers. Her survey revealed that the Ogooouee-Maritime was one of the areas most affected by crop-raiding in Gabon. She also found that the cane rat was blamed most for crop damage across the whole country, except in the Ogooouee-Maritime region, where elephants were blamed most. Walker (2010) used a similar approach in her study of farmers' choice of deterrent methods against crop-raiding. These studies are highly informative, but they did not monitor damage systematically across seasons. Languy (1996) carried out trials of electric fences in the Gamba region, near Loango, but recorded only data on elephant damage. Blaney et al. (1999) and Le-Duc Yeno et al. (2006) carried out socio-economic surveys during which they collected information about crop-raiding, but like Lahm (1996) and Walker (2010), they did not survey fields repeatedly across seasons. As the Gabonese government, with the support of FAO, is currently engaging with human-wildlife conflict mitigation, detailed evidence-based studies are clearly missing.

Loango National Park lies in the heart of the Ogooouee-Maritime region, where many protected species act as pests. Its high potential for conservation, research and tourism make Loango a pole of attraction for international scientists and business, while simultaneously making conservation and human-wildlife conflict, particularly crop-raiding, central to local communities' concerns. This chapter aims to characterise the pattern of crop-raiding by medium to large mammals in and around Loango National Park, and to investigate the biophysical factors affecting it. The specific aims are to determine:

- Which species raid fields and how these species rank in relation to frequency and area damaged
- The extent of crop damage and crop loss due to each pest

- Which natural (season, surrounding habitat type and perimeter on the forest edge) and anthropogenic (number of neighbouring fields, distance to roads, to closer habitation and the protected area) factors affect patterns of crop-raiding.

4.2 Methods

4.2.1 Field descriptions and crop inventories

I used a Garmin 60CSx Global Positioning System (GPS) and ArcMap to map the study area and the selected fields (see Chapter 2). For each farmer, I mapped and made an inventory of *old fields* (created in 2008) and *new fields* (created in 2009). In addition, I mapped and measured *new fields* for all farmers in Idjembo and Ntchongorové to assess the spatio-temporal distribution of fields more generally, to map all areas dedicated to farming at the study site and to check how representative my sample was. To measure field area, I assumed that fields were polygons and recorded the GPS points of all the corners, as in Webber (2006). I then calculated the area of each field with the Polygon Area Function in ArcMap. *New fields*, cleared in 2009, had just been planted or weeded and were quite open (Fig. 4.1), making them easy to walk through. For each *new field* ($N_{Ntchongorové}$ = 12 fields, $N_{Idjembo}$ = 11 fields), I recorded the types of crops grown, the area planted for each crop, the density/frequency of crop for the three most important crops (manioc, banana and taro), and the number of neighbouring fields of the same age. To calculate planting density for manioc, I followed methods used by Hill (2000): I placed five 2x10 m quadrats randomly in each field and calculated the mean number of manioc stems/20 m^2. As banana and taro were never planted over an extended area, and were easy to count, I recorded the number of stems in each field directly. For all the other crop species, I recorded presence/absence.

In contrast to *new fields*, the growth of weeds and crops in *old fields* made it difficult to enter and move through them (Fig. 4.2). In addition, *old fields* ($N_{Ntchongorové}$ = 9 fields and $N_{Idjembo}$ = 5 fields) had often been harvested and/or raided to some extent before the study began. As a consequence, I recorded field size and estimated the area not yet harvested or damaged. I visited villages in what is locally referred to as *la Haute* three times, and surveyed *new fields* as follows: 5 in Ntchonimbani, 3 in Iloupi and 11 in the park.

Figure 4.1: Left: a newly planted field at the beginning of the study. Right: Kharl, my assistant, in a particularly well-weeded 12 month *old field.*

Figure 4.2: A particularly dense *old field*. The picture was taken 18 months after planting. The flattened manioc stems in the bottom-right corner result from trampling by elephants.

4.2.2 Field monitoring

To record the frequency and patterns of crop-raiding in the study area, I visited each farmer every two weeks from December 2009 to November 2010. This is similar to the frequency used in other studies of crop-raiding (e.g., weekly records: Naughton-Treves 1997 and Webber 2006; monthly records: Hill 2000 and Perez and Pacheco 2006), and allowed me to monitor one *regroupement* per week while allowing time for anthropological investigations. Initially, I provided farmers with calendars to record crop-raiding events, as used in Linkie et al (2007). However, the high rate of illiteracy meant that this method was not successful. I surveyed all *new fields* at each visit, but visited *old fields* only when informants told us damage had occurred. I surveyed farms in Ntchongorové and Idjembo 17 and 16 times, respectively, and corrected for this difference when comparing the two sites. I made additional field visits occasionally after elephant raiding events, increasing the frequency of survey for this pest species to 18 for both Ntchongorové and Idjembo. In *la Haute*, I surveyed *new fields* and *old fields* opportunistically because I had so few opportunities to survey. I pooled data from all *regroupements* in *la Haute* due to their similarity (e.g., no direct access through land, fields surrounded by mature forest, maximum of five households and all families relying heavily on fishing activities), and because samples in Ntchonimbani and Iloupi were too small to be analysed independently.

4.2.2.1 Frequency of damage

I considered a crop-raiding event as the occurrence of damage caused by one animal species between two visits. Because I was primarily interested in mammalian crop-raiding, I recorded diseases and damage caused by insects as presence/absence. For damage caused by mammals I recorded the following data for each pest and crop species (manioc, banana and taro) at each visit to *old* and *new fields*:

- Location/GPS point of the central point of damage per pest/crop
- Distance from centre of damage to the forest edge
- Pest and crop species
- Species and stage of crop damaged
- Part of the plant damaged and type of damage
- Frequency of damage
- Estimated area damaged and intensity of damage (see sections 4.2.2.2 and 4.2.2.3).

My observations and discussions with farmers during the pilot phase suggested that some species damaged crops more at the field/forest boundary. Furthermore, Naughton-Treves (1998) showed that sight distance from the forest edge was an important factor in primate crop-raiding. Based on this result, I recorded the distance of the central point of the damage to the forest edge as close (≤ 20m) or far (> 20m), which represents the mean sight distance at the study site. In order to determine sight distance, my assistant and I assessed the maximum distance at which we could see each other, at hip height for all *new fields* at the beginning and the end of the study, and I took the mean. While different species are likely to have different visual limits at different heights, this provides information on possible fine-scale movement by raiders in fields.

I identified pest species through examination of tracks, dung, tooth-marks, and eating strategy. I identified pests to species-level when possible, and lumped identifications into groups otherwise. It was often difficult to differentiate damage caused by different rodent species, so I combined them under the label "rodents" for analysis. I also combined the different species of duikers and antelopes under the label "antelopes" for the purpose of analysis. It was impossible to tell whether guenons (*Cercopithecus* sp.) crop-raided, but interviews and my observations suggested that only red-capped mangabeys raided. I therefore lumped all observations of monkeys along with gorillas and chimpanzees under "primates". I analysed elephants individually and lumped all other pest species under the label "other species".

I noted the maturity of a damaged manioc plant as immature when it was a seedling up to about 1.5 m high, and mature afterwards, based on farmer's descriptions. This reflects the presence of palatable manioc tuber rather than the maturity of the plant as harvested by farmers. I recorded part of plant damaged as root/tuber, stems, leaves and fruit.

I estimated the frequency of raiding events by looking at signs of decay on plants, dung or track, such as change in colour, dryness, and whether the signs had been washed by rain. I scored frequency as 1 (1 raid between visits), 2 (at least 2 between visits), 3 (at least 3 between visits) or 4 (at least 4 different raids between visits). I attributed scores 3 and 4 only when farmers said they had suffered more than two raids and tracks in fields confirmed their statements. To prevent overestimation of damage frequency, I gave a frequency score of > 1 only when there was clear evidence of multiple raids, such as repeated damage on the same plant. In cases of doubt, I gave a score of 1 (the minimum). I also used a more conservative approach, which was to record frequency score using only non-raided/raided. While both these frequencies are likely to be underestimations, they allow for comparisons between pest species and locations.

4.2.2.2 Area damaged

Estimating actual crop damage is difficult, time consuming, and controversial. The methods used represent a trade-off between accuracy and labour intensity (Hoare 1999; Hill, Osborn and Plumptre 2002). No systematic survey method currently exists to allow precise estimation of damage, and various methods have been used, making comparisons across studies difficult (Hill, Osborn and Plumptre 2002). Following Zadoks (1985), I defined the area damaged as the area that suffered from the action of any harmful agent leading to a reduction in the quality or quantity of yield. To obtain estimates of damage that were both statistically robust and allowed comparison with previous studies, I used a transect-like method. My assistant and I walked through the fields in a systematic way, following parallel lines (Fig. 4.3).

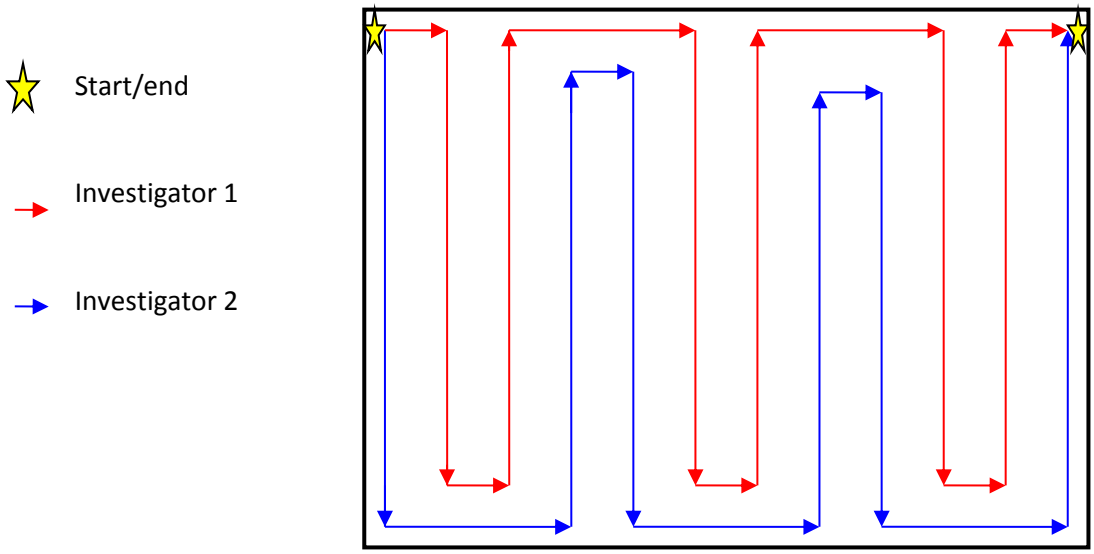

Figure 4.3: Crop-raiding survey methods.

Visibility in fields decreased over time due to plant growth. To ensure a constant level of surveillance across visits, I determined the number of transects per field, and the distance between the two investigators, at each visit based on visibility. Each transect started at one corner of the field and followed the edge(s) of the field (Fig. 4.3). I set the distance between the two investigators so that all stems between the two investigators were visible to at least one investigator. When one of us spotted damage, we assessed it together to avoid double counting. During transects, I recorded the number of damaged stems for manioc, banana and taro. This method was labour intensive, and the gain in accuracy compared to a simple visual estimation of damage is debatable. However, systematic transects were the only way to provide a reliable account of damage by rodents and medium size herbivores, which is difficult to spot from a distance (Fig. 4.4).

Figure 4.4: Example of rodent damage to manioc roots, while the stems are untouched. This type of damage is typically difficult to spot from a distance.

For manioc, I estimated the area damaged in two different ways. Where possible, I estimated the damaged area by counting the number of damaged stems, which I then converted into area using the mean planting density (Hill 2000). When the damage was over an extended area, or when we could not identify individual stems, I estimated the area damaged directly as a proportion of the field damaged to the nearest 5 %, and converted this into m^2. To do this, I took the mean of independent estimates made by my assistant and myself. To ensure estimate accuracy, I tested our ability to estimate areas by first estimating damage and then counting the exact number of stems damaged and comparing the resulting values during the first month of the study. For villages in *la Haute,* an *écogarde* was also present, so I estimated the area damaged as the mean of the three observers' estimates. During transects, I was unable to estimate the area devoted to crops other than manioc accurately, because banana and taro were often very patchy in distribution and stems were interspersed with manioc. Hence, I recorded the numbers of stem damaged directly. I recorded damage to fruit (e.g., mangoes), or to other minor food species (e.g., tomatoes, spinach), as presence/absence only.

4.2.2.3 Intensity of damage

We estimated the intensity of damage for each pest/crop pair using the same index as Parker and Osborn (2001):

Low: some severely damaged plants and damage not critical to the plant

Medium: some (25-75 %) critically damaged plants

Intense: most (> 76 %) of the plants are critically damaged

Intensity is a valuable tool to assess how damage events lead to actual loss of plants and post-production. It also allows comparison between pest species, crop species and sites. When plants were damaged regularly, preventing them from maturing, I set the intensity as medium to reflect the possible loss of production to the farmer.

4.2.3 Data Analysis

4.2.3.1 Frequency, area damaged and crop loss

I used field as a discrete unit of analyses as it was appropriate for my investigation of farmer's vulnerability to crop-raiding, and is relevant to both animals and farmers (Naughton-Treves 1998). To facilitate comparisons with other studies of crop-raiding, I used the frequency score of damage and the area damaged for most analyses. I recorded area damaged in all three sampling zones (N = 40 fields), but only recorded damage frequency in Ntchongorové and Idjembo (N = 22 fields). I calculated crop loss to assess the consequence of crop-raiding for farmers in terms of food and economic loss based on damage intensity. For *low* intensity damage I considered the loss as zero, as the plant was not removed from the field, and could still produce harvestable food. For *medium* intensity damage I estimated the loss as half of the damaged area, and for *intense* damage, I estimated loss as the total area damaged.

For manioc in *new fields*, I adapted Parker and Osborn's (2001) index of severity to assess the impact of the different raider categories. This index is based on a matrix figuring the area damaged per unit (field) for each level of intensity (Table 4.1). For each field, I related the proportion of the field lost to wildlife, as described in the previous section, to the high intensity level (blue in Table 4.1). Thus, I assessed the severity of crop loss per field for the study period.

Table 4.1: Matrix showing the level of severity assigned to each combination of 'extent' and 'intensity' from Parker and Osborn (2001). I used the high level of intensity, shaded blue, to assess the severity of crop loss per field.

	Proportion of area damaged				
Intensity	**0-10 %**	**11-25 %**	**26-50 %**	**51-75 %**	**76-100 %**
Low	Low	Low	Low	Medium	High
Medium	Low	Medium	Medium	Medium	High
High	Low	Medium	High	High	High

4.2.3.2 Spatio-temporal analyses

To assess the effect of season on crop-raiding, I grouped the data into wet (February-April 2010 and October-November 2010) and dry (Mid-December 2009-January 2009, May 2010-September 2010) seasons. The dry season during the study period was drier than expected by farmers, and drier than usual in March, April, May and September (compare Fig. 4.5 with Head et al. 2011). However, the monthly rainfall pattern followed normal patterns, with a short dry season from mid-December to mid-January and a long dry season from May to the end of September (Fig. 4.5).

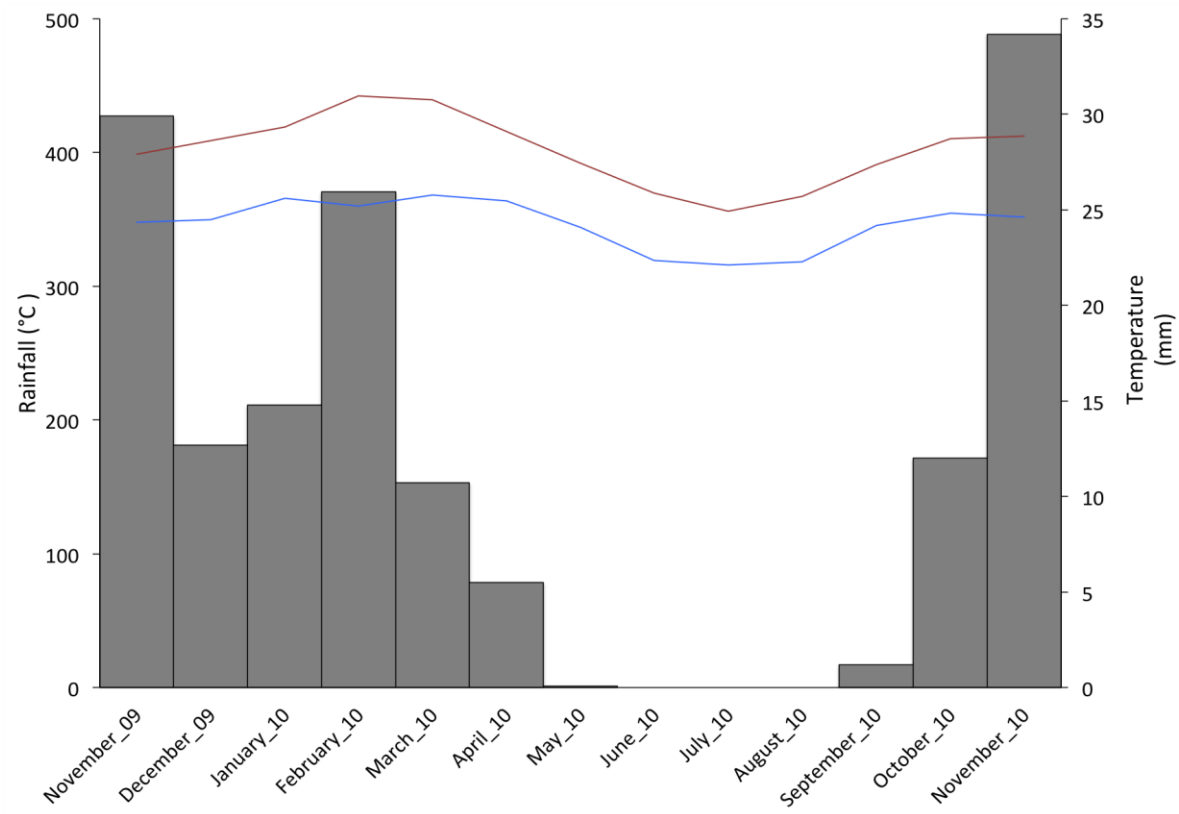

Figure 4.5: Temperature (red line represents maximum, blue line minimum) and rainfall (grey bars) in Loango during the study period (2009-2010). Data provided by the Loango Great Ape Project of the Max Planck Institute for Evolutionary Anthropology, Leipzig.

To investigate the impact of surrounding habitat type on crop damage, I recorded the type of forest surrounding each field. I distinguished between three types of forest: mature secondary forest, young secondary forest and young secondary forest with palm trees. Mature secondary forests are those that have been exploited by forestry or for agriculture and have reached a mature stage of regrowth. I estimated that these forests were older than 10-15 years. Young secondary forests are those in any successional stage from old fallow to young forest of less than 10 years old. Young secondary forests with palm trees are those in early successional stages in which palm trees are present at relatively high density. This habitat was widely distributed around Ntchongorové only. I differentiate young forest with palm trees from other young forest for several reasons. First, this forest type, which seems to be the remnant of intensive palm use and planting by villagers, seemed structurally different from the other young forest encountered elsewhere. Second, farmers attributed a different value to these forests, saying the soil was less fertile and that palm roots prevented good crop growth. Third, many famers explained that they preferred to farm in "palm forest" because there were fewer crop-raiders making it an interesting point of investigation. I tested for differences between young and mature forests, and for differences between the three habitat types.

I used ArcGIS 9.2 to map the informants' fields the year before, during, and following the study period. I superimposed this map on a map provided by WCS Gabon, and adapted by me, to assess the impact of different factors on the level of crop-raiding on *new fields*. Using the *nearest feature* tool in ArcGIS, I calculated the distance to the park boundary, closest road(s), and closest human settlement (which could be a permanent habitation or a camp) as an indicator of human presence/disturbance for each field. When there was a camp in the field, I set the distance to the closest settlement to zero. For distance to the park boundary, I set a positive distance for fields outside the park and a negative distance for farms inside the park. I also calculated the distance to the lagoon as a result of many complaints from farmers living on the Eastern side of the lagoon saying the elephants swam across the lagoon from the park. As all fields were located on the forest edge, I did not record distance to the forest edge or the number of fields between the forest and the field damaged. However, a study in Nigeria suggests that farmers feel that damage is diluted when there are adjacent fields (Atteh 1984). To test this hypothesis I recorded the number of adjacent fields of the same age for each field.

4.2.3.3 Statistical analyses

I carried out all data analysis using SPSS 20.0. Where data were not normally distributed I transformed them using $\log_{10}$ and used parametric tests when possible. If the results of the normality test were still ambiguous following transformation ($p \geq 0.06$), and/or violated the assumption of equal variance, I used non-parametric tests (Dytham 2011). I set significance at $\alpha \leq 0{,}05$ and all tests were two-tailed. For all analyses of raiding frequency I first conducted analyses with the frequency of raiding events scored 1 to 4, then crosschecked my results using the 0/1 score. I present the latter results only when there was a discrepancy between the two analyses.

I used ANOVA, t-tests, Kruskal-Wallis or Mann-Whitney U tests to compare field size and crop-raiding between study zones. To compare the area of crop damage by different pest species, and to assess the impact of seasonality, I used Friedman tests and Wilcoxon sign rank tests. To compare the damage caused by different pest species, I used only data from Ntchongorové and Idjembo (N = 22), where I collected systematic data on all pests. I carried out surveys unequally in the dry (N = 10 visits) and the wet season ($N_{Ntchongorové}$ = 7 visits, $N_{Idjembo}$ = 6 visits), so I corrected the frequency of raids and the area damaged for the number of visits per village in each season. I examined data for *old fields* separately because I only recorded elephant damage for these fields. Finally, I excluded fields in *la Haute* from the seasonality analysis because I surveyed damage to fields only once or twice, and only during the dry season. When the results of Kruskal-Wallis and Friedman tests were significant, I carried out post hoc tests without using the Bonferroni correction, as this correction provides conservative results that are not appropriate to exploratory analyses such as this one (Moran 2003). I could not use regression analysis to assess the impact of various factors (distance to the park, roads, the lagoon, the closest human settlement and the number of adjacent fields) on crop damage because my sample size was too small and the data too skewed for such analysis to be informative. I therefore used multiple correlation analysis to investigate possible trends. I used the Kendall τ rank correlation coefficient rather than Spearman correlation because it is more powerful for smaller sample sizes (Field 2009). The sample size was larger for analyses related to elephant damage (N = 40 fields) but I used the Kendall test for consistency. Finally, I used a Pearson Chi squared test of independence to assess whether fields damaged by elephant in the past were more likely to be raided again.

4.3 Results

4.3.1 Field size

Fields at the study site ranged 180-16,790 m^2 (median 3,650 m^2) in size, and size differed between study zones (Table 4.2; Fig. 4.6). Fields in *la Haute* were significantly smaller than fields in Idjembo and Ntchongorové (ANOVA: df = 2, F = 7.32, p = 0.001).

Table 4.2: Results of t-tests comparing field size in the three study zones. (Significant results are in bold)

	df	t	p-value
Ntchongorové – Idjembo	55	-0.32	0.747
Idjembo – *la Haute*	55	3.21	**0.002**
Ntchongorové – *la Haute*	58	3.13	**0.003**

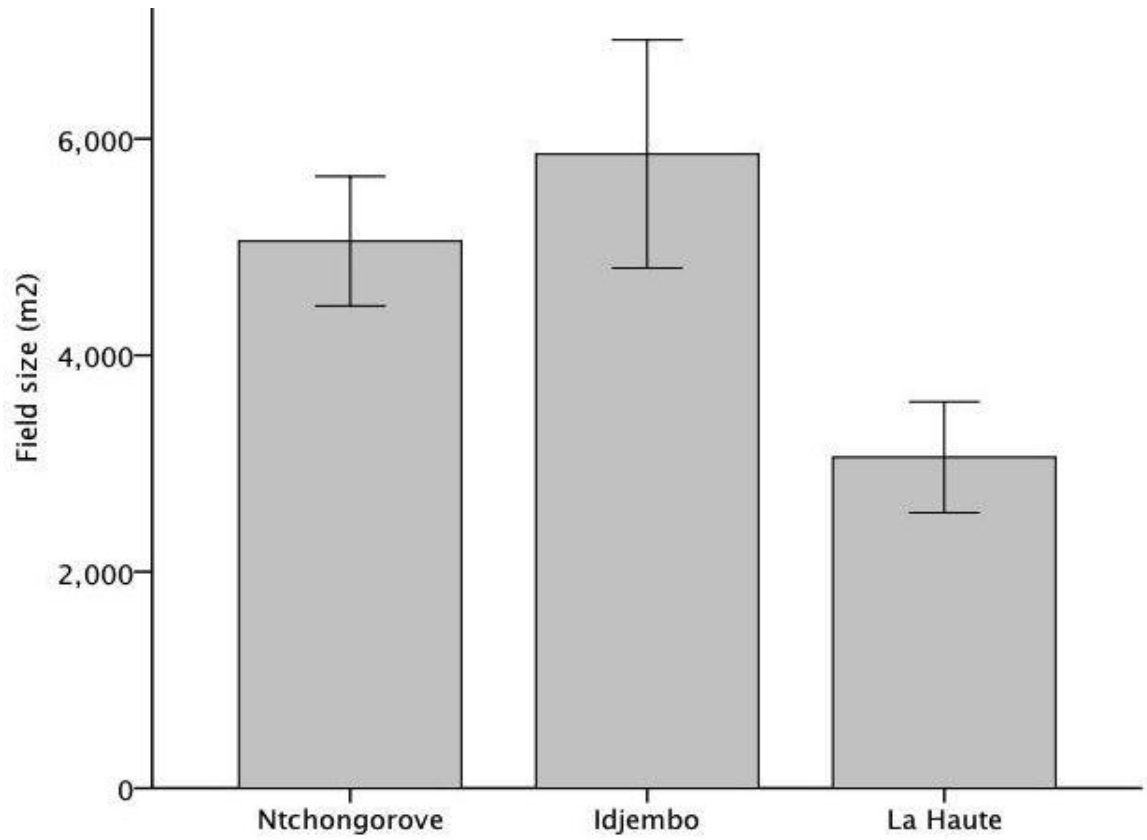

Figure 4.6: Mean (± SEM) field size in the three study zones.

4.3.2 Pattern and extent of crop damage

In both Idjembo and Ntchongorové, a *new field* (Fields 12 and 18, respectively) selected for the study was entirely destroyed and abandoned at the very beginning of the study. The first field was destroyed before my first visit, by various species. I therefore excluded it from all the analysis as there were no crops left to be damaged. The second field was destroyed at the start of the planting stage by several elephant raids. I considered this field only when analysing elephant damage, as there were no further crops available to be damaged after these events. One field in *la Haute* could not be measured, and the area damaged accurately estimated, I therefore discarded it from statistical analysis. Elephants also destroyed one *old field* in both *regroupements*. In one case, the field was partially replanted prior to my visit so I was unable to estimate the extent of the damage. In the other case the field was abandoned before my pilot phase. While I accounted for these fields when considering the number of fields damaged at the study site, I did not include them in other analyses.

4.3.2.1 Damage by all organisms

I recorded at least nine different groups of pests that damaged crops (Fig. 4.7). Most were mammals, for which I give detailed descriptions below. I also recorded two crop diseases during the study. I found African cassava mosaic disease in most fields, but never over extended areas. The second disease seemed to only affect chilli pepper plants, resulting in damaged leaves and premature fruit drop. Various insects also attacked fields. The most widespread was mealybug (probably cassava mealybug, *Phenacoccus manihoti*), which was often mistaken for a new disease by farmers. The variegated grasshopper (*Zonocerus variegatus*), called “Malian cricket” by local farmers, was prevalent at the beginning of the wet season in both years (2009 and 2010), and damaged most crop species. Local informants noted that this grasshopper had only appeared within the last few years. During the dry season, farmers complained about damage from banana stem borer insects, which they blamed on beetles. However, I did not observe any damage on stems during the study and could not confirm these reports. Similarly, farmers reported damage by guineafowl (*Agelastes niger, Numida meleagris* and *Guttera sp.*) to manioc and taro, but I did not observe this. I observed damage by humans on only one occasion, although this was a regular source of complaint by farmers, especially in Ntchongorové. In this event, all taro in the field was taken while the owner of the field was away from the village. Damage, or stealing, by people is difficult to assess, as the tracks in the field are similar to those the owner would leave when harvesting her own crops. During interviews, many complaints about human damage referred to less important food items (e.g., chilli peppers, fruits, and

greens), which might partially explain the lack of theft observed during my study. Several informants added that "thieves" were often their own relatives who would come to harvest available food during their absence. I did not record livestock as pest species, because farmers do not own any.

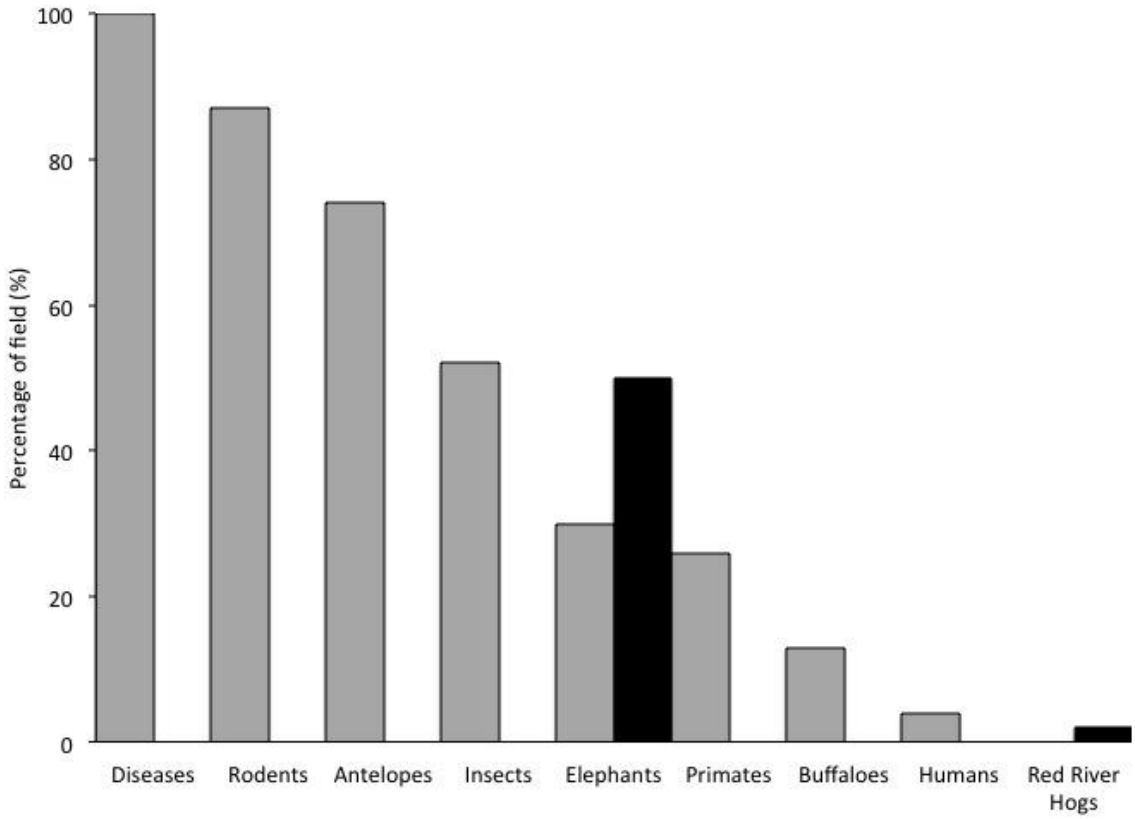

Figure 4.7: Percentage of farms damaged by different pest groups during the study period. Grey bars are for *new fields* in Ntchongorové and Idjembo (N = 23 fields), black bars include fields in *la Haute* and *old fields* (N = 56 fields).

4.3.2.2 Damage by mammals

4.3.2.2.i Crop damage and pest groups

22 of 23 of fields in Idjembo and Ntchongorové and 17 of 19 fields in *la Haute* experienced at least one raiding event by mammals (Fig. 4.7). Different crop species experienced different levels of damage. 90 % of raids targeted manioc (N = 239) compared to 10 % for banana or taro (N = 24). Damage to minor food crops such as pumpkin, peanuts and sugar cane, mangoes, papaya and pineapple was rare. Farmers complained about damage to maize by mangabeys and to sweet potatoes by elephants or rodents, but I did not record this during the study.

Elephants foraged on manioc, banana, taro, pineapple, sugar cane and squash. Farmers also complained of damage to sweet potatoes, corn and pumpkin, although I did not record this during the study. Elephants targeted manioc and taro tubers and leaves, pith of bananas (Fig.

4.8), and the entire plant for sugar cane. They often uprooted entire plants of all crops (Fig. 4.9 and Fig. 4.10). Squash were damaged only once when elephants trampled them. According to farmers, elephant raids occurred exclusively at night (between 10:00 pm and 06:00 am).

Figure 4.8: Banana plant broken by elephants.

Figure 4.9: Foreground: damage to a field by elephants. Background: the non-damaged part of the field. This is the same field as in Fig. 4.2.

Figure 4.10: *Old field* damaged by elephants. This is the same field as Figs. 4.2 and 4.9.

Crop-raiding rodents include the brush-tailed porcupine (*Atherurus africanus*), the greater cane rat (*Thryonomys swinderianus*) and at least one species of rat that I was unable to identify. Rodents mostly raided manioc (N = 114), although I also recorded rodent damage to taro (N = 1) and sugar cane (N = 1). Rodents damaged fields in different ways at different growing stages. During the early stages of growth, rodents (exclusively cane rats) cut stems entirely in a characteristic sloping manner (Fig. 4.11). When plants were mature, they dug out and ate the tuber (Fig. 4.12). The most damaging species was the cane rat.

Figure 4.11: Characteristic damage to manioc stem by a cane rat.

Figure 4.12: Rodent damage to manioc root (most likely by a cane rat).

I differentiated at least three species of raiding antelopes using tracks, dung, and in one case an encounter: bay duiker (*Cephalophus dorsalis*), yellow-back duiker (*Cephalophus sylvicultor*) and sitatunga (*Tragelaphus spekii*). These antelopes fed exclusively on leaves, especially manioc young leaves (Fig. 4.13).

Figure 4.13: Antelope damage to a manioc seedling.

Gorillas fed exclusively on bananas and ate the pith in all cases, breaking and opening the entire plant to do so (Fig. 4.14). They never ate banana fruit, which could almost always be found untouched at the site of the damage. One banana field, which was not included in my sample, was entirely destroyed by gorillas. Banana fields are uncommon in Loango and this field belonged to an employee of the tourism company who aimed to make additional income with his field. Chimpanzees raided ripe papaya (2 events) and sugar cane (1 event). However, despite the high availability of manioc, I never recorded chimpanzees feeding on it. Damage caused by red-capped mangabeys focused exclusively on manioc tuber. Mangabeys dug out and ate tubers, sometimes uprooting the entire plant and carrying it into the forest nearby (2 events).

Figure 4.14: Banana plant eaten by gorillas.

4.3.2.2.ii Frequency of damage

I recorded a total of 263 raiding events for the whole study site, giving a mean (± SEM) frequency per field of 10.9 ± 1.5 raids. However, very few fields experienced no, or more than 20, raids (Fig. 4.15). There was no difference in raid frequency per field between Ntchongorové and Idjembo when combining all pest groups (df = 21, t = -0.47, p = 0.646) or per pest group (Table 4.3). I therefore pooled *regroupements* for further analysis. The different groups of pests raided at significantly different frequencies (Kruskal-Wallis test: df = 3, χ^2 = 30.59, p < 0.0001). Rodents and antelopes raided significantly more frequently than elephants or other species (Table 4.4, Fig. 3.16).

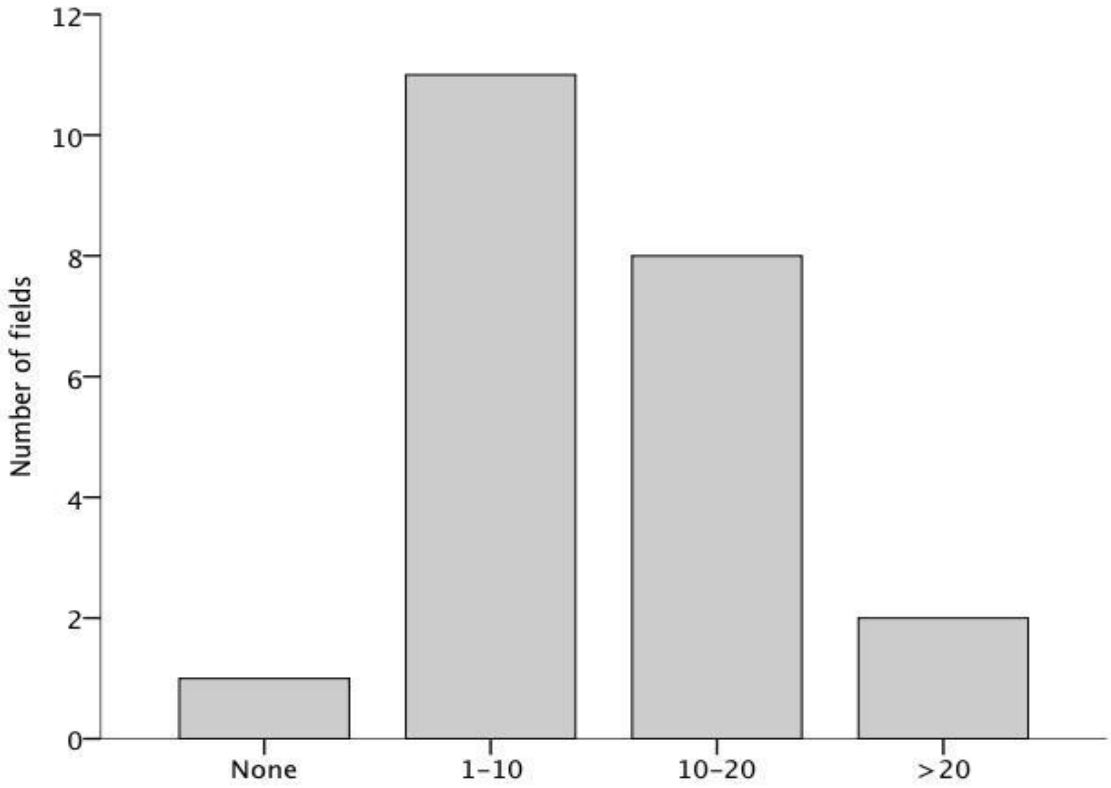

Figure 4.15: Number of fields damaged by frequency of raids (N = 22).

Table 4.3: Results of t-tests and Mann-Whitney tests comparing raid frequency between Ntchongorové (N = 11) and Idjembo (N =10). For elephants $N_{Ntchongorové}$ = 11 and $N_{Idjembo}$ = 11.

Raiding species	Critical Value	p-value
Elephants	U = 59.50	0.949
Rodents	t = -1.83	0.084
Antelopes	U = 47.50	0.605
Other species	U = 45.00	0.512

Table 4.4: Results of Wilcoxon tests comparing raid frequency by different pest groups. (N = 21, Significant result in bold)

Pest groups compared	Z	p-value
Elephants – Rodents	-3.67	**< 0.0001**
Elephants – Antelopes	-3.32	**0.001**
Elephants – Other species	-0.06	0.953
Rodents – Antelopes	-1.02	0.306
Rodents – Other species	-3.67	**< 0.0001**
Antelopes – Other species	-3.23	**0.001**

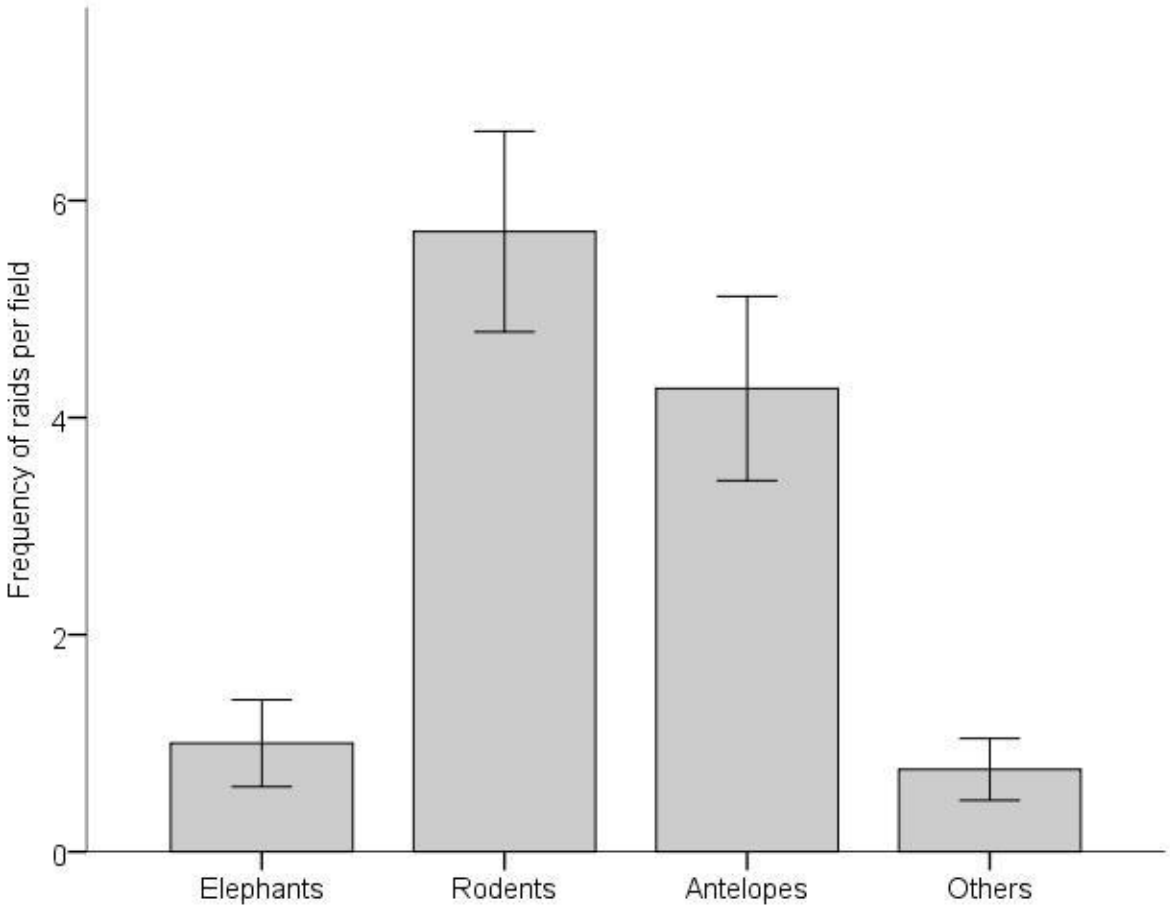

Figure 4.16: Mean (± SEM) raid frequency per field by pest group during the study period.

4.3.2.2.iii Extent and intensity of damage

In total, 46,071 m^2 of *old* and *new fields* were damaged. For *new fields*, the mean area damaged per field was 916.5 ± 313.2 m^2 (N = 40), but most fields experienced < 500 m^2 of damage (Fig. 4.17a). The proportion of field damaged ranged 0-100 %, with a mean of 20.0 ± 4.2 % (N = 40, Fig. 4.17b). Idjembo and Ntchongorové did not differ in area damaged (Mann-Whitney test: $N_{Ntchongorové}$ = 11 and $N_{Idjembo}$ = 11, U = 55.00, p = 0.748) or proportion of field damaged (U = 53.00, p = 0.652) for all pest groups combined.

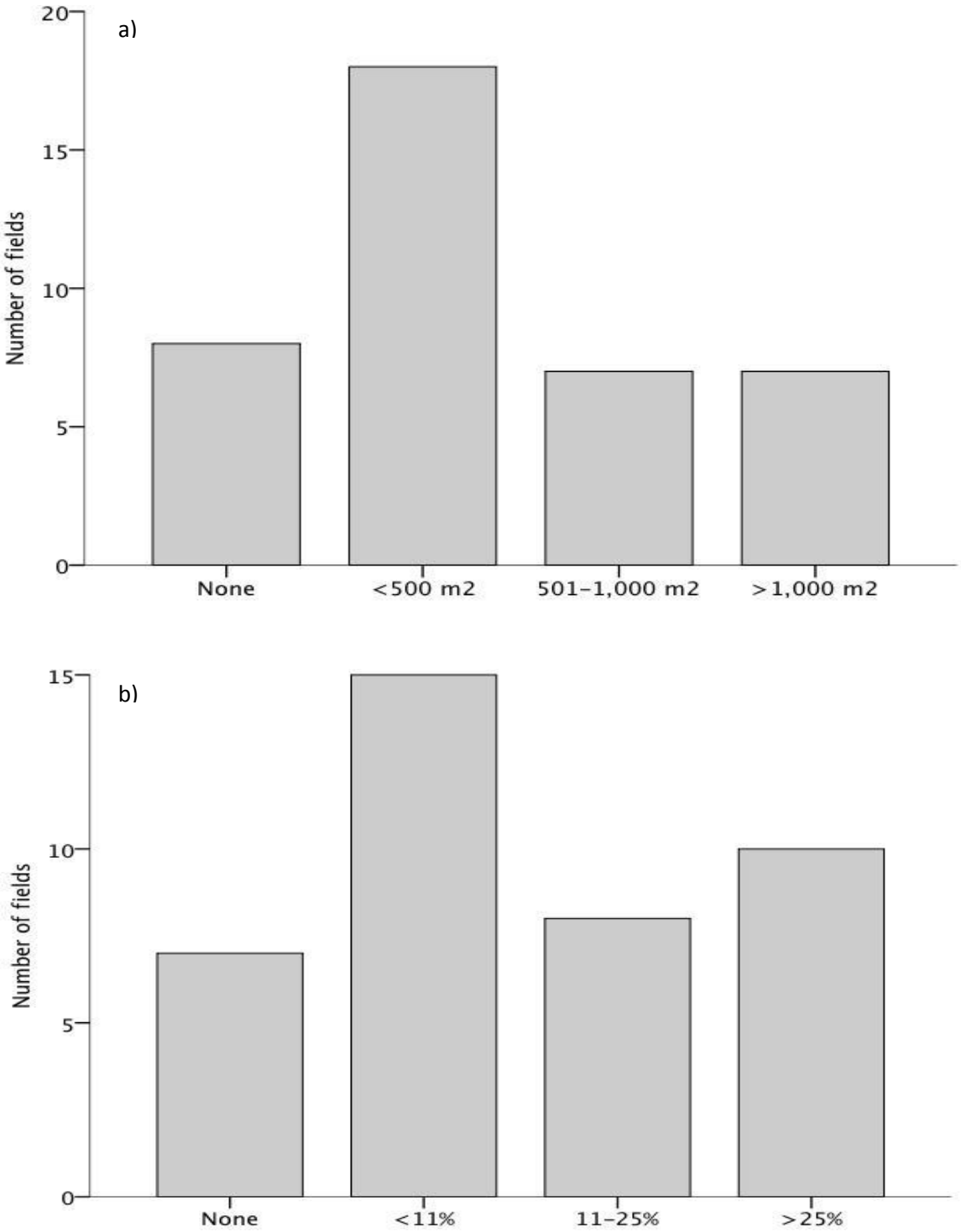

Figure 4.17: Number of fields by a) area damaged and b) proportion of fields damaged (N = 39).

Elephants damaged the largest areas, damaging 57 % (12,387 m^2) of the total area damaged in *new fields*, followed by 21 % (4,583 m^2) for rodents, 20 % (4,384 m^2) for antelopes and only 2 % (420 m^2) for other species. Elephants also damaged 8,509 m^2 in *old fields* and 15,800 m^2 in *la Haute*. In addition to manioc, elephants damaged banana and taro in 8 fields during 20 raid events. They raided banana and taro along with manioc in 13 cases, and just banana in seven cases. When elephants damaged banana or taro in a field, the mean damage was 52 % of the

planted banana (range 1-100 %) and 37.5 % for taro (range 1-100 %). Gorillas damaged a total of 16 banana stems over 3 fields, for a mean 11 % (range 2.6-20 %) of the banana present. The area damaged per field by pest groups did not differ between Ntchongorové and Idjembo (Table 4.5), so I therefore pooled the data for further analysis. The area damaged varied significantly between pest groups (Friedman test: df = 3, $\chi^2 = 22.46$, $p < 0.001$) and post hoc tests revealed that other species damaged crops less than rodents and antelopes (Table 4.6, Fig. 4.18). Elephant damage was more intense than other pest groups, with 80 % of elephant damage classified as intense compared to less than 20 % for the three other groups (Fig. 4.19).

Table 4.5: Results of Mann-Whitney tests comparing area damaged per field and pest group between Ntchongorové (N = 11) and Idjembo (N = 10). For elephants $N_{Ntchongorové} = 11$ and $N_{Idjembo} = 11$.

Raiding species	U	p-value
Elephants	60.00	1.000
Rodents	58.00	0.898
Antelopes	56.00	0.797
Other species	52.50	0.863

Table 4.6: Results of Wilcoxon tests comparing the area damaged by different pest groups. (N = 21, Significant result in bold).

Pest groups compared	Z	p-value
Elephants – Rodents	-1.25	0.212
Elephants – Antelopes	-1.49	0.136
Elephants – Other species	-1.12	0.263
Rodents – Antelopes	-0.40	0.687
Rodents – Other species	-3.74	**< 0.001**
Antelopes – Other species	-2.94	**0.003**

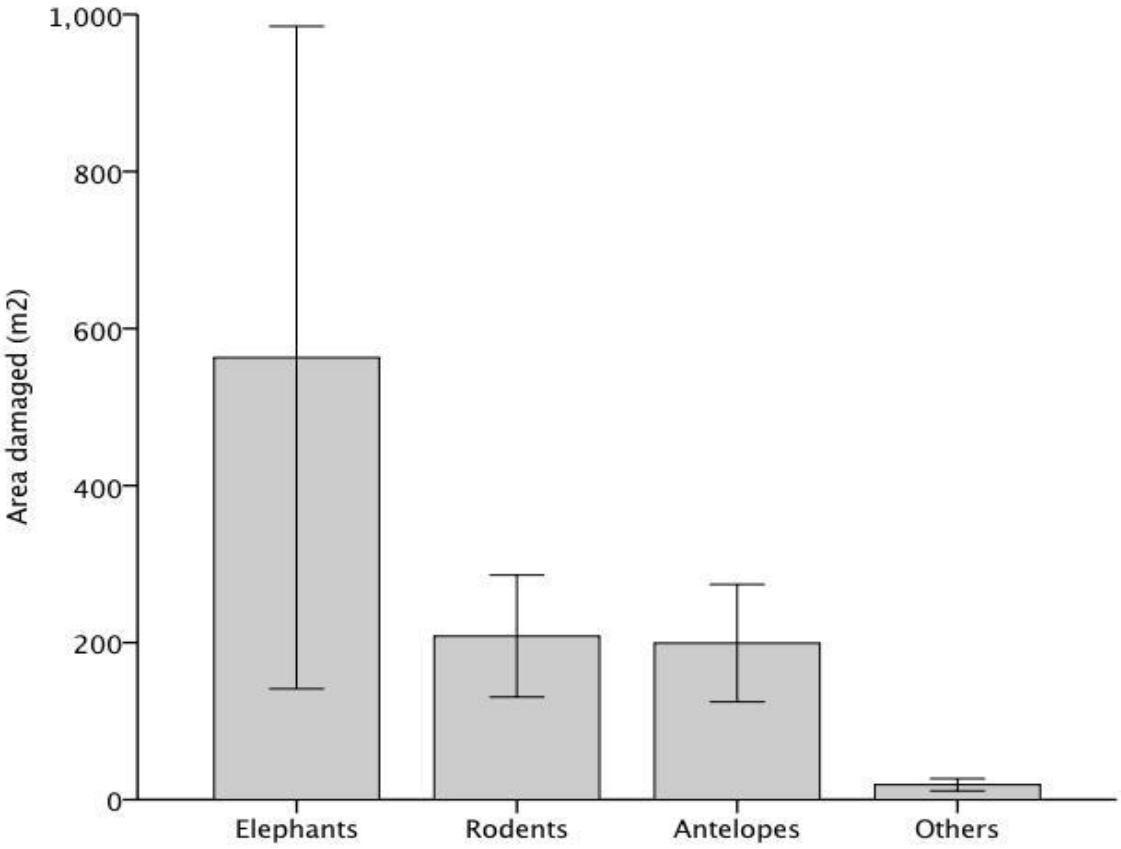

Figure 4.18: Mean (± SEM) area damaged per field by pest group.

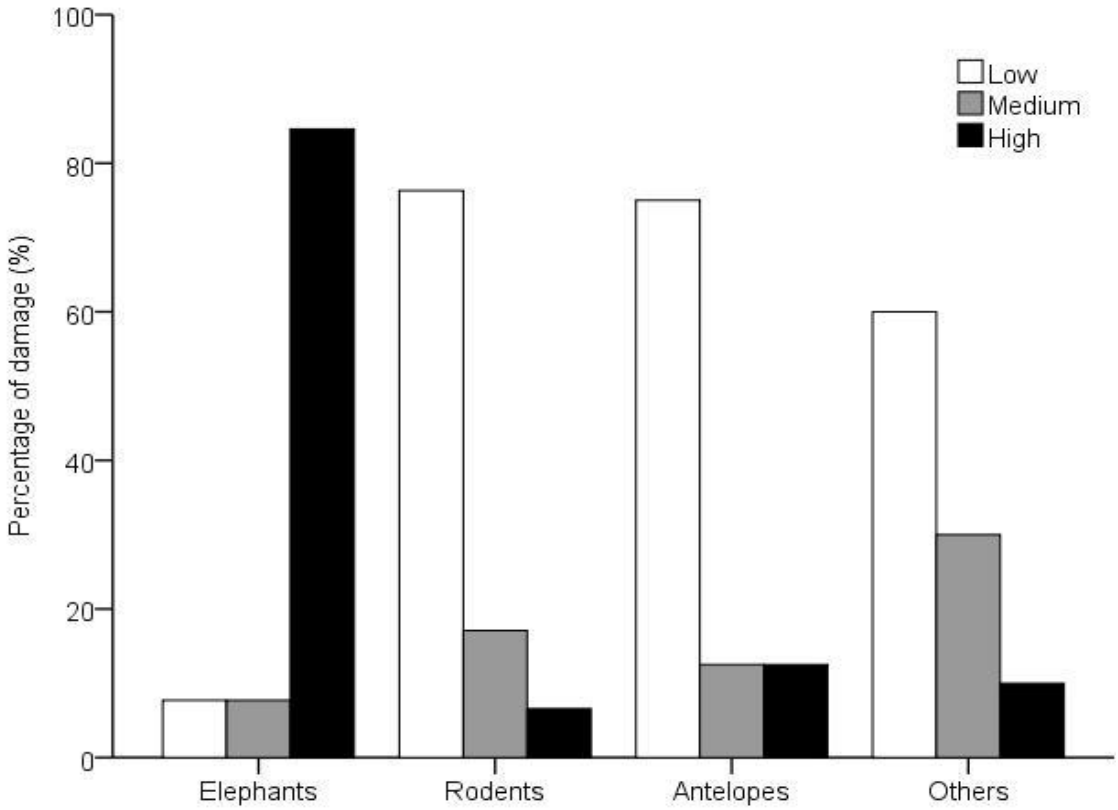

Figure 4.19: Percentage of low, medium and high intensity damage by pest group.

Although I could not include data from *la Haute* in the previous analyses, as I could not record damage for all pests, I did investigate whether the three *regroupements* differed in the area damaged by elephants. The three zones differed significantly (Kruskal-Wallis: df = 2, χ^2 = 13.34, p = 0.001) with elephants damaging *la Haute* more heavily than Ntchongorové ($N_{Ntchongorové}$ = 11 and $N_{laHaute}$ = 18, U = 39.00, p = 0.003) or Idjembo ($N_{Idjembo}$ = 11, U = 34.00, p = 0.003).

4.3.2.2.iv Severity and crop loss

In total, 11 of 42 *new fields* and 2 of 14 *old fields* were severely damaged (Fig. 4.20), among which eight *new* and two *old fields* were damaged by elephants only, and two *new fields* were damaged by the combined action of rodents, antelopes and other species. Of the eight *new fields* that were severely damaged by elephants, seven were located in *la Haute*. The two *old fields* damaged were located in Idjembo. Farmers in *la Haute* claimed that another eight *old fields* had been severely damaged by elephants during the previous and the study year. A further five fields (three *new* and two *old*) suffered damage of medium severity, of which four were damaged by elephants and antelopes together.

The total crop loss caused by mammals in Loango during my study was 35,428 m^2, which is equivalent to 75 % of the total area damaged. If we exclude *old fields* and *la Haute,* for which I only recorded area destroyed, this drops to 50 %. The mean crop loss when considering all new fields (N = 40) was 16.00 ± 3.96 % (range 1-90%) per field and crop loss did not differ between the three *regroupements* (Kruskal-Wallis: Area lost: df = 2, χ^2 = 2.46, p = 0.292; Proportion of field lost: df = 2, χ^2 = 2.21, p = 0.331). When considering only damaged fields (N = 24), the mean crop loss was 26.67 ± 5.64 %.

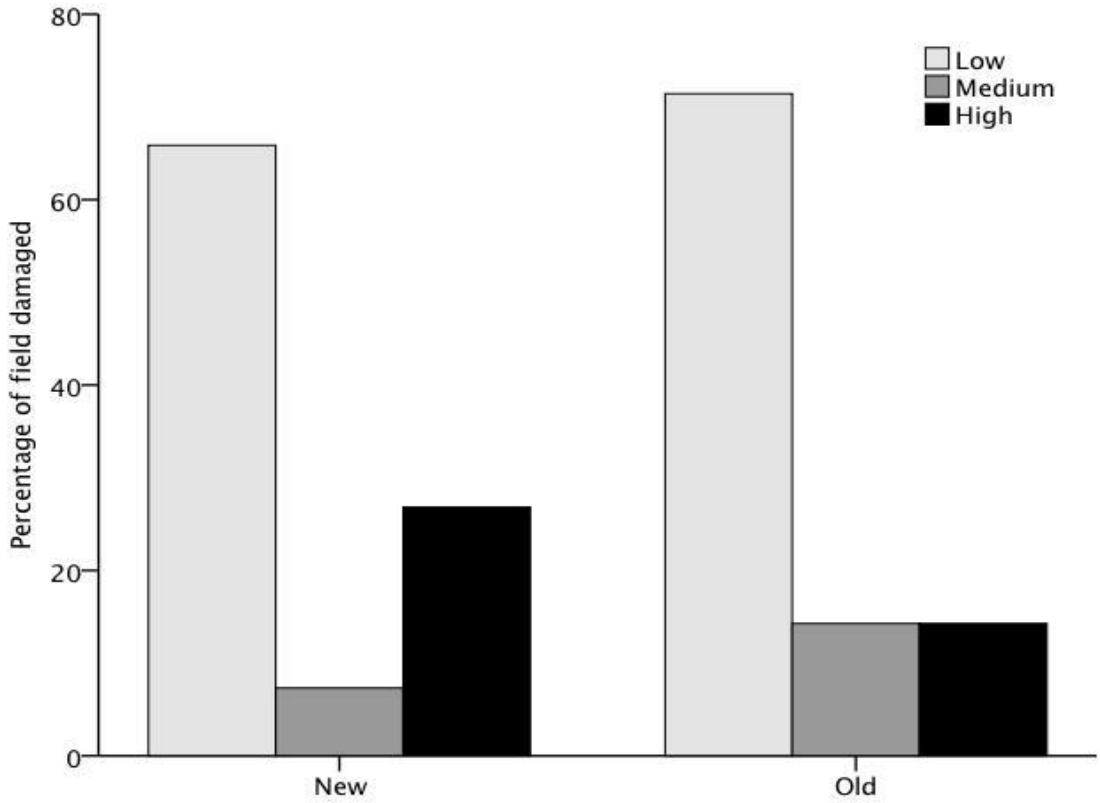

Figure 4.20: Percentage of fields damaged by level of severity for *new* and *old fields.*

Elephants were responsible for 84 % (22,606 m^2) of the total crop loss and 61 % of the crop loss excluding *la Haute* (Fig. 4.21). Elephants caused greater crop loss per field than any other pest group (Table 4.7) but this difference was not significant (Friedman test: df = 3, χ^2 = 7.13, p = 0.068). Rodents (2,559 m^2), antelopes (1,698 m^2) and other species (71 m^2) caused less loss (Table 4.7 and Fig. 4.21).

Table 4.7: Mean (± SEM) area of crop destroyed (m^2) per field by pest group.

Pest groups		**Mean**	**SEM**
Elephants	Ntchongorové and Idjembo	303.9	213.9
	La Haute	883.5	471.9
Rodents		121.9	83.1
Antelopes		80.9	52.4
Other species		3.2	1.9

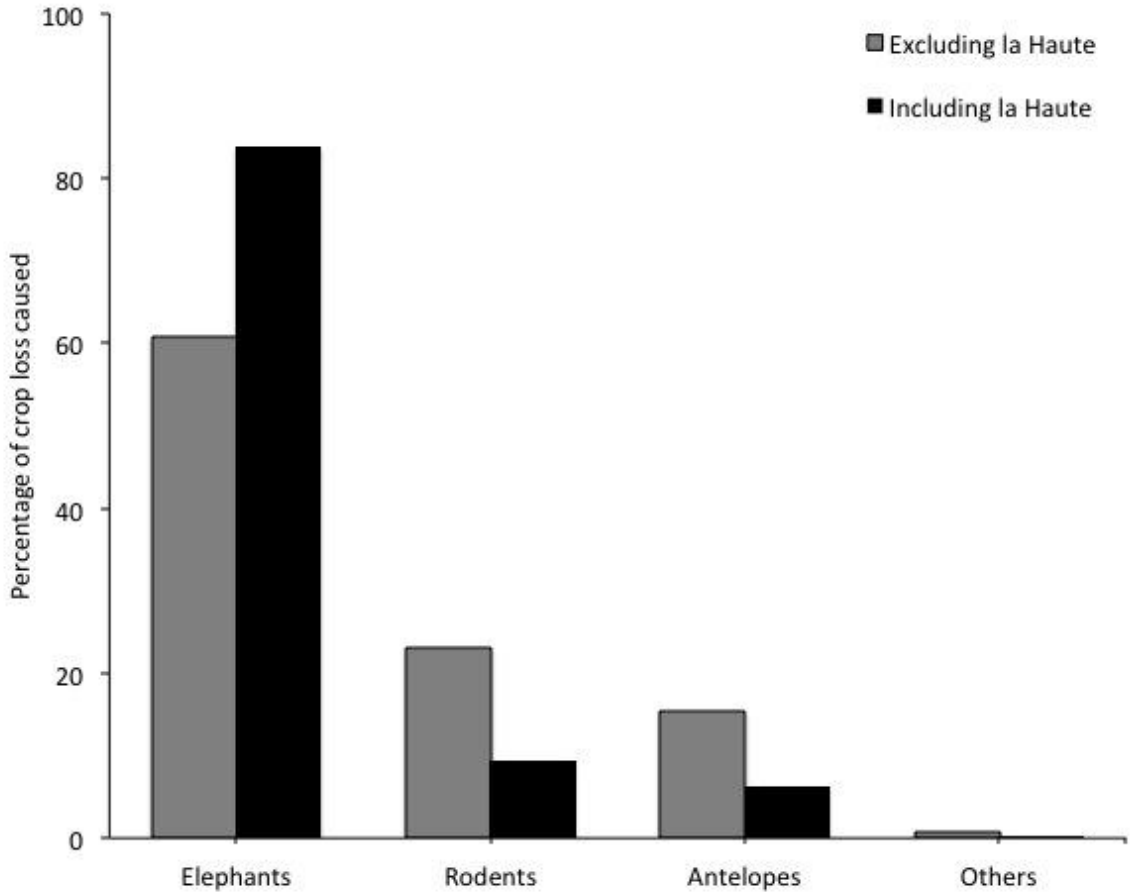

Figure 4.21: Percentage of crop loss by pest group.

4.3.3 Factors affecting crop damage

4.3.3.1 Natural factors

4.3.3.1.i Seasonality

There was no significant difference in the total frequency of damage (df = 21, t = -0.46, p = 0.650) or the area damaged (Wilcoxon: N = 22, Z = -0.23, p = 0.821) between the dry and the wet seasons. Similarly, there was no difference between seasons when I split the data by pest group, except for rodents, which damaged more during the wet season than during the dry season (Table 4.8, Fig. 4.22). For the most damaged field in Ntchongorové, which is also the field furthest away from the centre of the *regroupement*, all raids occurred during the wet season (December 2009, then end of January to April 2010). However, the two other fields damaged in Ntchongorové were damaged in both seasons, and most of the damage recorded occurred during the dry season. In *la Haute*, farmers complained heavily about elephant damage during April and May but some farmers also said that elephants wiped out their fields in November and

December. All raids by others occurred during the dry seasons, except for one raid by red-capped mangabeys.

Table 4.8: Results of t-tests and Wilcoxon tests comparing damage between the dry and the wet seasons by pest group. (Significant result in bold)

Pest group	Frequency of damage			Area damaged		
	N/df	Z/t	p-value	N	Z	p-value
Elephants	N = 22	Z = -0.77	0.444	22	- 0.94	0.345
Rodents	df = 20	t = -1.72	0.101	21	- 2.62	**0.009**
Antelopes	df = 20	t = -0.07	0.942	21	-1.63	0.102

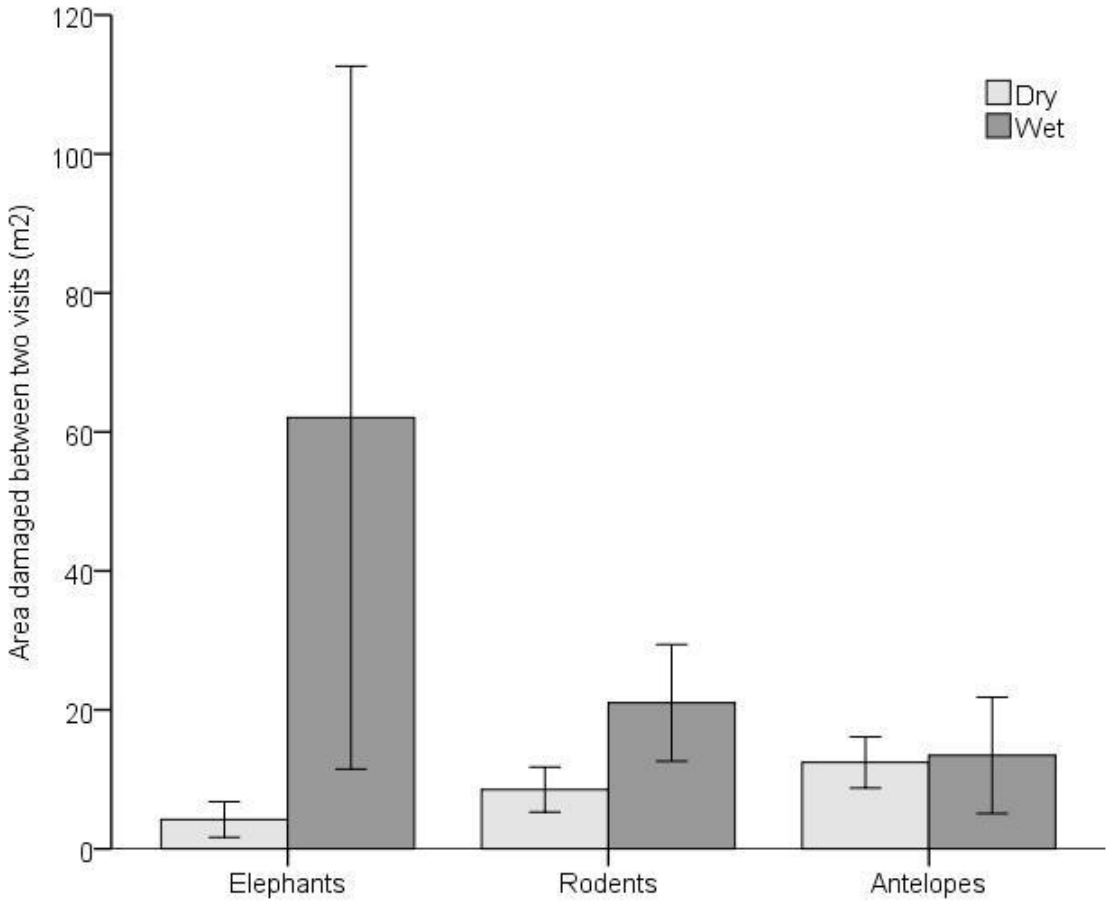

Figure 4.22: Mean (± SEM) area damaged by pest group by season.

4.3.3.1.ii Surrounding habitat

Mature secondary forest surrounded 30 fields, young secondary forest surrounded four fields and young secondary forest with palm trees surrounded six fields. The frequency of raiding events did not differ significantly by forest age in Ntchongorové and Idjembo (N_{Mature} = 12, N_{Young} = 10, Mann-Whitney: U = 37.50, p = 0.140). However, the frequency of raiding events differed

between the three different forest types (N_{Mature} = 12, N_{Young} = 4, N_{Palm} = 6; Kruskal-Wallis: df = 2, χ^2 = 6.76, p = 0.034) and post hoc tests revealed that raid frequency was lower in palm forest (5.1 ± 1.9) than in mature forest (13.2 ± 1.9) or young forest (14.9 ± 4.0) (Table 4.9). However, frequencies did not differ when I used the non-raided/raided frequency variable (Kruskal-Wallis: df = 2, χ^2 = 4.91, p = 0.086). There was no difference in area damaged by forest age when including all zones (Mann-Whitney: U = 135.50, p = 0.656). There was a tendency for the area damaged to differ between fields in different forest types, but the result was non-significant (Kruskal-Wallis: df = 2, χ^2 = 5.91, p = 0.058).

Table 4.9. Results of Mann-Whitney tests comparing raid frequency between surrounding forest types. (Significant results in bold)

Forest types compared	Frequency of damage	
	U	p-value
Mature – Young	22.00	0.862
Mature – Palm	11.00	**0.018**
Young – Palm	2.00	**0.038**

Elephants

Elephant damage did not differ between mature and young forests ($N_{Mature\_Frequency}$ = 12, N_{Mature_Area} = 30; N_{Young} = 10; Mann-Whitney: Frequency: U = 52.00, p = 0.628; Area: U = 90.00, p = 0.062). Frequency of damage did not vary between forest types (N_{Mature} = 12, N_{Young} = 4 and N_{Palm} = 6; Kruskal-Wallis: df = 2, χ^2 = 3.25, p = 0.197), but there was a tendency for area damaged to differ, although the result does not reach significance (N_{Mature} = 30; Kruskal-Wallis: df = 2, χ^2 = 5.68, p = 0.059, Fig. 4.22). Post hoc tests revealed a possible tendency for elephants to damage less in palm forests than in mature forest (Table 4.10, Fig. 4.23). In addition, elephants damaged more fields located at, or touching, fields raided in the past (df = 1, χ^2 = 5.32, p = 0.021) but they did not damage more on the forest edge (Wilcoxon: Frequency: N = 19, Z = -1.09, p = 0.276; Area: N = 19, Z = -1.10, p = 0.273).

Table 4.10: Results of Mann-Whitney tests comparing area damaged by elephants between surrounding forest types. (Significant result in bold)

Forest types compared	Area damaged	
	U	p-value
Mature – Young	51.00	0.661
Mature – Palm	39.00	**0.029**
Young – Palm	6.00	0.257

Rodents

There was no difference in the frequency (df = 19, t = 1.10, p = 0.286) or area (Mann-Whitney: U = 50.5, p = 0.808) of crops damaged by rodents by forest age (N_{Mature} = 12, N_{Young} = 9). There was a tendency for the frequency of rodent damage to differ between forest types (N_{Mature} = 12, N_{Young} = 3 and N_{Palm} = 6) but the result was not significant (Kruskal-Wallis: df = 2, χ^2 = 6.04, p = 0.054). The result was also non-significant when using the non-raided/raided frequency variable (Kruskal-Wallis: df = 2, χ^2 = 5.01, p = 0.082) so I did not explore this further. The area damaged did not differ between forest types (Kruskal-Wallis: df = 2, χ^2 = 3.46, p = 0.177). Finally, rodents did not damage more on the forest edge than elsewhere (paired t-test: Frequency: df = 15, t = 0.99, p = 0.336; Area: df = 15, t = 1.078, p = 0.298).

Antelopes

There was no difference in the frequency (Mann-Whitney: U = 44.50, p = 0.508) or area (U = 42.00, p = 0.422) of crops damaged by antelopes by forest age (N_{Mature} = 12, N_{Young} = 9). While antelope damage did not vary in frequency by forest type (N_{Mature} = 12, N_{Young} = 3 and N_{Palm} = 6; Kruskal-Wallis: df = 2, χ^2 = 5.08, p = 0.079), there was a significant difference in area damaged (Kruskal-Wallis: df = 2, χ^2 = 7.70, p = 0.021). Post hoc tests revealed that antelopes damaged more in fields surrounded by mature forests and young forests than palm forests (Table 4.11 and Fig. 4.23). Antelopes raided more frequently (paired t-test: df = 15, t = 2.29, p = 0.037) and raided larger areas (paired t-test: df = 15, t = 2.90, p = 0.011) on the forest edge.

Table 4.11: Results of Mann-Whitney tests comparing the area damage by antelopes between surrounding forest types. (Significant result in bold)

Forest types compared	Area damaged	
	U	p-value
Mature – Young	8.00	0.180
Mature – Palm	14.00	**0.041**
Young – Palm	0.00	**0.024**

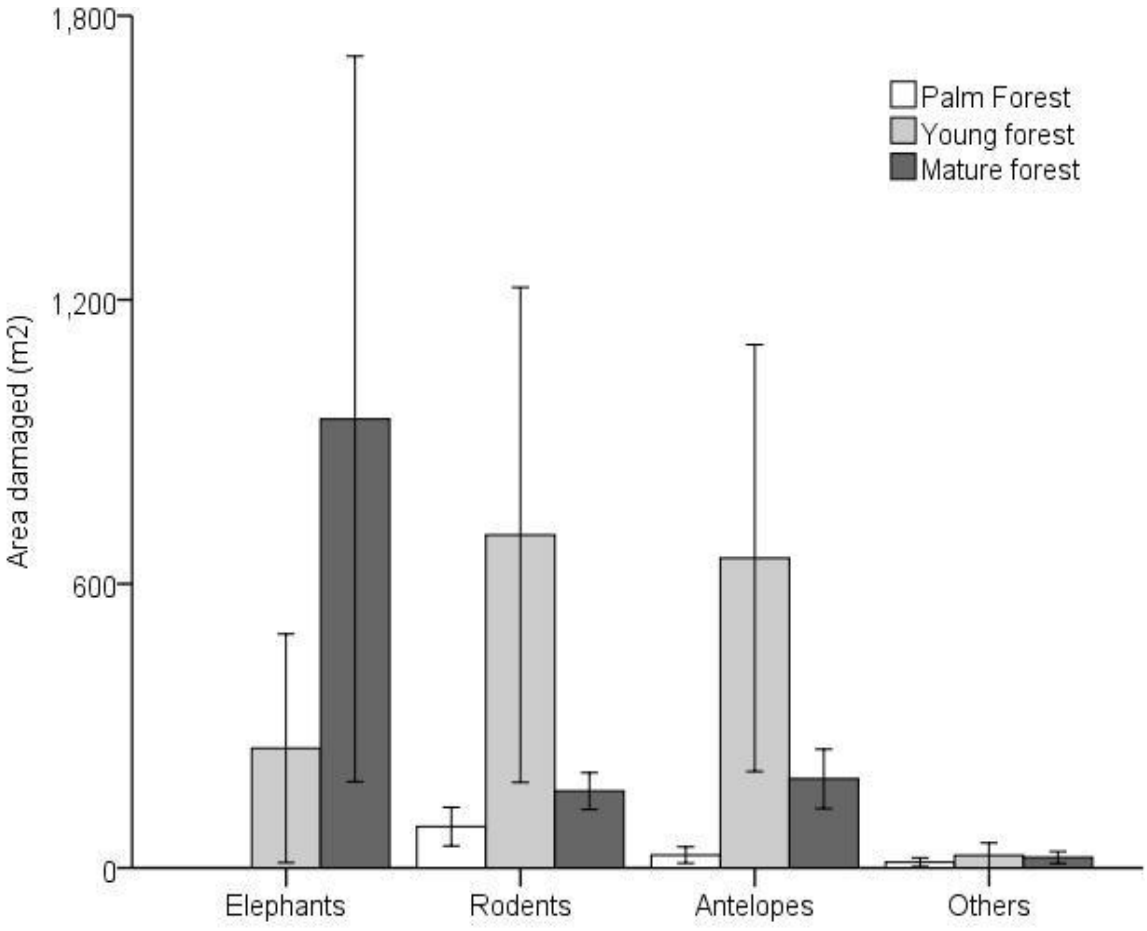

Figure 4.23: Mean (± SEM) area damage per field by pest group and surrounding forest type.

4.3.3.2 Anthropogenic factors

4.3.3.2.i Preliminary analysis

Fields in Ntchongorové were significantly closer to the park boundaries (1.2 ± 0.1 km) than those in Idjembo (9.0 ± 0.4 km) (Mann-Whitney: U = 0.00, p < 0.01). Distance to the park was negatively correlated with distance to roads, showing that villages in *la Haute* are significantly

further away from roads than other *regroupements* (Table 4.12). Because distance to the lagoon was strongly correlated with distance to the park and to roads, I excluded it from the following analyses. Because both distance to the park and to roads are known to affect animal behaviour (e.g., Kagoro-Rugunda 2004; Laurance et al. 2006a), I retained both variables for the following analyses.

Table 4.12: Results of Kendal's τ correlations examining relationships between anthropogenic factors (N = 40). (Significant result in bold)

Kendall's correlation		Distance to lagoon	Distance to settlement	Distance to road
Distance to park	τ	0.72	-0.02	- 0.34
	p	**< 0.001**	0.855	**0.002**
Distance to lagoon	τ		- 0.11	- 0.56
	p		0.362	**< 0.001**
Distance to settlement	τ			0.10
	p			0.375

The number of neighbouring fields per field differed significantly between *regroupements* (Kruskal-Wallis: df = 2, χ^2 = 11.76, p = 0.003). Fields in *la Haute* (N = 18, mean ± SEM: 0.39 ± 0.17) had significantly fewer neighbouring fields than fields in the two other *regroupements* (Ntchongorové: (N = 11) 1.27 ± 0.24; Idjembo: (N = 11) 2.64 ± 0.67, Table 4.13).

Table 4.13: Results of Mann-Whitney tests comparing the number of neighbouring fields per field in the three study zones. (Significant results in bold)

Comparison	U	p-value
Ntchongorové – Idjembo	42.00	0.243
Ntchongorové – *la Haute*	42.00	**0.009**
Idjembo – *la Haute*	40.00	**0.007**

4.3.3.2.ii Effect of anthropogenic factors

When considering all pest species together, crop damage was not affected by any of the anthropogenic factors (Table 4.14). Nor did any factors affect elephant damage. The frequency of rodent damage was lower in fields closer to the park but the correlation is weak, and was non-significant when I used the non-raided/raided frequency variable (τ = 0.284, p = 0.078). No

other factors affected damage by rodents. Antelopes tended to damage more fields located closer to roads, and the correlation is moderate. Antelopes also tended to damage fields with higher numbers of neighbouring fields less frequently. However, distance to the park and distance to settlements did not affect antelope damage.

Table 4.14: Results of Kendal's correlations examining the relationship between crop damage and anthropogenic factors. (Significant results in bold)

Anthropogenic factors tested		Distance to park	Distance to roads	Distance to settlements	Number of neighbouring fields
All pest groups (N = 22)					
Frequency of damage	τ	0.07	-0.20	-0.11	-0.15
	P	0.651	0.193	0.512	0.379
Area damaged	τ	0.11	-0.17	-0.00	-0.13
	p	0.363	0.122	0.981	0.290
Elephants					
Ntchongorové and Idjembo (N = 22)					
Frequency of damage	τ	-0.06	0.15	0.11	-0.24
	p	0.717	0.385	0.543	0.204
Area damaged	τ	-0.06	0.08	0.01	-0.25
	p	0.745	0.638	0.939	0.191
La Haute (N = 18)					
Area damaged	τ	-0.29	- 0.28	-0.08	-0.27
	p	0.099	0.116	0.663	0.185
Rodents (N = 21)					
Frequency of damage	τ	0.35	-0.15	-0.13	0.13
	P	**0.029**	0.362	0.458	0.449
Area damaged	τ	-0.15	-0.12	-0.03	-0.02
	p	0.349	0.264	0.847	0.925
Antelopes (N = 21)					
Frequency of damage	τ	-0.15	-0.29	0.02	-0.44
	P	0.359	0.076	0.922	**0.012**
Area damaged	τ	-0.03	-0.33	0.03	-0.28
	p	0.855	**0.039**	0.872	0.115

4.4 Discussion

4.4.1 Extent and pattern of crop damage

Fields in Loango were similar in size to farms in other sites in Gabon (0.4 ha, Lahm 1993; 0.33 ha, Blaney et al. 1999) but slightly smaller than in other countries in the Central African region (Uganda: 1.4 ha, Naughton-Treves 1998, 0.7 ha, Hill 2000). Mammal damage caused to fields in and around Loango National Park is much higher than previously recorded: 16 % crop loss per field compared to 0.75 % (Languy 1996) and 6.2 % (Blaney et al. 1999). When considering only damaged fields, the mean crop loss increases to 27 %, still higher than 6.5 % recorded by Languy et al. (1996), but similar to the losses of 25 % recorded by Hill (2000) in Uganda. One possible explanation for the difference between my data and those of Blaney (1999) is that, like Lahm (1998), they collected data in each village only once, so their data under-estimate annual crop loss. Damage to crops in Loango also varied locally, which is consistent with the literature on crop-raiding (Languy 1996; Hill, Osborn and Plumptre 2002; Linkie et al. 2007), and may explain the differences between my results and those of other studies.

While most fields experienced some damage, it was unequally distributed among fields, as in many other studies of crop-raiding (Lahm 1993; Languy 1996; Naughton-Treves 1998; Hill 2000; Webber 2006; Linkie et al. 2007). Most of the damage caused by mammals targeted manioc, and all species except gorillas raided manioc, which is also the main food and cash crop for farmers in Loango. Unlike Uganda, where baboons are often the major pest species (Naughton-Treves 1998; Hill 2000), primates were not a serious problem in Loango, as they targeted mostly fruits and non-major food crops. Farmers often allowed chimpanzees to raid fruit, describing them as “ingenious”, “sneaky”, and “intelligent”. When primate pests are associated with acceptable crop-raiding and values linked with human behaviour, farmers are often more tolerant towards these species (Hill and Webber 2010), and this also seems to be the case in Loango. Villagers also tolerated mangabeys and guenons around villages even though they were sometimes shot at when raiding fields. The absence of mandrills (*Mandrillus sphinx*), who are known to raids heavily in other parts of Gabon (Lahm 1993), probably influences the low level of primate damage in Loango.

Rodents and antelopes damaged crops more frequently than other pest species, which is consistent with studies in Cameroon (Arlet and Molleman 2007) and the Democratic Republic of Congo (Drazo et al. 2008), and with farmers’ perceptions in many regions of Gabon (Lahm 1993, 1996). Of the rodents, the cane rat was the most damaging species, as is also recorded in Cameroon (Arlet and Molleman 2007). The frequency of elephant raids was typically low, but the most damaged field in Ntchongorové was raided 39 times by elephants in January-April 2010,

with 22 visits in February alone. This farmer had already suffered from the destruction of her fields by elephants in the two previous years. This observation, from the only farmer who updated her calendar, suggests that elephants can be persistent raiders, especially when they have previously raided fields successfully. Statistical analysis confirmed this, as farms located at, or near, fields raided by elephants in the past were significantly more likely to be raided. This result supports previous studies from Kenya (Sitati, Walpole and Leader-Williams 2005) as well as local farmers' reports in Loango. One farmer in Idjembo explained that she moved her field to a new location because rodents were not present there yet and also because elephants "haven't found the place yet".

Rodents and antelopes damaged most fields but most of their damage was moderate or low. In contrast, elephants showed a rare but extreme raiding pattern, consistent with the literature concerning other sites (e.g., Lahm 1993; Naughton-Treves 1997; Hoare 1999). While elephants raided less frequently than rodents and antelopes, they were the most damaging pest, as they were responsible for 57 % of the area damaged, and 84 % of the loss incurred by farmers. Statistical tests did not show significant differences between species, possibly because of the small sample size and because I used a ranking non-parametric test that compared damage on a field-by-field basis. Rodents damaged many fields that elephants did not raid at all, meaning that the tests may have lacked a sufficient sample of comparable data. The same test also found no significant difference between damage by elephants and other species, although the latter is very low in both frequency and area, supporting this hypothesis. Because elephant damage is particularly clustered, a larger sample size, for example including *la Haute,* would probably have been more informative, particularly as elephant damage was the most severe at *la Haute*. I detected very little or no rodent damage in *la Haute,* and interviews with farmers suggested that damage by rodents, antelopes or other species was not a problem during the study period. This suggests that rodent damage was negligible compared to elephant damage in *la Haute,* or that it was undetectable because elephant damage was so severe.

The growth and ripening stage of crops can be an important parameter in explaining the timing of pest damage (Chiyo et al. 2005; Tweheyo, Hill and Obua 2005; Webber et al. 2011). At my study site, one field was completely devastated at the growing stage by the cumulative effect of rodents and antelopes. Rodents and antelopes never caused heavy loss to mature plants, unlike elephants. Elephants only damaged two recently planted fields, and uprooted most banana and taro seedlings without eating them, which may suggest an exploratory or opportunistic raid. All other raids were on mature plants. Of the nine farms that were severely damaged during the study, elephants were solely responsible for damaging eight and all were damaged when mature. This contradicts findings from Languy (1996), who found no differences in damage to young and mature fields. Damage at the growing stage, while devastating for the

farmer, did leave time to partially replant the field, as discussed by Hill (2000). Some farmers in *la Haute* used the short dry season to plant *new fields* when crop-raiding destroyed their entire fields before January. This is consistent with farmers in other parts of Gabon, such as Makokou (in the North), where the short dry season is well-defined and farmers clear two fields a year, one in each dry season (pers. obs.). However, when the damage destroyed a mature field, farmers had to wait until the next dry season to replant. Because of their tendency to inflict severe damage to mature fields, elephants are therefore the most damaging pest for subsistence farmers in Loango.

4.4.2 Factors affecting crop-raiding patterns

4.4.2.1 Elephants

4.4.2.1.i Seasonality and access to water

Elephant damage follows seasonal patterns in Africa (Hoare 1999; Chiyo et al. 2005; Barnes et al. 2006; Linkie et al. 2007). In Gabon, seasonality in crop-raiding by elephants seems to differ between regions. Lahm (1996) found that damage is higher during wet seasons in forested areas and the coastal areas, where my study is located, but higher in the long dry season in savannah villages in South Western Gabon. My results do not show any particular pattern at the scale of the study site. Rather, they are consistent with findings from Loango South, where most farmers complained about elephant damage all year long but with micro-scale variation (e.g., between *regroupements* and villages: Blaney et al. 1999). There are several possible explanations for the lack of clear seasonal pattern at the scale of the study site.

First, manioc and bananas, the most damaged crops, are perennial and there is no seasonal peak in availability. Thus, there is no peak damage season, as suggested by Chiyo et al. (2005) for Uganda. Second, elephants may show seasonal movements that would lead to micro-scale variation in crop-raiding. Chiyo et al. (2005) suggested this when they hypothesised that the proximity of wet season forage sites in forested habitats such as Gabon could explain localised peaks in elephant damage. The Akaka area of Loango National Park, a large swamp area south of the study site (Fig. 4.24), shows increased elephant density during the dry season. Tourism activities centre on that area during the dry season partially for that reason, and researchers in the area corroborate these observations (Wrege et al. 2010; Matthew H. Shirley pers. com). A long-term research team in the area also observed higher elephant density around swamps during the dry season (Josephine Head and Luisa Rabanal, pers. com.) and Lahm (1996) recorded similar observations from villagers in the north of Gabon. These results are congruent with the literature stating that water availability and the availability of accessible herbaceous

forage in swamps may explain elephants ranging patterns during the dry season (White 1994; Blake 2002; Buij et al. 2007).

To examine the hypothesis of micro-scale seasonal variation in elephant crop-raiding, we need to take a closer look at spatio-temporal structure of damage in Loango. Most of the damage in the most damaged field in Ntchongorové occurred during the wet season. Many farms in Idjembo and *la Haute* received heavier damage in April and May, based on farmer interviews and my observations. This represents the transition between the wet and dry seasons. The villages in *la Haute* are located between Ntchongorové/Idjembo and Akaka, making it likely that they are raided as elephants leave the northern and more forested areas of study site to move south toward Akaka and the swampy areas near rivers (Fig. 4.23). According to previous studies in the Central African region, the home ranges of forest elephants range 7.3 to > 200 km^2 and are larger for males than for females (Blake et al. 2008; Kolowski et al. 2010). In Loango National Park, Blake et al. (2008) recorded a mean home range of 55.5 km^2 for six radio-collared female elephants. Thus elephants in Loango have a home range large enough to include both Akaka and my study villages (Fig. 4.24).

I recorded crop damage and elephants tracks on roads in Idjembo during the entire dry season, which may result from the presence of at least two permanent swamps permitting the year-long presence of elephants in the area. However, the high damage to *old fields* in Idjembo during the dry season could also be explained by seasonality in human activity patterns. Farmers in Idjembo have their *old fields* near the village while most of their *new fields* are located in Mpembanyanbiè. At the beginning of the dry season farmers start clearing their *new fields*, and many farmers in Idjembo left their villages and their *old field* unattended for several days or weeks, making it an easy target for roaming elephants (Chapter 5). As a consequence, the pattern of elephant damage may be explained partially by their movements across the landscape, and the availability of swamps and water points, rather than the biophysical characteristics of each field (Fig 4.24).

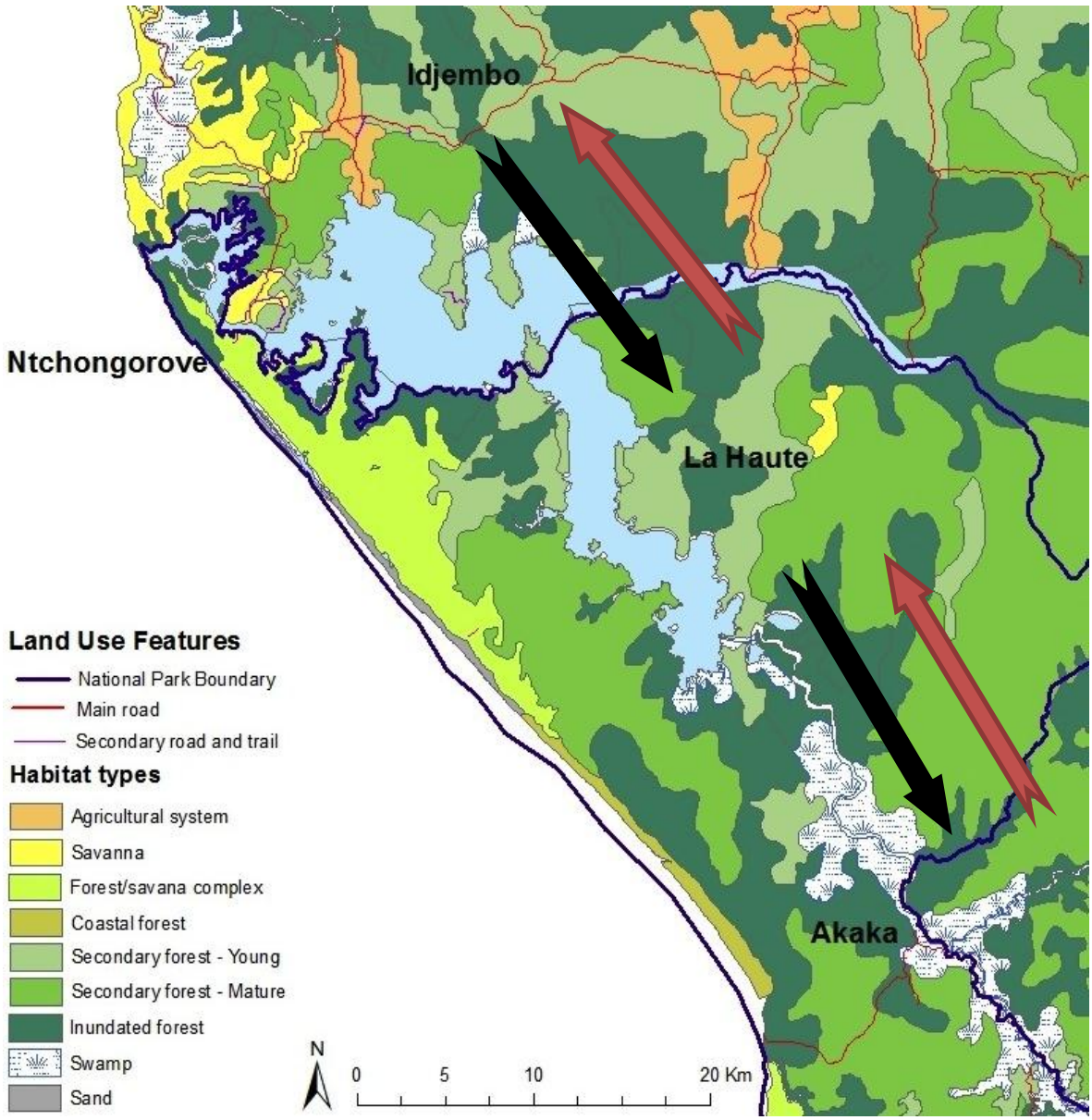

Figure 4.24: Possible seasonal movements of elephants that may underlie patterns of crop damage. Black arrows represent movements at beginning of the dry season and red arrows possible movements at the end of the dry season.

4.4.2.1.ii Habitat and human disturbance

There was a tendency for elephants to damage more fields located in mature forest. Mature forests surrounded most of the fields in Idjembo, all farms in *la Haute* and the three damaged fields in Ntchongorové. This result, however, must be viewed with caution, if only because the number of fields in mature forest was disproportionately high compared to the number of farms in other forest types, which might bias the results. In addition, palm forest was exclusively found close to the village centre in Ntchongorové, where human density is the highest at the study site, representing a possible confounding effect as several studies have reported that human disturbance is the best determinant of elephant range and habitat use

(Barnes et al. 1991; Laurance et al. 2006a; Blake et al. 2008; Kolovski et al. 2010). Ntchongorové also possesses the highest density of savannah compared to the other two sites, which may deter elephants. Osborn and Parker (2002) suggest that open areas, of at least 5 m wide in their study, increased raiding elephants' wariness. Nyhus et al. (2000) also show that crop-damage increases with increasing forest cover on field edges, and I found that elephant damage significantly more in *la Haute* where the numbers of neighbouring fields is lower. It is, therefore, possible that the larger open area resulting from combined fields acts as a deterrent for elephants. As a consequence, in forested habitat such as Loango, field isolation is likely to increase vulnerability to crop-raiding. However, this result may also reflect a dilution of damage across fields, rather than an actual decrease in the area damaged, as suggested by Nigerian farmers in Atteh (1984). Finally, this finding may reflect an effect of higher human density in contiguous than isolated fields, but I could not control for this in my analysis.

I also found that elephants raid more in *la Haute*, i.e., closer to or in the National Park, although the correlation with distance to the park was not significant. This tends to support Hoare's (1999) hypothesis of "frontline farms" – farms between human-dominated landscape and wildlife refuges – that suffer from heavy damage. Because law enforcement inside the park is recent, it is unclear how much protection is actually provided to elephants. However, as described in Chapter 3, hunting has been controlled for decades in what is now the park, and is generally quite low in the whole area. Villages in *la Haute* are also further away from roads than other villages in the study. Previous studies suggest that elephants avoid roads (Blake et al. 2008; Wrege et al. 2011), but I did not find this. In fact, I recorded regular use of roads by elephants and other mammals such as antelopes, primates and leopards, even on well-used roads, and people in Idjembo did not recommend walking on the road at night because of possible encounters with elephants. For two fields damaged by elephants, I frequently recorded tracks, trails or roads leading to the damaged field. Laurance et al. (2006a) and Blake et al. (2008) suggest that elephants avoid roads much more under increased hunting pressure. As a consequence, my findings may support the claims by some conservation actors and local people that hunting pressure is low at my study site. My observations of crocodile, hippos, antelopes, chimpanzees and gorillas near both Idjembo and Ntchongorové also support this view. However, there is a need for detailed data on the level of hunting in the area to test this hypothesis. This is difficult to obtain, as hunting is mainly an illegal activity that can be overlooked easily. Finally, local people and authorities blamed increased crop damage by elephants on oil exploitation and forestry. They blamed oil companies for disturbing the animals' habitat and forestry for depleting the forest of elephant food trees, pushing them towards villages where disturbance is less and food is abundant.

It is likely that the effects of field isolation, lower human density and moderate human disturbance, combined with a matrix of forest at different stages of succession, increases vulnerability to crop-raiding in Loango and makes fields in *la Haute* particularly attractive to elephants. However, the location of permanent water points is likely to influence elephant movements across the landscape, and explain spatio-temporal variations in damage.

4.4.2.2 Rodents and antelopes

Unlike observations made in north-east Gabon by Lahm (1993), rodent damage in Loango was clearly seasonal. While rodents raided year round, they damaged fields more during the wet season. Rainfall, and consequently food availability, influence breeding patterns in rodents (Leirs et al. 1996, Makundi, Massawe and Mulungu 2006, Drazo et al. 2008), which reproduce during period of food abundance, i.e., wet seasons with lots of fresh grass. This pattern would increase rodent density but also food requirements, as lactating females have higher energetic requirements (Speakman 2007). Drazo et al. (2008) also showed that rodents damaged crops more at the seedling stage in the Central Africa region. Similar complaints by farmers of damage to seedlings occur in Tanzania and Ethiopia (Makundi et al. 2005). My results are consistent with such findings as most of the damage concerned manioc seedlings. In Loango, manioc seedlings appear sometimes in the short wet season and extends into the long wet season. Thus my results support the hypothesis that rodent damage is seasonal, influenced by rain and consequent increased food availability. In contrast, antelope damage was not affected by season, which is surprising as antelope damage targeted particularly new shoots and young leaves of manioc plants, which are more abundant at the wet season.

Drazo et al. (2008) showed that rodent damage was higher in fields bordering fallows or on non-weeded fields where there was an abundance of food and shelter. Studies in Australia (White, Horskins and Wilson 1998) and Vietnam (Brown et al. 2006) drew similar conclusions. Farmers at my study site often linked rodents with grass density in fields. During the dry season the lack of rain led to the non-renewal of grass. In addition, local communities use the dry season to burn savannahs and around villages to maintain the mosaic savannah-forest, and to avoid uncontrolled hot fires. The consequence is a lower availability of suitable rodent habitat, shelter and food near fields during the dry seasons. Antelope damage was lower in forest with palm trees. As for elephants, it is likely that the higher human density around fields in these forests, rather than the type of forest itself, limited antelope presence and field incursions.

Rodent damage did not seem to be affected by distance to roads. This is surprising as roads act as good dispersal routes for rodents (Drazo et al. 2008), and we might expect increased crop-raiding closer to roads. Rodent damage was affected by distance to the park with increasing

damage further away from the park. The reasons for this are unclear but probably lie in the structure of the habitat and the availability of refuges rather than the distance to the protected area itself. Savannah, which can be an appropriate habitat for rodents, is more abundant in Ntchongorové, which is closer to the park than Idjembo. However, there were no significant differences in crop damage between Idjembo and Ntchongorové. As a consequence, further investigation may be needed to understand rodents and the distribution of rodent damage in Loango and Gabon more generally.

In contrast to rodents and elephants, antelopes and duikers damaged more fields that were closer to roads. This is surprising and contrasts with observations in the Central African Republic (Blom et al. 2004), and elsewhere in Gabon (Laurance et al. 2006a), that suggest that antelopes avoid roads. I often spotted antelope tracks on roads during my study. If antelopes use roads to move, they may be more likely to raid fields that are easily accessible from these travel routes, explaining my results. In addition, my results showed that antelopes, unlike elephants and rodents, fed mostly on the forest edge. In several cases antelope damage followed the field/forest boundary, probably so that the animal could stay close to the forest cover. Such risk-averse behaviour is common in human-disturbed habitat (e.g., Blom et al. 2004; Graham et al. 2009). This hypothesis would also explain why antelope damage decreases with increasing numbers of neighbouring fields, as larger open areas would render them more wary.

4.5 Conclusion

My results show that both elephants and rodents cause significant damage to fields in Loango. While rodents, and particularly cane rats, caused frequent damage, this was usually of low severity. Therefore, rodents are not a direct threat to local livelihood in most cases. Elephants, however, were responsible for 86 % of moderately and highly damaged fields, and were the most damaging pest. They were also the pest most complained about by farmers, which is consistent with Lahm's (1996) results. My investigation suggests that field isolation (arrow A in Fig. 4.25) combined with shifting cultivation in a densely forested area (arrow B) is the main force driving crop damage at the scale of the field.

My analysis also shows that seasonality can be an important factor in explaining micro-scale variation in Loango (arrow C in Fig. 4.25), and supports the notion that human-elephant conflict might be better understood at the landscape level than at the field or *regroupement* scale, as also suggested by previous studies (Sitati, Walpole and Smith 2003; Sitati, Walpole and Leader-Williams 2005; Graham et al. 2009). Few studies have looked at elephant movements in Gabon (Blake et al. 2008; Kolowski et al. 2010), and those that have were limited to a National

Park and an oil concession with highly controlled levels of human activity and disturbance (Blake et al. 2008; Laurance et al. 2006a). Understanding how elephants use their habitat while adapting to human disturbances in a country where wild space dominates would provide invaluable information for the mitigation of crop-raiding in Loango and Gabon.

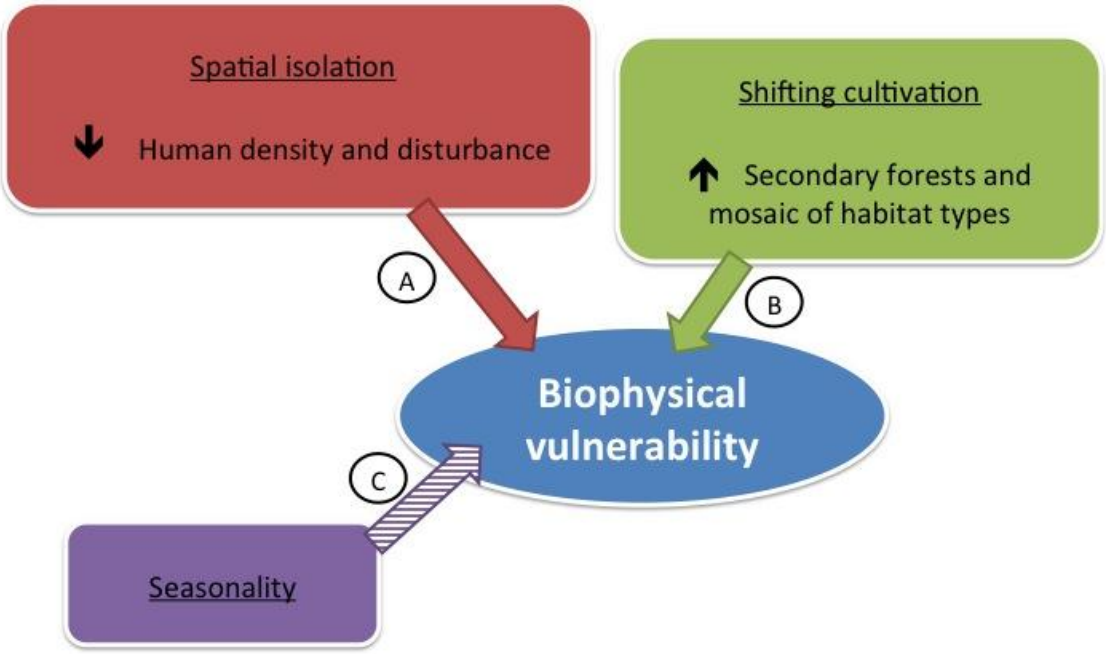

Figure 4.25: Biophysical vulnerability to crop-raiding in Loango. Letters are explained in the text. Solid arrows represent an aggravating effect and stripped arrows represent an influence. Small black arrows pointing down represent a decrease and those pointing up represent an increase.

Gabon is thought to have the largest forest elephant population in Central Africa and elephants occur as much outside as inside protected areas (Blanc et al. 2007). With the park authorities becoming increasingly efficient in controlling hunting in the park, wildlife densities are likely to increase, which will lead to increasing human-elephant interactions and conflicts in the future. Farmers at my study site trapped one gorilla and shot four elephants as direct retaliation for crop-raiding between 2009 and 2011. As killing protected species is illegal this is likely to be an underestimate of the level of retaliation in the area. Crop-raiding in Loango, as elsewhere, has adverse consequences on wildlife survival, and conservation actors in Loango need to prioritise human-elephant conflicts. Understanding influences on crop-raiding is important but is not necessarily enough to mitigate it. In the following chapter, I therefore look at farmers' ability to mitigate crop-raiding at the individual and institutional level.

Chapter 5 – Crop-raiding mitigation: the failure of individual and institutional strategies

5.1 Introduction

Crop-raiding by wildlife is not a new problem, and African farmers have tried for centuries to limit it by various methods (Vansina 1990; Pourtier 1989a). The first step in crop-raiding mitigation is often the use of "deterrent methods" in fields (Hill and Wallace 2012). In Gabon, as in many African countries, traditional, low-cost, deterrent methods are the only affordable way for farmers to limit damage from wildlife (Osborn and Parker 2002; Osborn and Parker 2003; Walker 2012). Traditional deterrent methods can be active (drive away methods) or passive (e.g., scarecrows). The most common strategies include guarding, which often involves chasing away raiders, making noise (e.g., drumming, home-made bells), barriers or ditches, fires, lights, firing a gun in the air or shooting the raider directly, and putting traps or snares around fields (Osborn and Parker 2002; Osborn and Hill 2005; Sitati and Walpole 2006; Graham and Ochieng 2008; Walker 2012). Deterrent methods can also be strategic, for example distributing crops based on raider preferences (Barnes 1996) or planting extra crops to compensate for expected loss (Walker 2010).

Most studies suggest that traditional deterrent methods are rather ineffective and eventually result in raiders becoming habituated, particularly in the case of elephants (Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2002, 2003; Sitati, Walpole and Leader-Williams 2005; Graham and Ochieng 2008). Moreover, even if temporarily efficient, traditional methods rarely solve the problem, but instead displace raiders to neighbouring fields and villages (O'Connell-Rodwell et al. 2000; Graham and Ochieng 2008; Hill and Wallace 2012). Furthermore, they are often socially or economically costly (Hill 2000; Osborn and Parker 2003; Sitati and Walpole 2006; Walker 2012). In Gabon, Walker (2010, 2012) showed that most methods were not cost-efficient when compared to doing nothing or planting more to compensate for expected losses. Hence, even if a deterrent was proven to be effective, farmers might still not adopt this strategy (Graham and Ochieng 2008; Sitati and Walpole 2006). Finally, experimental studies of traditional deterrent methods have largely concentrated on East and Southern Africa. The efficacy of most deterrent methods in the Central African landscape, where dense forest cover, the practice of shifting cultivation and a low human density are combined with a high animal density, remains unknown.

In addition to methods used directly in fields, other strategies are sometimes available to farmers through national regulations. A widespread response to crop damage is selective killing of the raiding animal, either legally or illegally (Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2003). In some African countries, legislation allows for state-controlled killing or translocation of problem animals (O'Connell-Rodwell et al. 2000; Nelson, Bidwell and Sillero-Zubiri 2003). However, such methods are rarely implemented effectively and can be very costly

in the case of translocation (Nelson, Bidwell and Sillero-Zubiri 2003). Compensation schemes are also used, but their effectiveness in protecting farmers' livelihoods is unclear (Nelson, Bidwell and Sillero-Zubiri 2003; Nyhus et al. 2005). In most developing countries, farmers are effectively single-handed in their efforts to protect their fields and cope with crop destruction, because governments are unable, or unwilling, to tackle the problem (Osborn and Parker 2003; Osborn and Hill 2005).

In this chapter, I investigate the use of strategies to mitigate crop-raiding in Loango at both the individual and institutional level. I aim to provide a baseline from which further material and legal trajectories to improve crop-raiding mitigation in Loango, and more generally in Gabon, can be discussed. I begin by assessing the use and apparent effectiveness of traditional deterrent methods used by farmers. I then discuss the variables which affect the implementation and effectiveness of these methods, as well as whether methods used elsewhere (e.g., beehives) could be implemented in Loango in the future. Finally, I describe the legal framework structuring crop-raiding mitigation in Gabon and examine whether the system in place is efficient in supporting farmers' efforts and protecting their livelihoods.

5.2 Individual strategies

5.2.1 Methods

To investigate the use and efficiency of the various deterrent methods, I combined the results obtained in my investigation of the extent of crop-raiding (Chapter 4), with observations of the deterrent methods present in fields. To investigate whether the use of deterrent methods by farmers is related to past damage, I used a Pearson test of independence using presence/absence of damage in *old fields* and presence/absence of deterrent methods in *new fields*.

I used two different methods to investigate the effectiveness of traditional deterrent methods at different scales. First, I analysed the effectiveness of deterrent methods at the scale of the field. I classified all possible deterrent methods into categories, noted the presence/absence of each deterrent method for each field and counted the total number of different categories employed simultaneously. I then tested for differences in the frequency of damage and area damaged per field (m^2) between fields with each category, using a t-test if data were normally distributed, and Mann-Whitney U tests otherwise. As for analyses on crop-raiding in the previous chapter, I also carried out analyses using the non-raided/raided frequency variable to test for possible inconsistencies in the frequency score, and show results for non-

raided/raided when the results differed. I tested each type of deterrent method for each pest type, although some deterrent methods are designed to repel specific pests. I analysed whether the cumulative number of deterrent method categories used per field affected the frequency and area damaged using the Kendall coefficient of correlation.

Second, I investigated potential avoidance of deterrent methods by wildlife at a finer scale. Here, I determined whether the centre of damage for each event was close to (≤ 20m) or far from (> 20 m) any permanent deterrent methods present. This is the same distance scale as I used to investigate the effect of the distance from the forest edge in Chapter 4. For this analysis, I used data from fields that maintained at least one permanent deterrent method, and where at least one damage event occurred. I used a paired sample test to compare the frequency of raids and the area damaged in the two distance categories. Where it was possible to normalise the data, I used a t-test. Otherwise, I used a Wilcoxon Signed Rank test. For all tests, I set the significance level at $\alpha < 0.05$ and used two-tailed tests.

To investigate the financial cost and affordability of deterrent methods for farmers, I estimated the local income for subsistence households in Loango based on surveys carried out in 1998 (Blaney et al. 1999) and 2005 (Le-Duc Yeno et al. 2006). These surveys show that women in the Loango area earned on average CFA 30,000 (US$ 57[3]) per month from agriculture. While agriculture does not generate important income, farming is still important in providing food and in structuring women's identity and sense of purpose, particularly for elders (Chapter 2). Blaney et al. (1999) also estimated that fishing activities, which are mostly carried out by men, generated an average income of CFA 250,000 (US$ 478) per month. It is unclear whether they estimated fishing income based on data from the peak fishing season (the wet season), or on an annual basis. For the purposes of my calculation, I assumed the income was annual. While fishing is a lucrative activity, many households do not fish because of the lack of the money to pay for a boat or sometime the lack of man. In addition, fishermen who do not earn an outboard engine, and enough money to pay for the fuel, are limited to seasons where fish are abundant close to their village. Blaney et al. (1999) also suggest that traditional medicine can represent an important source of income in the area. During my study, four informants practiced traditional medicine, but each did so only once or twice, far less than Blaney et al.'s report of 10 cases a month. Using Blaney et al.'s estimate of CFA 405,000 cash benefits per case, and two treatments per year per informant from my observations, I estimated the annual income generated through traditional medicine at CFA 910,000 (US$ 1,739).

The World Bank data (2005) reveal that 19.6 % of the population in Gabon live under the international poverty limit of US$ 2 a day and 45 % of the Gabonese rural population live under

[3] Conversion rate of 1 US$ = CFA 523.294 on the 4th July 2012

the national poverty line. Income generated by agriculture alone (US$ 684 per year) allows farmers' households to almost reach the international poverty limit. I therefore used income generated by farming only as an estimate of income for low-income subsistence households, consistent with both previous surveys (Blaney et al. 1999) and the World Bank data. I estimated the average income for medium-income households, that carry out both agriculture and fishing, and which represent 15 % of households at the study site (Le-Duc Yeno et al. 2006), at US$ 535 per month (US$ 6,421 per year). Finally, I estimated the average income for higher income subsistence households that employed agriculture, fishing and traditional medicine, as US$ 680 per month (US$ 8,160 per year). Oil companies in the area provided temporary work to younger men, and it is likely that some households also accumulated additional income from pensions and other minor sources, such as palm wine production. However, I did not include these in my calculations, because I do not have detailed information on these additional sources, and because most of my informants' households did not benefit from wage labour or pensions. Thus, my value for higher income households represents income from subsistence only. I then estimated the cost of two strategies, guarding and guarding plus barriers, based on Walker's (2010, 2012) model of the costs of deterrent methods in Gabon, and based on the cost of hiring someone at the minimum wage at the time of the study (CFA 150,000 = US$ 300 per month). Finally, I used semi-structured interviews and ethnography to investigate farmers' use of various deterrent methods and their perceived effectiveness and affordability.

5.2.2 Results

5.2.2.1 Deterrent methods used in Loango

People in Loango used both active (e.g., drumming on barrels) and passive (e.g., scarecrows) deterrent methods (Table 5.1), with a maximum of five different deterrent method categories per field. During the study, 24 % (N = 9) of farmers put no deterrent in their *new fields,* leaving 22 % of all *new fields* left unprotected. This value increases to 30 % when considering both *new* and *old fields,* but farmers protected three of the unprotected *old fields* until the creation of their *new field*, when they moved their camp and deterrent methods to their *new field*. Of the 21 farmers whose *old fields* had been damaged by elephants, 81 % (N = 17) used deterrent methods in their *new field*. This is significantly more than where *old fields* had not been raided (df = 1, χ^2 = 10.16, p = 0.001). Three of the four farmers that did not use deterrent methods in their *new fields* despite having their *old fields* raided cleared their *new field* 8 km from both their *old field* and their villages. These three farmers were from Idjembo and all built a camp in their *new fields*, but did not use it. The fourth farmer lived in *la Haute* and said that deterrent

methods were not worth the effort, as elephants would destroy the field anyway. This farmer had her field heavily damaged during the two years before the study and the year of the study. Only 11 % (2 of 18) farmers whose *new field* was damaged by elephants, did nothing to protect it, included this farmer.

Table 5.1: Deterrent methods used in Loango.

Deterrent method	Number of farms	Percentage of fields
Noise	20	49 %
Camps*	16	39 %
Barriers	9	22 %
Lamps	9	22 %
Fire	9	22 %
Nothing	8	20 %
Scarecrows	7	17 %
Odour	5	12 %
Strategic deterrent methods	3	7 %
Snares or traps	1	2 %

***I counted camps only when they were occupied at night, at least occasionally. Some farmers never stayed in their camp to guard at night and I recorded these as "no camp".**

The number of deterrent method categories per field differed by *regroupement* (Kruskal-Wallis: df = 2, χ^2 = 6.74, p = 0.034). Farmers in Idjembo used fewer categories per field than farmers in *la Haute* ($N_{Idjembo}$ = 11 and $N_{laHaute}$ = 18, Mann-Whitney: U = 44.00, p = 0.012, Fig. 5.1). However, there was no difference between Ntchongorové and Idjembo (df = 20, t = 0.73, p = 0.471) or Ntchongorové and *la Haute* ($N_{Ntchongorové}$ = 11, Mann-Whitney: U = 64.50, p = 0.122). For this reason, and because crop damage was higher in *la Haute* (Chapter 4), I conducted further statistical analyses on data from *la Haute* separately. Making noise, camps, barriers, lamps and fire were generally used to repel elephants and sometimes antelopes. Scarecrows, odour and snares generally targeted antelopes, primates or rodents. However, farmers hoped that each deterrent method used would work on as many different raider species as possible.

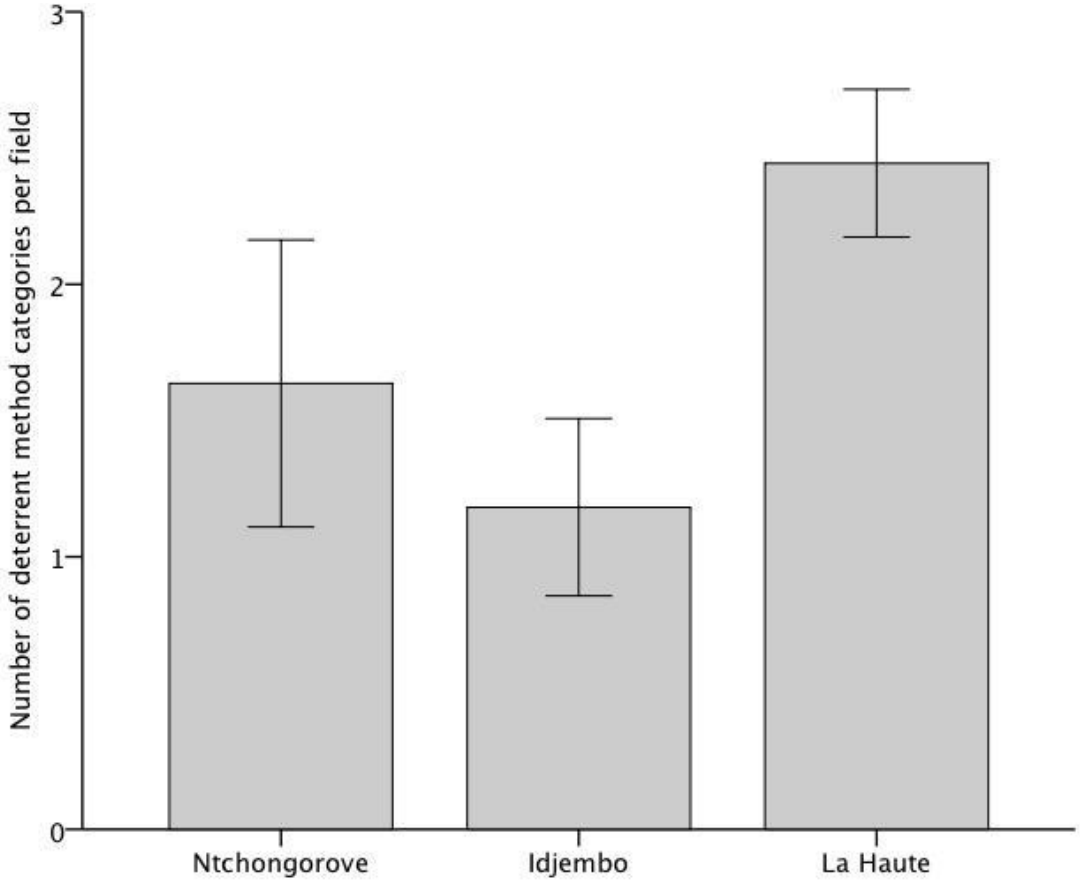

Figure 5.1. Mean (± SEM) number of deterrent methods used per field in the three study zones.

Making noise was the most popular strategy (Table 5.1) and all farmers who used this method had their field damaged by elephants. Noise-makers generally consisted of home-made bells placed in the fields or attached to barriers (Fig. 5.2), but noise-making could also consist of farmers drumming on empty barrels at sunset and during the night (Fig. 5.6). Farmers also used drumming as a preventative measure, i.e., drumming at regular intervals during the night to prevent animals approaching the field, or as a repellent to chase away animals during raids. Active noise-making was associated with a camp in eight cases.

Figure 5.2: Cans attached to an electrical cable used as a barrier and acting as a bell to alert farmers when an animal touches the cable.

The second most-used deterrent was the presence of a camp (Fig. 5.3). The camp was usually at the centre of the field or close to access routes and was, therefore, very rarely on the forest edge (Fig. 2.4). Farmers planting in Mpembanyanbiè stayed in their field during the peak labour period, or when they went to their field to collect food, then returned to their villages 8 km away. In the absence of previous elephant damage, farmers were unlikely to have camps or to stay in them if they did. Camps were generally used in combination with chasing animals away and making noise, sometimes with use of lights and on one occasion with shooting a crop-raiding animal. One farmer's husband openly discussed shooting and killing raiding elephants. He said he had shot at least four raiding elephants between 2008-2010, killing at least two, and possibly three, of them. Another man was arrested for killing a crop-raiding elephant during the study and a third shot an elephant just after the end of the study. The local authorities also reported several other killings in villages outside the park. I recorded cartridges in one field during the dry season, which coincides with the open hunting season for partially protected and non-protected species. According to the farmer who owned the field, someone had shot at red-capped mangabeys while they were in the field.

Figure 5.3: A camp in a field destroyed by elephants in *la Haute.*

I only observed the use of barriers in *la Haute,* and noise-makers were attached to the string surrounding the field in all cases (Figs. 5.2 and 5.4). Cans were attached in groups along the string, and made a noise when the string moved. Barriers were made of simple metal wire or electrical cables. Some people mentioned the possibility of using barbed wire instead, but I did not observe this during the study. Some farmers built barriers of branches and weeds when they weeded their field to protect it against rodents, but they never fully enclosed the field. Other farmers opportunistically put grass cutting at the base of manioc stems to hide the roots from rodents.

Figure 5.4: A barrier made of string with cans attached to it and an oil lamp on the floor.

Oil lamps, or artisanal lamps, were used mostly in Ntchongorové and *la Haute* and usually in combination with other deterrents. Farmers placed them at the corners of the fields and particularly on the forest edge (Figs. 5.4, 5.5, 5.6). Fires were usually only built in camps or under small huts built specifically for this purpose around the field.

To prevent antelopes, buffaloes and possibly rodents from entering their fields, farmers scattered white tee-shirts, scarecrows, or colourful plastic items in their fields, particularly around the edges. They also sometimes used such markers to separate two contiguous fields. This method was not used in *la Haute* and farmers never said they used it against elephants. Farmers also used odour on several occasions. One farmer burned a combination of chilli, plastic, and rotting palm nuts to repel elephants, but odour was mostly used to deter rodents. Two farmers in *la Haute* collected their urine to spray on the edge of their field to repel rodents, while another farmer placed a bucket with rotting food and fish in her field.

In three cases, farmers used, or planned to use, strategic deterrent methods. I could not test the efficiency of these strategic deterrent methods statistically in the analysis below due to the small sample size. One farmer planted bitter manioc, which farmers say is not favoured by elephants, between the bananas and the forest in the hope that this would keep the elephants away from the bananas. Two farmers planted only a few banana stems in their field, and instead planted bananas around their village to be able to protect them better. These two farmers also

discussed planting only bitter manioc near the forest to limit its attractiveness to elephants the following year. Farmers never mentioned planting more crops to compensate for possible future loss, which contrasts with Walker's (2010) findings. By contrast, several farmers said that they planted less, in order to plant closer to their house or because there was no need to work hard if everything would be destroyed anyway. Most families that said they planted less also said that they relied more heavily on other activities such as fishing. I did not see any traps during the study period and recorded snares around only one field. Two farmers said they used snares in the forests surrounding their fields during interviews but I did not observe any in or around their fields.

Figure 5.5: A lamp and bell in the corner of a field to deter potential raiders.

Figure 5.6: An artisanal oil lamp, also used as a drum, and accompanied by a fireplace. Roofs are built to protect lamps and fires from the frequent rain in the wet season.

5.2.2.2 Effectiveness of deterrent methods

5.2.2.2.i At the scale of the field

Considering all pests in Ntchongorové and Idjembo, the frequency of damage per field was higher in fields with noise than without, and higher in fields with fire than without (Fig. 5.7, Table 5.2). Results using the non-raided/raided frequency variable were almost significant for noise (df = 20, t = -2.06, p = 0.053) and results were still significant for fire (df = 20, t = -2.40, p = 0.026). However, damage frequency was not related to the presence/absence of any of the other deterrent method categories. The frequency of damage per field was not significantly correlated with the number of deterrent methods used (Table 5.3). The area damaged per field was higher in fields with noise and light than fields without these deterrent methods (Fig. 5.8, Table 5.2). Area damaged per field was not related to the presence/absence of any of the other deterrent method categories and was not correlated with the number of deterrent method categories used per field (Table 5.3).

Table 5.2: Results of t-tests and Mann-Whitney tests comparing the frequency and area of crops damaged between fields with and without various deterrent methods. (Significant results in bold)

All pests (N and I)		**Noise**	**Camp**	**Barrier**	**Light**	**Fire**	**Scare -crow**	**Odour**
Frequency	df/N	df=20	df=20	NA	N=22	df=20	df=20	df=20
(N=22)	t/U	t=-2.15	t=0.44	NA	U=20.50	t=-2.25	t=0.46	t=-0.57
	p	**0.044**	0.662	NA	0.464	**0.036**	0.654	0.575
Area	U	13.00	42.00	NA	7.00	26.00	51.00	45.00
(N=22)	p	**0.019**	1.000	NA	**0.040**	0.218	0.945	0.858
Elephants (N and I)								
Frequency	U	23.50	37.50	NA	14.00	26.50	49.50	47.50
(N=22)	p	0.140	0.704	NA	0.191	0.218	0.837	0.971
Area	U	24.00	41.00	NA	12.50	26.00	51.50	44.00
(N=22)	p	0.164	0.940	NA	0.132	0.218	0.945	0.802
Elephants *(La Haute)*								
Area	U	19.00	36.00	35.00	24.00	17.00	Na	3.00
(N=18)	p	0.738	0.762	0.696	0.291	0.277	Na	0.444
Rodents (N and I)								
Frequency	df/N	df=19	df=19	NA	N=21	df=19	df=19	df=19
(N=21)	t/U	t=0.06	t=0.36	NA	U=17.00	t=0.17	t=-0.31	t=1.00
	p	0.953	0.720	NA	0.857	0.866	0.762	0.329
Area	U	25.00	38.50	NA	8.00	30.00	36.00	34.50
(N=21)	p	0.240	0.905	NA	0.238	0.445	0.360	0.424
Antelopes (N and I)								
Frequency	df/N	df=19	df=19	NA	N=21	df=19	N=21	df=19
(N=21)	t/U	t=-2.67	t=0.21	NA	U=3.00	t=-2.58	U=36.50	t=-1.45
	p	**0.015**	0.834	NA	0.057	**0.019**	0.360	0.163
Area	U	15.00	36.00	NA	6.00	23.00	35.00	34.00
(N=21)	p	**0.040**	0.780	NA	0.152	0.179	0.322	0.424

NA (not applicable) indicates no field with the deterrent method. N and I = Ntchongorové and Idjembo.

Table 5.3: Results of Kendal's correlations examining the relationship between crop damage and the number of deterrent methods used per field. (Significant results in bold)

	All pests		Elephants			Rodents		Antelopes	
	N and I		N and I		*La Haute*	N and I		N and I	
	Freq	Area	Freq	Area	Area	Freq	Area	Freq	Area
N	22	22	22	22	18	21	21	21	21
τ	0.27	0.22	0.26	0.25	0.21	-0.03	-0.01	0.45	0.37
p-value	0.105	0.185	0.175	0.188	0.291	0.849	0.950	**0.011**	**0.033**

Freq = frequency; N and I = Ntchongorové and Idjembo.

Neither elephant nor rodent damage differed between fields with and without deterrent methods, either in Ntchongorové and Idjembo or in *la Haute* (Table 5.2). Furthermore, there was no significant correlation between the number of deterrent method categories per field and elephant damage in Ntchongorové and Idjembo, or in *la Haute* (Table 5.3). The same was true for rodent damage. The frequency of antelope damage was significantly higher in fields with noise and with fire, than without (Fig. 5.9 and Table 5.3). However, the result for fire was non-significant when I used the non-raided/raided frequency variable (df = 19, t = -1.82, p = 0.084). The frequency of antelope damage was significantly positively correlated with the number of deterrent methods used (Table 5.3). The area damaged by antelopes was higher in fields with noise (320.02 ± 117.59) than without (163.77 ± 90.26) (Table 5.2), and the area damaged per field was significantly positively correlated with the number of deterrent methods used (Table 5.3).

I could not carry out statistical analyses for other raiding species due to the scarcity of data. However, buffaloes damaged fields with empty camps on four occasions and a field with a scarecrow once. Gorillas and red-capped mangabeys damaged fields with camps (gorillas = 3, mangabeys = 3), scarecrows (gorillas = 3 and mangabeys = 6) and noise (mangabeys = 2). Red river hogs damaged one field with a camp, which was empty at the time.

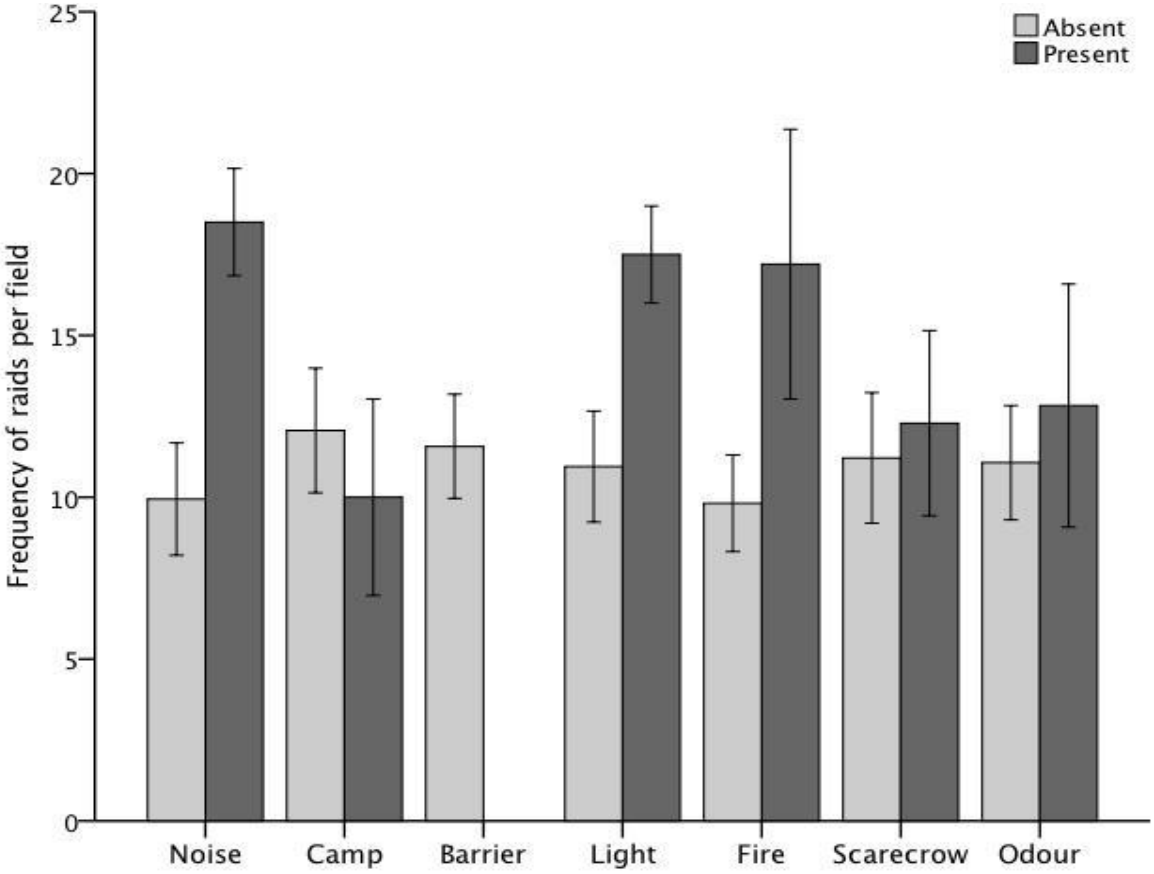

Figure 5.7: Frequency of raids per field with and without deterrent methods all pest groups combined.

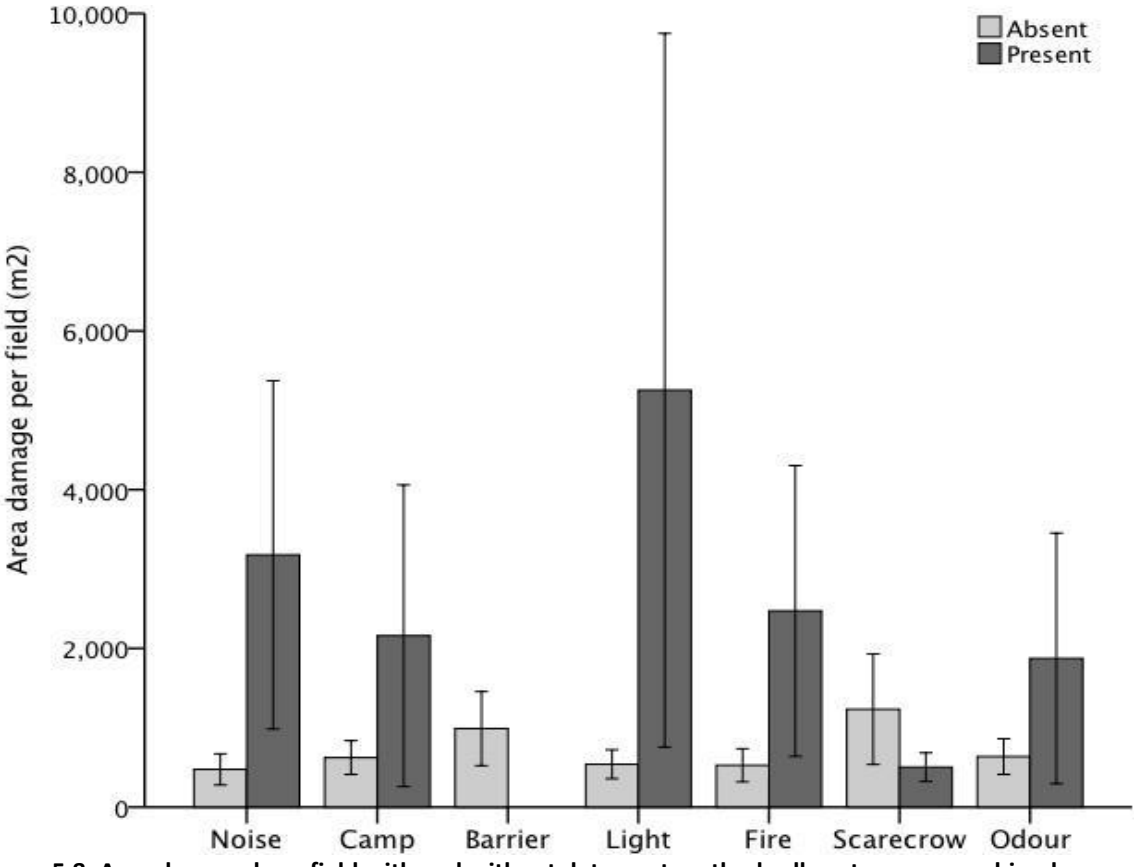

Figure 5.8: Area damaged per field with and without deterrent methods all pest groups combined.

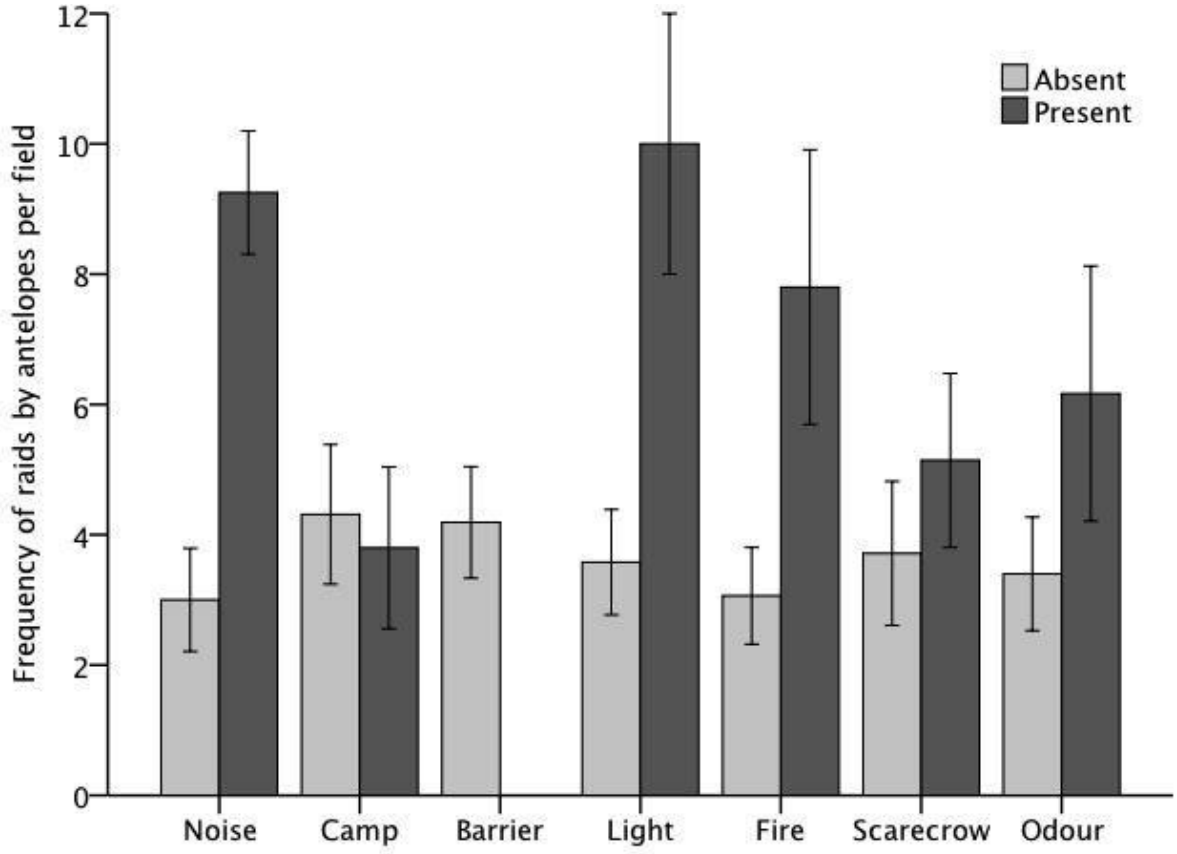

Figure 5.9: Frequency of raids by antelopes per field with and without deterrent methods.

5.2.2.2.ii Fine scale deterrence

Considering all pests, the area damaged was higher far (i.e., > 20 m) from deterrent methods than close (i.e., < 20 m) to them, although there was no difference in the frequency of raids (Fig. 5.10 and 5.11, Table 5.4). There was no effect of distance to deterrent methods for elephant damage, but rodents and antelope did more damage far from deterrent methods than close to them (Fig. 5.10 and 5.11, Table 5.4). The rare damage caused by primates was both close (N = 3) and far (N = 4) from deterrent methods. The same applies to buffaloes (close = 1, far = 3). Red river hogs damaged crops once, far from a deterrent method.

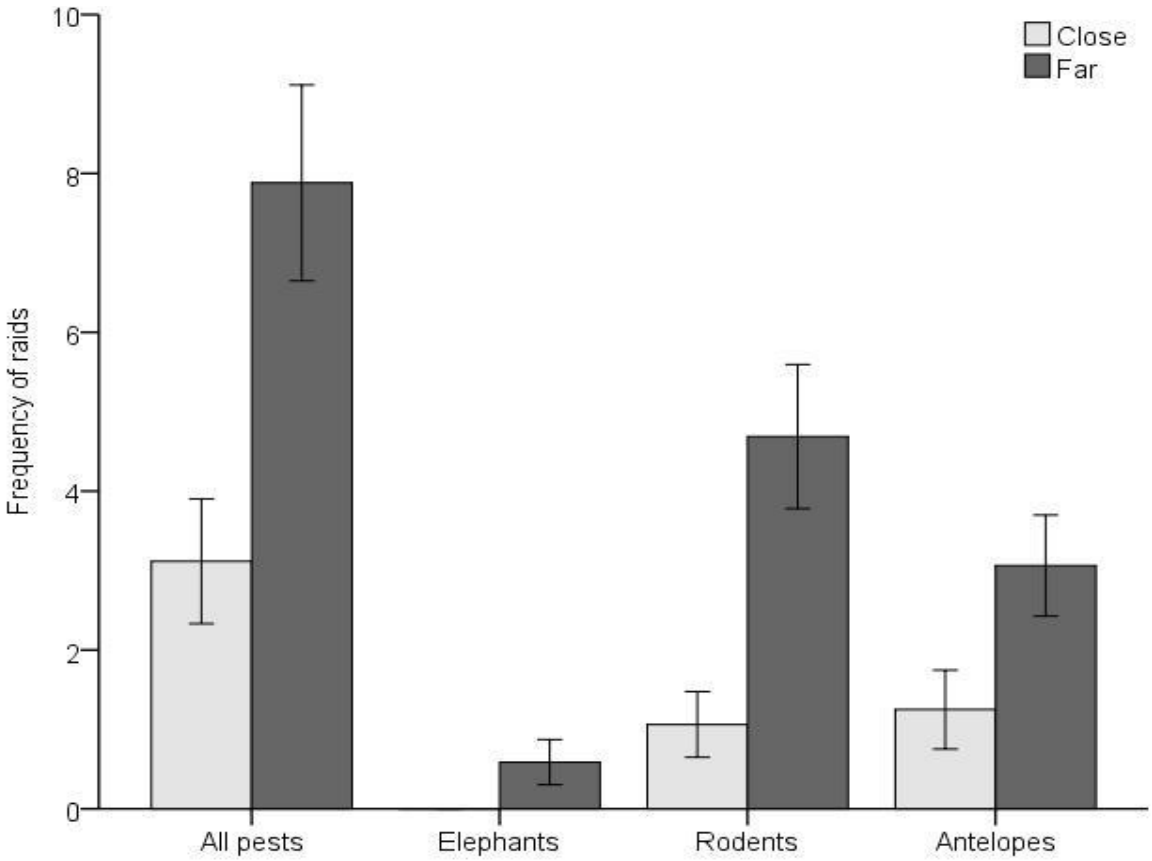

Figure 5.10: Mean (± SEM) frequency of raids close to and far from deterrent methods by pest group.

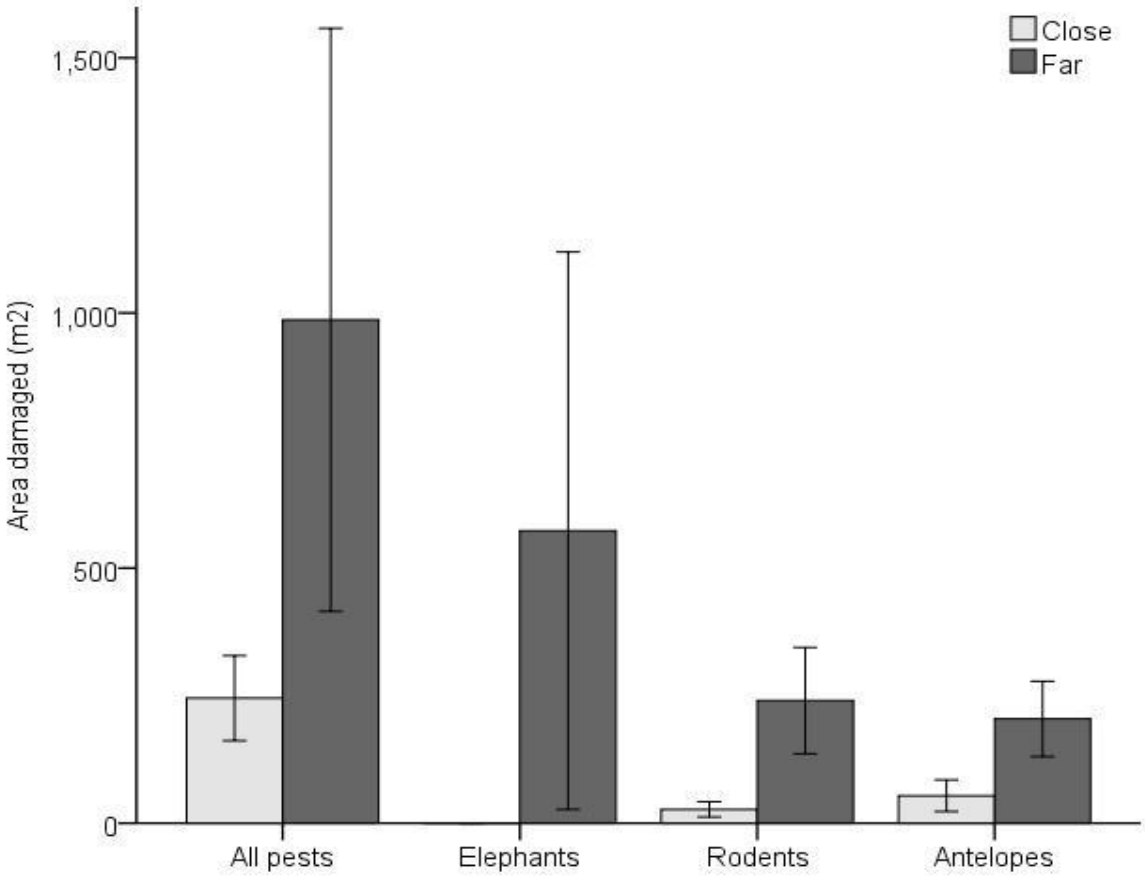

Figure 5.11: Mean (± SEM) area damaged close to and far from deterrent methods by pest group.

Table 5.4: Results of t-tests and Wilcoxon tests comparing crop damage close to and far from deterrent methods by field. (Significant results in bold)

		Frequency		Area	
		Critical value	**p-value**	**Critical value**	**p-value**
Pest	**df**				
All pests	16	Z = 2.27	0.226	t = 2.23	**0.018**
Elephants	17	Z = 0.18	0.854	Z = 0.41	0.686
Rodents	15	t = -4.56	**< 0.001**	t = -0.41	**< 0.001**
Antelopes	15	t = -3.29	**0.005**	t = -4.57	**< 0.001**

Using only data from Ntchongorové and Idjembo.

5.2.2.3 Estimation of costs

In theory, farmers could guard their fields themselves most of the time, and only need help during seasons of high damage, high labour or when they had to leave their fields due to sickness, ceremonies or other obligations. I therefore calculated the cost of guarding both full-time and part-time. Based on my observations, I estimated that farmers would need support for a minimum of two months per year, at the end of the dry season when farmers create *new fields*, but still need to guard *old fields* and attend ceremonies, which is similar to estimation made by Fresco (1989) for Africa (mean of 3 months). As a rule, farmers hire labour for less than the minimum wage, which is CFA 150,000 (US$ 300) per month, but complement the salary with food and drinks. Hence, I considered the total payment as equivalent to the minimum wage. Walker (2010) estimated the labour cost of guarding a field full-time as US$ 1,797 per year plus US$ 0.01 per metre perimeter, and the material cost at US$ 35 for building a hut plus US$ 0.02 per metre perimeter. I calculated the mean perimeter of fields at my study site as 300 m. This gives an annual cost of full-time guarding of US$ 1,841 per year, or US$ 3,600 per year using the minimum wage (Table 5.4). The minimum cost of hiring guards part-time is estimated at US$ 306 per year based on Walker and US$ 600 per year based on the minimum wage.

Walker (2012) estimated that fencing with barbed-wire costs US$ 0.90 per metre perimeter for materials and US$ 0.17 per metre perimeter for labour. Based on this, it would cost US$ 2,162 per year to protect an average size field (300 m perimeter) in Loango using full-time guarding plus barbed-wire barriers, or US$ 360 per year for part-time guarding and barbed-wire. Using the minimum wage rather than Walker's estimates, this increases to US$ 3,921 per year full-time and US$ 654 per year part-time.

5.2.3 Discussion

As in many countries of Africa, farmers in Loango use a diversity of strategies to repel crop-raiding animals, with some farmers using many different methods while others use none (e.g., Lahm 1996; Naughton-Treves 1997; Hill 2000; Osborn and Parker 2002). Only 24 % (9 of 38) of farmers in Loango left *new fields* unprotected*,* which is lower than the 36 % recorded by Lahm (1996) in her nationwide survey of Gabon. In addition, only 1 of 16 farmers whose fields had been damaged by elephants during the previous year left their *new fields* unprotected. This suggests that farmers assess the risk of crop-raiding, and those expecting serious damage, such as that caused by elephants, protect their field more intensely, as also reported for Uganda (Naughton-Treves 1997) and other areas of Gabon (Walker 2012). In contrast, Walker (2010) suggests that farmers expecting low or no damage may not consider it cost-effective to implement deterrent methods. Farmers' pro-activity also explains why the number of deterrent method categories used per field is higher in *la Haute*, as elephant damage is more widespread and more intense (Chapter 4). The same line of reasoning may explain why damage (frequency and/or area damaged) is higher in fields with noise, light and fire. It is likely that farmers suffering from higher level of damage invest more in these strategies. In addition, some farmers reacted to raids by adding deterrents to their field, and a few farmers only used deterrent methods after the first raids occurred. Two farmers added more tee-shirts along the edge of their fields following crop-damage by antelopes, and one added smelly items after several raids by rodents. When fields were located far from the farmer's village, as for most farms in Idjembo, several farmers said that they would move to their camp once raiding started: "When elephants start to come, I start too [to protect the field]". Another farmer started to light fires in her field following an elephant raid. However, she did not light fires every day thereafter, and did not guard her field consistently, as she had no camp and was elderly. Thus, reactions to damage may also partially explain why fields with noise, light and fire suffered from increased damage.

My results show that the practice of shifting cultivation creates a dilemma for farmers in terms of field protection. They can rarely protect two or three fields at the same time efficiently, particularly when fields are not contiguous. Three farmers did not guard their *new fields* as they were located eight kilometres from their village and *old fields*. These farmers were optimistic about the new location of their field, as this new location was thought to receive low crop damage, but abandoned daily surveillance due to the distance between their village and their camp. The spatio-temporal constraints of shifting cultivation can be a serious limitation on farmers' abilities to protect their field, and should not be underestimated.

5.2.3.1 Elephant deterrents

My results suggest that none of the traditional deterrent methods used in Loango affect the frequency or area damaged by elephants. Here, I investigate the possible reasons for different deterrent method categories.

5.2.3.1.i Guarding

Guarding did not decrease the frequency or extent of elephant damage, even when used in combination with other deterrent methods. Sitati, Walople and Leader-Williams (2005) suggest that guarding is most effective when guards are stationed outside fields, and can detect raiders before they enter the field, which is crucial to successful field protection. However, their study was located in Kenya where the prevalence of savannah habitats, which are open compared to the tropical rainforest, allows for early detection of raiders. The context in Loango is very different. First, most camps were located at the centre of the field and none were at the interface between the forest and the field. In addition, most fields had more than one side on the forest edge, complicating the decision of where to site a camp. Where fields are surrounded by forest, rendering early detection difficult and in most case impossible (Barnes 1996), effective guarding might require additional guards, or collaboration between farmers of contiguous fields.

Another difficulty of guarding is animal habituation to non-lethal deterrent methods. According to farmers in Loango, Vansina (1990) in Equatorial Africa and Morris (2000) in Malawi, elephants can be dauntless, particularly when in groups. In Loango, one farmer recalled how she, her husband, and their dogs were chased back to their village by a group of elephants who came to raid her field repeatedly. She explained that she and her husband were so scared that they stayed in their house while the elephant raided her field. The same farmer, who kept records of each attempt by elephants to raid her field, received 39 elephant visits over the course of three months (January-April 2010, see Chapter 4). She used a combination of guarding, making noise and odour, and said elephants only damaged her crops on a few occasions because of this. However, despite her intense investment in protecting her field, this farmer suffered from 60 % crop damage and 30 % crop loss during the year of the study, and had lost > 75 % of her field the previous year. These results suggest that while guarding may sometimes be effective in preventing a few raids, it is not sufficient to protect fields long-term. It also supports previous studies showing that elephants eventually habituate to deterrent methods that they perceive as non-dangerous (Barnes 1996; Nyhus, Tilson and Sumianto 2000; O'Connell-Rodwell et al. 2000; Nelson, Bidwell and Sillero-Zubiri 2003).

Due to the ineffectiveness of guarding, most farmers in Loango expect to be allowed to shoot at elephants to habituate them to the danger of raiding fields, in addition to the direct benefit of killing the raider when possible. Local farmers said that this method was effective in limiting the frequency of raiding in the past, as also reported by Lahm during her interviews (1996). Barnes (1996) proposed shooting repeatedly at, and killing, elephants around villages to create an "elephant exclusion" zone as a way of limiting crop-raiding. In Loango, however, it seems that what was previously an efficient method for short-term control is now obsolete. One farmer's husband shot at four elephants in the two years that preceded the study, killing at least two of them, but elephants still regularly visited her field. This supports the literature which states that lethal control has very limited long-term impact as regular raiders are eventually replaced, and as killing does not deal with opportunistic raiders (Osborn and Parker 2003; Sitati and Walpole 2006; Parker et al. 2007).

Guarding is also labour intensive and can be expensive (Hill 2000; Graham and Ochieng 2008; Walker 2012), limiting its successful implementation by farmers. Full-time guarding requires at least one member of the household to guard the fields every night in the case of contiguous fields, and several family members in the case of non-contiguous fields. During school holidays, relatives often come back to their ancestral villages and can help with the guarding, but this is not necessarily efficient as it is only temporary, and relatives are not necessarily present when it is most needed. Due to the rural exodus and its negative impact on access to labour (Lahm 1996, Chapter 6), and the ageing and sparsely distributed rural communities, farmers cannot sustain the effort necessary to farm during the day and guard during the night over long periods of time. As proof, 12 farmers in Loango said that their fields were damaged when they were away attending ceremonies, in cities, or ill. Animals, particularly primates and elephants, adapt to guarding effort and tend to raid when fields are left unattended (Kavanagh 1980; Knight 2003; Lahm 1996; Sitati, Walpole and Leader-Williams 2005; Graham et al. 2009; Hill and Wallace, 2012). These examples clearly indicate that guarding requires a constant effort that is not always possible.

In theory, farmers could hire guards to guard their fields if they are unable to do it themselves. However, in practice this option is unrealistic for most farmers. As stated earlier, almost 20 % of households in Gabon live under US$ 720 per year, and an additional 45 % of rural people live under the national poverty line (The World Bank data 2005). For these households, hiring a part-time guard would require the investment of at least 45 % of the household's annual income and hiring a full-time guard would require more than the annual income (Table 5.5), which would jeopardise their economic security. As income is used to pay for school and medicine, among other things, it is likely that such an investment would threaten farmers' health, and possibly their children's health and education. Furthermore, villages in *la Haute*

suffer from spatial isolation, both from each other and from other *regroupements*, making hiring temporary guards even more difficult and expensive. For medium and high rural income households, farmers would have to invest > 20 % their annual income for part-time guarding, and > 40 % for full-time guarding, respectively (Table 5.5). For most farmers, this is still a substantial investment, especially as guarding does not necessarily ensure full protection of the field. These calculations also assume the protection of one field a year, when in practice, farmers possess several fields of varying ages, increasing both material and labour costs. If two guards are needed per household, the number of households able to afford several part-time guards reduces greatly and full-time guarding becomes unaffordable even for high-income households. Finally, farming does not provide a large source of income in Loango compared to other activities (e.g., fishing, oil companies, tourism: Blaney et al. 1999), meaning that the people who can afford guarding the most are the ones who need it the least, as they probably rely little on farming for subsistence.

Table 5.5: Proportion of income spent on different deterrent methods by income category.

	Guarding				**Guarding + barrier**			
	Part-time		**Full-time**		**Part-time**		**Full-time**	
Deterrent cost (US$)	**306**	**600**	**1,841**	**3,600**	**360**	**654**	**2,162**	**3,921**
Income category								
Low (US$ 684)	45%	**88 %**	**269 %**	**526 %**	**53 %**	**96 %**	**316 %**	**573 %**
Medium (US$ 6,421)	5 %	9 %	29 %	**56 %**	6 %	10 %	34 %	**61 %**
High (US$ 8,160)	4 %	7 %	22 %	44 %	4 %	8 %	26 %	48 %

The first column of each deterrent method represents estimates calculated using data from Walker (2012). The second column represents estimates calculated using the minimum wage. Results in bold are costs > 50 % of annual income.

5.2.3.1.ii Barriers

As in previous studies, I found that barriers made of simple wire did not prevent serious crop destruction in *la Haute*, even when used in combination with other deterrent methods (Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2003; Sitati and Walpole 2006). On one occasion, the farmer's husband fenced the side of the field on the forest edge but did not fence the whole perimeter of the field. Elephant(s) went around the barriers and still damaged her field. This is not surprising as elephants are known to find their way around barriers when an opening exists or if the barrier is broken (O'Connell-Rodwell et al. 2000; Sitati and Walpole

2006). However, most farmers did not use barriers to prevent animal entrance. Instead, they combined barriers with noise-makers that acted as an alarm system, to detain elephants temporarily and give the farmer time to reach the raiders and attempt to chase them away. Barriers are, therefore, only efficient if combined with guarding. However, the use of barrier and guarding require the investment of at least 53 % of the annual income for the poorest households. In this context, and as described for guarding only, the households who would most need to protect their field are the one the less likely to afford it. Barriers made of logging cables can be very effective at preventing elephant damage (Languy 1996). However, putting these barriers in place is very labour intensive, and Languy (1996) estimated that seven adult men are needed. Hill (2000) in Uganda and Graham and Ochieng (2008) showed that labour-intensive deterrent methods are often unlikely to be broadly implemented by farmers. As access to labour is a problem in Loango, such methods are unlikely to be considered or implemented. In addition, logging cables are not readily accessible or affordable for farmers, making this method unrealistic, particularly as several fields need to be protected per year, and field locations change every year.

5.2.3.1.iii Light and fire

There was no significant effect of light and fire on elephant damage. In many cases, I found tracks of elephant damage immediately adjacent to lamps and fires. On several occasions, lamps were broken and farmers declared that elephants threw the lamp away with their trunks to break it:

> *To start with, the elephant is used to people now. Lights used to work but not anymore. The lamp, it is not his problem anymore. When the banana is here, he* [the elephant] *has to take it. The lamp is here and here he eats. If the lamp is too bright, he takes it with his trunk and he throws it away. You come the next morning the lamp is broken and him and the food are gone.*

Despite the obvious lack of success of these methods, farmers still use lamps and petrol to light their field. They believe that, although light is unlikely to repel all raiding, it will repel some, and therefore save some crops. For most farmers interviewed, putting up lamps was a way of feeling in control, even when they seriously doubted the effectiveness of the method. For example an informant expressed this as “But Emilie, what can I do? I can’t leave my field with no protection!”. This method, however, increases the farmers’ level of frustration, as the use of lamps leads to ongoing expense (i.e., buying oil for the lamps and sometimes replacing the lamp), but provides little or no benefit.

5.2.3.2 Deterrent methods for other pests

5.2.3.2.i Noise, light and fire

Noise, light and fire, which are often associated with the use of a camp, did not affect rodent damage. Antelope damage, however, was higher in fields using noise and fire. In addition, the area damaged by antelope was positively correlated with the number of deterrent methods per field. As for the analysis combining all pests, I think this result reflects the reaction of farmers to increased damage rather than any attraction of antelopes to these deterrent methods. On one occasion, Kharl and I disturbed a raiding antelope during our survey while the farmer was also about 100 m away. The antelope did not seem deterred by the noise of the farmer's daily activities (digging up roots, cooking, etc.), or us, until we got to within less than 10 m when it ran back into the forest. Elephants also raided this particular farmer regularly so she guarded her field at night, drumming on barrels, and using lamps and odour to repel animals. Clearly, none of these strategies were effective in deterring antelopes, rodents or elephants.

5.2.3.2.ii Tee-shirts and scarecrows

Tee-shirts and scarecrows, which specifically targeted antelopes, buffaloes and primates, were not effective at the scale of the field. Farmers never used tee-shirts to protect the entire perimeter of the field, perhaps because they tended to put them in places where antelope had previously damaged crops. In addition, farmers did not always put the deterrent methods on the forest edge, the entry point for raiding animals and where antelopes damaged most, which may explain continued damage.

Tee-shirts and scarecrows may only deter antelopes when close-by. This hypothesis is supported by the results for fine-scale deterrence, which suggest that both rodents and antelopes raided less near deterrent methods than far from them. While these results could be very promising, they must be interpreted with caution. First, I often observed tracks of raiders close to tee-shirts, scarecrows and lights. Second, some fields had a limited number of scattered deterrents, increasing the size of the area far from deterrent methods when compared to the amount of field close to a deterrent method for these fields. This pattern may have exacerbated the effect shown in my analysis. However, I could not control for this parameter for each field due to the study design. Third, other factors may better explain this apparent fine-scale avoidance by animals. For example, most camps were located at the centre of fields, while antelopes tend to damage crops on the edges. Thus, my results may not reflect the effect of the deterrent but rather the fact that deterrent methods are not located where they might be most effective. However, I believe that these preliminary results are promising to improve current low

costs deterrent methods and deserve further investigation. A controlled follow-up experiment should be designed to test the validity of these preliminary results on fine-scale avoidance of deterrent methods, and to investigate how the location and distribution of deterrent methods might affect their effectiveness.

5.2.3.2.iii Traps, snares and hunting

Trapping or hunting rodents is not widespread in Loango and only one man recalled catching a cane rat in a trap during the study. Farmers do not even try to catch cane rats as they believe they are impossible to catch, or simply state that they do not know how to catch them. For example:

> *Cibissi* [the local name for cane rat]*? This phantom? No, you can't catch it. It has a lot of trails, it is everywhere. It comes in that way, leave the other way. If you put a trap here, he creates a new route somewhere else*

Languy (1996) also suggested that cane rats are difficult to catch, and that even if catching is possible, it would never decrease the population sufficiently to reduce the level of crop damage. This is surprising as cane rat hunting is very common in West Africa, where it provides a source of protein, and sometimes income through the sale of bushmeat (Asibey and Child 2002; Okorie and Ekechukwu 2004). According to local informants, cane rats started to colonise the area, or at least became a problem, 10-15 years ago, possibly as a result of natural colonisation from eastern parts of the country (Jori, Mensah and Adjanohoun 1995; Drazo et al. 2008). My interviews also revealed that people do not eat cane rats in Loango, which probably explains the lack of incentive to invest in trapping and hunting, and corroborates previous records in the Central African region (Jori, Mensah and Adjanohoun 1995). Most informants said they would refuse to eat such a "creature", although the same informants usually ate porcupines, which are very similar. In contrast, cane rat meat is highly valued in most West African countries (Jori, Mensah and Adjanohoun 1995; Adu, Alhassan and Nelson 1999; Asibey and Child 2002). A change in attitude could allow the development of sustained efforts to hunt and trap. This, in turn, would provide farmers with a reliable source of protein, and possibly income, while protecting fields from excessive damage. One young hunter started to hunt cane rats during the study and brought back cane rats on two occasions that he and his relatives ate. While this was the exception rather than the rule, it is possible that cane rat hunting and consumption could develop through peer-imitation, especially as there are no particular taboos concerning cane rats in Loango.

The lack of observations of traps and snares around fields is quite surprising. Lahm (1996) and Walker (2010) refer to snares and traps as being very common, and sometimes the most common deterrent method in Gabon. The only snares I observed were set by a vacationing relative and targeted antelopes, which were not a significant crop-raiding problem in that particular field. Some farmers suggested that they set traps in the forest but not directly on the field because if other people knew the location of their snares they would go and steal trapped animals. Furthermore, snares and most traps are illegal in Gabon, and hiding them was probably a strategy to avoid control by wildlife authorities. However, when snares are not put directly on the edge of field, they are less likely to protect it against raiders. Interviews also revealed that traps and snares were more commonly used in the past, but a current lack of use has resulted in the knowledge of how to deploy them not being passed on and, thus, lost. Most men acknowledged their ignorance of such methods and only a few men were known as competent hunters. Farmers also claimed that they did not use traps or snares because they were dangerous. Fours farmers recounted the story of a specific farmer who used to have an elephant trap near his field but accidently caught and disabled a visitor. The farmer had to pay the injured man's family compensation for the accident. Farmers extended this potential risk to their children, who often wander around fields. Finally, animals injured by snares can become very aggressive and injure humans. For example, a buffalo injured by a snare attacked and severely injured a man guarding a field in Ntchongorové before the study began. During the study, the only mention of a snare catching a raider animal referred to a village in the periphery of the park where a gorilla was caught entering a field and then killed.

5.2.3.3 Possible future strategies

5.2.3.3.i Grouping fields

Atteh (1984) suggests that clustering fields may dilute individual crop damage and allow cooperative guarding, limiting intense damage. As discussed in Chapter 4, communal planting increases the size of the open area, by comparison with the forest, therefore creating a potential buffer if the animal associates open area with risk (Osborn and Parker 2002). When I investigated whether the number of neighbouring fields affected the level of damage, I found that antelopes damaged more frequently with increasing field isolation (Chapter 4), which may suggest a positive effect of clustering on this species. However, farmers who clustered their fields in Idjembo did not cooperate to guard adjoining fields. As a result, one farmer reported that raiding elephants were displaced from a guarded field to a nearby unguarded one. This suggests that individual guarding displaced damage rather than prevent it, similar to findings

concerning the effectiveness of barriers (O'Connell-Rodwell et al. 2000; Sitati and Walpole 2006). Ultimately, a larger open area could possibly improve sighting distances while guarding, thereby increasing the likelihood of early detection, and rendering guarding more efficient (O'Connell-Rodwell et al. 2000; Osborn and Parker 2002; Sitati and Walpole 2006).

The main obstacle to the implementation of such methods is the difficulty with which people cooperate in Loango. Ogra (2009) recorded similar findings in India where only 27.4 % of farmers said they would be wiling to cooperate with other farmers. During my study, members of a local initiative supporting local development held a meeting at the village. They aimed to help local associations to obtain international funding. Most of the meeting was spent trying to convince people that they would only receive support if they worked as a unified association. Several associations have been created in the area in the past, among them a farming cooperative, but all were inactive at the time of my study because members had lost their motivation to work for the group. The farmers' association in Idjembo, created under the impetus of a local politician and the *Chef de regroupement*, quickly became dormant, and the communal field they had created became the responsibility of the local politician only. When I questioned people about their lack of motivation to work collectively, many showed a lack of trust in reciprocal help and a fear of the risk, or rather the expectation, that one individual would "steal" the benefit of the collective work. In some cases, farmers feared jealousy or conflicts that could emerge from sharing with others, which might result in witchcraft, curses or false denunciations to the police. Similar to Kohler's (2000) "man-elephant" of Congo, some farmers feared shape-shifters who could turn into elephants to raid their field at night as a result of jealousy or conflicts.

The lack of cooperation between farmers could also be a consequence of male-female relationships. The field represents the ability of a woman and a wife to provide food for her family (Chapter 2). Sharing work between farmers would dilute each farmer's effort. One informant expressed this as follows:

> *No! I can't help others. I will work hard and I will have no benefit. People will say that the woman I have helped is strong. Nobody will recognise my work.*

Many men spoke about women in terms of "good wife", "strong wife" or "strong woman" in relation to either farming or domestic duties. On many occasions, in both urban centres and rural areas, men married a woman after having spent several years, sometimes decades, with several women at the same time. Thus, women are put in a situation where they are evaluated by men, and need to prove themselves, for long periods before marriage. While polygamy seems to be disappearing in younger people, competition between women is nonetheless still present, as suggested by the use of the word *"rivale"* (rival) between co-wives, and may prevent

cooperation. In fact, each wife clears, plants and weeds only her own field, although fields belonging to co-wives are often contiguous. The income generated by the sale of food products also benefits only the owner of the field. Leach (1992) recorded similar behaviour in Sierra Leone, where fields were used in relationship negotiations between co-wives, and often in reference to the husband. She explained that the division of space can be used as a map of social relationships and described the lack of incentive to cooperate as (Leach 1992: 85-86):

> *In practice there are various reasons why individual wives might want to maintain separate crops: for marketing, separate cooking for herself and children, feeding her own farm workers, visiting kin or strangers and as inputs in her own exchange network. [. . .] Thus interests in private farm space (hinda = place) reflect interests in private social and economic space.*

Thus, my results support previous studies in suggesting that we cannot assume that farmers will cooperate with one another in Gabon (Lahm 1993; Walker 2012). Implementing communal or cooperative farming would require time and effort from national and international institutions as well as from the farmers themselves.

5.2.3.3.ii Habitat management

Drazo et al. (2008) suggested that the only way to effectively limit rodent crop-raiding is to limit the extent of appropriate habitat, like fallows around fields, in addition to traps and hunting (e.g., with dogs in Democratic Republic of Congo). In Gabon, farmers weed their field or village full-time, but labour constraints generally prevent them from also weeding the land surrounding their fields. Fire and burning could be used to keep field surroundings clear, but this would be difficult in the wet season when fires are difficult to light. Moreover, the savannah is abundant in Ntchongorové, and clearing field surroundings only might not be sufficient to limit the availability of habitat and thus the presence of rodents in the vicinity of fields.

5.2.3.3.iii Chilli fences, vegetation hedges and beehives

Chilli fences show some success in repelling elephants in East Africa (Sitati and Walpole 2006; Graham and Ochieng 2008). These are barriers made of string, sometimes with several lines, with tee-shirts attached. Farmers apply a chilli-based mixture to the fence regularly, which should act as a repellent for elephants. While this system seems promising, it can be costly for poorer households due to the costs of string, tee-shirts, and oil, and can be very labour intensive

in the wet season, making this method unaffordable for some farmers (Graham and Ochieng 2008; Hill and Wallace 2012). Hill and Wallace (2012) show that vegetation hedges can be successful in protecting fields from primates. In places where primates, such as mandrills, are more of a problem than in Loango, this method could prove effective and trials should be implemented. Beehive fences involve placing an artificial beehive every 10 m on the edge of the field, and also seem promising (King 2011). However, farmers in Loango refused this unanimously, mainly due to the risk of attacks on children or visitors. This sentiment mirrors that of trapping and represents more a fear of the possible cost associated with compensation, or illness, than a real fear of bees. In addition to the potential danger of beehives, there is a need for a market evaluation for honey. Farmers never referred to using honey in villages, collecting it in the forest or selling it. I did not see people selling honey in markets during my study and most farmers already struggle to access markets to sell their manioc. Such a method is therefore unlikely to be adopted widely in Loango for the moment.

5.3 Institutional mitigation strategies

5.3.1 Lodging a complaint

The legislation regulating defence against crop-raiding is based on decree 187/PR/MEFCR of 4th March 1987 and law 016/01 of the Code Forestier (Forestry and Wildlife Regulations) that permit two main responses to wildlife depredation. People suffering from crop depredation by wildlife are expected to lodge a written complaint with the nearest local wildlife authority (MEF). At the study site, the closest wildlife authority is the *Brigade de Faune* in Ntchongorové. If it is not possible to reach Ntchongorové, or if no MEF representatives are present at the *Brigade*, then the petitioner must go to the nearest town (Oumboué) to complain to the head of the MEF brigade. In theory, farmers with limited transportation can lodge a complaint with their *Chef de Regroupement* who will then communicate the complaint to the MEF. Once the complaint is official, and signed by the authority responsible, employees from the *Brigade de Faune*, in addition to a representative of the Ministry of Agriculture, survey the raided field, identify the animal responsible and estimate the surface damaged and crop loss.

In practice, the legislation is impractical and ineffective from both farmers' and officials' perspectives. The reporting system requires that farmers read and write, but many of them are illiterate. They must also invest time and money in transport at a point when their main source of livelihood has been destroyed. Most farmers do not have the money or the means to reach the closest town easily. Villagers in *la Haute* need a boat and fuel to reach the closest village

with an MEF representative (Ntchongorové), and most farmers have to rely on the availability and willingness to help of the two fishermen in the lagoon that have a boat[4]. To make a return trip from *la Haute* to Ntchongorové, would cost US$ 24-57 (12,500-30,000 CFA) in fuel for a medium-sized boat (estimated 50 litres of fuel at 250-600 CFA per litre), and would take at least an entire day to complete the journey and lodge the complaint, and most likely two days. In Idjembo, people must go to Ntchongorové or Oumboué and the same problem of transportation occurs, but in this case with a car. The return journey to Oumboué from Idjembo or Ntchongorové costs about US$ 10[5] (5,000 CFA) using the local bush-taxi. In Ntchongorové, the MEF or ANPN representative should be present year-round, so reporting a complaint should not be a problem. However, as described in previous chapters, some villages are located up to 12 km from the centre of Ntchongorové, where the *Brigade de Faune* is located. The spatial distribution and isolation of many villages is a serious constraint on crop-raiding management. Ogra (2009) reports similar findings in India, where illiteracy, time constraints and the complexity of getting to the nearest authority led to only 11 % of respondents approving of the reporting system.

Another constraint is the structure and lack of effectiveness of the civil procedure. Farmers often say that the *Chef de Brigade* did not come to visit their field even though they called him, or made sure he heard of their misfortune through somebody else. The *Chef de Brigade*, however, explained to me that without an official written complaint, his superiors will not provide him with the necessary assignment order, funds or logistics to monitor damaged fields. Finally, both officials and farmers report that the rare official complaints lodged in the past did not lead to any action. This leads to a negative feedback circle where farmers struggle to use a system that may help to mitigate their loss, and do not see the result of their efforts when they do contact authorities, which reinforces their feeling that they cannot trust the system, and ultimately leads them to complain less frequently, as exemplified in the following quote:

> *We called the chef de Brigade and he said he would come, but look! Nothing happened. He never came. We also talked about it with the guy from agriculture, water and forest, everybody, and nothing. Now we neglect that* [lodging a complaint]*. We are going to go to Oumboué for what?*

[4] During a post-research visit in November 2012 most families in *la Haute* had a working boat engine.
[5] During the post-research visit in 2012 the price increased to 7,000 CFA

5.3.2 *Battue administrative*

Once the damage is officially reported, the *Préfet* can, if the damage is extensive or repeated, organise a "*battue administrative*" (administrative culling), to kill the problem animal. *Battue administrative* is not applicable inside the National Park and is the responsibility of the state. The regional council is charged with finding and hiring a professional hunter who should kill no more than two animals per *battue*. The MEF representatives are in charge of obtaining the tusks to prevent illicit ivory trafficking if the culprit is an elephant, and the local villagers are allowed to keep the meat for their own consumption or for sale at local markets. A *battue* was organised a few years before the study, following one of the rare complaints recorded in the area. This was the only *battue* referred to while I was in Loango and was apparently cancelled at the last minute because it had been planned to take place in the park by mistake, which is illegal. Most officials I interviewed considered *battue administrative* ineffective in protecting farmers' fields, particularly those in the study area, as the villages are so scattered that not all raiders will be eliminated. Officials also suggested that other raiders would soon replace killed animals, even if the actual raider was killed, which is supported by the literature (Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2003). As a result, officials feel powerless to resolve the situation through the application of legal mechanisms, and one acknowledged that he generally advised farmers to use self-defence.

5.3.3 Self-defence

According to legislation, farmers can kill a marauding animal when it is found raiding their field, even if it is a protected species and in the park. The limitations imposed on self-defence are that animals must be shot not more than 5 km away from the damaged field, the farmer should possess a hunting permit and a declared, insured gun, and the farmer should call the authorities to declare the killing. While officials sometimes advise farmers to use self-defence, farmers do not feel this can really help them, although most farmers would like the right to kill elephants. While they believe culling elephants is the most effective practice to limit crop-raiding, at least in the short-term, the limitations imposed on self-defence make it unrealistic from the farmers' point of view. Killing an elephant in a field in the middle of the night is dangerous and in most cases unfeasible. Visibility is bad so farmers need to be close to the animal to shoot it, rendering the situation very risky. The risk of injuring the elephant rather than killing it is high, as admitted by both farmers and the wildlife authorities. Almost all farmers recalled stories of injured and dangerous animals in the area, such as the buffalo cited earlier, that MEF representatives killed after it injured a man guarding a field. In addition, most farmers

do not have, and cannot afford the price of, a gun, bullet and the permits needed to defend themselves legally. An alternative would be to hire a professional hunter, but again the money required is generally lacking or seen as less of a priority than clearing a *new field* or paying for school fees. To worsen the matter, many farmers stated that local hunters now refuse to kill elephants on behalf of others because of the fear of trouble with the authorities. Moreover, even if farmers use self-defence despite all these limitations, they find it unfair that the elephant tusks should be handed over to the authorities. Farmers consider that they should be reimbursed by being permitted to sell both the meat and the ivory because they, alone, incur the cost and danger of killing the animal. The fact that the authorities demand the valuable tusks seems like theft, as clearly expressed by this informant:

> *You will come and ask me for the tusks? Did you pay the cartridge? Are you going to reimburse me what the elephant ate in my field? At times, I am obliged to beg 100 CFA here, a 100 CFA there to pay everything. The cartridge is CFA 10,000. Now if you want the tusk you reimburse me everything!*

Finally, MEF representatives need no specific assignment order to verify that the killing was done according to the regulations when farmers kill an elephant. From the explanations officials gave during interviews, when the killing of an animal is reported, either by the shooter himself or through denunciation, they must confirm that the law was not broken. Mere rumour can lead to an investigation by MEF and ANPN representatives. Officials visit the relevant village, check the validity of permits and weapons and requisition the tusks in the case of elephants. For farmers, the fact that authorities have no logistics or funds to investigate the destruction of their fields, but do have the logistics needed to come and investigate elephant killings, represents clear proof that authorities prioritise animals above humans needs, as expressed by one informant:

> *Here if you kill your monkey, you see them coming* [MEF representatives]. *She mimics them 'oh you can't kill, show me your gun and where is the permit and all this'. However, when your field is entirely destroyed nobody makes any noise* [comes].

5.3.4 Compensation schemes

When farmers lodge a complaint, which is already problematic, the law includes the possibility of compensation. Although compensation schemes are conceptually attractive, their usefulness

in practice is debatable (Nelson, Bidwell and Sillero-Zubiri 2003; Nyhus et al. 2005). Farmers in Loango expressed a lack of faith in compensation schemes. The first reason they provided was a lack of trust in the state to provide compensation for all the damaged farms, and a fear of corruption leading to compensation never reaching the raided farmer. Second, when, or if, compensation is paid, it is often long after the event, and so does not address the immediate lack of food or income. Third, the cash eventually given provides only a temporary relief, especially in societies such as the ones in Loango, which tend to share resources (Chapter 6), while crops harvested from the damaged field could have provided subsistence for months, if not years. One farmer expressed this as follows:

> *My plantation will give me food and money for at least two years. Once the money they give is finished, what am I going to eat until my next field is ready?*

For this reason, several farmers in Loango considered compensation, which is currently not in use in Loango, to be an unsuitable solution if used in isolation. Ogra (2009) reported similar findings in India, where 89 % of farmers consider compensation schemes unbeneficial.

The Gabonese government seem to have contradictory visions of compensation. Recently, the government specified the amount payable to farmers for each type of crop damage (Decree 1016/PK/MAEPDR, 24th August 2011), and suggested that institutions in charge of protected areas are responsible for compensating farmers when damage occurs in such zones. However, the government also expressed a lack of interest in the development of such a strategy during a workshop for the mitigation of human-wildlife conflict held in Libreville in 2010. The government has not yet allocated a reliable and sustainable source of funding to compensate farmers. Therefore, it is unclear whether compensation will be used effectively in Gabon in the future. Finally, putting compensation schemes in place runs the risk that farmers will stop protecting their crops as they know they will be compensated for crop loss, or that farmers will move to high conflict areas in order to receive more money (Nyhus et al. 2005). Thus, compensation should be put in place only if an efficient control is in place and only when accompanying measures to reduce damage are also in place.

5.4 Conclusion

Traditional deterrent methods, as used in Loango, are not effective. The most serious impediment seems to be a shortage of labour, which prevents most households from implementing deterrent methods effectively, if at all. Shifting cultivation, which divides fields and therefore labour, spatially, adds to the labour and material costs of field protection.

Furthermore, the spatial isolation from which most farmers suffer, and the concomitant social isolation, increases vulnerability to crop-raiding as farmers are less able to defend themselves or to access state institutions (arrows marked A in Fig. 5.12). A lack of cooperation between community members (arrow B), which prevents farmers from alleviating the material and labour costs of deterring raiders, is also a major constraint. As most studies of traditional deterrent methods include the need for cooperation (Infield and Namara 2001; Osborn and Parker 2003; Sitati, Walpole and Smith 2003; Graham et al. 2009), it is not surprising that I found that none of the traditional methods are successful in Loango. This lack of trust also prevents farmers from using the institutional pathways that are in theory at their disposal (arrow C). Finally, my results suggest that strategies that are successful elsewhere may not be feasible or acceptable in Loango. Any trials of new strategies should consider the limitations discussed in this chapter. The institutional management of crop-raiding mitigation is no more successful than deterrent methods. The complexity of the administrative process and its application, in addition to the chronic lack of funds and logistics of wildlife authorities, make current strategies unaffordable for farmers, or inefficient at limiting or compensating crop damage (arrow D). This ineffectiveness in alleviating crop-raiding by state representatives worsens the climate of distrust by communities toward local authorities (arrow E). Ultimately, farmers are not only alone in their fight against crop-raiding, but they are also constrained by conservation regulations (arrow F).

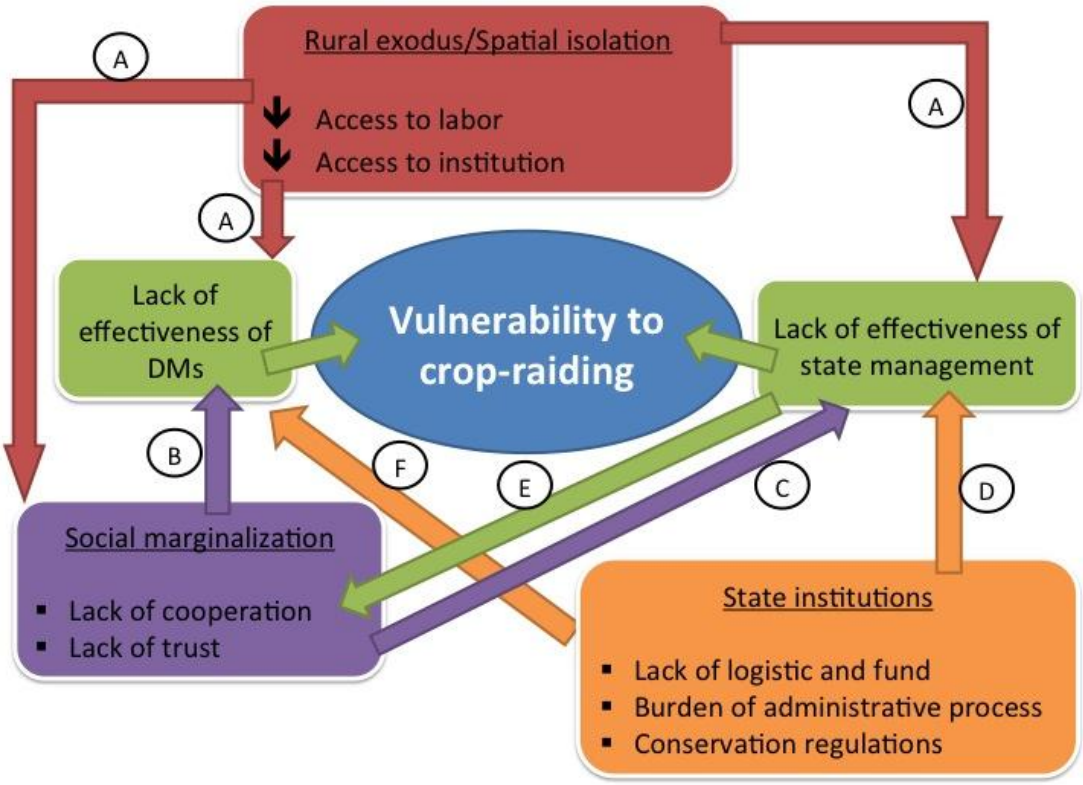

Figure 5.12: Factors affecting the success of mitigation strategies and the effect on vulnerability to crop-raiding. Letters are explained in the text. Solid arrows represent an aggravating effect. Small black arrows pointing down represent a decrease.

Chapter 6 – Social vulnerability and crop-raiding: an ethnography

6.1 Introduction

The study of human-wildlife conflict lies at the interface between biological and social sciences. However, with few exceptions (Naughton-Treves 1997; Naughton, Rose and Treves 1999; Naughton-Treves and Treves 2005; Kaswamila, Russell and McGibbon 2007; Barirega et al. 2010; Hartter, Goldman and Southworth 2011), studies of crop-raiding do not examine the social aspects of the problem in detail. For instance, questions such as how crop-raiding affects farmers' livelihoods, what coping strategies farmers use, and their efficiency, are scarcely addressed in the literature. Crop-raiding leads to increased food and economic insecurity for subsistence farmers in both Tanzania (Kaswamila, Russell and McGibbon 2007) and Uganda (Barirega et al. 2010). Food security is achieved if "adequate food (quantity, quality, safety, sociocultural acceptability) is available, accessible and satisfactorily utilized by all individuals at all times to live a healthy and happy life" (Gross 2002: 343). Economic security represents an income that allows access to minimum basic requirements in terms of daily subsistence, such as health and educational services (United Nations 1995; Gross 2002). According to the United Nations (1995: 41), the combination of food and economic insecurity are the major components of absolute poverty, which is defined as "A condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information. It depends not only on income but also on access to services". If crop-raiding has a negative effect on both food and economic safety, then there is little doubt that it can lead to increased vulnerability to poverty. Moreover, Cannon, Twigg and Rowell (2003) showed that poverty is often strongly linked to increased vulnerability to disasters. In Uganda, the vulnerability of poorer households to crop-raiding is compounded by the fact that they can only afford land on the forest edge, which is the area most likely to be raided (Naughton-Treves 1997, Naughton, Rose and Treves 1999). Where communities who are already vulnerable to poverty are also more likely to suffer from crop-raiding, this can lead to an immediate subsistence crisis.

In addition to these obvious links with poverty, crop-raiding also leads to more subtle aspects of vulnerability, both short- and long-term. For example, farmers guarding their fields against crop damage are more at risk from mosquito-borne diseases like malaria (Hill 2000, 2004). Moreover, guarding fields leads to increased physical exertion, loss of sleep and increased stress, which can increase health problems and decrease education levels (Hill 2000, 2004; Linkie et al. 2007; Hartter, Goldman and Southworth 2011). This leads to a cascade effect as lower educational levels lead to increased vulnerability to poverty and lack of resilience in a crisis (United Nations 1995; Dercon 2000; Cramb et al. 2009). However, increasing access to formal education can also lead to increased vulnerability to crop-raiding through decreased

participation in the labour force, as children who attend school cannot help in the fields (Gabon: Lahm 1996; South-East Asia: Cramb et al. 2009). To worsen the matter, improved education reduces interest in the rural lifestyle (Cramb et al. 2009). Thus, crop-raiding has implications and causes that reach much further than an analysis of economic loss alone suggests. Vulnerability to crop-raiding is the result of complex and fine-tuned balances between a diversity of parameters, including demography, socio-economics and politics.

In this chapter, I aim to provide insights into the various factors affecting social vulnerability to crop-raiding in Loango, as well as the consequences of crop-raiding for farmers at the socio-economic level. I use social vulnerability as a social condition which underlies an inability to respond, cope and absorb crisis (Cutter 1996; Cutter et al. 2003). I attempt to disentangle pre-existing social vulnerability (i.e., social factors that may exacerbate the effects of crop-raiding) from the consequences of crop-raiding for farmers' livelihoods and their resilience to crop-raiding. Using data from ethnography and semi-structured interviews, I describe the current structure and function of farming systems in Loango and the importance of farming to livelihoods. I then discuss the factors that make farmers more or less vulnerable to crisis, including crop-raiding. Next, I investigate how crop-raiding impacts farmers' livelihoods in the short- and long-term and ask whether this affects vulnerability to crop-raiding through a negative feedback effect. Finally, I describe possible coping mechanisms used by farmers and discuss whether these are efficient in alleviating the negative consequences of crop-raiding.

6.2 Pre-existing vulnerability: the rural exodus

The rural exodus in Gabon, described briefly in Chapter 3, began with the French colonial administration's active *regroupement scheme*, during which villages were relocated on roads or along rivers. Pourtier (1989a) suggests that this phenomenon was amplified by the development of the forestry and oil exploitation sectors. These required a large, localised male labour force, which drew men away from their villages in search of lucrative wage labour. This pattern also applied more generally to sub-Saharan Africa (Bryson 1981). At first, women were not enticed to leave their villages, but this changed as companies realised that women farmers could produce a cheap source of food for their employees (Pourtier 1989b). As a consequence, companies started to accommodate entire families, sometimes creating on-site schools and supporting farming (Pourtier 1989b). This, added to the recruitment of civil servants for urban centres by the state, exacerbated the rural exodus, particularly of young people and men (Pourtier 1989b). In Loango, people, and young people especially, tend to favour urban lifestyles with relatively easy access to amenities such as schools, electricity and health centres, which are lacking in rural

areas. For many young men and women, the harsh nature of farming activities and of life in rural areas is a reason to remain in urban centres, even when unemployed. This phenomenon is common and similar trends have been reported in South-East Asia (Cramb et al. 2009) and Japan (Knight 2003), for example. Several households in *la Haute* are composed of only the husband during most of the year, while the wife, or a female relative in some cases, stays in a city with the children during school terms. Women and children return to the villages only for the school holidays, which coincide with the dry seasons when *new fields* are cleared and planted. Transfers between urban and rural areas thus occur at regular intervals and reflect a trade-off between the need for access to natural resources and income, and access to amenities. However, the consequence of this attraction to urban centres is a chronic lack of labour in rural areas.

For the most part, the practice of shifting cultivation is based on a gender division of labour and therefore requires both men and women (e.g., Pourtier 1989a; Vansina 1990; Leach 1992; Coomes, Grimard and Burt 2000). As described in Chapter 2, men participate at the beginning of the farming process when they help to clear the land that will become the field. Men's work consists of cutting down large trees with axes or chainsaws at the beginning of the dry season. This is physically intense as most fields are still cleared with an axe, and it is unusual for women to be involved. Women with no available male relatives often have to hire local men to clear their fields, which entails an extra cost that they cannot always afford. Such women are likely to be among the poorest, partially due to the extra costs incurred by the employment of external labour, as in Sierra Leone (Leach 1992) and Nigeria (Fregene Tosan and Bolorunduro 2009). One of my informants explained this as follows:

> *As I am now, I have made this little garden that monkeys and cane rats have eaten. Where do you find enough* [manioc] *to sell? Before, you didn't need to pay people to clear your field* [suggesting you had people to do it] *but now you need money and alcohol for someone to clear your field.*

Agriculture has been deeply affected by the rural exodus, particularly the exodus of young men, due to this need for men during the first stage of farming practices (e.g., Pourtier 1989b; Cramb et al. 2009; Fregene Tosan and Bolorunduro 2009). One of my informants, whom I estimated to be more than 70 years old, explained to me that she was obliged to work in other farmers' fields to earn money to pay men to clear her own field, because her husband was too old to do it himself. This situation is problematic, as it increases the labour required from farmers. It is even more problematic at my study site, where most farmers do not hire women. Thus women are unable to earn the money required to clear their own fields. When farmers cannot afford the extra cost, or labour, of clearing a *new field*, they can also replant on young fallows that do not yet have big trees, allowing them to clear the field themselves with a

machete. Coomes, Grimard and Burt (2000) rightly consider that male labour can constrain the fallow period in shifting cultivation systems. Several of my informants who were over 60 years old gave age (i.e., lack of strength and poor health) and lack of relatives as an explanation for the small size of their fields or the location of their current fields on young fallows. For example, one husbandless informant, about 70 years old, said:

> *I have cleared a little garden here near my old garden* [which was a place where she used to have a garden only few years ago]. *I wanted to clear a field in Mpembanyanbiè but my children said I was too old to go far and that I should stay near the village.*

However, fields created on younger fallows tend to have a higher incidence of weeds (Fresco 1986), increasing labour requirements in a different way. In addition, young fallows have not necessarily benefitted from good soil regeneration, suggesting that production will be lower for a similar workload (Cramb et al. 2009). To equal the production of fields cleared from mature forest, farmers will therefore need to increase field size, which once again leads to an increased workload of planting and weeding. From a conservation perspective, a shortened fallow period negatively affects soil fertility, thus increasing the risk of permanent deforestation over time (Dove 1983; Coomes, Grimard and Burt 2000; Cramb et al. 2009). When farmers do not have the ability to pay for external labour and cannot manage the extra labour required to clear *new fields*, they generally farm smaller fields (Pourtier 1989a), with consequent lower production. This, in turn, undoubtedly increases farmers' vulnerability to food crisis, as they are unable to adapt to any increase in food demand or any additional loss in production.

The lack of men further affects women in that they need to perform activities generally undertaken by men. For example, men are expected to provide animal protein, in the form of fish or meat, while women provide the accompaniment for the meal. For people in Loango, a meal without protein is not considered as a meal and is often associated with the word "*disette*", which refers to famine and food scarcity. Many men in the area were too old or disabled to fish on their own during my study. Most people had not the necessary boat, and could not afford to buy one, to engage in fishing. Moreover, many women did not have a husband because they were divorced, widowed, or simply single. The consequence was that several women were obliged to fish in addition to their farming and domestic activities, which imposed a significant constraint on the time dedicated to each activity. For women unable to fish, the lack of men resulted in lower access to protein. The exodus of young women also increased the work required. Previously, women benefitted from help from female relatives, particularly daughters, in all activities from planting to the production of processed manioc, this last activity being particularly labour intensive (Bryson 1981; Fresco 1986; Vansina 1990; Cramb et al. 2009). With

the lack of younger relatives, who are at school or in urban centres, farmers now face their heavy workload with very little external help.

Finally, the rural exodus has exacerbated the spatial isolation that renders farmers more vulnerable to a range of problems, including social marginalisation and health problems. As most people cannot afford a boat outboard motor or a car, they travel between villages by walking or rowing. However, elderly people are rarely strong enough to travel in such a physically exhausting manner and depend on others for travelling opportunities (Chapter 5). Villages are becoming smaller and increasingly isolated from one other, creating islands of low human density, which is likely to increase biophysical vulnerability to crop-raiding (Chapter 4). Elderly people are therefore increasingly distanced from the support of the younger generation, social infrastructure and state agencies. Most villagers in Loango National Park and its periphery are isolated from schools, nurseries and other infrastructure, decreasing their ability to resolve or mitigate health problems and poverty. In addition, young people are even less likely to stay in these villages and often prefer to stay where there are infrastructure and work opportunities, such as in Ntchongorové.

The effects of the rural exodus on farming have led to an increase in the labour requirement for individuals, which strongly constrains farmers' ability to farm and produce the surplus that would make them more resilient to crop loss. The lack of available young people creates a negative feedback cycle whereby a lack of labour increases labour requirements, as also described by Guyer (1977, cited in Bryson 1981). In her review of women's investment in agriculture in sub-Saharan Africa, Bryson (1981) discusses the work of Laburthe-Tolra (1975) and Guyer (1977) which suggest that women's workloads range from 45 to > 73 hours a week for food production and domestic labour. In this context, the additional labour required from women due to the rural exodus might not be achievable, creating a labour bottleneck that ultimately leads to farmers' inability to produce sufficient food and income. In addition, and as described by the United Nations (1995), the most vulnerable (i.e., elderly people, husbandless women and poorer households) are most affected by these societal changes, and the least able to cope with and mitigate crisis. In this context of an unreliable and limited labour force, and, as a consequence, an unreliable income and food supply, any event that affects a farmer's ability to plant and harvest one year, such as crop-raiding, can bring them to the brink of immediate subsistence insecurity (Scott 1976).

6.3 Consequences of crop-raiding

6.3.1 Loss of income

In northern Gabon and Congo, subsistence agriculture provides a 5-15 % surplus, which farmers can use as a source of income (Mengho 1978 and Wilkie and Sidle 1990, cited in Lahm 1993) giving an average of 10% surplus production in the Central African region. In the Democratic Republic of Congo, Rösler (1997) estimated that only 28%-38% of farmers were self-sufficient and that only 0-8 % were surplus producer (considered as farmers producing >25% surplus in caloric needs). In Chapter 3, I showed that crop-raiding led to a mean production loss of 16 % per field in Loango, which increased to 27 % when considering only fields damaged at least once. Crop-raiding reduced the production of 34 % of fields by over 10 % (10 –100 %) and 21 % of fields by over 25 % (25-100 %) of their surface area. Crop damage is therefore higher than the surplus production values cited above. We can assume that at least a third of farmers in Loango received no income from farming during the study, although this is the main or only source of income for most of them (mean 75 %, 35-100 %, Chapter 2).

To investigate how crop-raiding affected the economic security of farmers' households, I calculated the economic loss due to crop-raiding. I questioned all farmers about how many baskets of manioc tubers they could harvest from each manioc stem and how many "*paquet*" of manioc they could produce from one basket. A *paquet* of manioc is the standard unit sold in markets and comprises ten sticks of prepared manioc wrapped in leaves. I used these data to calculate the mean number of stems/basket and *paquets*/basket. Using the area lost and the mean planting densities described in Chapter 4, I calculated the estimated number of manioc stems lost per farmer and transformed this into the number of *paquets* lost, and finally into economic loss in both CFA and US$. There is significant variation in the price of the manioc *paquet* between the village or the closest town (Oumboué) (CFA 3,500-4,000[6]) and the city (CFA 6,000-8,000 in Port-Gentil). Because farmers at the study site had very few opportunities to sell their manioc in Port-Gentil, I based my estimation of economic loss on selling prices in the closest town, and chose the higher value of CFA 4,000 per *paquet* to account for the few farmers, or few occasions, where farmers sold their manioc at a higher price in Port-Gentil. Farmers estimated that one manioc stem, if uprooted at maturity, would provide them with enough to make a mean of 2.83 manioc *paquets* (range 1-4.5). Using this value I calculated that crop damage to manioc represented an estimated economic loss of US$ 8,711 (CFA 4,557,530), with a mean of US$ 347 (CFA 181,369) per affected household (range US$ 7-3,112; CFA 3,533-

[6] During the post-research visit in 2012, the price of the *paquet* was CFA 5,000

1,628,017), which is much more than the US$ 60 per farmer affected by elephants estimated by Naughton-Treves and Treves (2005) in Uganda. For households living solely on income generated by farming (US$ 684 per year, Chapter 5) this loss can be devastating. On average, the loss represented 51 % of the farmer's annual income, but in cases of extreme damage crop-raiding resulted in the loss of the entire household income (range 0-100 %). For farmers at the higher end of the income range, the loss is low on average (4.2 %) but it can still represent up to 38 % of the US$ 8,160 annual income for the most damaged fields (US$ 3,112 of damage).

Cash generated through the sale of food products is generally used to buy items farmers do not produce themselves (e.g., oil, soap and clothes). The loss of income therefore generates a loss of access to basic items and a general decrease in the quality of life. Cash generated through farming must also pay for everything related to children's education, including books and uniforms, and on occasion the rent for a house in town, where children can attend school or receive unexpected medical treatment. When crop-raiding prevents a farmer from making any income, the entire family livelihood, sometimes including the maintenance of family members too old to work, is threatened. A further negative effect is the inability of farmers to pay for the material or people needed to protect their fields against crop-raiding (Chapter 5). Thus, when a field is destroyed, both the income essential for survival today, and that required to create and secure future sources of income through farming, disappear.

Finally, crop-raiding puts farmers in a situation of dependency on their children and other relatives. One of my informants said that elephants had damaged her field every year for the last three years. As a consequence, she was obliged to ask her children for money regularly. She expressed her frustration as follows:

> *Now we are suffering. Even getting matches it is difficult. We have to ask the children. We keep asking our children but it is tiring to ask your children all the times. Asking when you need to go to the hospital yes, but we cannot ask all the time and for everything. I am not used to live like this. When I work, it is for them. When I will be tired* [too old to work]*, they will be taking responsibility for me. But not as long as I am in a good shape* [still able to farm]*. If I already start asking all the time, people will say 'ahh your mother it is too much'. We cannot ask at all time.*

Thus, crop-raiding put farmers in a position of complete dependency on the willingness and ability of their relatives to take care of them, even before they become very old or disabled. The loss of a field, or an inability to farm despite being fit to do so, undermines people's pride and sense of identity, as they live on the efforts of others rather than on their own work.

6.3.2 Loss of food

Based on the data for crop-loss presented above, and evaluations of production surplus (Lahm 1993; Rösler 1997), we can estimate that at least 21 % of farmers' households lacked both food and income due to crop-raiding during the year of the study. The loss of food due to crop-raiding affects farmers differently according to whether they possess an *old field* that they can rely on and how much damage is caused. Manioc roots cannot be preserved for long once they have been harvested. Similarly, processed manioc cannot be conserved for more than a few days. The field therefore represents both the place of production and the place of storage. By raiding the field, animals are symbolically raiding the farmer's larder. One informant complained about how crop-raiding deprived her of the produce she kept for the holidays:

> *Look! I was keeping this field for the summer when my children will come. What am I going to do now that elephant have started to damage it? I am obliged to uproot it before they* [elephants] *finish it all. Now what are we going to eat during the summer?*

In addition, when farmers cannot rely on *old fields*, they harvest manioc from their *new field* earlier, meaning that tubers are smaller and that farmers have to harvest more plants to harvest the same quantity than if they harvested at maturity. The consequence is that farmers might only be able to harvest a field that should provide food for up to three years for a year, or less.

Manioc represents 60 % of the daily caloric intake for most Africans and is, therefore, the main staple crop food (Fresco 1986). Farmers in Loango plant mostly manioc and this is the most important food and cash crop for all farmers interviewed. However, the other crops planted (e.g., banana, taro, sweet potatoes), allowed a greater diversity of food consumption. In addition to a large proportion of the manioc, one of the farmers in Ntchongorové had her entire banana and taro crops devastated by elephants two years in a row. She explained to me that during these two years she, her co-wife, and their husband relied almost exclusively on what was left of the manioc, potatoes and the occasional rice they bought thanks to help from their children as exemplified by the following quote:

> *Last year we survive only thanks to the potatoes. But the potatoes that I dig out to eat, if I could sell that I will make a lot of money. And what will happen this year? We are going to eat only rice and potatoes like last year? No I haven't been raised like that.*

And this, by a farmer who suffered heavy crop-damage in *la Haute*:

It is lucky we still have the little sweet bananas. It is what saves us.

In addition to the loss in quantity of food, crop-raiding in Loango also decreases the quality of the food supply by decreasing the diversity of food items, consistent with previous studies in Uganda (Barirega et al. 2010). With decreasing diversity of food, and sometimes lower food intake, it is likely that heavy crop-raiding has a negative effect on farmers' nutrition and, ultimately, their health.

Finally, when animals destroy an entire field, which is the worst-case scenario, farmers lose not only their food but also their ability to plant *new fields*. Farmers take the cuttings necessary to plant the *new field* from the older fields. If the *old fields* have been destroyed, and farmers do not have relatives willing to share their cuttings, they must find extra money to buy new cuttings from the market. If farmers have lost their production to crop-raiding, and thus their source of income, their ability to buy new cuttings may be limited or even zero. As a result of crop-raiding, farmers lose food directly during the raid itself, but also over the following months and years due to the snow-ball effect of early harvest and the decreased ability to plant *new fields*.

6.3.3 Increased heath problems and risk of injury

Crop-raiding affects farmers' health directly, as encounters with wild animals can be dangerous. Elephants sometimes injure, or even kill, people in Africa (Thirdgood, Woodroffe and Rabinowitz 2005). I recorded no injuries or deaths caused by elephants during my study or in interviews, and even the elders I spoke to recalled no such incidents. However, during interviews farmers often expressed fear of injury. Many farmers, particularly those in the park, recall being chased by elephants while trying to protect their field. Most of them described how they ran away and hid in their house, leaving elephants to destroy their fields rather than risking injury. While I did not record any accidents in relation to elephants, a buffalo injured a man, as mentioned earlier (Chapters 4 and 5).

In addition to the direct lack of food, low diversity of food intake, and the risk of injury and death, farmers in Loango complained a great deal about the stress and lack of sleep caused by crop-raiding. To be more precise, it is the fear of crop-raiding and the protection of the fields that creates stress and lack of sleep. Farmers whose fields are attacked regularly by elephants complain of chronic stress, and effects they attribute to stress, such as high blood pressure and headaches, as exemplified in the following statements:

With the animals coming you can't sleep. During the day you work and during the night you have to stay awake because of the elephants. We can't live without sleeping you see. And you know shouting all the time gives you sickness. Headaches and so on. I have high blood pressure you see, and when the elephant comes, oh but my blood pressure increases. You sleep but you always have your ears opened and each time there is a branch cracking in the distance you have to go and check.

You see, deep sleep it is not when you live at the village. You sleep one hour, two hours, and then you wake up, you go and bang on the barrels. From 3 am every day I can't go back to sleep.

The medical literature reveals that lack of sleep induces physiological stress, which in turn leads to sleep disruption, and that both stress and lack of sleep affect the immune system negatively (Carskadon 2004; Hall et al. 2004; Glaser and Kiecolt-Glaser 2005; Meerlo Sgoifo, and Suchecki 2008). Ultimately, increased stress and a lack of or disturbed sleep can lead to increased cardio-vascular incidents and an increased risk of mortality (Hall et al. 2004; Meerlo, Sgoifo and Suchecki 2008). The potential effect of crop-raiding on farmers' health is, therefore, pervasive and affects farmers both short- and long-term. Ultimately, if farmers suffer more chronic illness and compromised immune systems, this will decrease their ability to farm while increasing the need for income to pay for doctors and medicine.

6.3.4 Loss of a safety-net against economic hardship

The loss of a field also represents the loss of a coping mechanism against economic hardship. I witnessed several young couples who returned to stay in their village after losing their jobs in town as also recorded in Gabon by Lahm (1993). They were unable to survive or take care of their children in an urban centre without a source of income. In addition, several young mothers living in towns cleared a small field in their home village as a fall-back strategy, but abandoned these fields because they then stayed in town. However, in times of dire need, they could always return to harvest something for their own consumption. Beauchemin (2002) also describes agriculture as a safety net in times unemployment in Ivory Coast. Thus, crop-raiding can be seen to increase food and economic insecurity for both rural and urban dwellers, and undermines a possible safety-net in time of hardship. Several of my informants expressed this as follows:

Ah when I will die my children [she includes grandchildren] *will say 'Ah when our mother was still alive we didn't suffer, we didn't have to pay for food'. As long as I live they can come every summer and rest.*

I live in the bush, I prefer. My children they suffer in the city. At least when they come here they can come and eat for free. When they will return to the city they will regret 'Ah when I am with mum I eat for free'.

Gabon suffered from a high level of unemployment with 16-19 % of the working population unemployed and 41 % of people aged < 24 years unemployed in 1993 (United Nations data 1993[7]). In addition to the unemployed, farming is also the main source of food and sometimes income for retired people, whether or not they receive a pension. In this context of high unemployment and rare distribution of pensions at retirement, access to food and income through farming is important at both local and national scales.

6.3.5 Social disruption

6.3.5.1 Disappearance of villages and *regroupements*

It is not uncommon to abandon fields and villages as a direct consequence of crop-raiding (Barnes 1996; Hill, Osborn and Plumptre 2002), and, in several instances during my study, farmers abandoned farming for a few years when they considered that the damage was too serious. Crop-raiding in a shifting cultivation system, however, can also induce the slow disappearance of villages or *regroupements*. *Regroupements* are usually composed of villages, which are themselves composed of consanguinal and affinal kin. Each year, each woman clears a *new field* from the forest. As a consequence, each year, fields are located further and further away from the original village, at least until the end of the fallow period when farmers can return to an *old field* site. If each farmer builds a new camp in the *new field* every year, then members of the same family become scattered away from the village. When fields are far from the village, farmers usually stay in their camps full-time and whole *regroupements* and villages begin to disappear as a consequence. On some occasions, members of the same household spread out to protect fields of different ages. For example, two couples and one mother and daughter in Ntchonimbani ended up living in different camp sites due to the need to stay in their fields. Ntchonimbani disappeared in this way and villagers complained about this at length (Fig. 6.1). Similarly, the *chef de regroupement* in Idjembo regularly expressed his fear of the

[7] No data are available for Gabon after 1993.

disintegration of the regroupement as people moved their fields further and further away from their villages in search of fertile land and/or elephant-free areas. This situation, in turn, increases farmers' spatial, and therefore social, isolation, while decreasing the protective effect of guarding as fewer and fewer people guard one field at the same time. Furthermore, scattered villages increase the travel times required for farmers to reach one another, their original village, or amenities such as water points. As many farmers already suffer from time constraints and labour shortage, this increased time pressure can only lead to increased time away from the field while doing other activities. Another possible consequence of village abandonment is lower housing quality both in camps and in the villages. Camps are very basic structures that provide little in the way of protection and insulation from the elements while the properly constructed wooden houses that are left unattended in the village quickly decay from lack of care (Fig. 6.1).

Figure 6.1 : Houses collapsing as a consequence of village abandonment in Ntchonimbani.

6.3.5.2 Disruption of the parent-child relationship

Most women in sub-Saharan Africa are expected to provide food for the household even when men engage in wage labour (Bryson 1981). As described in Chapter 2 and 5, goes further in Loango where fields represent the farmer's value. Thus, when crop-raiding prevents women from fulfilling their duty as food providers, it is their status as a good mother and wife that is in jeopardy. Crop-raiding prevents farmers from feeding their children, but it also increases the risk that children, generally the eldest, will leave school early in an attempt to provide an income. The impact of crop-raiding on women's status and children's education can be significant. As one woman informant described it:

> *I have my kids studying in Oumboué* [the neighbouring town] *and I have nothing to send to them. Now they are going to have to find a way themselves. They will have to find their own money to buy food.*

Some parents are also worried that their inability to take care of their children may lead them to engage in criminal activities:

> *Look at all the children we have to take care of. They are our children. Are you going to let them go and steal? You're going to find them in jail. How am I going to do to keep my children? You have to understand, here without the manioc you don't even have 5 franc* [meaning any money].

The lack of food resulting from crop-raiding leads to further isolation of farmers from their relatives and makes access to labour even more difficult. Farmers tend to be isolated from their urban family for most of the year. Visiting children and grandchildren can be very important in providing labour during the dry season. One informant, who had her entire field destroyed by elephants, explained that she was obliged to ask her children to send rice and oil along with the grandchildren. Such a request could cause her children to hesitate, or even refuse, to send the grandchildren to visit their grandmother. They may send their offspring to another relative who can take care of them without the donation of oil and rice, or keep the children in town. This farmer expressed her distress as follows:

> *At the dry season, it is when you see all the children coming* [she is referring to children and grandchildren]. *You can see Lambert* [the local bush taxi] *with all the children* [in his cars, dropping them in the various villages]. *What are you going to give to the kids if there is nothing in the field? So my children are saying 'no I can't send the kids to the village anymore, mum has nothing'. My children are going to*

avoid me because of the lack of food? No it is too much. It's not people eating now it is the animals.

This isolation adds to the difficulties farmers face, and creates a vicious circle of vulnerability where farmers who suffered from food loss through crop-raiding will not receive the support, in terms of labour, from relatives that could help them secure the next year's food supply.

6.3.5.3 Disruption of social cohesiveness

The dry season represents the period of ceremonies during which many people concentrate in a village for several days. For example, one initiation I witnessed lasted a week, and all the families of the young girls being initiated, as well as other members of the community, were present throughout this time. Women related to the host household, or attending the ceremony, are expected to participate in the supply of food (Chapter 2). However, the host family remains in charge of most of the food supply. Ceremonies are costly, as they require large amounts of food and drink. When a farmer cannot supply food because her field has been destroyed, she is incapable of hosting a ceremony properly. In some cases, farmers require assistance to buy manioc for the occasion, or relatives and neighbours fill the gap with contributions from their own fields. This, however, often places the farmer in a position where she must rely on charity:

Look Emilie people come for the ceremony and elephants have taken everything. We don't have enough food for the ceremony and we are obliged to buy from others. That is not good.

Farmers in Loango take great pride in participating in the family economy, via cash and commodities, and are expected to do so. As described in Chapter 2 and 5, food sharing maintains or creates wives' social networks. As a consequence, crop-raiding can deprive farmers of their ability to maintain healthy social interactions and therefore impede social cohesiveness. Knight (1999: 632) described a similar finding in Japan and expressed it as: "In raiding gardens in remote hamlets, monkeys deprive elderly villagers of a symbolically important currency in social exchange". In addition, because of crop-raiding, many farmers hesitate to leave their field unattended to attend ceremonies for fear of losing their annual harvest (Chapter 5). During interviews, 15 farmers said that in the past people could plant their fields and leave them unattended for several weeks or months, and complained vehemently about their current lack of mobility as exemplified in the following quote.

Now when you have a field you cannot move anywhere. The elephants now enslave you.

By disrupting farmers' social status and mobility, crop-raiding ultimately undermines the cohesiveness of the entire community.

6.4 Coping strategies: Spatial fluidity, livelihood diversification and mutual sharing

While crop-raiding reduces farmers' livelihoods and their resilience to subsistence crises, farmers use several mechanisms to cope with, and adapt to, the negative consequences of crop-raiding. The principal strategies in Loango centre on the spatial adaptability of farming, livelihood diversification, and sharing of money and food between members of an extended family.

6.4.1 Inheritance, residence and spatial diversification

Although the primary aim of fields is food production, the practice of shifting cultivation is also of central importance in the organisation of land tenure in Loango. When farmers clear forest to create *new fields*, the land automatically becomes part of the household and family holdings, as it has been *travaillée*. As highlighted by Pourtier (1989a), clearing a patch of mature forest for a village or field location is very labour intensive and farming on land that has been *travaillée* in the past is much easier. The notion of proprietorship over the land is therefore based on the value of the work invested by a person. I use the term proprietorship, rather than ownership, as it does not necessarily refer to the Western idea of contemporary legal rights over the land. Work therefore provides farmers with wealth, in that it confers riches on the farmer's family in the form of a transmissible commodity, the land. Agondjo (1967, cited in Pourtier 1989a) explained that access to land is the most important attribute for the Nkomi, which, along with Ngowé, is the most common ethnicity at my study site (Chapter 2).

Customary land tenure is still very much respected locally, and people keep track of which land is attached to which lineage according to who lived and farmed in each location in the past. Proprietorship is therefore maintained over time regardless of whether the land is currently under use or has reverted back to forest. Several farmers in Loango had reclaimed

villages and adjacent fields that had been unused for decades (Chapter 2). An informant explained this situation as follows:

> *When I retired, I first went back to Yombé, as my mum was still alive. Then when she died I came back here. I came to renew where I was born in 1929. Even the chef de Canton* [his brother living in the village on the other side of the lagoon] *was born here. We were all born here. It is my land here, all the way up to Koumouloudou over there* [he points at a location south from his village].

While the Ngowé and Nkomi are considered to have matrilineal descent systems in theory (Gaulme 1979; Vansina 1990), descendants live on, and claim proprietorship over, both paternal and maternal land in Loango. They do so opportunistically according to the closeness of their relationship with one or the other side of the family and their need, or desire, to be in a particular area. People refer to their residence as "the land of my relatives", which includes both paternal and maternal kin without distinctions. This fluid inheritance/residence system, which allows for a diversification of settlements locations, may well be a consequence of virilocality associated with matriliny. Vansina (1990: 153) describes this situation as:

> *Matrilineal descent did not alter that a married woman lived at the residence of her husband. Her children lived with her, and hence, away from their mother's brother. There was therefore no congruence between residence and lineage, and members of the same lineage lived in different villages and quarters.*

A similar system has been described for the Ndembu society of Congo (Turner 1957, 1967, 1995). According to Turner (1957), there is a permanent tension between matriliny and virilocality, which he describes as competing rather than adaptive. While I do not analyse descent and residency in depth in this thesis, some points that structure access to land are of interest for the mitigation of crop-raiding. Matriliny allows for the creation of anchored, permanent settlements. However, when in combination with virilocality, the inheritance/residence system allows for adaptability to subsistence needs, for example by allowing hunters to follow mobile wildlife (Turner 1995). According to Turner (1957), this permanent tension allows descendants to claim rights and positions of power – in the case of Loango land – on both their parents' sides, and people favour one mode or the other opportunistically (Turner 1995). Using Turner's analysis, I believe that this combination of matriliny and virilocality is an advantage when coping with crop-raiding. For example, farmers can spread the risk of catastrophic loss by planting crops in several villages, as they do in Loango. Several farmers discussed the possibility of moving back to their mother's or father's land if crop-raiding became unbearable where they were. During my study three farmers planted one

field on their own mother's/father's family land, and one field on their husband's family land. One of these farmers said that she was doing so to limit the risk of losing her entire production to crop-raiding. Such spatial diversification is of particular use in countering elephant damage, as elephants tend to raid zones they raided successfully in the past repeatedly (Chapter 4). This conclusion is in line with Carter (1997), who also describes field scattering as a strategy to lower the risk of stochastic and localised disasters in West Africa.

While the opportunity to shift locations can be helpful, it is not always possible for farmers to farm in different places simultaneously if the family lands are too spread out, and transport opportunities are rare and/or costly, as also described by Carter (1997). Spatial diversification will only be possible in Loango if the local transportation system is improved. In addition, Gabonese society is moving toward an officially controlled system of land allocation and tenure, closer to that of Western countries. Officially, all land belongs to the state and landowners pay the land registry service to obtain a title deed. However, it is still unclear whether title deeds include only permanent settlements like villages, or also include current and future fields and camps. The adoption of the new land tenure system is likely to prevent the current mobility and fluidity of farming and residence practices, unless the legislation considers fluidity in title deeds. This issue will be even more acute in the National Park. As I describe in Chapter 3, the creation of the park has already put limits on the customary land tenure system and how it is managed locally. It is, therefore, likely that land diversification will no longer be possible, or will be limited, for villages inside the park, unless farmers start farming in the periphery. Because of the transportation constraints at the study site, this will only be possible if farmers move out of the park permanently.

6.4.2 Livelihood diversification

Rural dwellers in Africa often have a portfolio of activities and income sources as a strategy to cope with the risk of subsistence crisis (Vosti and Witcover 1996; Ellis 1998, 1999; Dercon 2000; Ellis and Allison 2004). Livelihood diversification occurs at the scale of the household in Loango and is accomplished through the gender separation of labour. As described earlier, women are expected to farm and produce non-protein food and some additional income from the sale of agricultural produce, while men are expected to provide protein in the form of meat and fish, and/or to provide the income necessary to pay for everything the households do not produce themselves (e.g., oil, milk, medicine, school fees). The most lucrative activity in Loango is fishing, and households can compensate for crop loss through cash obtained in this manner. Some fishermen/farmer households even report that they have focused their activities on fishing because of the frequency and scale of crop-damage (Chapter 5), and the resulting loss of food

and income. The main limitation of fishing as a coping mechanism in Loango is its seasonal nature. Farming requires the most intense work during the dry season, when farmers clear and plant *new fields*. Tomatoes, corn, sweet manioc, taro and banana have all been harvested by the dry season, and farmers' households rely mostly on bitter manioc and potatoes at this time. At the same time, the abundance of fish in the nearby lagoon decreases, while it increases in rivers further away. Therefore while fishing is theoretically possible year-round in the lagoon, the dry season is a period of food and income shortage for households whose men do not fish, or who cannot afford to reach the productive rivers in the dry season due to the lack of an appropriate boat with an outboard motor, or money for fuel. The coincidence of food shortage in farming and fishing makes fishing an unreliable coping strategy for poorer households as expressed by informants:

> *Manioc is life, even though you don't have fish, you will always have food in your field.*

> *Fishing? Look my husband he is going fishing, it cost us fuel and nothing. Not even enough to put in the soup. With farming it is all year round you can have money and food. With fishing no.*

Fishing in the lagoon is highly seasonal and, while it is highly lucrative during the wet season and fisherman have surplus to sell, it is not always sufficient to provide an economic safety net year-round. One of the main reasons for this is the sharing principle (see section 6.4.3) which requires villagers to share their income with relatives. This means that money obtained from fishing is not necessarily saved but is shared with members of the extended family who need it as soon as it is available. Nonetheless, when considered at the scale of the year, fishing undoubtedly provides a safety-net for some subsistence households, especially those in the park. However, with the increasing limitations posed on fishing due to conservation, it is questionable how long this will continue to be true.

While hunting is not a regular activity in Loango, subsistence hunting occurs often enough to allow villagers to cope with periods of fish scarcity. I never observed any form of hunting during the wet season during my stay, but I did observe it on several occasions during the dry season. In one village, a man shot a monkey in trees directly next to the house, and the head of the household told me:

> *Ahh Emilie, we haven't caught fish in many days and this monkey has been taunting us all day hanging around the village like that calling us.*

Wilfred and Maccoll (2010) showed that the frequency and scale of wildlife poaching increased with decreasing income from agriculture. We can, therefore, imagine that commercial hunting, which is a lucrative activity in Africa in general and in Gabon in particular (Davies 2002), will become an attractive option for many more villagers if no other opportunity to receive income is available. I am not aware of any full-time hunters in my study area, but such illegal activities may have been hidden from me. Both Blaney et al. (1999) and local wildlife authorities assert that bushmeat is regularly on sale in the closest town to the study site. It is, therefore, likely that hunting is a source of income, at least for some households, and thus a possible source of income diversification. Where hunting is highly profitable, and farming is unreliable, it is even possible that farming becomes secondary, as I described with fishing earlier.

Occasionally, households boosted their income through the practice of traditional medicine, an activity mostly performed by women. I encountered two women in Ntchongorové and two in Idjembo performing traditional medicine (Chapter 5), and another woman started to do so at the end of my study. Medicine may represent an important part of these women's income but only one woman considered it as her main source of income. Many young people and urban dwellers consider traditional medicine out-of-date and question its potency, thus less and less people use it. Thus, for most women, the income generated by traditional medicine was too irregular to be considered reliable or a source of economic security:

> *Yes, I do initiations but initiation it is once or twice and then nothing for two years. The fields give you food every day.*

Other sources of income for men came from pensions (in rare cases), the temporary and rotational employment provided by the local oil company, other occasional maintenance work for the local telephone company, construction work, or, in two instances, including Kharl, as research assistants. Because these jobs are temporary and unreliable, people do not consider them as proper sources of income, but rather as "a little help". Conservation actors are the major sources of alternative employment in the area, mostly through tourism, but they tend to employ young people, while the majority of the farmers in the area are older, often of retirement age. Furthermore, during the year of my study the main tourism company in Loango closed, leading to many local people losing their jobs. Tourism is a volatile and uncertain activity, dependent on the international economy but threatened by institutional uncertainty and trends in popularity (Leisher et al. 2010). In addition, Walpole and Thouless (2005) demonstrate that current tourism in the tropics is unlikely to sustain or provide benefit to an entire community. Finally, in Loango, young couples with at least one member working in tourism tended to not engage in farming at all, replacing one income by another rather than diversifying incomes. Consequently, these activities cannot be considered as real and efficient coping strategies.

While diversification can, on occasion, avert immediate subsistence crisis, diversification through wage labour is risky as it targets mostly men and may draw them away from the village where they are needed. In addition, some studies in Africa suggest that women's assets are more beneficial to household livelihoods and target the next generation more efficiently through improved education and health than assets provided to men (Haddad, Hoddinott and Alderman 1997; Quisumbing and Maluccio 2000; Coad et al. 2010). It is, therefore, not certain that income generated through men's labour is efficient in countering subsistence crisis. Caution should therefore be applied when considering all sources of income diversification as equally beneficial in limiting the negative consequences of crop-raiding for farmers' households.

6.4.3 The sharing principle

Where coping mechanisms within the household unit fail, another mechanism based on the social construction of family links remains available. Folke et al. (1998, cited in Folke et al. 2007) describe various types of risks they term "surprise", and different responses to each class of surprise. Type I surprise, referred to as "local surprise" by Gunderson et al. (1995, cited in Folke et al. 2007: 16), includes stochastic events that are expected and can be estimated in a Bayesian fashion, like crop-raiding. According to Folke et al. (1998, cited in Folke et al. 2007: 16), the risk associated with "local surprise" can be mitigated through "risk reducing and risk spreading or risk pooling across independent individuals" strategies. These responses are adapted to "risks that are amenable to economic rationality on an individual level" and are "manageable at the scale of the individuals or associations of individuals" (Folke et al. 2007: 16). This risk pooling strategy relates to another process of mutual reciprocity described by Bahuchet (1990), where "A way of reducing risk is pooling by means of creating social ties based on mutual obligation". Bahuchet (1990: 39) also relates "mutual obligation" to "general reciprocity", in which "the counter-gift is implicit but the expectation of reciprocity is indefinite (the vague obligation to reciprocate when the giver is in need or the receiver is able to)". This system, based on a norm of sharing and gifting, relies on a form of mutualism favourable to the reduction of risk, and is also observed elsewhere, for example in Botswana (Cashdan 1985), the Central African region (Bahuchet 1990) and Venezuela (Gurven et al. 2000).

The income sharing, and sometimes food sharing, I observed in Loango seem to fit the risk pooling and risk spreading strategies described in the literature. A farmer confronted by a crisis was usually obliged to ask relatives beyond the household for goods or even money, as I described earlier. In Gabon, extended families share resources, and can become very large, providing a broad network of reciprocity. At the study site for example, most people native to the area seem to be related through direct kinship or through marriage. This system is important

in helping all family members to cope with a diversity of crises, or simply when facing large costs such as a bride price. For example, if someone is sick and requires medical treatment but cannot afford it, all members of the family who can afford to do so are expected to contribute. Through this sharing principle, the negative effects of economic and food insecurity affecting one household are shared among all family members who can afford to participate, and are willing to do so. Thus, the consequences of crop-raiding are spread among family members, generally all the way to urban centres, where family members with a regular source of income live most often. One example from Loango exemplifies this phenomenon clearly. During the dry season, I visited an informant whose *old field* was almost entirely empty. When I asked why, she explained that one of her sons had come and harvested manioc to sell in town. This informant used to have an annual contract for manioc supply with the local forestry company, making her financially self-sufficient. However, because her son had emptied one of her two *old fields*, and her *new field* was not yet mature, she told me that she had been obliged to cancel her manioc contract to ensure food supply for the household. While she complained about her son taking too much manioc from her field she also added:

> *But it is my son who provides me with what I need. If I ask for matches or so, he sends it to me. He is the one who bought me the generator.*

In this example, the generalised sharing principle seems to fit the description of "demand sharing" given by Peterson (1993), in that the giving is solicited by the individual in need. Through this explicit demand for mutual exchange, which may span weeks, months, or years, the farmer ensures she has access to basic commodities when needed.

This system, however, has limitations that should not be overlooked. First, sharing can only be efficient at a small scale because of transport difficulties. If relatives live far afield, they may be unable to send the support required easily or quickly enough to support those in need, or even be unable to send it at all. This observation is consistent with Cashdan (1985) who states that when transport costs become significant, and sometimes as populations become increasingly sedentary, reciprocity is likely to be replaced by storage. However, storage in Loango is done in the fields, and is hindered by crop-raiding. As a consequence, the use of reciprocity as a strategy to cope with crisis is likely to be under increasing constraints at the study site where transport is difficult and costly. Second, sharing can only work as long as family members can afford to share, while the reciprocity systems prevent accumulation of riches (Peterson 1993; Walker 2012). In many cases, people living in cities and working for an income earn just enough to support their own children's needs. Several tourism employees, when asked whether they supported their farmer relatives, told me that they could only do so "from time to time". In such cases, the money potentially provided through relatives is not always available

when it is needed. Consequently, reciprocity can only work as long as sufficient members of the family can afford, and are willing, to support others. In other words, as long as the sharing process is indeed reciprocal. As described in Peterson (1993), sharing can be refused, although this rarely occurs directly. In demand sharing systems, refusal is accomplished through "hiding, secretive behaviour and lying" (Peterson 1993: 864). This form of refusal is undoubtedly present in Loango. Some of my friends living in cities, wealthier than most of the members of their family, chose to live on their own and far from the houses of most their relatives as a way to limit interactions and sustained demands. One of the farmers selected for the study hid one of her fields from me, and the rest of the village, for a whole year. In addition, some other farmers lied openly, but not consistently, about their sources of income. The lack of incentive for villagers in Loango to live with each other, which they cite as a way to limit jealousy, may also reflect a desire to hide wealth and limit demand sharing. In the end, the spatio-temporal constraints of reciprocity, and the potential variability in family members' ability and willingness to share, make reciprocity quite an unreliable coping mechanism to absorb crisis, as one informant said:

> *When I ask for matches or oil for the lamps they say 'Oh mum, I don't have the money yet, they haven't paid me yet'. It is always I don't have the money yet. How do I do to live in the meantime? [. . .] If I had my field I wouldn't be like this, I could have my money.*

6.5 Conclusion

In this chapter, I have demonstrated that the rural exodus of young people of both genders acts as an out-migration of the labour force leading to a decreased ability to farm and an increased vulnerability to environmental crisis (box 1 in Fig. 6.2). Farmers are ageing and are increasingly spatially and socially isolated, which, in turn, increases their vulnerability to poverty (box 2), health concerns, and crop-raiding (arrows marked A). Crop-raiding in Loango thus acts as an additional burden on already vulnerable and marginalised communities.

Crop-raiding affects farmers' livelihoods in many different ways (arrow B in Fig 6.2). It leads to loss of food and income, which can bring some households to the brink of a subsistence crisis and increases vulnerability to poverty (box 3 and arrow C). Crop-raiding induces health problems both directly and indirectly, by increasing the risk of injury and by the increased exposure to mosquito-borne disease, stress, lack of sleep and possibly through a consequent reduced immune system response (arrow C). Crop-raiding prevents farmers from using fields to

ensure access to food and income that act as a safety-net during times of unemployment or at retirement (arrow D). Finally, crop-raiding threatens the farmer's role within the family and the community. By preventing women from fulfilling their role as non-protein food provider, crop-raiding decreases their ability to host relatives, which in turn decreases access to an already small and unreliable labour force. Crop-raiding therefore creates a negative feedback circle, as it increases food, cash and labour shortages while leading to an increased workload and an increased need for cash and labour. Ultimately, crop-raiding favours a negative spiral of increased vulnerability to crop-raiding and poverty (in order: arrows marked B, C, D and E).

Farmers use several strategies to reduce or cope with the risks of subsistence crisis, including crop-raiding (box 4 and arrows marked F in Fig. 6.2). First, they display an inheritance/residence system based on an opportunistic combination of matriliny and virilocality, which allows them to shift or spread the location of their fields to avoid catastrophic loss, or to move away from areas of intense crop-raiding. However, this system is less and less applicable, partly due to the difficulty of transport between sites, and the transformation of land tenure from customary and fluid to state-controlled and fixed (box 5 and arrow G). Second, subsistence households, including farmers, tend to use a portfolio of subsistence activities, which should ensure access to income in case of the failure of one source of income. Farmers in Loango rely mostly on other extractive activities, such as fishing and possibly hunting. However, the study site lies in a protected area, leading to a concern as to how farmers' households will be able to diversify their activities where the extraction of natural resources is forbidden or restricted, and where the options available to farmers to protect their fields are limited (Chapter 6, arrow G). From a conservation perspective, conservation actors should be concerned that loss of production through increasing crop-raiding might lead to increasing fishing or poaching, as shown in Tanzania (Wilfred and Maccoll 2010). The presence of wage labour in the area could compensate for this loss. However, because wage labour tends to focus on the younger generation and is unreliable, its effect on farmers' livelihood security is limited or null. Finally, local people display norms of reciprocity and sharing that should act as a risk-spreading strategy, limiting the risk of catastrophic subsistence crisis. In reality, this strategy is under great constraint, as transport problems render the sharing of resources difficult. In addition, people's ability and willingness to share are unpredictable, making reciprocal sharing unreliable. The sharing principle also creates the risk that repeated damage spreads vulnerability to all family members if too few of them are wealthy enough to support the others. In this respect, vulnerability to poverty through crop-raiding may spread to the entire extended family. Unemployment in Gabon is high (United Nations data 1993) and it is, therefore, likely that many young people are, or will be, unable to support their relatives in times of need. In the worst-case

scenario, young people actually rely on their relatives for access to food or income rather than providing them with risk-spreading alternatives.

It seems that farmers in Loango are increasingly vulnerable to crop-raiding, partly due to the pervasive effects of rural exodus. In turn, crop-raiding leads to increasing vulnerability to poverty, which ultimately renders them more vulnerable to future crop-raiding. Even when crop-raiding is not increasing in terms of area damaged, its negative impact on farmers' livelihoods is increasing due to demographic pressures, lack of effectiveness of coping strategies and conservation regulations.

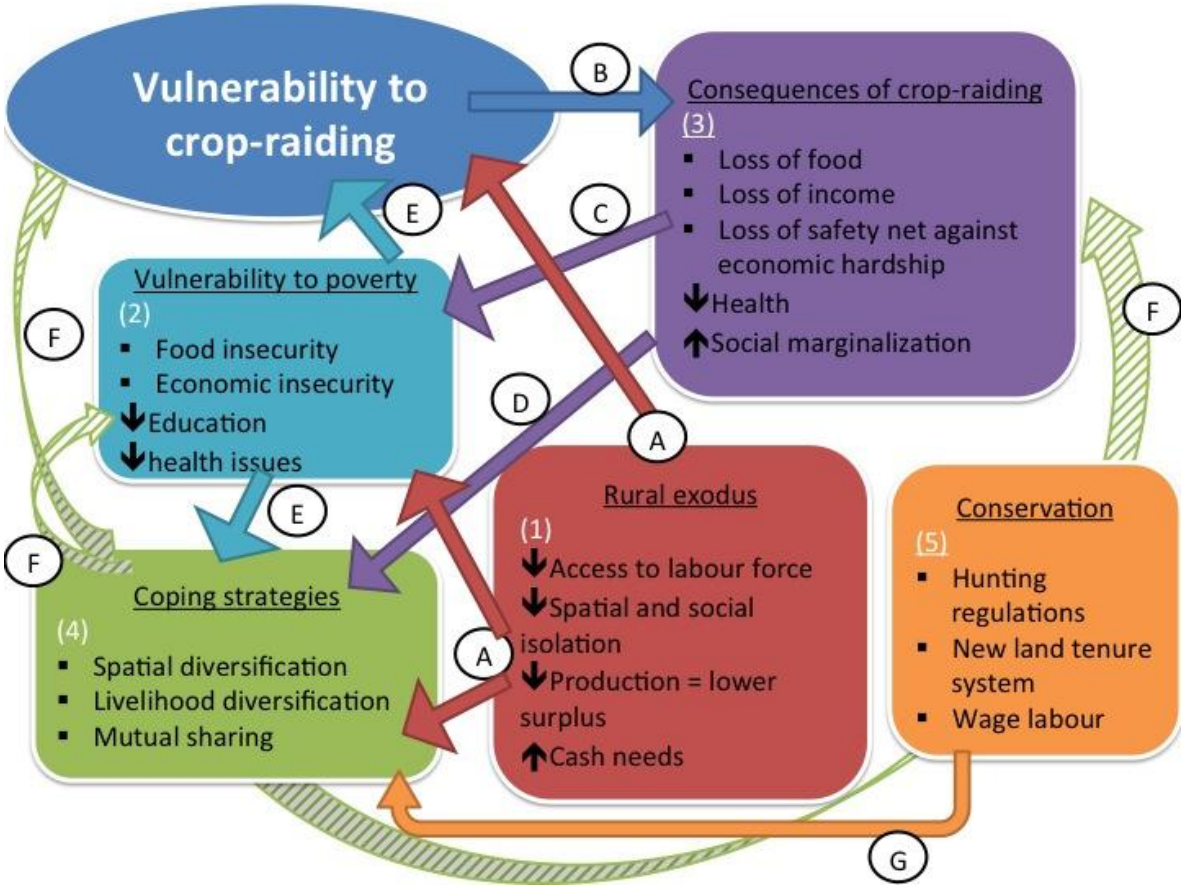

Figure 6.2: The main trends characterising farmers' social vulnerability to crop-raiding in Loango. Numbers and letters are explained in the text. Solid arrows represent an aggravating effect and striped arrows represent a theoretical positive effect. Small black arrows pointing down represent a decrease and those pointing up represent an increase.

Chapter 7 – Discussion

7.1 Review of the results

Through this thesis, I have analysed vulnerability to crop-raiding in three dimensions as described in Chapter 1 (Fig 1.1), namely: institutional, biophysical and social. Here I summarise the findings for each dimension and integrate them to highlight the main processes driving vulnerability to crop-raiding in Loango.

7.1.1 Institutional vulnerability to crop-raiding

Historical interactions and trade with Europeans have strongly influenced people's use and view of nature in Loango. Local people value nature and its preservation for utilitarian, aesthetic and naturalistic reasons. The local environmental ethics are grounded in a local interpretation of sustainability, which shares much theoretical common ground with science-based conservation. Conservation practices, however, restrict people's access to important fall-back resources, restrict the fluid use of land across the landscape, hindering possible coping strategies, and disempower local leaders through transfer of power to state representatives (Chapters 3 and 6, box 1 and arrow A in Fig. 7.1). In so doing, conservation threatens what Leach, Mearns and Scoones (1999) refer to as local environmental entitlement, and which ultimately represents a farmer's ability to secure a livelihood through access to resources. Thus, and despite ideological common ground between local people and conservation actors, some conflicts arise. As in other parts of Africa (e.g., Naughton-Treves 1997; Hill 2000; Hill, Osborn and Plumptre 2002; Madden 2004), crop-raiding is the main source of complaints by farmers about local authorities in Loango and the main reason to dislike wildlife conservation. It seems that conflicts around crop-raiding are often used as a starting point for, or a symbol of, general disapproval of the strong top-down approach of conservation practices. The lack of engagement between stakeholders leads to increasing marginalisation of local people, which is at the root of a local form of daily resistance (box 1). This resistance, which is mainly expressed through cultivated ignorance of conservation regulations, should be a major concern, as it is likely to lead to uncontrolled conflicts, and might ultimately lead to the failure of conservation, as has been the case in Madagascar (Peters 1999) or Benin (Idrissou et al. 2011).

In this context of lack of trust between authorities and local people, the institutional pathways available to limit crop-raiding are often ignored or resented by farmers, even when they could provide some relief. The state provides strategies to kill, or allow the killing of, crop-raiding animals, and to compensate for the economic loss suffered by raided farmers. However, the complexity and lack of adaptability of the reporting process often makes implementation

impossible. Farmers' increased spatial isolation (box 2 in Fig. 7.1), leads to increased social and institutional isolation, which in turn worsen farmers' ability to use existing legal mitigation strategies, or to access the benefits provided by conservation (arrow B). The lack of trust between farmers and the local authorities and the widespread suspicion of corruption are worsened by the inefficiency of the system in place (box 3), and generates a lack of incentive to use institutional channels (arrow C).

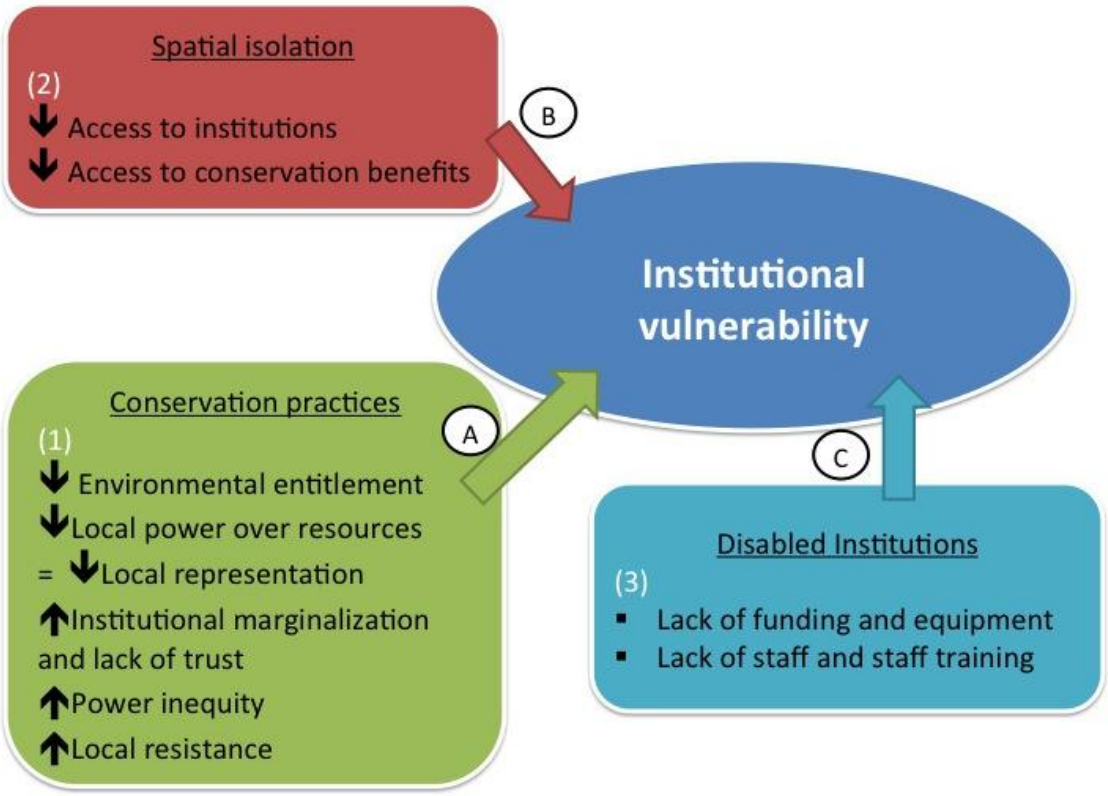

Figure 7.1: Institutional vulnerability to crop-raiding in Loango. Numbers and letters are explained in the text. Solid arrows represent aggravating effects. Small black arrows pointing down represent a decrease and those pointing up represent an increase.

7.1.2 The biophysical dimension of crop-raiding

Elephants are the most damaging species in Loango, followed by rodents (Chapter 4). Crop-raiding is higher than previously reported (Blaney et al. 1999), and this can be explained by both ecological and anthropogenic aspects of the landscape. Fields in *la Haute* are raided more than fields in other *regroupements* and temporal patterns of raids seem to fit seasonal use of the landscape by elephants (arrow A in Fig. 7.2). Furthermore, villages in the park are surrounded by mature secondary forest, which is a habitat well-suited to many raider species, such as elephants and gorillas. Shifting cultivation combined with low human density often leaves tracts of secondary forest, which is attractive to elephants, alongside fields and villages, increasing the

risk of damage (arrow B) (Barnes 1996; Lahm 1996). Increased damage may also be the result of increased wildlife densities in and around the park due to conservation, but no data are available to test this hypothesis in Loango or in Gabon in general.

Villages in the park are more spatially isolated than elsewhere, and fields rarely have neighbouring fields that could potentially dilute the risk of crop-damage. In addition, the rural exodus that occurred in Gabon, combined with the lack of interest shown by young people in the rural lifestyle, led to lower human presence in the area. Some crop-raiding species adapt their behaviour and ranging patterns to human activities and disturbance (Graham et al. 2009; Laurance et al. 2006a). This makes it likely that the decrease in human density in Loango facilitates increasing incursions by wildlife into human territory (arrow C in Fig. 7.2). Local people and authorities both blame increased crop damage on oil exploitation and forestry, something that deserves further investigation. Overall, the demographic changes and the distribution of past and present anthropogenic disturbances seem to be the main forces driving biophysical vulnerability to crop-raiding in Loango.

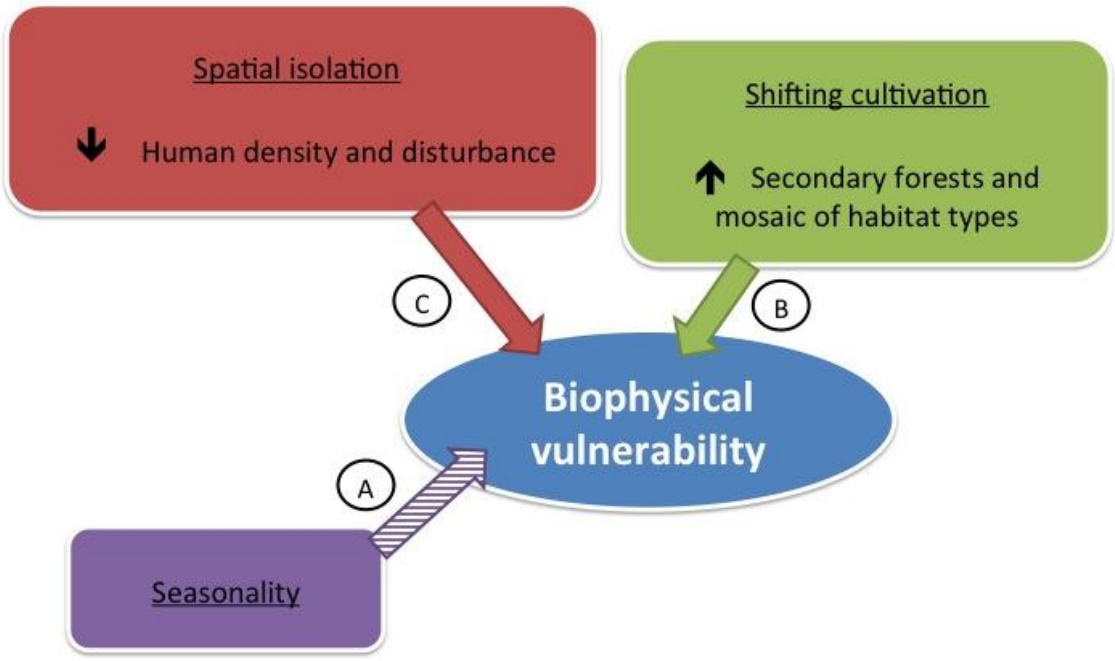

Figure 7.2: Biophysical vulnerability to crop-raiding in Loango adapted from Figure 4.25. Letters are explained in the text. Solid arrows represent an aggravating effect and striped arrows represent an influence. The small black arrow pointing down represents a decrease and the one pointing up represents an increase.

7.1.3 The social dimension of crop-raiding

7.1.3.1 Deterrent methods

Farmers use a variety of traditional deterrent methods to prevent or limit crop-damage by wildlife, many of which are also used in other countries of Africa, Asia or Latin America (Sillero-Zubiri and Switzer 2001; Osborn and Parker 2002; Nelson, Bidwell and Sillero-Zubiri 2003; Osborn and Parker 2003; Osborn and Hill 2005; Parker et al. 2007). The most commonly used method in Loango is noise, followed by, and often in combination with, a camp in the field (Chapter 5). My results suggest that none of the strategies currently in use are effective, even when used in combination. This lack of efficiency is mostly attributable to farmers' inability to use the strategies efficiently either full-time or at the times when they are most needed, partially due to a low access to labour force (boxes 1 and 2 and arrow A in Fig. 7.3). Farmers are less and less able to defend themselves due to their own physical limitations (box 1 and arrow A) (e.g., they are older and unable and/or too scared to chase elephants away), time constraints (box 1 and arrow A) (e.g., they cannot work during the day and stay awake to protect their fields at night) and poverty (box 3 and arrow B) (e.g., a lack of money to pay for ropes, guards and guns). In addition, while collaboration between people would help to facilitate access to labour and mitigate the financial costs associated with guarding, the social isolation created by spatial isolation and the pervasive lack of trust between people in Loango (box 4 and arrow C), which is rooted in suspicion of corruption and fear of retribution from jealousy, interferes with successful collaboration, limits the effectiveness of mitigation strategies (arrow D), and ultimately increases vulnerability. Finally, conservation regulations greatly limit farmers' use of mitigation strategies they used in the past (arrow E).

7.1.3.2 Consequences of crop-raiding

The consequences of crop-raiding in Loango are multiple and in many cases similar to those reported elsewhere in Africa (box 5 in Fig. 7.3) (e.g., Lahm 1996; Naughton-Treves 1997; Hill 2000; Nyhus, Tislon and Sumianto 2000; Thirdgood, Woodroffe and Rabinowitz 2005; Kaswamila, Russell and McGibbon 2007; Ogra 2008). However, rural people are already more vulnerable to poverty, and crop-raiding, due to the negative effect of rural exodus on access to labour (arrows marked A, F and G). The main consequences for individual farmers are increased food shortage and economic vulnerability through direct loss of food and income, and increased illness related to stress and lack of sleep and increased labour requirements (e.g., the need to

replant several times a year). The added demand for labour incurred by farmers can amplify vulnerability to poverty because farmers are unable to create a safety-net through income diversification strategies for example (arrow H) (Watts and Bohle 1993; Blaikie et al. 1994; Ellis 1999; Ellis and Allison 2004). Other consequences are subtler and consist of the use of shorter fallow periods because of the need to replant repeatedly after raids, or to keep fields closer to the village, where they can be better protected. However, shorter fallow periods lead to lower production due to soil erosion, which ultimately increases labour requirements. Farmers living in camps also suffer from lack of comfort, increased risk of health problems related to a lack of water sources, and a lack of protein when fields are located far from the lagoon. The need to stay in camps also leads to the slow disappearance of larger villages and *regroupements* and increases spatial isolation as villages fragment and scatter, and thus become more exposed to crop-raiding (arrow I). The need to stay in camps also reduces farmers' mobility as they are reluctant to leave their field unprotected, which aggravates their existing social marginalisation. Finally, life in camps increases the time taken to travel to visit relatives in case of need and can lead to further isolation from amenities such as schools, nurseries and hospitals.

7.1.3.3 Coping with crop damage

The coping mechanisms used previously in Loango are now out-of-date, maladapted to contemporary socio-economic and demographic constraints and no longer functional (box 2 in Fig. 7.3). Sometimes, farmers try to scatter their fields to limit the risk of the loss of their entire production. However, changes in the land tenure system and the problematic transportation in the area limit the feasibility and effectiveness of such a strategy (box 6 and arrows marked A and E). In the past, farmers shared food and cash within households and across the extended family. With young people engaging less in farming, direct food sharing is not always possible, especially when travelling constraints render exchanges problematic. There are sources of income diversification in the area, particularly through tourism (box 6). However, wage labour generally employs young men, and sometimes young women in the case of tourism. Thus, it rarely benefits farmers' households, who are often of retirement age. Furthermore, due to the lack of access to labour, especially within their household, farmers are often unable to diversify their sources of income in ways that enhance their ability to cope with crop-raiding (arrow A). Even when some members of an extended family receive a substantial cash income, the amount shared is generally insufficient, and too irregular, to ensure the economic and food safety of relatives whose fields have been destroyed. Furthermore, wage labour opportunities are very unequally distributed (arrow E), as most of them are in Ntchongorové, very few are in Idjembo and none are in *la Haute*. As also described by Walpole and Goodwin (2001), Walpole and

Thouless (2005) and Leisher et al. (2010), conservation-related benefits rarely reach the households the most affected by conservation conflicts in Loango.

7.1.3.4 Social vulnerability to crop-raiding: a summary

Social vulnerability to crop-raiding, as I interpreted it, combines the inability to prevent or limit raids with an inability to cope with them when they arise. In Loango, social vulnerability is clearly rooted in the demographic and socio-economic changes that occurred over the past few decades in Gabon (arrows marked A, C and F in Fig. 7.3). The main drivers of social vulnerability are social isolation (box 4), often created or worsened by spatial isolation (box 1), poverty (box 2) and conservation (box 6). Crop-raiding is an aggravating factor of poverty, thus creating a spiral of poverty-vulnerability to crop-raiding (in order: arrows marked G, J, (H, I), (A, F, C), (B, G) and D).

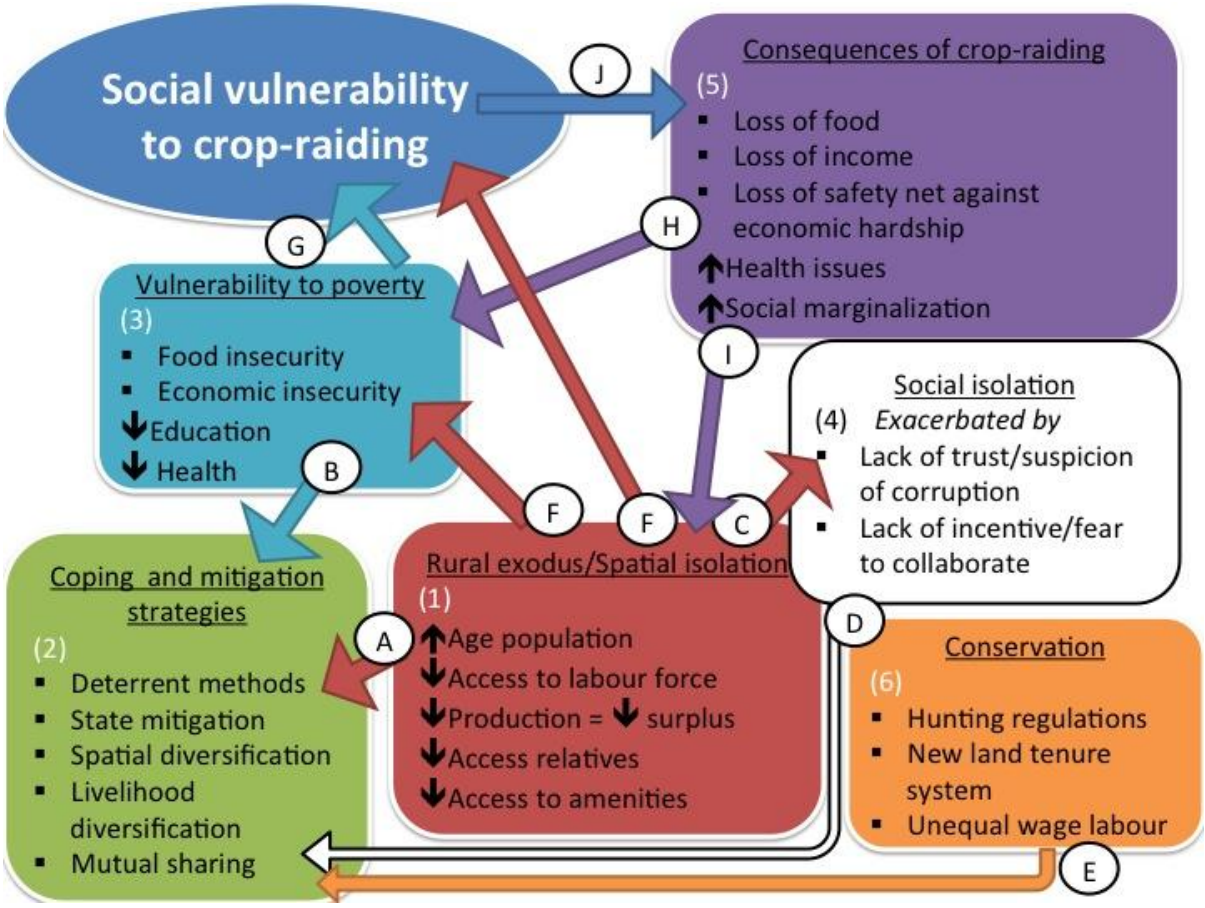

Figure 7.3: Social vulnerability to crop-raiding in Loango, adapted from Figure 6.2. Numbers and letters are explained in the text. Solid arrows represent an aggravating effect. Small black arrows pointing down represent a decrease and those pointing up represent an increase.

7.1.4 Vulnerability to crop-raiding – a conclusion

To conclude, spatial and social isolation (found in boxes 1, 2, 3 in Fig. 7.4), emerge as predominant forces that coalesce to increasingly expose farmers to crop-raiding. Both forms of isolation, resulting from socio-economic, demographic and institutional changes, are also particularly important in explaining farmers' inability to respond and cope to such crisis, as summarised in Figure 7.4.

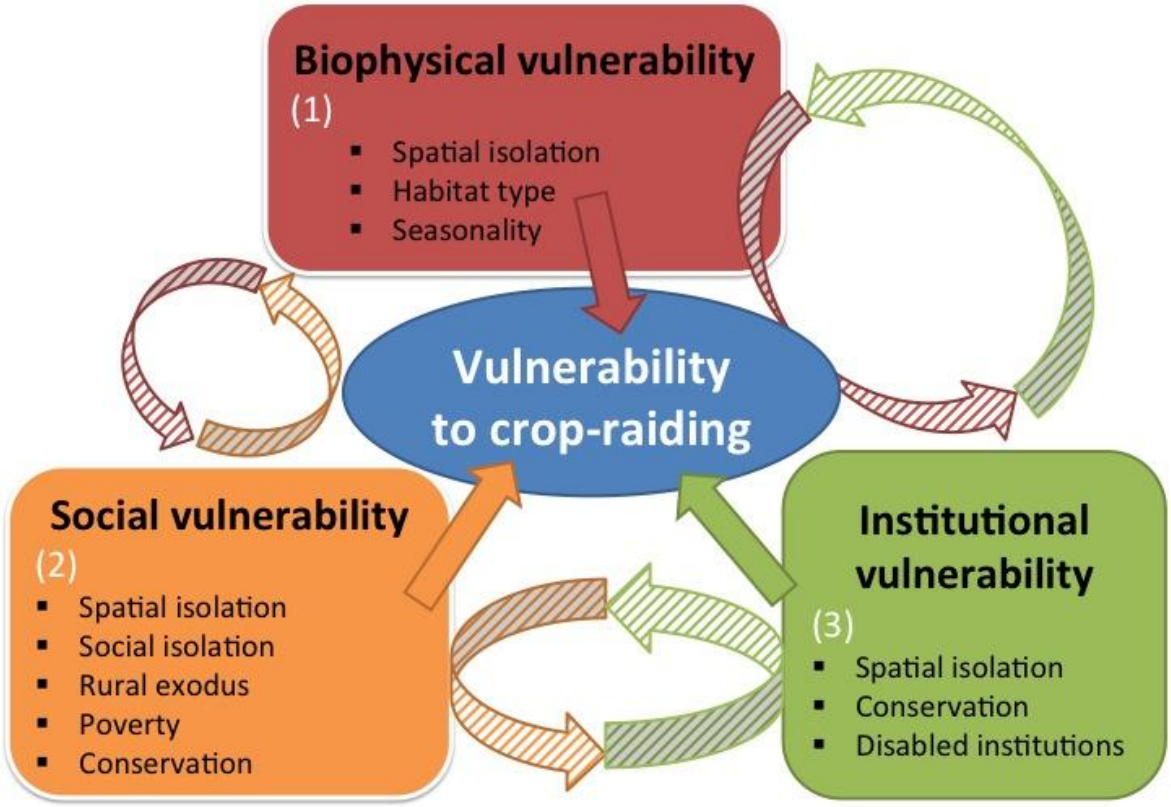

Figure 7.4: Threefold vulnerability to crop-raiding in Loango. Numbers are explained in the text. Solid arrows represent an aggravating effect and striped arrows represent an influence.

7.2 Management implications

7.2.1 Improvement of deterrent methods

In this section, I suggest two strategies to improve field protection. Preventing raiders from entering fields is critical in decreasing the level of crop damage, much more than chasing the animal once in the field (Sitati, Walpole and Leader-Williams 2005). Efforts should therefore focus on improving the feasibility and efficacy of guarding fields. Several studies from East Africa suggest that setting up camps some distance from the field, potentially between the field and

the forest, and the presence of watch towers and dogs could increase the efficacy of guarding (Osborn and Parker 2003; Graham and Ochieng 2008). However, cooperation between farmers and clustering fields would be required to reduce the labour costs associated with guarding, and to ensure there will always be a guard.

During my interviews, one farmer suggested the collaborative farming and guarding practice illustrated in Figure 7.5. The figure shows fields of two consecutive years. Each year, when clearing a *new field* on the edge of the previous one, farmers should move their camp to protect all their fields simultaneously. The farmer who described this design planned to put camps in the middle of the field, as farmers do currently. However, because putting the camp between the field and the forest should improve detection, and increase guarding efficiency, I have placed camps on the forest edge. According to the farmer who made this suggestion, if farmers cooperate to guard their fields together, then they would have the opportunity to rest or travel on a rotational basis as there would always be others on guard.

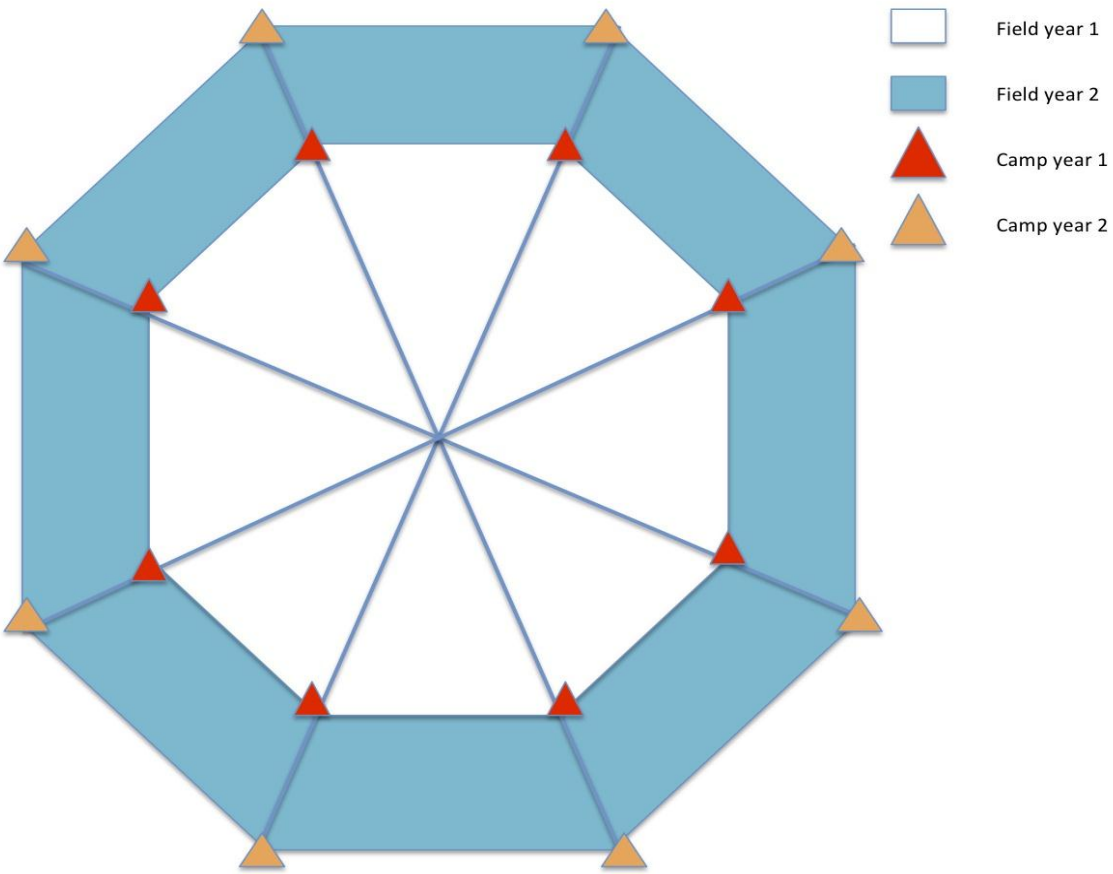

Figure 7.5 Guarding strategy proposed by a farmer and modified based on the crop-raiding literature.

While this simple technique seems realistic and a good compromise, there are several difficulties with it:

1. Clustered fields imply that unrelated farmers would share a piece of land. I describe how the land tenure system is based on family land in Chapter 3. To resolve this, grouping fields will require arrangements between farmers, local leaders, and probably local authorities, to clarify land allocation.

2. Because farmers use a shifting cultivation system, they would need to create *new fields* following the pattern described every year. If farmers create *new fields* on the edge of old ones, as they do today, they need to move their camp every year to stay on the forest edge. This is already a problem for many farmers, who generally lack the labour and material needed to create new camps every year. In addition, moving fields every year will eventually lead to a system where fields will be too far from one another to benefit.

3. The lack of cooperation in Loango (Chapter 5) makes such systems challenging to put in place, and systems of collaborative guarding would require careful consideration of local social susceptibility. Farmers will need to be involved at all stages of the planning process and they will need to cooperate with relatives or neighbouring farmers, as also suggested by Walker (2010), rather than at the scale of an entire *regroupement*. In a few cases, neighbouring farmers already cooperated informally, which is promising. If a few farmers agree to a trial for one or two years, and if this trial is successful, then it is likely that neighbouring farmers would employ it as long as it is affordable in terms of labour and money.

Another system could be developed simultaneously, but at a strategic level. The level of unemployment in Gabon is quite high, particularly for the 15-24 year age group, providing readily available labour (United Nations data 1993). We can, therefore, consider the creation of a small-scale cooperative system where groups of farmers could each contribute to hiring local men to clear and protect fields. Walker (2010) showed that Gabonese farmers are less likely to cooperate if cooperation requires financial input. However, on several occasions during my study, villagers set up "*tantine*", a collection of money dispensed in rotation to each member of the donor group. This suggests that similar systems could succeed as long as they mimic current local practices and are discussed, planned and organised by the farmers themselves. Unfortunately, this system depends explicitly on farming, or other activities, generating a reliable source of income that would allow farmers to contribute cash in the first place. It would also require a reliable and transparent system for employment and financial management, as many farmers cite corruption as the main reason why they fear, and refuse, cooperation with other farmers. NGOs and local companies may be able to provide support and training to build local people capacity in managing such cooperatives.

7.2.2 Improvement of the reporting system

The reporting system allowing farmers to request *battue administrative* or claim compensation can be improved easily. First, the MEF, the ministry responsible for the management of human-wildlife conflict, could allow official complaints to be made by telephone for isolated villages such as these in the park, leading to a visit from the MEF representatives. Visiting every farmer who calls might be financially and logistically complicated, particularly if farmers call after every raid. However, local authorities could visit the entire *regroupement* following reports of serious damage, to avoid repeated visits, for example. An alternative option would be to monitor crop-raiding several times a year in the entire area, perhaps after each rainy season, during which famers could report damage officially. If money and logistics are a problem, these reporting sessions could be done simultaneously with an education campaign or socio-economic surveys when they are organized. A further option, not mutually exclusive with the first two, would be to empower *écogardes* to report complaints officially. *Écogardes* carry out frequent anti-poaching patrols, accompany all researchers working in the park and will be part of future education campaigns. They are, therefore, likely to be in regular contact with local people and could report damage to the representatives of the MEF opportunistically. These representatives could then organise an official visit. This would circumvent problems with transport and illiteracy. In addition, it would be beneficial to train the MEF representatives and *écogardes* in the management of conflicts with local communities, and in the collection of data related to the social aspects of conservation. Whether improved reporting will lead to more actions to mitigate crop-raiding, and how this would occur, is still unclear. However, better reporting will provide readily accessible data to analyse crop-raiding and its development, and could improve relationships with local communities if they feel they are listened to and their issues are considered, at least on the short term.

7.2.3 Compensation scheme

As I describe in Chapter 5, compensation should be one of a variety of strategies used to mitigate the negative impacts of crop-raiding. Other measures to limit the occurrence of crop-raiding, and strengthen the capacities of communities and authorities, are required. In this context, making direct payments under the guise of general conservation benefits, or performance payments, may be an alternative approach to compensating for each and every loss (Ferraro and Kiss 2002; Nyhus et al. 2005; Jackson et al. 2008). Payments can improve the living standards of the whole community, by providing access to medical support, for example. Direct payments are also more positive as they are less likely to lead to decreased motivation to

protect fields, which has been reported in other countries (e.g., Nyhus et al. 2005). However, if direct payments are not sufficient, farmers whose fields have been damaged will not see their livelihood improved and compensation will be considered of limited use. A combination of compensation in cases of heavy damage and direct payment (see section 7.2.4) might be more appropriate to the particular context of crop-raiding.

7.2.4 Initiate an effective benefit sharing system

The National Parks should implement the benefit sharing mechanism that is planned in the future management plan quickly. The share of benefit should first target a project for the entire community and also households who do not already directly benefit from conservation through employment, for example, and households suffering most from conservation's negative impacts. ANPN and NGOs could initiate systematic social surveys and monitoring of the impact of conservation in order to distribute benefits more efficiently and equitably. As logistics and funding are limited, social surveys could be carried out along with some biological surveys, and social data could be collected opportunistically during meetings and education campaigns. Social surveys should include, among other things, investigations of what is considered an appropriate benefit by local people, to ensure that benefits received in the future are understood as such. Farmers often overlooked benefits they could or do receive because these benefits did not fit their expectations, particularly when the benefits were indirect. Furthermore, neighbouring communities will only acknowledge conservation benefits if conservation actors engage genuinely, actively and frequently with them. As one informant stated:

> *It is not what you give which matters; it is how you give. He gave a school but he took its value away because he gave it with the bad heart.*

7.2.5 Community conservation

Community conservation is a broad term encompassing various degrees of local community involvement in conservation matters, from simple consultation to active local management (Adams and Hulme 2001; Carlsson and Berkes 2005). Here, I use "community conservation" as implying the active involvement of local communities in the management of natural resources, and "collaborative" or "participatory conservation" when communities are not in charge of management but are included in the decision-making process. Community conservation has been described by its defenders as the panacea for the problems associated with fortress

conservation, and as a mitigation strategy for loss of livelihood and loss of power over local natural resources. Despite this idealistic picture, most studies of community-based conservation struggle to present examples of clear success stories, and it is criticised by defenders of both nature and people for not being beneficial to conservation or for just being another way to control access to resources based on Western values (Adams and Hulme 2001; Hughes and Flintan 2001).

Community associations do exist in Loango, although some are more active than others. One was in a revival phase during my study under the impetus of a local figure interested in developing his native region. At the end of the study, several meetings were held with representatives from most *regroupements* in the area. However, according to several members, negotiations were difficult, longer than expected and the outcomes uncertain. Several informants expressed doubts that these meetings would be successful in creating long-term incentives for them to participate in the association. Despite current limitations, WWF trials of community-based actions have been quite successful in Loango South, with the *Groupement d'Intérêt Communautaire* (Community Interest Group) and the *Case Abietu* providing tourism managed by local villagers. While these initiatives remain small in scale and struggle to find economic support, they are encouraging examples, as local members of these groups have been dedicated to collective action for several years. Members of this association could act as ambassadors to promote the development of community-based activities in other areas of Gabon, starting with their neighbours in Loango North.

Finally, community conservation requires a willingness on the part of the state to devolve some of its power to local communities. This seems unlikely in the current political context in Gabon. For example, a workshop organized by FAO and MEF to initiate mitigation strategies for human-wildlife conflict reflected a top-down approach, required by the MEF itself, despite the fact that most studies of human-wildlife conflicts highlight the need for bottom-up, or at least collaborative, strategies (e.g., Hill, Osborn and Plumptre 2002; Treves et al. 2006, 2009). Currently, community conservation does not seem widely applicable in Gabon in general, or Loango in particular. Before such a strategy could be put in place, a great deal of effort would be needed to improve farmers' capacity to work together and have their voices heard. As mentioned earlier, such measures will also require the implementation of transparent processes and the construction of supportive institutional and financial structures, all of which are currently lacking.

7.2.6 Participatory management

In their review of community conservation, Adams and Hulmes (2001: 197) stated that: "There is a temptation to see the aim of community conservation as to keep a truculent populace quiet so the serious business of science based ecosystem management can proceed unhindered". Statements made to me by foreigners (conservationists, managers of tourism and scientists) in Loango sometimes suggested a similar view, which may explain partially why participatory conservation in Loango remains at the level of rhetoric. While conservation actors should not be expected to tackle all development problems and authorise people to use the park without any restrictions, it is only fair that they invest in the communities whose livelihoods are at stake through the imposition of conservation regulations.

The potential for collaboration and better management practices is nonetheless present in Loango; particularly as local environmental ethics share common ground with conservation ideology (Chapter 3). The local authorities and the project manager of the NGO working locally all expressed the view that communities should be included, but also believed that they did not have the time, funds and logistics to provide the necessary attention to community engagement. Many farmers expressed their need to be listened to by institutions, either the NGOs or local authorities, and to be included in the decision-making process. To make this happen, some of the resources provided to conservation must be used to establish effective collaboration with communities, improve their capacity to express their opinions and integrate them in management decisions.

Communities can be included in management through active participation and the creation of efficient feedback networks. Several steps can help to create these networks.

1. Conservation actors must realise that, by following the strong top-down approach already used by the state, they only reinforce farmers' opinions that conservation is done by, and for, national and international elites, with little consideration for local inhabitants. To avoid unfruitful escalation of conflict, open or hidden, conservation actors should invest in regular meetings and exchanges with the entire community, and should be careful not to limit their interactions to local elites.

2. Hidden conflicts and passive resistance are present and should be acknowledged. Passive resistance does not lead to conflict resolution or generate channels of communication, but leads to increased polarisation between parties, which will ultimately fuel resentment and conflicts. The stakeholders present, and especially those already working in collaboration, should set up regular village meetings in both the park and the buffer zone. Through increased interactions, farmers and conservation actors can create networks of communication that will

facilitate mutual understanding. Only then can they develop innovative solutions to overcome current livelihood and conservation weaknesses.

3. Conservation actors must accept that they need to challenge their own beliefs as much as they believe they have to challenge those of the local community. For these future collaborations to be effective, conservation actors must stop picturing local farmers as ignorant. They should acknowledge the local view of environmental sustainability, as it is expressed in local discourse, as the first step towards a contemporary and local conservation. It is very important that farmers learn from science as much as managers learn from farmers and local communities. Because of the low level of scientific education in Loango, conservation actors can highlight discrepancies, contradictions or erroneous biological beliefs. They can also provide farmers, and villagers more generally, with a window on the rest of the world, new ideas and possible options from other studies in other places or countries. Helping farmers to make informed decisions should be part of the training and education process that conservation actors already carry out. To achieve this aim, scientists and conservationists should be required to hold meetings to present their projects and results. The tourism industry could also be used as a powerful tool to alter the local communities' view and use of nature. Tourist operators, in association with local authorities and NGOs, could organise projects where members of local communities are invited to visit the park for nature viewing. Such an initiative would be moderately costly but has the potential to provide long-term benefits. Changes in behaviour following regular exposure to a non-consumptive view of nature have been observed in eco-guides and trackers in Loango (Josephine Head and Luisa Rabanal pers. com.; pers. obs.). Several guides and trackers said that they would no longer engage in hunting, or hunt some protected species, after working for tourism or the Loango Great Ape project for a few years. Similar changes may occur over time if local communities are given the opportunity to interact with nature in a non-consumptive way, and if suitable livelihood alternatives are found. This interactive form of education would also reduce villagers' feelings of exclusion from the park and from conservation.

4. Conservation actors should be ready to include more capacity building for local villagers. Capacity building in management, collaboration, and finance has been shown to enhance living standards and the livelihood security of poor households, which resulted in beneficial changes in communities, in Ethiopia (Coppock et al. 2011). Training in micro-project management should be included to provide villagers with the knowledge required to manage their associations efficiently, for example. International actors possess knowledge and a network that local communities are both ignorant of and excluded from. If conservation actors consider that they are not responsible for "development", as I have often heard, then they could initiate

collaborations with development agencies to provide local communities with the support they need, which will eventually also benefit conservation.

5. In addition to the creation of social capital at the local level, local communities and authorities must work in a concerted manner so that feedback is sent back to higher administrative levels and to policy-makers. National policies need to be adapted so that the voice of marginalised communities can be incorporated along with biodiversity assessment.

Participatory and collaborative management is unlikely to succeed straight away or to be free of disagreement, conflicting views and debates (Idrissou et al. 2011; Treves, Wallace, and White 2009). However, in most cases, these debates and conflicts can be used as a constructive tool to increase mutual understanding and the building of social capital (Peterson, Peterson and Peterson 2005; Olsson et al. 2006). As described in Chapter 3, conflicts should therefore be seen as opportunities to move away from old stereotypes and unidirectional management towards inclusive and adaptive governance.

7.2.1 Local development and support to local initiatives

Tourism already provides sources of development and employment and should, in theory, provide the National Park with a sustainable source of income through park fees. However, both tourism and conservation provide benefits almost exclusively to Ntchongorové. Furthermore, tourism is dependent on the worldwide economy, which has proven to be unreliable in the last few years. As a consequence, tourism should not be the sole benefit derived from conservation. In addition, my experience in Loango suggests that the willingness of tourist operators to work with local communities varied greatly from one manager to the next. In one tourism company, managers changed frequently, every year or two, and their degree of interaction with local people ranged from none to high. Tourism operators should implement official partnerships to ensure continuity in their relationships with communities, as they do with authorities. The way tourism and conservation supports local initiatives, such as via local restaurants or potential art markets, is equally variable and uncertain. One tourist operator declared that he had discussed the possibility of taking clients to a village if villagers would open a craft market or a restaurant. However, rumours I heard at the end of the study suggested that jealousy from other villagers resulted in this project being abandoned. Making such processes of negotiation public and transparent, and calling for everyone's presence, may provide a starting point to overcome individual jealousy and promote collaboration.

7.3 A reflection on the interdisciplinary approach

7.3.1 The challenge of interdisciplinary practice

7.3.1.1 Managing differences

Conducting interdisciplinary research such as this one is a considerable challenge (Brewer 1999; Marzano, Carss and Bell 2006; Ostreng 2010). The major problems encountered are the use of different terminologies, different background knowledge, and the existence of cultural differences leading to mistrust between members of different disciplines (Brewer 1999; Hardin and Remis 2006; Marzano, Carss and Bell 2006; King, Biggs and Loon 2007; Tress, Tress and Fry 2007). These factors were reflected during my own work. Ostreng (2010) and Nikitina (2012) rightly suggest that interdisciplinarity requires one to become a polyglot. In my case, coming from a biological background, I had to learn how social scientists express themselves. The use of a specific vocabulary and forms of expression reflects and highlights a deeper appreciation of the world. Learning a new language, therefore, cannot be isolated from learning a new culture, a new way of looking at the world and a new way of investigating it. Thus, the journey required from me the curiosity of the traveller, and, in a sense, I had to perform a form of participant observation, and use anthropological techniques, in order to become an anthropologist.

The biggest difficulty I confronted was the opposing criteria imposed upon data validity and interpretation by each discipline. Natural scientists use a hypothetico–deductive approach and often focus on samples large enough to allow statistical analysis (King, Biggs and Loon 2007; Drury, Homewood and Randall 2011). My training in biology taught me that the aim of research should be to provide an objective representation of reality, free from emotions or subjective interpretation, suggesting the existence of one and only one truth to be discovered. As a consequence, the inductive and qualitative approach used by social sciences remained confusing for months. Only through practice in the field did I start to develop an understanding, and a full acceptance, that diverse realities could be combined to provide a new form of understanding. Knowing that different worldviews exist is necessary but not sufficient to accept that such different views can be simultaneously and equally valid. In a study of how to integrate social science into conservation, Fox et al. (2006: 1819) quoted a natural scientist as saying “I think bringing human dimensions to biology is already happening, but often at the expense of ‘good science’”. A conservationist friend of mine expressed similar feelings when reading my writing, asking me how my subjective interpretation could be a valid result. I believe I had a similar misunderstanding at first. However, my curiosity about anthropology, combined with the belief that the social sciences are necessary in conservation, compelled me to investigate how social

scientists validate their data, rather than trying to evaluate validity using natural sciences criteria. In that respect, conducting interdisciplinary studies at the individual level is fruitful as it forces the researcher to put stereotypes aside, and to try to understand another discipline rather than judging it according to an inappropriate standard.

7.3.1.2 Mutation

My experience led me to picture myself as a system in transition. Entering interdisciplinarity, for want of a better word, is accepting the temporary, or permanent, loss of one's identity, as our fundamental beliefs and knowledge are first shaken, then transformed. Ostreng (2010: 98) describes this process of hybridisation as the journey from "interdisciplinary sensitivity", which corresponds to the desire to enter into an interdisciplinary perspective, towards "interdisciplinary competence" through "interdisciplinary practice". Ultimately, he believes this process leads to the creation of an "interdisciplinary identity". The transformation is expressed graphically in Figure 7.6, created by MacMynowski (2007) in her attempt to describe the continuum of intersecting knowledge.

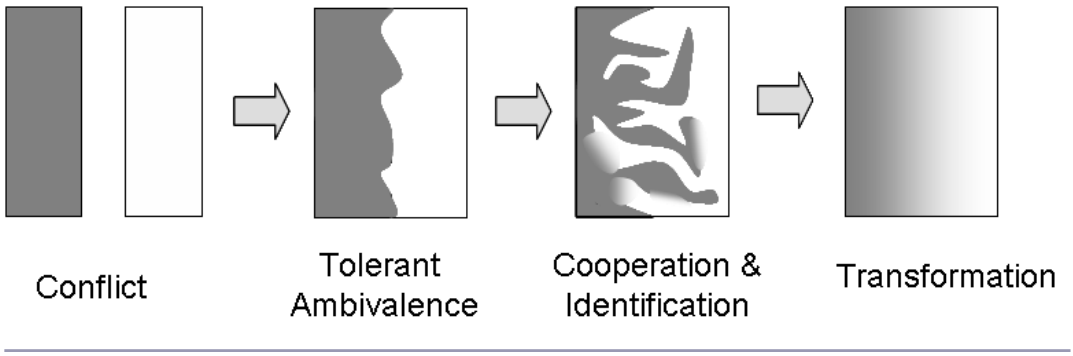

Figure 7.6: Continuum of intersecting knowledge claims. Source: MacMynowski (2007)

Contrary to the first step in MacMynowski (2007), my reflection was not characterised by one unique period of conflict. Rather, minor conflicts emerged at all stages of the practice of interdisciplinarity. My understanding and acceptance of social concepts improved through the resolution of these conflicts, and I was increasingly willing to combine the two disciplines. Eventually, this learning process led to an increasing ability to incorporate the various ideas and concepts as part of the same understanding. This last step, reflected in the thesis you are now reading, expresses my metamorphosis from "cooperation and identification" to "transformation" and "hybridisation".

Entering interdisciplinary work willingly, while not necessarily preventing difficulties, helped me to overcome obstacles, in a similar way to that described by Hardin (a social scientist)

and Remis (a natural scientist) when referring to their collaborative research in the forests of the Central African Republic (Hardin and Remis 2006). This contrasts with much interdisciplinary work, especially in conservation, which stems from the call by social scientists especially, and some conservationists, to include people in conservation (e.g., Balmford and Cowling 2006; Robinson 2006). Calls for the inclusion of people in conservation planning and practice led international organisations, and particularly funding agencies, to favour integrated research and to promote engagement above the mono-disciplinary perspectives and the solely biology-based conservation previously encouraged. As a consequence, many social and natural scientists entered into interdisciplinary work through obligation rather than desire and mutual respect. It is, therefore, not surprising that so many collaborative working groups struggle to implement interdisciplinarity. Building interdisciplinary groups based on individual enthusiasm could, I think, increase the rate of successful and productive collaborations.

7.3.2 Interdisciplinarians link both concepts and people

I found many resemblances between the challenge of interdisciplinarity and that of collaborative management in conservation. The difficulties faced in any collaborative projects are, in many cases, those associated with working across disciplinary boundaries (Brown 2003; Campbell 2005; Buanes and Jentoft 2009). Different, and sometimes opposing, identities, values and agendas are present and confront one another. Interdisciplinarity often starts with a lack of trust between participants, as does collaborative work in conservation. It takes time to integrate new knowledge, find common ground, and use this to move on, and so does the creation of social capital between conservation actors and the development of participatory conservation actions. Researchers, students and practitioners engaging in interdisciplinary thinking would undoubtedly benefit from the literature on mutual learning, the creation of social capital and adaptive governance. Similarly, conservationists interested, or engaged, in working with local communities, especially those from different cultural backgrounds, would benefit from the literature concerning the challenges, purposes and benefits of interdisciplinarity, which may not have much appeal from a distance.

One of the competences developed by interdisciplinarians is to find commonalities between items, concepts, or people that appear unrelated at first. Due to their knowledge of different disciplines, culture and languages, interdisciplinarians can ease communication between groups and act as a translator for interdisciplinary research groups. Due to their ability to make links between apparently unrelated ideas, concepts and methods, interdisciplinarians can facilitate discussions and highlight common ideas and goals that can then be discussed by

the group. In this way, they are very much like conflict mediators who lead opposing groups towards resolution of a conflict.

Some authors have suggested that interdisciplinary investigations, such as this one, may lead to the disintegration of the core of each discipline (e.g., Milton 1996). My experience is different. The use of the vulnerability concept as an analytical framework, as in this study, bases its analyses on, and needs, disciplinary concepts that are then examined in interactions with others. As a consequence, and following Buller's (2009: 401) vision, I believe that interdisciplinarity can "transcend the original disciplines". To me, interdisciplinary work provides insightful adaptation of elements taken from disciplinary concepts, supporting Bruhn (2000) and Szostack (2002) in the belief that interdisciplinarity does not threaten disciplines' integrity, but instead requires robust disciplines.

7.3.3 The use of vulnerability as a framework in conservation research

7.3.3.1 The advantages of vulnerability

The concept of vulnerability has been very useful in my attempt to investigate crop-raiding holistically. It has provided a conceptual and integrated framework that includes the various aspects of crop-raiding as summarised below:

- The institutional context of crop-raiding and how it affects farmer's vulnerability to crop-raiding, understood as institutional vulnerability
- The spatio-temporal structure of exposure to damage, understood as biophysical vulnerability
- The social causes of vulnerability to crop-raiding and the consequences of crop-raiding for farmers' livelihoods, understood as social vulnerability

Many of my results are comparable to those of other studies of crop-raiding, which suggest that the structure of this integrated analysis is correct. However, I investigate how each domain interacts with others in more depth than previous studies. For example, I reflect on how factors of social vulnerability (e.g., rural exodus and poverty) affect biophysical vulnerability (e.g., animals are not deterred by human disturbance as in the past). I show that demographic and socio-cultural changes affect farmers' abilities to cope with crop-raiding substantially, and perhaps more than possible, but unquantified, changes in animal density. I also show that the quality of stakeholder interactions, or, in the case of Loango, the lack of quality interactions, affects farmers' abilities to use existing legal pathways that could provide immediate relief, such as compensation. Last, but not least, I show that isolation, in both its geographical and social

form, is the dominant force driving vulnerability to crop-raiding in Loango. Interdisciplinary studies are expected to focus on processes and interactions between the different aspects of one problem of interest (Lowe and Phillipson 2006; King, Biggs and Loon 2007), and this is exactly what the concept of vulnerability helped me to accomplish.

As this study, and many others, shows, crop-raiding encompasses a broad range of topics, issues and possible analytical approaches. The diversity of themes and perspectives from which crop-raiding can be, and has been, investigated, can be overwhelming. For example, some studies are centred on animal movement (e.g., Sitati, Walpole and Smith 2003), perceptions of loss and raider species (e.g., Hill and Webber 2010), or symbolic factors underlying perceptions and interpretations of crop-raiding (e.g., Koehler 2000). My results, as another example, suggest a strong convergence between the poverty and conservation themes, similar to Hogan and Marandola (2005: 455), who highlight convergence between "poverty, exclusion and marginalisation on the one hand, and society-environment interactions on the other". On occasions, it was difficult not to be drawn into the study of vulnerability to poverty itself because of these strong links, particularly as I was using a similar analytical framework to most studies of poverty and livelihood. Similarly, when working on the context of conservation, it was sometimes tempting to become drawn into the political debate concerning fortress vs. community conservation. The use of vulnerability to crop-raiding as the main question under investigation provided me with an anchor preventing me from dispersing in too many directions, or diverting completely into a side theme. Ultimately, the use of vulnerability as an analytical framework acted as a catalyst, allowing me to synthesise several existing perspectives and providing a basis for the development of new insights.

7.3.3.2 Limitations of the use of vulnerability

My study has the same limitations as many other studies of both vulnerability and crop-raiding. One repeated criticism in many studies on both themes is a lack of quantification, and models, describing and predicting patterns of damage or of vulnerability. Other limitations, that I did not necessarily confront during my study, include the need to triangulate data, or the difficulty in negotiating analyses across scales (see Cannon, Twigg and Rowell 2003 for a list of limitations). Modelling dynamic interactions generally requires a large amount of data to be reliable (Luers et al. 2003; Priston and Underdown 2009; Nijman and Nekaris 2010), and this is often unrealistic when considering the time and financial constraints faced by interdisciplinary researchers. Moreover, quantification and/or mapping of social concepts can easily fall into the trap of over-simplification (Fraser, Mabee and Slaymaker 2003). However, efforts to model and quantify some aspects of social vulnerability (e.g., Cutter et al. 2003; Luers et al. 2003; Luers 2005;

Carreño, Cardona and Barbat 2006) show promise and provide a baseline for future research aiming to map and evaluate various degree of vulnerability. I limited the quantitative aspect of my study to the exposure component in order to explore all the possible factors of importance and not restrict the scope of investigation. Thus, my results provide strong baseline data for future, more focused studies and potential models. Finally, vulnerability science could be criticised for restricting the scope of anthropological analysis to very pragmatic concerns, preventing deeper investigation of more abstract themes. I hope I have demonstrated in this study that the vulnerability framework also allows for, and needs, the inclusion of more abstract themes, such as resistance, to be complete.

7.3.3.3 Why use vulnerability?

Despite its possible limitations, vulnerability seems particularly suited to the study of natural resource management and nature conservation. First, this concept eases the integration of natural and social sciences into a combined framework, supporting the conclusions of Hogan and Marandola (2005). As an example, vulnerability is used intensively in studies that link the human and environmental spheres of climate change. Second, I believe that the focus of vulnerability science on pragmatic topics mentioned in the previous section can be a strength for conservation. Brosius (2006: 685) describes how anthropology's inputs in conservation are often dismissed for being mere criticisms, for lacking application and being limited to "sterile debates". By rooting the debate around pragmatic concerns, vulnerability can facilitate the work, and communication, of interdisciplinary team members by focusing on what each discipline can provide to resolve particular practical questions. Third, vulnerability can be adapted to analyses at various scales, comparable to a matriochka (a Russian doll), while also allowing navigation between the different scales (Cutter 2003; Turner et al. 2003, Fig. 7.7). This includes different spatio-temporal scales, as exemplified by the historical changes affecting farmers' perceptions and use of nature in my study.

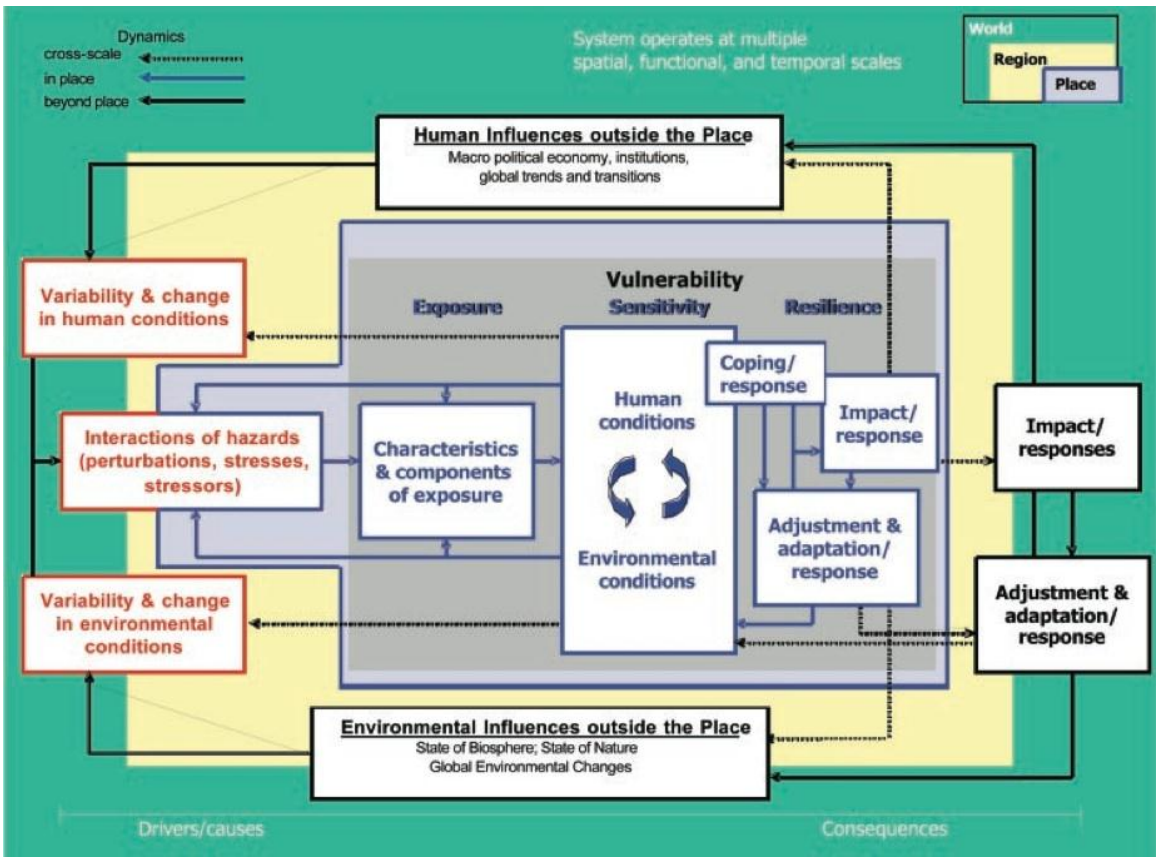

Figure 7.7: Example of the various scales that can be integrated into the vulnerability framework according to Turner et al. (2003).

Fourth, vulnerability can be adapted to various types of investigation, precisely because it can be used as an analytical framework. While I used mostly a people-centred approach in this study, conservationists interested in animal-based science could also benefit from the use of this concept. Conservationists interested in elephant conservation, for example, could use the vulnerability framework to integrate the biological and anthropogenic threats to animal survival. This might combine factors such as loss of habitat, increased poaching, population size and the impact of conservation, as just a few of many examples. Finally, the vulnerability concept could be attractive to both social and natural scientists as it permits the integration of both quantitative and qualitative data. Natural scientists seeking quantitative data can concentrate on the modelling and statistical sides of vulnerability, while social scientists can provide subtler and more nuanced perspectives to be included at various steps of the modelling process. Thus, the concept of vulnerability answers calls by both conservation practitioners and the academic world to place conservation in its biophysical, historical, political and socio-cultural context in order to achieve adaptive and equitable management.

7.4 Conclusion

Contrary to requests from farmers and some conservationists in the field, there is no simple "*médicament"* (remedy) for crop-raiding. Socio-cultural, economic and institutional constraints, including conservation, are at the core of farmers' vulnerability to crop-raiding in Loango, and the challenge ahead should not be underestimated. A variety of changes is required, including increased awareness by communities of the factors that affect their livelihood, increased support for capacity building and the creation of social capital between conservation actors and local communities. The need to work more closely with local communities in Gabon has been highlighted previously by Adams and McShane (1996), and by Lahm (1996), and it is time to recognise this need. Gabon is a very promising country for conservation, and much can be achieved for both people and conservation if all stakeholders engage in modifying current trends. Because Gabon has such a low population, it is a country with a great potential to experiment with creative paths through collaborative and adaptive management, but all actors must be ready to incorporate new forms of management, and be open to unexpected changes. As Olsson et al. (2006: 11) wrote: "The transition to adaptive governance can only be navigated, not planned". The current government is trying to develop agriculture to achieve food production self-sufficiency as well as to preserve its natural heritage, with the slogan "The Green Gabon". Local environmental ethics promote a similar approach and should be used as a tool to incorporate livelihoods into the conservation agenda, and to develop new forms of conservation that will be in harmony with local principles. This context of desire for change from both the country elites and the local community represents a wonderful window of opportunity for conservation and local communities to engage in a more proactive, integrated and sustainable endeavour.

Appendices

Interview guides

My name is Emilie and I am a PhD student. I am here to ask you some questions about your farm, how you do agriculture and what issues you might have with your farm. I am a student and therefore I will not be able to provide you with any rewards for taking part of the interview, but you are free to answer or not answer my questions. The interview will last approximately 45 minutes. If you take part in the interview, you are free to leave at any time without giving any reasons, and if you provide any information that you would prefer not to be included in the study, you only have to request it and it will be removed. All the information I will record will be anonymised and kept locked up when I am in Gabon or in the UK. I will be the only one to have access to the information you will provide. Would you like me to continue?

Do you agree that I may record you with an audio recorder?

Interview guide 1: farmers

Date: Village: Interviewee ID:

Gender: Age: Ethnicity: Occupation of interviewee:

Number of people in the household and occupation:

Questions	Prompts	Notes
You are doing agriculture. Can you explain to me in more detail how you do this?	Timing of activities (clearing up forest, planting, harvesting) Which crops are planted? Who works on the farm? Have you always farmed? If not what was your previous activity?	
Do you (the household) have any source of income?	What are they? Agriculture/fishing/oil industry/forestry industry/ecotourism/civil servant/NGO/others?	

	Which are the most important?	
Where are your fields located?	Why? Do you own the land? Is it family land? For how long have you/the family been living here?	
How many fields do you possess?	Why do you have several fields? *If applicable* When did you plant them? Do you still harvest all of them? Which crops specifically?	
Which crops are most important to you?	Why? (food crop and cash crop) Ranked order of crop Ranked order of crop per crop type	
Did you plant other crops in the past?	Which ones? Why did you stop?	
Do you think there is any difference between how you farm now and how you used to farm in the past?	Why?	
Have you experienced any problem with your crops?	What are they? Which one is the biggest problem in your opinion? Has it always been a problem? How was it in the past? If it is different now, do you know why?	
You said animals come to destroy your fields, could you tell me which ones?	Which ones are the worst and why? Could you ranked them by order of importance?	

	How often do you see them (do they raid)? Do you see them all the time? If not, when do they come the most? Do you know where they are coming from? Has it always been like this? If not what is different?	
How does crop damage affect you? Your village?		
How do you protect your fields from animals?	Have you always used these methods? Do you think it works? Why? Did you use other methods in the past? Which ones? *If applicable* Why did you stop? *If applicable*	
What do you think could help protect you crops better?	Why? Did you try new techniques? If not why?	
Is there anything else you would like to tell me?	Why is it important for you?	

Interview guide 2: local communities – farmers and non-farmers.

Date: Village: Interviewee ID:

Gender: Age: Ethnicity: Occupation of interviewee:

Number of people in the household and occupation:

Household sources of income: agriculture/fishing/oil industry/forestry industry/ecotourism/civil servant/NGO/others

Questions	Prompts	Notes
(If applicable) **Did you or your family do other activities in addition to agriculture in the past?**	Which ones? When and why did you stop?	
What are the benefits/drawbacks to having the forest around? Wildlife?	Which ones Why? For wildlife: Any particular ones? Why?	
What do you think about protecting the forest and the wildlife?	Important/not important - Good/bad/Neutral? Why? Who is responsible for the animals? Do you think you receive benefits from leaving in the forest and with wildlife? Which ones?	
You live near a national park. Did you know that?	How did you know? Who came to explain it to you? When? Who is responsible for the park? Do you know if you are inside the park?	

	What does a national park mean to you?	
Did the creation of the park change anything for you?	For your activities? Household income? For the village? The people? The animals? Do you receive benefit from the park?	
(If applicable) **Did the creation of the park change anything about crop damage?**	How? Why is that?	
(If applicable) **Who is responsible for protecting crops against animals?**	Why? *If applicable*	
What do you think about: NGOs? The *Brigade de Faune*? The ANPN? Tourism?	Do you know them? Someone working there? Do you know what they do? What do you think about what they do? (Good/bad/neutral)	
Is there anything else you would like to tell me?	Why do you think it is important?	

***Interview guide 3*:** NGO, tourism, research team and local authorities employees and managers.

Date: Interviewee ID:

Gender: Age: Ethnicity: Occupation/Status of interviewee:

Number of people in the household and occupation:

Household sources of income: agriculture/fishing/oil industry/forestry industry/ecotourism/civil servant/NGO/others.

Questions	Prompts	Notes
How long have you been living in the village?	Is your family from the area? Where? OR Why did you come?	
You work for …	What is the function of your institution? Do you believe it benefits wildlife conservation and local people in Loango? Why? Could it be improved? How?	
Do you believe the National Park/ Conservation is important?	Why?	
What are the benefits/ drawbacks of the National Park? Of conservation?	For you / The village / The area/ The country? For the forest/ wildlife? Why?	
What are currently the biggest threats to wildlife and the park?	List them in order of importance How do you think these threats can be tackled?	
***(If applicable)* Do you (your institution) work in collaboration with:** NGOs? The *Brigade de Faune*?	Why? What do you provide to one another? Should this collaboration be improved? Why?	

The ANPN? One of the tourism company?	Could it be improved? How?	
Do you think their work is benefiting Wildlife conservation? Local people?	Why? Could it be improved and why?	
Are you aware that local farmers suffer from crop damage by wildlife?	How do you know? Do you know anybody that suffers from crop damage? What is your link to this person (family, friends, none)	
Do you think it is an important problem?	Why? Do you think it impacts on conservation? How? Do you think it needs to be solved? Why? Any idea of how we could try to solve it?	
Do you work with local communities?	How? Since when? Do you think it is important to work with people for conservation? Why? Could work with local communities be improved? How? Do you think local communities value Conservation and your work?	

Is there anything else you would like to tell me?	Why do you think it is important?	

Thank you very much for your time. Your answers have been very valuable to the project. I will be interviewing many other people in the village to have as many points of view as possible. I will come back to Gabon in … and I will organise a meeting to explain what I found out.

Thanks again for you participation.

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