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BUSHMEAT HARVESTING, TRADE, AND CONSUMPTION DYNAMICS IN NORTHERN GHANA

BY

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DECLARATION

I hereby declare that this thesis and the work presented in it are entirely my own and have been generated by me as the result of research work undertaken under supervision.

I certify that, to the best of my knowledge, this thesis has neither been presented wholly nor partially to any other University for a degree. I confirm that this work contains no material previously published or written by another person, except where reference to other people's work has been explicitly stated and any help received duly acknowledged.

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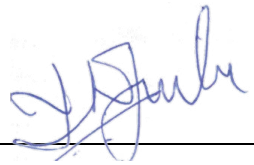
Sign  Date: 25th May, 2022.

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ABSTRACT

Bushmeat (or wild meat) is an important source of animal protein and cash income, particularly for the rural poor in sub-Saharan Africa. However, overexploitation of bushmeat in tropical Africa is an issue of concern because it represents one of the most significant threats to the persistence of wildlife populations and the sustainable development of rural communities in the region. Issues related to bushmeat harvesting, trade and consumption have received little attention in the savannah regions, possibly due to a misconception that bushmeat hunting in these ecosystems is a subsistence activity that has low impact. The overall aim of this study was to generate new knowledge of bushmeat hunting, trade and consumption dynamics in northern Ghana, where little is known about the dynamics of the savannah landscape, and to understand factors influencing individuals' hunting, trading and consumption behaviour. Specifically, this study sought to characterise bushmeat markets, describe bushmeat supply chains and investigate the extent of long-distance trade to other regions in Ghana and cross-border trade with neighbouring countries. The study also focused on assessing how hunters use the landscape and habitats for hunting and factors influencing hunters' behaviour. Finally, it examined how bushmeat contributes to meat consumption within households in the study area. Ecological and socio-economic data were collected from October 2018 through October 2019, using a combination of direct observations, structured interviews, as well as trader diary records and participatory mapping. Market surveys and 21 trader interviews were conducted in three markets (Sandema, Fumbisi and Chiana) in the Upper East region and one market (Buipe) in the Savannah region of Ghana. Four hundred and seventy-one households and 56 hunter interviews were carried out in the villages of Kayoro in the Kasena Nankana West district and Doninga in the Builsa south district. Overall, a total of 10,407 carcasses of at least 28 species of wild animals were recorded across the three markets studied. This represents a biomass harvest of about 8,397 kg of bushmeat. The results show that the bushmeat trade in the

Sandema, Fumbisi and Chiana markets was dominated by amphibians, with three species; the Edible bullfrog *Pyxicephalus edulis*, African Groove-crown frog *Hoplobatrachus occipitalis*, and Dakar grassland frog *Ptychadena trinodis*, accounting for 82% of the total number of wild animal carcasses recorded. This clearly contrasts records from markets in southern Ghana where rodents and ungulates dominate the trade. The three study markets varied in terms of species and numbers of carcasses traded. Bushmeat was sold throughout the year in all the markets, with all species groups being traded in almost all months, but in varying quantities. Significantly higher numbers of carcasses were recorded in the dry than wet season in all three markets (Poisson GLM analysis of deviance; $\chi_{(1,44)} = 9.77$, $P<0.01$). The price of bushmeat was variable (ranging from 14.86 ± 6.36 to 35.84 ± 5.87 GH¢ per kg), but generally more expensive than domestic meat such as beef. Four different actor groups traded along the supply chains: hunters, middlemen, wholesalers and local market retailers, all of whom depended wholly or partially on bushmeat exploitation as their source of income. Based on the extent of trade, three different types of supply networks were identified: local, long-distance and cross-border. Bushmeat was supplied to the markets from a large catchment involving several small rural communities and villages within the study area and across the Ghana-Burkina Faso border. This is the first study to describe large supply networks of bushmeat in northern Ghana and also the first attempt to quantify and characterize the extent of cross-border trade of bushmeat between Ghana and a neighbouring country. The long-distance trade network seems to be shaping both hunting and trade dynamics in the north. A key indication from the results is that there is a fairly substantial unmet local demand, which is present in part due to much of the trade, notably in larger bodied and more valuable species, being diverted to more lucrative southern markets. This would suggest that the comparatively "poor" northern economy, simply cannot compete for these products on a price basis, and thus wholesalers and middlemen choose to transport and sell the bulk (>80%) of the meat harvested from the north to southern markets.

Bushmeat harvesting in villages in northeast Ghana is practiced for income generation, pest control and household consumption, however, the bulk of hunters' catch (74%) was sold for income. Many hunters were farmers (98%) and hunting increased in the dry season when there were limited other livelihood options for men. The hunting methods used (shotgun, snares, with dogs, bow and arrow, catapult) varied significantly amongst hunters and between the two villages (χ^2= 12.99, df=3, P<0.05). Spatial analysis indicated that distance to village (Kayoro- z= 2.08, P<0.05; Doninga- z= 4.63, P<0.01) and percentage tree cover (Kayoro- z= 1.97, P<0.05) were significant determinants of hunting site selection, with strong preference for sites with high tree cover. Perceptions of hunters in this study suggested that the population of most wild animal species in the area have undergone rapid depletion, resulting in a decreasing return on hunting efforts. Even though households preferred bushmeat together with other meat types, fish was the most popular form of animal protein. The majority (70%) of households preferred bushmeat for its taste, however, bushmeat was eaten irregularly and the consumption frequency differed significantly between the two villages (χ^2=46.30, df =6, P<0.05). Factors such as hunting on the farm are important predictors of bushmeat preference, implying that a household need to have a hunter to have access to bushmeat for regular consumption. The findings from this study contribute to bridging the knowledge gap in the level and extent of bushmeat hunting, trade and consumption in northern Ghana. The findings also highlight the potential negative effects of increasing hunting intensity on wild animal populations, the implications for species conservation and the urgent need for management interventions and increased enforcement of wildlife regulations in the area and the country as a whole.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

CI	Confidence Interval
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COVID-19	Coronavirus Disease-2019
CREMA	Community Resource Management Area
ECBAS	Ethics Committee for the College of Basic and Applied Sciences
EVD	Ebola Virus Disease
FAO	Food and Agriculture Organization
GH¢	Ghana Cedi
GLM	Generalized Linear Model
GMT	Greenwich Mean Time
HNKS	Hannah Naa Kai Sackey
IUCN	International Union for Conservation of Nature
MNI	Minimum Number of Individuals
PAs	Protected Areas
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
US$	United States Dollar

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background

The importance and value of wildlife resources for people cannot be underrated. For many years, wildlife has served as a significant source of food, traditional medicine, and livelihood for many people (Ntiamoa-Baidu, 1998; Milner-Gulland *et al.*, 2003; Schulte-Herbruggen *et al.*, 2013; Boakye *et al.*, 2016). The meat of terrestrial wild animals (popularly known as bushmeat in Africa) is an important source of animal protein. It contributes significantly to food security, especially in areas where there are few or no alternative animal protein sources (Nasi & Fa, 2015). Virtually all wild animal groups are exploited and found on markets, including several species of amphibians, birds, reptiles and mammals (Cawthorn & Hoffman, 2015; Mohneke *et al.*, 2010; Ntiamoa-Baidu, 1987; Taylor *et al.*, 2015; Wilkie *et al.*, 2016). However, the diversity of bushmeat species hunted by people differs from place to place. For example, species found on markets may vary due to availability, catchment characteristics (Dupain *et al.*, 2012), hunter behaviour (e.g., hunting methods, seasonality of hunting activities) (Kümpel *et al.*, 2009; Mohneke *et al.*, 2010) (and / or trader behaviour (Allebone-Webb *et al.*, 2011).

Bushmeat is an important source of income, particularly for the rural poor, contributing to household economies throughout the supply chain (Mendelson *et al.*, 2003; Coad *et al.*, 2010; Brashares *et al.*, 2011; Cawthorn & Hoffman, 2015; McNamara *et al.*, 2016; Wilkie *et al.*, 2016). Bushmeat may be sold locally or transported to larger markets, particularly in urban centres, where it fetches higher prices (Ntiamoa-Baidu, 1998; Allebone-Webb *et al.*, 2011).

For local markets in rural areas the bushmeat on sale usually comes from nearby catchments. In contrast, bushmeat supplied to urban centres may come from sources much farther away, even from neighbouring countries (Ntiamoa-Baidu, 1998; Fa *et al.*, 2006; Mohneke *et al.*, 2010; Sackey, 2014).

In many areas in Africa, well- established and complex rural–urban trade supply networks exist (Falconer, 1992, Mendelson *et al.*, 2003). This chain can be simple (e.g., Anstey, 1991) or complex like the one reported by Falconer (1992). In her survey of the Kumasi market in Ghana, Falconer (1992) found two commodity chains in the same market: one supplying smoked meat from the northern savannahs, whilst the other supplied fresh meat from the southern forests of the country.

Commercial hunters are the primary source for most commercially traded bushmeat. Harvested meat may then be transported to market either by the hunters themselves, or middlemen. Meat may be transported fresh or preserved in some way such as smoking. In many cases hunters are farmers from lower income households, with little education and limited sources of other income (Loibooki *et al.*, 2002; Lindsey *et al.*, 2011). However, considering that the trade is relatively easy to enter compared to other livelihoods, has low risk and is seasonally flexible, it is particularly attractive to rural people especially farmers where agricultural activities and incomes are themselves highly seasonal. Mendelson *et al.* (2003) found that hunters make a substantially greater profit than others in the supply chain, even urban actors (such as chopbar owners) who tend to make higher investments but get relatively less profit margins. With the increasing demand for bushmeat in urban centres, the trade has become more profitable to hunters involved in the business (Cowlishaw *et al.*, 2007). However, the continual benefits from bushmeat as a natural resource will depend on its availability and abundance.

Currently, overexploitation of bushmeat in tropical forests is an issue of concern because it represents one of the most significant threats to the persistence of wildlife populations. Apart from small rodents and fast reproducing species, all species of wild mammals are currently overexploited in many areas in Africa (Cawthorn & Hoffman, 2015; McNamara *et al.*, 2016; Wilkie *et al.*, 2016). This threat has been more aggravated in recent years as the bushmeat trade has become increasingly commercial and large-scale in nature, as opposed to its previous more localised nature (Asibey, 1974; Ntiamoa-Baidu, 1987; Cawthorn & Hoffman, 2015; Wilkie *et al.*, 2016). Unsustainable hunting practices have increased, driven by factors such as growth in demand for bushmeat from the rapidly expanding urban areas in Africa and changes in hunter behaviour to meet the demand (Brashares *et al.*, 2011; Coad *et al.*, 2013).

Ghana has not been immune to these threats. The country's wildlife resources have declined significantly over the past few decades due to various forms of anthropogenic activities (Bakarr *et al.*, 2001; Hackman, 2014), including hunting and habitat loss. Many of the country's wild animal species such as pangolins, large ungulates and primates have become locally endangered, and hunting has been identified as a key contributor (Bakarr *et al.*, 2001; Hackman, 2014; Boakye *et al.*, 2016). Overexploitation of bushmeat and factors such as habitat loss have greatly impacted the country's forest ecosystems, with consequences for the people dependent on them. Failure to address the issue will result in further severe wildlife declines with significant ecological and socioeconomic repercussions (Lindsey *et al.*, 2013).

1.2 Justification

Bushmeat hunting and trade has long been recognised as a severe threat to wildlife in many forested regions in Africa. However, the issue has received little attention in the savannah regions, possibly due to a misconception that bushmeat hunting in these ecosystems is a

subsistence activity with low impacts (Lindsey *et al.*, 2013; Nielsen & Meilby, 2015). According to du Toit & Cumming (1999), the African savannah region supports a higher diversity of native large mammals (>5 kg) (e.g., ungulate species) than is found in any other biome. This distinct faunal diversity and herbivore biomass density is directly related to the high spatial heterogeneity of African savannah ecosystems (du Toit & Cumming, 1999). However, there is literature suggesting that hunting has an adverse effect on large mammal assemblages in these areas (e.g., Bonnington *et al*., 2007; Aalangdong, 2010; Nielsen & Meilby, 2015). Hence increasing research efforts to better understand the dynamics of hunting in the savannah areas and its impacts on wild animal populations is greatly needed for conservation of wildlife populations.

Studies that have explored the bushmeat trade in the southern regions of Ghana have covered various thematic areas including community livelihood components and trade characteristics (e.g., Ntiamoa-Baidu, 1998; Cowlishaw *et al.*, 2005b; Crookes *et al.*, 2007; Alexander *et al.*, 2015; McNamara *et al.*, 2016; Ntiamoa-Baidu, 2016), providing information on how best to manage bushmeat exploitation for conservation purposes. The bushmeat trade and hunting in Kumasi and its surrounding villages in particular have received much attention perhaps due to its geographic position between savannah and forest regions and also its highly organised bushmeat trade. Two such studies (Falconer, 1992; Ntiamoa-Baidu, 1998) reported that smoked meat from the northern savannahs of the country was frequently traded on markets in the city, but this is already more than 20 years ago so the situation is very likely to have changed.

Additionally, very few studies have attempted to understand the extent of bushmeat extraction and trade dynamics in the northern part of the country. A rapid one-week survey of bushmeat markets in 2016 suggested northern Ghana represents an important hub for bushmeat

(Ntiamoa-Baidu, 2016). Furthermore, anecdotal evidence suggests northern Ghana is a key trade route for smoked bushmeat on markets in the south of the country. This current study seeks to address the knowledge gap, undertaking the first comprehensive survey of local markets and communities to understand both the human and ecological dimensions of the bushmeat trade in northern Ghana. Improving our understanding of which species are traded, and the origins of animal carcasses on the markets is important, particularly as there are a number of protected areas and forest reserves in the region that could be potential sources.

Northern Ghana is highly rural (by regions Upper West: 83.7%; Upper East: 79.0%; Northern: 69.7%) and inhabited by smallholder farmers (Ghana Statistical Service, 2012; 2013) with high poverty levels (Canagarajah *et al.*, 2001; Ghana Statistical Service, 2018). Despite agriculture being the economic activity of many people (80.0%), Aalangdong (2010) reports hunting to be a principal profession in these rural savannah landscapes of the country, and notes the dependence on bushmeat as an important source of protein and income for the local communities.

Although the characteristics of the bushmeat commodity chain have been investigated in Ghana (Cowlishaw *et al.*, 2005b; Mendelson *et al.*, 2003; Ntiamoa-Baidu, 2016), no attempt has been made to establish the number and volume of wild animal species comprising the trade flow in the northern part of the country. Due to a range of factors such as livelihood dynamics and patterns of land use (Boafo *et al.*, 2014), it is expected that bushmeat extraction levels and trade characteristics in northern Ghana might differ from what pertains elsewhere in the country. Also, despite recognition of the significant contribution of bushmeat to household food security and income generation in many parts of Africa (Wilkie *et al.*, 2016), the precise value and contribution of bushmeat to human livelihoods and wellbeing requires more detailed assessment (Nasi & Fa, 2015).

1.3 Objectives

This study examines aspects of bushmeat exploitation and trade in the northern part of Ghana. Using mixed (qualitative and quantitative) methods, this study will profile bushmeat markets and examine both long-distance and local supply chains to provide an understanding of the organization of the trade, particularly important to identify in which key parts of the supply chain management interventions are likely to be most effective. Knowledge and understanding about factors influencing volume of trade and individuals' hunting and trading behaviour can be useful in assessing exploitation levels and to guide future conservation planning initiatives. The findings of this study will add to the existing data on bushmeat trade and exploitation in Ghana and provide a basis for future research and monitoring. In addition, conclusions from this study will provide basis for recommendations on how to best manage trade for the benefit of both people and wildlife.

The general aim of this study is to increase knowledge of bushmeat hunting in northern Ghana and explore the level and extent of the trade among the various actors in the supply chain. This study will document hunting and trading activities, as well as profiling patterns of local consumption, to understand the factors driving the trade in and around the main hunting sites in the region.

The specific objectives of this study are to:

- examine the characteristics of bushmeat markets and associated trade in northern Ghana;
- describe bushmeat supply chains and explore the extent of long-distance and cross-border trade of bushmeat;

- examine the characteristics of hunters in northern Ghana and factors that influence their hunting behaviour and how they drive the local hunting system;
- investigate how bushmeat contributes to meat consumption within households in northern Ghana.

The thesis is organised in nine chapters, starting with this general introduction. Chapter 2 provides an overview of the bushmeat literature, while Chapter 3 introduces the study sites and general methods used. Chapters 4 to 7 present the findings of investigations to address the four objectives outlined above. Chapter 8 provides a general discussion of the main findings of this thesis, while the concluding Chapter 9, provides recommendations for policy review and further research on the hunting and trade of bushmeat.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Importance of bushmeat

Wildlife resources contribute significantly to the livelihood security and well-being of people, particularly the rural poor. These natural resources serve multiple roles and provide many benefits to those that use them. The main contributions of forest products and wild animals to rural livelihoods include providing valuable sources of income, food, medicine, building materials and other household items (de Merode *et al.*, 2004; Brashares *et al.*, 2011; Schulte-Herbrüggen *et al.*, 2013; Alexander *et al.*, 2015; Boafo *et al.*, 2016).

2.1.1 Bushmeat as a source of food and nutrition

Humans have long relied on the meat of wild animals for food and continue to do so today. The meat derived from any wild terrestrial mammals, birds, reptiles, and amphibians harvested for subsistence or trade is commonly termed bushmeat (Redmond *et al.*, 2006; Nasi *et al.*, 2008; Cawthorn & Hoffman, 2015) or wild meat (Abernethy *et al.*, 2013). Bushmeat is an important food source throughout the developing world (van Vliet *et al.*, 2014; Wilkie *et al.*, 2016). It is valued as a key contributor to the nutrition and food security of these people (Brashares *et al.*, 2011; Cauthawn & Hoffman, 2015; Nasi & Fa; 2015). Bushmeat has long served as a significant source of animal protein for millions of people across Africa and is particularly important for the rural poor (Brashares *et al.*, 2011; van Vliet *et al.*, 2014; Nasi & Fa, 2015). The nutritional role of bushmeat, however, goes beyond protein intake, serving as an important source of micronutrients in some areas (Sarti *et al.*, 2015). A study by Golden *et al.* (2011),

investigating how access to wildlife as a food source affected child nutrition in a rural community in Madagascar, revealed that consuming more bushmeat was linked to significantly higher haemoglobin concentrations. Whilst bushmeat is often the only source of iron in some areas (Golden *et al.*, 2011), it bridges the fat gap in diets of peoples elsewhere (Sirén & Machoa, 2008)

According to the FAO (2014) at least one in every four people in Sub-Saharan Africa lack sufficient protein and calories. Hence, food composition should not be overlooked because, it is as important to food security and nutrition as its availability and access (Sunderland, 2011). Some studies have confirmed that the meat of most wild animals is nutritionally superior to domestic meat, in terms of yield of lean meat per kg of live weight (Nasi *et al.*, 2008). The nutritional composition of bushmeat species offers an equal or even greater quality of food than domestic meat like chicken, mutton, beef or pork, containing less fat and more protein as well as minerals (Bifarin *et al.*, 2008). For example, snails are known to be a good source of protein, low in fat, including extremely high levels of iron, calcium and vitamin B (Bifarin *et al.*, 2008). According to Wilkie *et al*., (2016) bushmeat can form as much as half of the annual protein needs for many rural households, however this is typically much less in landscapes where wildlife have already been severely depleted or where livestock production is more common (East *et al.*, 2005; Foerster *et al.*, 2012; Schulte-Herbrüggen *et al.*, 2013).

Bushmeat has often been linked with food security because of its contribution to the diets of poor rural dwellers, often representing the most important source of protein (Nasi *et al.*, 2008). Despite the typically high starchy constituents of diet in rural households assuring adequate calories, these foodstuffs (such as manioc or grains) provide small amounts of limiting nutrients per unit energy, implying that their use alone will not satisfactorily address the malnutrition problems experienced in many developing countries (Vinceti *et al.*, 2013). Many people living

in low-income areas depend on the harvest of wild foods to bridge the hunger gap caused by poverty and agricultural seasonality (Lindsey *et al.*, 2013; Schulte-Herbrüggen *et al.*, 2017). In view of this, the meat of wild animals often regarded as a luxurious commodity by people in urban areas, may be the main or only source of animal protein available for poor rural households (Fa *et al.*, 2015). This, then, highlights the significant contribution of bushmeat to food security. On the other hand, Nasi and Fa (2015) argue that bushmeat is a major contributor to food security if it is the only or main source of animal protein available, but less so when there are other readily available alternatives. However, in reality some people simply cannot afford to buy imported frozen meat, let alone the more costly domestic meat products (East *et al.*, 2005). In contrast, bushmeat is an accessible source of food that can basically be obtained for free rather than be bought (Kümpel, 2006). van Vliet *et al.* (2012) found that bushmeat was one of the cheapest meat sources available, constituting the protein staple for many poorer households in the Democratic Republic of Congo (DRC).

2.1.2 Cultural significance and medicinal value

Exploitation of wild animals for various purposes by rural dwellers is usually considered part of the way of life of these people, and part of the belief systems that give them their cultural identity (Wilkie *et al.*, 2016). Hence, for many indigenous people of Africa, especially rural people living in forest areas, hunting and the use of wild animals as food is deeply rooted in their cultures and traditions (van Vliet & Mbazza, 2011). Many cultural values exist in various parts of Africa which guide people's use of certain species of wild animals for food and non-food purposes. For instance, certain wild animals may not be killed, touched or consumed by some groups of people because of cultural beliefs or traditional taboos (Aalangdong, 2010). For example, among the Waala in the Upper West region and the Dagombas in the Northern

region of Ghana, the monitor lizard is used as a totem and the crocodile is revered as the god of the land (Aalangdong, 2010). In most African traditions, the medicinal value of wild animals is highly recognized. For centuries, certain wild animal species have been used in traditional medicine practices. A study by Boakye *et al.* (2015) revealed that 13 pangolin body parts are used to treat various medicinal conditions in Ghana. In the past, children in Ghana who were suffering from whooping cough were given rat (*Rattus* spp.) meat, which was supposed to make them recover (Asibey, 1974). The meat of grey duiker is added to some herbs to enhance wisdom and intelligence (Aalangdong, 2010).

2.1.3 Source of livelihood

Bushmeat is also a critical source of income, contributing to household livelihoods throughout the supply chain, from the hunter to urban market sellers (Mendelson *et al.*, 2003; Nasi & Fa, 2015; McNamara *et al.*, 2016). It can be important contributor to total income, mainly for poorer households (Crookes *et al.*, 2007) or as complement to other income sources (Alexander *et al.*, 2015). In an evaluation of the role of bushmeat in rural household economies in Equatorial Guinea, Kümpel *et al.* (2010) found that hunting was a major constituent of household incomes, carried out by around 60% of poor-to-middle income households. Bushmeat can be important to human well-being throughout the year in some areas, while in others its importance varies by season. Alexander *et al.* (2015) found that bushmeat hunting continued to play a role in the livelihoods of three rural communities in southern Ghana as a seasonal source of income. Bushmeat hunting thus, provides an essential income safety net in times of economic hardships, for instance during the lean agricultural season (Schulte-Herbrüggen *et al.*, 2013; Alexander *et al.*, 2015). On the contrary, a study in the Mankessim

area of Ghana found that 22.2% of traders relied on bushmeat as their sole source of income, and sold meat over 210 km away (Sackey, 2014).

2.2 What people hunt as food

A wide range of terrestrial wild animals are exploited as food all over Africa (van Vliet *et al.*, 2012; McNamara, 2014; Nielsen & Meilby, 2015; Wilkie *et al.*, 2016). Over 500 different species of wild animals are consumed in Sub-Saharan Africa (Redmond *et al.*, 2006), including some threatened or endangered species (Petrozzi *et al.*, 2016). Taylor *et al.* (2015) reports bushmeat sales, consumption and offtake for 177 species from 25 orders across 11 countries in West and Central Africa, over a 30-year period. Mammals, birds, amphibians and reptiles are the four most common taxa of wild animals hunted, traded and consumed (Taylor *et al.*, 2015; Table 2.1). However, the diversity of bushmeat species exploited by people differs from one place to another. This may depend on factors such as species available for hunting in each area and also the hunting regulations enforced in each location (Crookes & Milner-Gulland, 2006; Dupain *et al.*, 2012; Fa *et al.*, 2015).

For example, several species of invertebrates are locally important as dietary constituents, and traditional use of insects as food is widespread in sub-Saharan Africa (Ockerman & Basu, 2009). Some species of insects (larvae and/or adults) are seen as a delicacy in some communities, particularly moths and beetles. In Ghana the maggot of the palm beetle (*Phyncophorus phoenicals*) is a delicacy for some people (Asibey, 1974). African giant snails (e.g., *Achatina* sp.) are commonly eaten by both urban and rural dwellers in West Africa (Cowlishaw *et al.*, 2005b; Schulte-Herbrüggen *et al.*, 2013). Snails are most abundant in the forested areas, especially during the rainy season when they are heavily harvested.

Even though invertebrates can be important for people's diets, vertebrates constitute the bulk of the terrestrial wild animal biomass consumed by humans. Amphibians (frogs and toads) form a regular dietary item where they are available (Bhupathy *et al.*, 2013). For example, Mohneke *et al.* (2010) reported consumption of frogs and toads by villagers in Burkina Faso and trade by market vendors in Benin and Nigeria. They found that the African Tiger frog *Hoplobatrachus occipitalis*, was the most consumed species in Burkina Faso, followed by *Pyxicephalus edulis*; and toads were most preferred particularly by villagers in Ganzourgou, Burkina Faso. Various types of reptiles, including monitor lizards (*Varanus* spp.) and snakes like the African python (*Python sebae*), are relished as meat by many African communities (Ntiamoa-Baidu, 1998; Fa *et al.*, 2006).

Even though hunting efforts may differ both spatially and temporarily, the majority of bushmeat harvested are mammals (Table 2.1; Fa & Brown, 2009; Taylor *et al.*, 2015; Petrozzi *et al.*, 2016), including groups such as rodents, primates, ungulates, carnivores, and pangolins (*Manis* spp.). A diverse range of mammalian species is consumed in West Africa, possibly due to the scarcity of larger mammals (Cowlishaw *et al.*, 2005a; Schulte-Herbrüggen *et al.*, 2013). Where the trade has been documented in West Africa, rodents, antelopes, and monkeys are the three most common groups consumed by people (Cowlishaw *et al.*, 2005a; Fa & Brown, 2009; McNamara *et al.*, 2016; Petrozzi *et al.*, 2016). Although these three groups dominate the trade, their proportional contributions are relatively uneven (Swensson, 2005; Cowlishaw *et al.*, 2005a; McNamara *et al.*, 2016). Crookes *et al.* (2007) found that majority (88%) of bushmeat hunted around six villages in the Ashanti region of Ghana was rodents and ungulates. A high proportion of the rodents were consumed at home while the ungulates, notably Maxwell's duiker (*Philantomba maxwellii*) and bushbuck (*Tragelaphus scriptus*), were sold. Some studies have suggested that rodents are relatively more abundant in hunting offtakes in many areas of Africa because they are not subject to controlled hunting (Ntiamoa-Baidu, 1997) and are fast-

reproducing species (Cowlishaw *et al.*, 2005a). In addition, the rodent: ungulate ratio can be a mark of depletion, so the higher the proportion of rodents the more depleted the area (Rowcliffe *et al.*, 2003). The rodent species commonly consumed include squirrels, grasscutters *Thryonomys swinderianus*, giant rats *Cricetomys gambianus*, brush-tailed porcupines *Atherurus africanus* (Ntiamoa-Baidu, 1997; Cowlishaw *et al.*, 2005a; Sackey, 2014; McNamara *et al.*, 2016). In areas where hunting of large mammals is legally banned (e.g., South Africa), small mammals like field mice (*Mus* spp.), rock hyrax (*Procavia capensis*) and hares (*Lepus* spp.) are exploited for food (Ntiamoa-Baidu, 1997).

Table 2.1. The number of orders and species in the bushmeat database for the four most common taxa: mammals, birds, amphibians and reptiles. *[Also shown are the number of threatened species classified as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List] (IUCN, 2014; Taylor et al., 2015).*

Taxonomic group	Number of orders	Number of species	Number of threatened species (CR/EN/VU)
Mammalia	12	134	4/5/14
Aves	9	24	0/0/2
Amphibia	1	1	0/0/1
Reptilia	3	18	2/1/2

In sub-Saharan Africa, the bushbuck *Tragelaphus scriptus*, royal antelope (*Neotragus pygmaeus),* black duiker (*Cephalophus niger)*, Maxwell's duiker (*Philantomba maxwellii*), blue duiker *(Philantomba monticola)*, and bay duiker (*Cephalophus dorsalis)* are among the

most common smaller antelopes reported to be consumed by people in both urban and rural communities (Cowlishaw *et al.*, 2005a; Fa & Brown, 2009; van Vliet *et al.*, 2012; Sackey, 2014; McNamara *et al.*, 2016). Primates such as the moustached guenon (*Cercopithecus cephus),* gorilla (*Gorilla gorilla),* mona monkey *(Cercopithecus mona),* and chimpanzees (*Pan troglodytes)* also are enjoyed as bushmeat among some communities in Africa and are occasionally sold in bushmeat markets (Fa *et al.*, 2006; Petrozzi *et al.*, 2016; Wilkie *et al.*, 2016). Most fruit-bats (*Eidolon* spp.) serve as sources of wild meat in some areas, and may be smoked and packed in large quantities for markets (Kamins *et al.*, 2011). Birds such as francolins (*Pternistis* spp.) and guinea fowls (*Numida* spp.) are also hunted for food in many areas (Fa *et al.*, 2006; Sackey, 2014; Taylor *et al.*, 2015).

2.3 Bushmeat harvesting and hunter behaviour

2.3.1 Hunting methods

Hunting is the "extraction of any wildlife from the wild, by whatever means and for whatever purpose" (Fa & Brown, 2009). Hunting for bushmeat is a major component of rural livelihood strategies and an integral part of life in rural communities in the tropical forest zone of West and Central Africa (Kümpel *et al.*, 2010; Schulte-Herbrüggen *et al.*, 2013; Alexander *et al.*, 2015). Today, however, rapid population growth and urbanization have led to increasing commercialization of bushmeat hunting in most parts of Africa (Cawthorn & Hoffman, 2015).

In some places, wildlife laws and legislation exist regarding the times and place that hunting is allowed, the species and number that may be hunted, and the hunting methods that may be used. For example, in Ghana, legislation concerning bushmeat species is provided through the Wildlife Conservation Legislation and associated Amendments (LI 685 of 1971 and LI 1357 of 1988; Ntiamoa-Baidu, 1998). In the legislation, wild animal species are listed on one of three

schedules: Schedule 1 covers species that are wholly protected and cannot be hunted or traded at any time; Schedule 2 and 3 species can be freely hunted and traded outside a closed season of 1st August to 1st December, but Schedule 2 species also cannot be captured at any time if young, or if accompanied by young.

Hunters employ combination of numerous methods to catch their prey, depending on the type of hunting practice of the hunter (Kümpel *et al.*, 2009; Dobson *et al.*, 2019). The methods used include shooting with guns, trapping (snares), group hunting with dogs, use of fire to smoke animals out (Rist *et al.*, 2008; Kümpel *et al.*, 2009; Lindsey *et al.*, 2013; Yasuoka *et al.*, 2015; Alexander *et al.*, 2015) and poisoning (King, 2014; Ogada, 2014). Other methods used by hunters include catapults, gin traps (which are prohibited in Ghana), cutlass slaying and hand picking (Mohneke *et al.*, 2010). Generally, these hunting methods can be categorized into two main groups; active pursuit hunting and passive trapping or snaring (Rowcliffe *et al.*, 2003; Kümpel *et al.*, 2009).

Kümpel (2006) found that trapping with wire snares was the most widespread method in use in the Monte Mitra area of continental Equatorial Guinea, where she reported that the bushmeat trade was substantial and increasing. The use of snares for hunting is a cheaper option than guns, but also less efficient (Damania *et al.*, 2005), as snares are unselective and often kill non-target animals (Lindsey *et al.*, 2012). Hunting with guns and dogs are common methods of bushmeat extraction in Ghana. Holbech (1998) reported that 78% of hunters preferred using guns in the Bia Conservation area. Crookes *et al.* (2005) reported that 82% of all carcasses delivered to the Atwemonom market in the Ashanti Region of Ghana were killed with shotguns, while Alexander *et al.* (2015) reported preference for the use of guns and dogs among hunters in villages around Kumasi. In a study on acquisition and use of bushmeat in northern Ghana, Aalangdong (2010) found that 90% of hunters used shotguns and 10% used traditional methods

like traps, bows and arrows, and cudgels. Use of fire is a common practice in northern Ghana. The use of dogs is very much commercially focused, and often targets specific species, mainly the grasscutter (*Thryonomys swinderianus*) (Alexander, 2011). Hunting with dogs is however, prohibited by law in Ghana (Crookes & Milner-Gulland, 2006; Wuver & Attuquayefio, 2006) but there is indication that it continues to be used across the country (Aalangdong, 2010).

Hunting with guns is a selective method and allows for a greater degree of prey selection as hunters can choose between which species and size of animal to kill out of those encountered (Kümpel *et al.*, 2009). Use of guns is a relatively more expensive method of hunting, so other hunting methods like trapping are selected over it, especially among poor households (de Merode *et al.*, 2004; Kümpel *et al.*, 2009); however, Cowlishaw *et al.* (2007) pointed out that majority of hunters in Takoradi (an urban town) in Ghana employed wire snares rather than shotguns to capture prey. Because of their indiscriminate nature and potential danger to humans, certain types of snares/traps (e.g., gin traps and pit-fall traps) are prohibited in most parts of central Africa (Lindsey *et al.*, 2012) and also in Ghana (Ntiamoa-Baidu, 1998). Hunters employ a combination of several methods, often combining use of guns with help from dogs tracking the prey, but also dogs in combination with use of fire and/or cutlasses, or fire and cutlasses excluding dogs (Sackey, 2014).

While hunting with shotguns is mostly done by males, women and children in the household also take a substantial role in gathering of wild resources to feed the home (Ntiamoa-Baidu, 1997). Mohneke *et al.* (2010) report that most often, villagers in Ganzourghou, Burkina Faso, searched actively for frogs and caught them by hand. Alternatively, villagers designed basket traps which were efficient for catching frogs in swampy areas with shallow water. With the basket traps, up to 400 frogs was reported to be caught over one night. In Nigeria, frogs were

caught by hand (80%) or with the help of fishing nets (75%), followed by the use of hooks (35%) and basket traps (25%) (Mohneke, 2011).

2.3.2 Hunter characteristics and hunting strategies

Hunters use various strategies in order to maximize their catch; they may hunt during different times of the day or at night and complement active hunting with setting of traps in an effort to maximize their catch and profit. According to Kümpel *et al.* (2009), a hunter's personal profile such as their background, physical ability, skills and income security, influence the type of hunting they practice; and the overall effort he invests in hunting. They observed that hunter effort varied substantially and was influenced by various factors. For example, decisions on where to hunt, how far to go, duration of hunt and the type of prey to target, as well as hunting strategies, may vary among hunters, depending on their social characteristics. In the Kümpel *et al.* (2009) study, trapping strategies of individual hunters were best predicted by their age, and by whether they were a native of the village or not; the effort that a hunter expended on hunting declined with age, and was lower for non-native hunters.

Hunting practices may also be affected by the involvement of individual hunters in other livelihood activities. For instance, many hunters also farm (Mendelson *et al.*, 2003; Alexander *et al.*, 2015). McNamara *et al.* (2016) found that almost all hunters (94%) in villages around Kumasi engaged in agriculture to some extent. Farmers may trap bushmeat around their fields, often as a means of crop protection, but also for both home consumption and local sale, whereas others hunt commercially with guns and sell the majority of their produce in urban markets (Ntiamoa- Baidu, 1998). Hence the amount of time devoted to hunting and the equipment used is a decision taken in the context of the household's other income-generating activities.

2.3.3 Seasonal variations in hunting

Hunting activities are subject to seasonal variations and this affects the volume of wild animals hunted and traded (Crookes *et al.*, 2007; Brashares *et al.*, 2011; Schulte-Herbruggen *et al.*, 2013; McNamara *et al.*, 2016). The amount of time and resources that a household invests in hunting are dependent on the household's engagement in other livelihood activities such as agriculture (e.g., Crookes *et al.*, 2007; Schulte-Herbruggen *et al.*, 2013; McNamara *et al.*, 2016). Hunting activity in Ghana is thought to reach its peak in the dry season, when farmer-hunters are less occupied (Aalangdong, 2010; Brashares *et al.*, 2011). In contrast, Crookes *et al.* (2007) found that professional hunters hunt more during the agricultural peak period and suggests that this is likely to be so due to less competition for wild resources during that time, and also to meet market demand during the period when farmer-hunters are occupied with farming activities.

Roth *et al.* (2002) observed that the volume of animal species supplied to the Toumodi market in Ivory Coast was influenced by socio-economic as well as biological and ecological factors. For example, with the onset of crop farming activities, hunters cared about the cultivation of their fields and therefore had limited time for hunting activities. They also noted that the moon phases played a significant role in hunting, with hunting being more successful during the dark moon phase. Among collected species, frogs are particularly seasonal. For example, Mohneke *et al.* (2010) observed that frogs were usually collected during the dry season in Burkina Faso. Village frog collectors mostly comprised farmers, who were engaged with farm work during the rainy season and therefore had limited time for going after frogs. However, 29% of the villagers interviewed reported that they collected frogs all year round and a few (13%) collected them solely during the rainy season. Furthermore, the majority (82%) of professional frog collectors (N= 22) caught frogs during the dry season, 14% caught frogs all year round and only 4% caught frogs during the rainy season. The majority of the hunters in the savannah zone

of Ghana, considered the period December to May to be the peak hunting season with June to July as the lean season. In a survey of hunters in the savannah zone of Ghana by Aalangdong (2010), 63% of hunters stated that they hunted exclusively in the dry season and the remaining 37% hunted during both the dry and rainy seasons.

2.4 The bushmeat trade

2.4.1 Estimates of bushmeat harvest and scale of the trade

The bushmeat trade in West Africa is a significant economic activity (Cowlishaw *et al.*, 2005b; McNamara, 2014; Wilkie *et al.*, 2016), and the sale of bushmeat is considered as lucrative for many hunters and other actors in the commodity chain (Cowlishaw *et al*., 2005b; Cawthorn & Hoffman, 2015). Considering that the trade is relatively easy to enter compared to other livelihoods, low risk and seasonally flexible, it is particularly attractive to people in rural areas. Furthermore, a higher percentage of the income from bushmeat remains in the hands of the primary supplier (Mendelson *et al.*, 2003; Cowlishaw *et al.*, 2005b) as compared with forest products such as timber (Brown, 2003).

Estimates of the volume and value of the trade are however difficult, owing to its largely informal nature. Fa *et al.* (2005) estimated the exploitation levels of forest mammals in West and Central African sites to be high, with an average of 16,000 kg site^{-1} year^{-1}, from around 70 mammal species. An estimated biomass of 12,000 tons/year was harvested in the Cross-Sanaga river region of Nigeria and Cameroon (Fa *et al.*, 2006). Information on current bushmeat total production in Ghana is limited. However, Ntiamoa-Baidu (1998) estimated that 424,390 tons of bushmeat was harvested annually, worth US$ 350 Million; and 101,413 tons was traded (US$ 83million), with 60% of all sales occurring in urban areas of the country. (Cowlishaw *et al.*, 2005b) estimated harvested biomass of 191 tons per year in Takoradi in the Western region

of Ghana. In the Democratic Republic of Congo, urban consumption generates a trade of about 103–145 tons of bushmeat annually (Van Vliet et al., 2019).

2.4.2 Market profiles

Bushmeat is commonly traded as fresh, dried or smoked meat in markets in most African countries. Most bushmeat markets in West and Central Africa are dominated by ungulates and rodents, and to a lesser extent, primates and carnivores (Taylor *et al.,* 2015). The composition of species traded as bushmeat is also influenced by a number of factors, including the local history of hunting (Cowlishaw *et al.*, 2005a), catchment conditions (Dupain *et al.*, 2012; McNamara *et al.*, 2015), economic incentives such as the family's need for cash (de Merode *et al.* 2004; Schulte-Herbruggen *et al.*, 2013) and the relative prices of bushmeat species (McNamara *et al.*, 2016).

In a Congolese market, Dupain *et al.* (2012) reported 10,358 carcasses of bushmeat belonging to 33 mammalian taxa being traded between October 1997 and September 1999. In their study, primates and ungulates accounted for 45% and 43% respectively of the carcasses in the bushmeat market. Rodents (9%) and carnivores (3%) constituted lower numbers of carcasses, while pangolins, aardvark (*Orycteropus afer)* and hyrax contributed 0.14%. This trend of terrestrial mammals dominating the bulk of bushmeat markets has also been observed in Ghana. Swensson (2005) reported 11 species of wild animals being sold as fresh bushmeat during a two-month (December 2003- January 2004) survey of the Techiman market in Ghana. In his study, rodents accounted for nearly 95% of the total number of carcasses recorded, with the grasscutter (86%) being the most common species traded. Similarly, rodents and ungulates made up 84% of total retail weight of the bushmeat sold in the Takoradi market in Ghana, with the grasscutter and brush tailed porcupine, comprising 50% of the total carcass weight recorded

(Cowlishaw *et al.*, 2005a). More recently, McNamara *et al.* (2016) observed that the profile of the bushmeat species entering a Kumasi market in Ghana has been relatively stable over the past 20 years in terms of species type, with nine species of ungulates and rodents accounting for the bulk of bushmeat traded. However, there was an observed shift in the composition, reflecting an increase in the ratio of rodents to ungulates, from 1:4 in 1990 to 5:8 in 2011. In the one-week survey of the Atwemonom bushmeat market in June 2011, McNamara *et al.* (2016) reported that four rodent species (grasscutter *Thryonomys swinderianus*, giant rat *Cricetomys gambianus*, ground squirrel *Xerus spp.* and brush-tailed porcupine *Atherurus africanus*) comprised over 80% of the total number of carcasses. The most common species traded was the grasscutter which accounted for 62% of the total number of individual carcasses recorded. Even though the large-bodied species tend to be the targets of commercial hunters because they generate a larger return on investment (Wilkie *et al.*, 2016), there seem to be shifts in some areas to smaller animals. This could be accounted for by several factors, including declines in the abundance of preferred species. Today, even species which were once of little commercial value are found in markets. In the past, such species (e.g., giant rats) were eaten at home, given away or traded within the village, and thus never reached urban markets (Ntiamoa-Baidu, 1987 1998).

2.4.3 Actors in the bushmeat commodity chain and Patterns of trade

A commodity chain refers to the series of interconnected exchanges through which a product passes from the point of production until it is traded and finally consumed (Ribot, 1998; de Merode & Cowlishaw, 2006), highlighting the set of economic actors and activities involved (Grossman-Thompson & Lake, 2012). Some studies show that knowledge of how bushmeat commodity chains operate can be important to understanding and managing the routes that influence wild animal species extraction (e.g., Cowlishaw *et al.*, 2005b; de Merode &

Cowlishaw, 2006; van Vliet *et al.*, 2019). A few past studies identified only key actor groups and their roles in the trade (Falconer, 1992; Caspary, 1999; Fa *et al.*, 2000). Others have provided more comprehensive knowledge about how individuals enter the business, the division of labour amongst actor groups, and even how profits from the trade are shared amongst these actors (Mendelson *et al.*, 2003; Cowlishaw *et al.*, 2005b; van Vliet *et al.*, 2019).

The bushmeat trade comprises many different actor groups along the commodity chain (e.g., hunters, wholesalers, market traders, transporters). These actors play varying roles from the primary source to consumers at the end of long supply chains in cities. For example, Mendelson *et al.* (2003) identified five main actors in the Takoradi bushmeat commodity chain in Ghana, with bushmeat being traded freely between all actor groups. The market structure in Takoradi differed from that reported by Falconer (1992) in Kumasi; where, one of two commodity chains supplied smoked meat from the northern savannahs, whilst the other supplied fresh meat from the southern forests. In the Kumasi market also, Ntiamoa-Baidu (1997) reported that the trade was run as family businesses and handed down through generations.

Bushmeat is an important commercial commodity in many urban and rural markets throughout Africa where bushmeat marketing is particularly well developed (e.g., Sackey, 2014; Nielsen & Mielby, 2015; McNamara *et al.*, 2016). Wild animals hunted may be sold locally or transported to larger markets, particularly in urban centres, where they fetch higher prices (Sackey, 2014). Bushmeat sold within villages typically comes from hunting activities in nearby forests and farmlands, while supplies to urban centres may come from vast source locations, long distances and even neighbouring countries (Ntiamoa-Baidu, 1998; Crookes *et al.*, 2007; Mohneke *et al.*, 2010). For instance, according to Ntiamoa-Baidu (1998), fresh bushmeat coming to the Kumasi markets may come from as far as the Bono and Ahafo regions, while most of the smoked warthog (*Phacochoerus* sp,) meat sold was sourced from Burkina

Faso; but the trade routes are not known. Mohneke *et al.* (2010) characterized local small-scale use of frogs in Burkina Faso and an intensive large-scale, cross-border frog trade between Nigeria and its neighbouring countries.

2.5 Bushmeat consumption and preferences

Bushmeat is valued and eaten by all classes of people; for many people in urban areas distant from sources of wildlife, who normally have a choice of alternative sources of animal protein, bushmeat is considered a luxurious dietary item (Cawthorn & Hoffman, 2015). On the contrary, rural consumers and forest dwellers have few or no alternatives to bushmeat (van Vliet *et al.*, 2014; Wilkie *et al.*, 2016). People eat bushmeat for various reasons including culture, taste and availability, but cost also influences bushmeat consumption. These factors affect the frequency and pattern of consumption, and also vary between areas. For example, while the consumption of some wild animal species may be prohibited by one group due to cultural or religious reasons, that same species could be a delicacy to another group elsewhere (Fa *et al.*, 2002).

2.5.1 Availability and lack of alternatives

Availability and lack of alternatives drive bushmeat consumption. Some people depend on bushmeat as a source of animal protein because domestic alternatives (e.g., beef, pork) are scarce, or where available, are not affordable (Swamy & Pinedo-Vasquez, 2014). For such people, all species of wild animals are palatable. However, it goes beyond just availability; Asibey and Child (1990) observed that the majority of people in most African countries who eat meat, would eat bushmeat if it were readily available. For instance, Owusu *et al.* (2004) found that, almost all (91.3%) respondents in a survey of bushmeat use in the Afadjato-

Agumatsa area in Ghana said they would eat bushmeat if they had access to it. In a survey of rural households in Ghana, Alexander *et al.* (2015) observed low household-level consumption of bushmeat which they attributed to reduced availability, which in turn was attributed to a reduction in wild animal numbers. Other studies on bushmeat consumption in some areas within Africa show that where available, bushmeat continue to be a highly-valued wildlife resource (van Vliet *et al.*, 2014).

2.5.2 Taste and state

Individuals have strong preferences regarding bushmeat species, despite the wide variety of wild animals eaten. Taste preference has been observed to influence consumption of bushmeat (Schenck *et al.*, 2006). Across most parts of Ghana, grasscutter is the most preferred bushmeat species (Ntiamoa-Baidu, 1997; 1998; Alexander, 2011). For instance, 40-50% of respondents in a survey of meat preferences in different Ghanaian towns selected the grasscutter as their favourite species and 76% of people eating bushmeat in chop bars in Accra chose grasscutter as their preferred meat (Ntiamoa-Baidu, 1997). Owusu *et al.* (2004) also reported that grasscutter was the most preferred bushmeat species followed by duikers; the reasons given by respondents for their preference were that these species were common and hence easy to obtain (60.5%) and tasty (39.5%). In a similar investigation in the Central region of Ghana, Sackey (2014) found that grasscutter was the most preferred bushmeat species by consumers (63%), followed by royal antelope (15%).

By contrast, in a study in Equatorial Guinea, East *et al.* (2005) observed that the main difference made by consumers was based on food state, rather than food type. Imported frozen food such as chicken, pork chops and mackerel were widely and regularly available, and also much cheaper than fresh foods like bushmeat, but was not liked. Also, there was little preference for

smoked meat, which was cheaper but less available than fresh food. In contrast, smoked meat was preferred over fresh, and was usually available but more expensive than fresh meat in a Ghanaian market (Cowlishaw *et al.*, 2005b).

2.5.3 Role of price and income

The nutritional value of bushmeat does not always translate into high levels of consumption by people, as the market price of the commodity and also income levels of consumers influence consumption in both rural and urban areas (East *et al.*, 2005; McNamara *et al.*, 2016; Wilkie *et al.*, 2016; McNamara *et al.*, 2019). Even though some people who eat bushmeat as a luxury item are willing to pay high prices for their choice species, bushmeat may not be eaten frequently (McNamara *et al.*, 2016) or may be purchased in small quantities (Cowlishaw *et al.*, 2005b) due to cost. In a survey of consumers in Ghana, McNamara *et al.* (2016) showed that the high price of bushmeat discourages consumption in the city of Kumasi and surrounding communities. They also found that bushmeat is among the most expensive meats on local markets in the country. On the other hand, in Tanzania, Rentsch and Damon (2013) found that bushmeat was relatively cheap compared to other meats, particularly beef.

Wilkie *et al.* (2005) examined the role of price and wealth in consumer demand for bushmeat in Gabon and they found that consumption of bushmeat, fish, chicken and livestock all increased with wealth; and that higher prices of these types of animal protein resulted in lower consumption. In their evaluation of the relationships between consumption of different types of meat and fish and several parameters including income, preferences and availability in Equatorial Guinea, East *et al.* (2005) also found that consumption of all fresh foods (including bushmeat) increased with income. Findings from economic and wildlife use surveys conducted by Brashares *et al.* (2011) in households in four countries (Ghana, Cameroon, Tanzania, and

Madagascar) showed that the least wealthy households regularly consumed the most bushmeat in rural areas, whereas wealthier households showed higher rates of consumption in urban areas. They also found that bushmeat was significantly cheaper in 52 markets than domestic meat and fish in areas close to sources of wildlife. Some evidence also suggests that less bushmeat is consumed if its price increases or the price of substitutes decreases (Wilkie *et al.*, 2005; Rentsch & Damon, 2013).

2.6 Drivers of overhunting and bushmeat trade

Recently, hunting activities in sub-Saharan Africa have intensified due to several drivers, which vary significantly between regions and countries (Cawthorn & Hoffman, 2015; Wilkie *et al.*, 2016). Factors such as poverty and unemployment affect the intensity and levels at which bushmeat is exploited. In the past, hunting was mainly for subsistence rather than commercial (Asibey, 1974; Ntiamoa-Baidu, 1997; Fa & Yuste, 2001). Today, the emergence of a thriving commercial bushmeat trade has resulted in overexploitation of wild animals (Wilkie *et al.*, 2016). There is increased demand for bushmeat (Brashares *et al.*, 2011; McNamara, 2014). For example, high demand for bushmeat has been recorded for west and central African countries including Ghana (Wilkie *et al.*, 2005; Brashares *et al* 2011; McNamara, 2014). In order to meet increased consumer demands, hunting activities have intensified, also assisted by the availability and access to improved hunting equipment (Damania *et al.*, 2005; Coad *et al.*, 2010; Lindsey *et al.*, 2013) and improved accessibility of forest areas and markets (Cowlishaw *et al.*, 2005b; Lindsey *et al.*, 2013).

It cannot be overlooked that currently, many activities associated with bushmeat hunting and trade have become illegal in many parts of Africa (Lindsey *et al.*, 2013; Ogada, 2014; Wilkie *et al.*, 2016), including Ghana (Bokhorst, 2010; Sackey, 2014; Alexander *et al.*, 2015) . In the

past hunting and exploitation of wild animals in Ghana were controlled by indigenous beliefs and prohibitions such as species-specific taboos, and traditional sanctions (Ntiamoa-Baidu, 2008; Bokhorst, 2010). Every hunter was expected to respect the traditional regulation that existed in their communities. Such protocols are now violated due to the breakdown of traditional belief systems in certain areas. Furthermore, formal state legislation that exists to regulate hunting in countries where bushmeat is harvested and traded is often disregarded due to poor governance and weak law enforcement capacity (East *et al.*, 2005; Crookes & Milner-Gulland, 2006; Sackey, 2014; Cawthorn & Hoffman, 2015). Hence, restrictions on the times and place that hunting is allowed, the species and number that may be hunted, and the hunting methods that may be employed are violated. For instance, wildlife exploitation in Ghana is supposed to be regulated through the Wildlife Conservation Regulations that categorize species according to their conservation status and list species that may be hunted, as well as open and closed seasons for hunting (Ntiamoa-Baidu, 1998; Crookes & Milner-Gulland, 2006). However, this regulation appears to exist only on paper because in practice, enforcement is poor. For example, several studies (e.g., Conservation International-Ghana, 2002; Crookes *et al.*, 2005; Sackey, 2014) recorded trade in protected species during both open and closed hunting seasons, with disregard for wildlife laws.

Several studies conclude that bushmeat hunting in most parts of the world is no longer sustainable (Wilkie *et al.*, 2016). Lately, hunting practices have largely increased driven by factors such as improved road access to previously remote areas (Brodie *et al.*, 2015). Also, the growth in demand for bushmeat, mostly from the fast expanding African urban centres (Brashares *et al.*, 2011), has increased the economic incentives for local people to engage in hunting (Cawthorn & Hoffman, 2015), resulting in overhunting that is putting food security and peoples' livelihoods at risk (Nasi *et al.*, 2011). Furthermore, with the current scale of

commercialization of bushmeat hunting in most parts of sub-Saharan Africa, a wide range of wild animal species are now exploited throughout the year.

2.7 Impacts of overexploitation and implication for wildlife species conservation

Overexploitation of wild animals for food can have major impacts on both targeted species (Fa & Brown, 2009; Swamy & Pinedo-Vasquez, 2014; Boakye *et al.*, 2016) and ecosystem dynamics (Petrozzi *et al.*, 2016). The scale of hunting and trade in bushmeat poses a real threat to many wild animal species and has therefore been identified as a significant driver of defaunation in tropical forests, especially in West and Central Africa (Abernethy *et al.*, 2013; Petrozzi *et al.*, 2016). Studies on hunting in West and Central Africa have shown the consequent impact of bushmeat on species declines, particularly large mammals (Abernethy *et al.*, 2013; Petrozzi *et al.*, 2016). The increased extraction levels of bushmeat can impact on the ecology of their habitats (Brodie and Gibbs, 2009; Abernethy *et al.*, 2013; Petrozzi *et al.*, 2016), as some tree species with large seeds rely on large-bodied vertebrates for dispersal, with detrimental effects on carbon stocks and climate (Brodie and Gibbs, 2009; Jansen *et al.*, 2010).

Nearly two decades ago, Bakarr *et al.* (2001) reported that the forest system which was once extensive across Guinea, Sierra Leone, Liberia, Cote D'Ivoire and Ghana, has been reduced to a mosaic of farm bush, plantations and a few remaining forest blocks, with a resulting loss of animal species and the restriction of some species to remaining forest fragments. A landscape classification of the area around the city of Kumasi, Ghana, by McNamara *et al.* (2015) indicates changes in land cover within the bushmeat catchment area between the years 1986 and 2002. Their study showed declines in area of closed (7%) and open (6%) canopy forests, as well as closed canopy forest outside of reserves (47%) during the period. This illuminates the increasing levels of human activity and disturbance in the area, and the consequent impact

on biodiversity. The unsustainable level of bushmeat exploitation also threatens the food and livelihood security of the many people who depend on it (Cawthorn & Hoffman, 2015; Nasi & Fa, 2015).

There is evidence that the scale of hunting poses a real threat to many vulnerable African forest species; for instance, over 70% of all respondents (hunters, bushmeat traders, and chop-bar operators) in a survey conducted by Sackey (2014), in the Mankessim area in Ghana perceived a decline in wild animal numbers and bushmeat availability. Those who perceived a decline associated this mainly to use of herbicides in crop farms (37% of responses), overexploitation (20%) and other factors such as deforestation, poor markets and use of poisoned baits. Bushmeat hunting and overexploitation of vulnerable species has led to the depletion of many large bodied and slow reproducing species (Abernethy *et al.*, 2013). The ratio of rodents to other taxa such as ungulates delivered and sold in bushmeat markets provides a rough estimate of the impact that hunting has had on local wild animal populations (McNamara *et al.*, 2016). As a result of overhunting, the bushmeat markets across West Africa are now dominated by small bodied, fast reproducing species such as rodents, which are likely to survive the pressure from commercial hunters (Cowlishaw *et al.*, 2005a; Swensson, 2005; McNamara *et al.*, 2016). It is therefore not surprising that the grasscutter is the most commonly traded and consumed bushmeat species in many areas across West Africa (Cowlishaw *et al.*, 2005b; Abernethy *et al.*, 2013; McNamara *et al.*, 2019). There are fewer studies of actual population declines (Abernethy *et al.*, 2013) because it is difficult to monitor animal abundance than markets, even though market data are biased by factors such as preferences.

2.8 Bushmeat exploitation, consumption and public health

Bushmeat hunting and the consumption of wild animals is associated with an increased risk of getting zoonotic diseases and thus, has become an issue of concern for public health. Several wild animal species that are exploited as bushmeat are known or suspected to be reservoirs of infectious pathogens, including Ebola and monkey pox virus, even though relatively little is known about the transmission dynamics of such infections. For instance, species like fruit bats and non-human primates are suspected to be likely reservoirs of Ebola virus and have been implicated in Ebola Virus Disease outbreaks including the 2014 occurrence in West Africa (Pigott *et al.*, 2014; Chiappelli *et al.*, 2015). Activities such as hunting and butchering of wild animal meat have been noted as high risk activities for zoonotic disease spillover and have been suspected as potential sources for initial spillover events (Pigott *et al.*, 2014). In the more recent outbreak of the Coronavirus Disease-2019 (COVID-19) pandemic, the origin of the disease has been linked to a wet market in the city of Wuhan in China. It has been reported that the virus was first transmitted from an animal host to humans at this market, though this has not yet been confirmed (Cohen, 2020). A recent finding by Zhang *et al.* (2020) also suggests that the virus could have been transferred to humans through traded pangolins, at this market supported by the finding of Covid-19-like coronavirus from traded Malayan pangolins (*Manis javanica*), however, this has not been proven.

In addition, bacterial and parasitic infection risks from wild meat consumption are likely to be of great importance due to the inappropriate hygienic conditions associated with storage and transportation of wild meat (Ockerman & Basu, 2009; van Vliet *et al*., 2012). Given the public health importance of bushmeat and its potential effects on both local and national economies it has become even more vital to provide recommendations that guide initiatives which aim at

reducing the risky human-wildlife interactions which occur through the hunting and consumption of wild animals.

CHAPTER THREE

3.0 GENERAL METHODOLOGY

3.1 Study area

The study was carried out in the Upper East region of Ghana (Figure 3.1), located in the north eastern part of Ghana the country between longitude 0° and 1° West, and latitudes 10° 30′N and 11°N. The region is bordered by Burkina Faso to the north and Togo to the east and shares boundaries with Upper West Region to the west and Northern Region to the south. It has a total land surface of 8,842 square kilometres, which represents 2.7 percent of the total land area of the country (Ghana Statistical Service, 2013).

The topography of the area is generally undulating with slopes ranging from 200 meters to 300 meters in certain parts. The soil is "upland soil" primarily formed from granite rocks. Like most parts of northern Ghana, the area is drained by a number of important tributaries of the White and Red Volta and by the Sissili River and its tributaries (Ghana Statistical Service, 2013). Most of these streams are seasonal and dry up during the long dry season with an adverse effect on the supply of water for both agricultural and domestic use.

The study area experiences almost equal months of dry and rainy seasons in a year. The rainy season is typically from May to October and the dry season from November to April (Aalangdong, 2010; Ghana Statistical Service, 2013). The mean annual rainfall is between 800 mm and 1100 mm. The highest temperatures are recorded in March and this can rise to 45^0C, whereas the lowest temperatures are recorded in January.

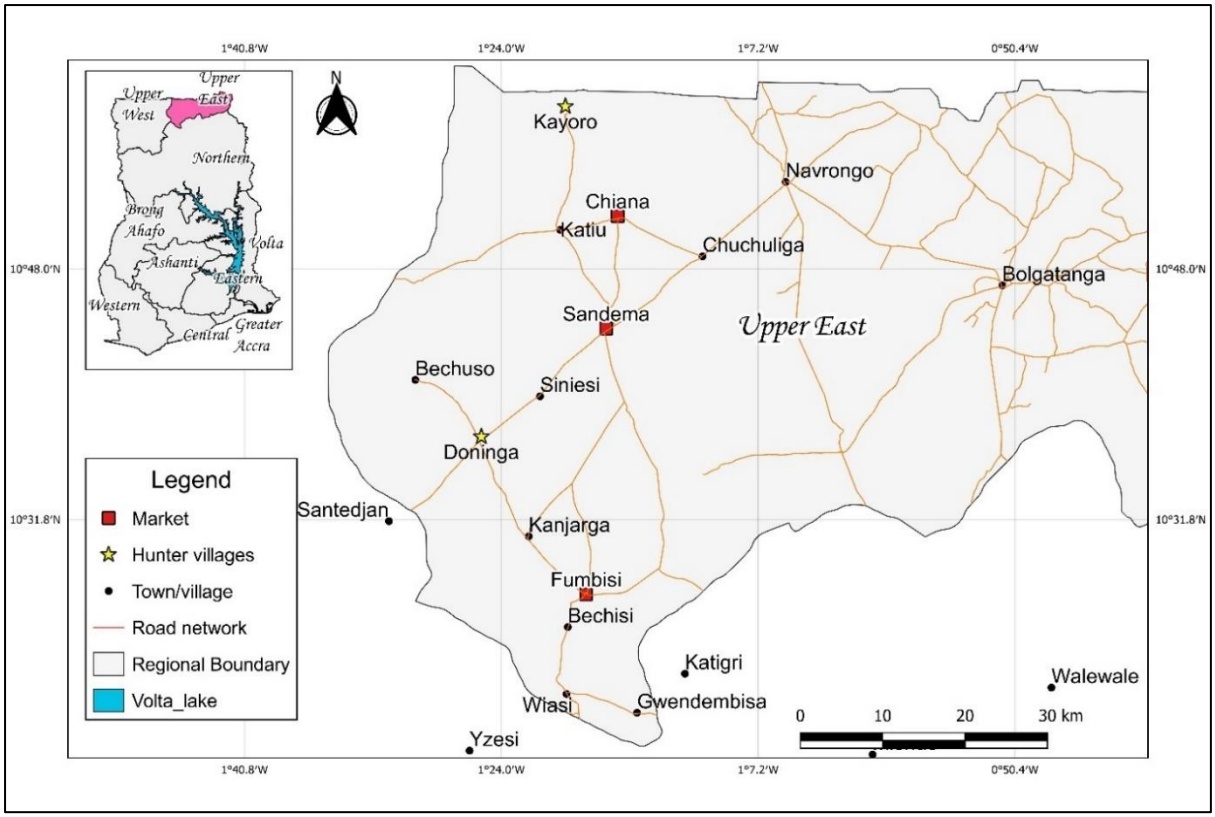

Figure 3.1. Map of the study area and location of the three market sites and two villages sampled (Fumbisi, Sandema, Chiana, Doninga and Kayoro).

The natural vegetation is savannah woodland and consists mainly of open savannah with grassland separating fire and drought-resistant trees of varying sizes and density (Ghana Statistical Service, 2013). However, anthropogenic activities such as, farming, bushfires and charcoal burning, have caused much damage to the woodlands and led to degradation of the vegetation cover of the area (Aalangdong, 2010). The grass is burnt by bushfires or scorched by the sun during the long dry season. The sheanut *Vitellaria paradoxa*, dawadawa *Parkia biglobosa*, baobab *Adansonia digitata*, and acacia *Acacia nilotica* are the most common economic fruit trees (Ghana Statistical Service, 2013).

The region is one of the least urbanized in Ghana; it is highly rural (79%) with dispersed settlements and only 21% of the population living in urban areas (Ghana Statistical Service, 2013). The region is also one of the areas in Ghana with highest per capita poverty; 67.7% in 2016/17 (Ghana Statistical Service, 2018). Agriculture is the main economic activity for about 80% of the economically active population, the majority of whom are smallholder farmers engaged in crop farming (Ghana Statistical Service, 2013; 2014a; 2014b; 2014d). The main cultivated crops are millet, groundnut, beans, guinea-corn, maize, sorghum, tomatoes and onions. Livestock and poultry rearing are also common in the area.

3.2 Study sites

Data for this study were collected from five locations, comprising two villages (Kayoro, Doninga) and three towns (Chiana, Fumbisi and Sandema). These five locations fall within three districts, Builsa North, Builsa South and Kasena Nankana West (Table 3.1). Household and hunter data were gathered in the two villages (Kayoro and Doninga), while market data were collected in the three markets at Sandema, Fumbisi and Chiana. The decision to select Kayoro and Doninga for the hunter and household surveys was based on: i) their identification as major source locations supplying bushmeat to markets (through consultation with key informants and knowledgeable individuals during the pilot survey); ii) accessibility by road; iii) good market integration; and iv) a positive attitude of the villagers, allowing research to take place in their community. The three market towns were identified based on expert knowledge from previous studies which suggested that they had substantial bushmeat markets (Ntiamoa-Baidu, 2016).

Table 3.1. Location and characteristics of sample sites.

Location	District	Town/ Village	Landcover [1,2]
Sandema	Builsa North	Town	Open tree/savannah woodland
Fumbisi	Builsa South	Town	Open tree/savannah woodland
Chiana	Kasena Nankana West	Town	Open tree/savannah woodland
Kayoro	Kasena Nankana West	Village	Closed tree/savannah woodland
Doninga	Builsa South	Village	Open tree/savannah woodland

[1] As described in the District Analytical Reports of the 2010 Population and Housing Census (Ghana Statistical Service, 2014a, 2014b, 2014d).

[2] Based on a GIS coverage map for the study area provided by the Centre for Remote Sensing and Geographic Information Services (CERSGIS), University of Ghana.

Sandema is the administrative capital of the Builsa north district (Table 3.1). The Sandema market operates on the 'market-day' system, where the market is run twice per week, with one major market and one minor market. Fumbisi is located in the Builsa south district and is 23 km south of Sandema. The Fumbisi market is operated once per week, following the major market day at Sandema. Chiana is located in the Kasena Nankana west district and is about 13 km north of Sandema. The Chiana market is operated on Fridays only. The three markets (Sandema, Fumbisi and Chiana) are the major centres for commercial activities in their respective regions, where both agricultural and manufactured goods are sold. These markets serve all the surrounding small communities and villages in the area. The two villages (Kayoro and Doninga) have direct and/or indirect links with the bushmeat trade in the three markets.

Kayoro (10.9749884°, -1.3300520°) is a remote village of about 5,271 people (GSS, 2014d), situated about 23 km north of Chiana and is a border town on the Ghana/Burkina Faso border (Figure 3.1). It is located in an area with moderately closed tree cover, perhaps because of its closeness to the Nazinga Game Ranch in the south of Burkina Faso, which lies just about 8 km northwards of the village. Kayoro is one of nine villages that bounds the Sanyiga Kasena Gavara Kara Community Resource Management Area (CREMA) (World Bank, 2016). Doninga (10.6192748°, -1.4217274°) on the other hand is a small community of about 2,914 people and is located between Sandema and Fumbisi, about 20 km and 24 km from Sandema and Fumbisi respectively (Figure 3.1). It is one of 26 villages surrounding Sumboru-Bechonsa CREMA. The dominant ethnic groups in Kayoro and Doninga are Kasena and Builsas, respectively. Traditionally, villagers are free to access natural resources anywhere on the communal village lands except locations designated as sacred areas by custom or state institution (Ghana Local Government Bulletin, 2016).

3.3 Ethics

Ethical clearance was obtained for this study from the Ethics Committee for the College of Basic and Applied Sciences (ECBAS) of the University of Ghana (ECBAS 040/18-19). Before conducting interviews at each study site, permission was sought from leaders of the community, following explanation of the research objectives. Respondents were asked for consent before the start of all interviews, and each interview started with a brief introduction outlining the purpose of the study, and providing assurance that all personal information would remain strictly confidential. The respondents were informed that the study was part of a university research project investigating factors influencing volume of trade and individuals' trading behaviour and that respondents would be anonymous. For all interviews, participants

were advised that they did not have to answer any question they did not wish to, and could withdraw at any time.

3.4 Market surveys

The market survey was aimed at obtaining information on bushmeat species characteristics and relative abundance of species traded, identifying and documenting the key actors in the commodity chain, as well as understanding their roles in the operation of the market. Data were collected from the main bushmeat selling stations in the three markets between 09:00 hours and 17:00 hours GMT on two consecutive market days within a two-week sampling session every other month. At each market a three-member team (researcher, one volunteer research assistant who has experience with surveys and a local assistant) collected data on bushmeat on the stalls and also as it was delivered to the market.

Bushmeat delivered to the market at the time of the survey was identified to species level where possible, using direct observation and recorded local names. Identification sheets for species groups (e.g., primates, duikers and other large mammals) with their local names were constructed and used in the identification process. To test the reliability of identifications, some species not occurring in the study areas were included on the sheets. Information on local names of species was obtained from traders and hunters (during a rapid survey of six villages in the pilot survey: Kayoro, Katiu, Nakong, Kanjarga, Doninga and Wiaga). Direct observation, followed by questioning as bushmeat was brought to the markets, was also used to ascertain local names. Digital photographs were taken of species to confirm identification where identification of species on the spot was difficult. For smoked species that could not be identified in the field (e.g., amphibians), fresh samples were obtained, preserved in 70%

alcohol and brought to the laboratory for further identification by an expert. The nomenclature used was based on Kingdon (2015).

3.4.1 Condition of animal carcasses and minimum number of individuals

The condition of animal carcasses (fresh, smoked, whole or parts of animals) were recorded. Smoked carcasses and those with missing appendages or heads which could not be identified to species or genus levels were identified to taxonomic groups (e.g., monkeys and birds) using observed features characteristic of those taxonomic groups. The minimum number of individuals (MNI) was estimated when body parts were encountered (Fa *et al.*, 2015). MNI is estimated as the fewest possible number of animals in a collection of body parts (e.g., if there are two legs, a left and a right, then the MNI=1, etc.).

3.4.2 Prices, Source locations and other Parameters

Information on purchase and sale prices of both smoked and fresh (whole/pieces) carcasses of species was obtained from traders and hunters (in some cases their representatives who delivered bushmeat to the market). The sources and destination of the carcasses were obtained from hunters and traders. The wholesalers, particularly, had defined onward routes for their stock. Where possible, information was collected on the weight of carcasses of animals, as well as the capture methods used. For comparison, data (weight, price, and type) were also collected on other types of animal protein sold in the study area, mainly fish and beef.

3.5 Trader surveys

Semi-structured interviews were held with bushmeat traders (wholesalers and market traders) in the selected markets to obtain information on bushmeat trading activities and involvement in other livelihoods. Questionnaires comprising close and open-ended questions were administered to the target groups (Appendix 1). In the open-ended questions, respondents had to provide their own views on the subject. For the close-ended questions, respondents had to choose from the options provided. Questions focused on species traded, products traded in addition to bushmeat, seasonal pattern of trading, how meat is sourced, trading relationship with hunters and other traders, the respondent's perceptions of changes in bushmeat availability, as well as factors impacting on species' abundance.

All interviews were conducted by the researcher and one trained interviewer using three languages (Buili - the native language of the respondents, Twi and English), depending on which language the respondent was most comfortable with. The questionnaire was piloted to ensure that all queries were resolved and that a standardized interview procedure was adopted by the two interviewers.

When a trader was located in the market, the interview team approached and explained the purpose of their visit to her. Traders who were uncomfortable or hesitant (perhaps afraid of being arrested, as bushmeat trading/hunting was illegal during certain times of year and also if they did not have a valid license) were not interviewed. Therefore, only respondents who were convinced, after being assured that the visit was of academic interest only, were interviewed. This does lead to selection bias and likely to underrepresent illegal activities.

3.6 Rural Surveys

Rural surveys were carried out in Kayoro and Doninga villages. Prior to the survey period, the researcher and research assistant spent two weeks in the study sites piloting the questionnaires, locating key informants, familiarizing themselves with the village life and establishing relationships with the villagers to ensure high quality data were obtained. Upon arrival at each village, the research team held discussions with the chief and community leaders and obtained approval for the research. The research objectives were explained to the community members through an official announcement.

The rural surveys used three approaches: i) focus group discussions were held in each of the selected villages prior to starting formal survey activities to obtain information about village life and local livelihood activities; ii) targeted sampling to obtain information from hunters; and iii) a general survey of households using a systematic sampling scheme to locate households to be interviewed.

Data were collected through structured and semi-structured interviews. All interviews were conducted in Twi, Buili, Kasem or English by the researcher and field assistant, with help from three local assistants to translate where necessary. Prior to data collection, all interview assistants received extensive training in social research methods. The interviews were conducted in a relaxed setting, as it was observed in the familiarization exercises that hunting was not a particularly sensitive issue and that people were willing to discuss hunting activities openly. At the end of the group discussions, participants were offered two cakes of soap each as appreciation for their time, and same was applied to respondents in the one-on-one questionnaire surveys.

3.6.1 Focus groups

The focus group discussions involved a small number of individuals, usually 7-14 people (Newing *et al.*, 2010). Selection of participants focused on individuals who were well placed to provide information pertinent to this study, and included hunters, opinion leaders and senior members of the community.

Two focus group discussions were held in each of the sites surveyed, one consisting of men and the other, women. This gender separation was culturally appropriate to reduce the likelihood that men would dominate the discussion in mixed groups, and also because men and women might have different gender roles (Brown & Marks, 2007). Questions focused on a village's main livelihood activities, seasonality of livelihood activities such as farming, patterns of their agricultural calendar (e.g., when the planting seasons and associated harvest were and what time of the year was associated with the lean hunting season), and a general discussion about bushmeat hunting, trade and meat consumption. In the male focus groups which included hunters, involvement in hunting and bushmeat trade was also discussed. Information gathered from the focus group discussions helped to inform the more detailed one-on-one surveys carried out with hunters and households.

3.6.2 Hunter interviews

Structured interviews (Appendix 2) were held with professional hunters in the selected villages to obtain information on livelihood activities, hunter behaviours and their perceptions of changes in bushmeat availability and factors impacting on species abundance. For the purpose of this study, professional hunters were defined as individuals who regarded hunting as one of their livelihood activities, whether for food or income. Hence, individuals who trapped wild

animals on their farms for opportunistic subsistence or as a means of pest control were not involved in the hunter survey.

Plate 3.1. Focus group discussion.

Hunters were identified and recruited during focus group discussions for one-on-one interviews and the snowball sampling approach was also used, where known hunters were asked to identify other hunters (McNamara, 2014). Information on bushmeat hunting activities was collected using a seven-day recall period (Schulte-Herbrüggen, 2011). If the respondent did not do any hunting in the preceding week, information from the last time he went hunting was obtained. Data obtained from the interviews were verified through triangulation with other respondents (e.g., members belonging to a particular hunting group).

3.6.3 Household interviews

Household surveys (Appendix 3) were used to obtain information and ascertain the harvest, use of bushmeat, and animal protein preference by households. For the purpose of this study a household was defined as a family group living together in one or more neighbouring houses and eating from a common pot (Kümpel *et al.*, 2010). Interviews were conducted with either the head of the household or the wife of the household head, especially in cases where the head agreed his wife was best placed to answer questions on household consumption. Surveys usually took place in the early morning and early evening to suit the daily work schedule of the respondents. To ensure the full geographical area of the village was covered by the survey, a systematic sampling approach was adopted and every third household was sampled. If a household was unavailable, the next available house was selected, but in a few cases the interview was rescheduled for the following day. No household declined a request for an interview.

3.7 Data management and statistical analysis

Data processing, organisation and manipulation were done in Microsoft Excel (Microsoft®), Statistical Package for the Social Sciences (SPSS) version 20, or R (R Core Team, 2019). Specific methods and statistical analyses for each data set are described for each chapter.

CHAPTER FOUR

4.0 MARKET DYNAMICS OF BUSHMEAT SPECIES IN NORTHERN GHANA

4.1 Introduction

Bushmeat harvesting and trade occur commonly throughout much of sub-Saharan Africa, where local communities living in forested areas depend on wildlife for food and income generation. The transition from subsistence to large-scale commercial hunting, however, poses a serious challenge for biodiversity conservation (Wilkie *et al.*, 2016). This challenge has escalated due to factors such as growing human populations, increased accessibility to wild animals as infrastructure expands, the need for income, and use of modern hunting techniques such as firearms (Poulsen *et al.*, 2009; Coad *et al.*, 2013; Alexander *et al.*, 2015).

Bushmeat markets are found in many rural and urban towns in many African countries, particularly in the West and Central African regions where the business is well-developed (Sackey, 2014; Fa *et al.*, 2015; van Vliet *et al.*, 2015; McNamara *et al.*, 2016). These markets typically serve as important concentration points of wildlife harvested from surrounding catchments. Patterns of trade flow are often highly dynamic with temporal and spatial fluctuations in species type, abundance and price. Information on numbers of animals appearing in markets is valuable for assessing the condition and status of fauna in the surrounding catchment areas (Cowlishaw *et al.*, 2005a; Dupain *et al.*, 2012; Fa *et al.*, 2015). For instance, analysis of counts of the numbers of carcasses of wild animals appearing in the markets and the volumes marketed has been used to provide information on; extraction estimates and type of wild animals being hunted in those areas, the status of the species in the

wild, and the level of exploitation (Cowlishaw *et al.*, 2005a; Fa *et al.*, 2015; McNamara *et al.*, 2016). Even though the complexity surrounding these markets may prevent firm conclusions on sustainability (Ling & Milner-Gulland, 2006; Waite, 2007), analysis of species profiles and volumes can provide useful insight and broad understanding of wild meat extraction across landscapes (Fa *et al.*, 2015). This can allow the identification of potentially overhunted and less-disturbed catchment areas for consideration in conservation planning. Bushmeat markets have also been used to investigate various characteristics of the trade to better understand its dynamics, from wildlife depletion to spatial and temporal changes, and consumer, hunter and trader behaviour (Allebone-Webb *et al.*, 2011; Crookes *et al.*, 2005; East *et al.*, 2005; Macdonald *et al.*, 2011; McNamara *et al.*, 2015; McNamara *et al.*, 2016; van Vliet *et al.*, 2012).

In Ghana, a number of bushmeat markets have been studied over varying periods, but the available studies have only gathered data for markets and trade patterns in the southern part of the country (Cowlishaw *et al.*, 2005a; Crookes *et al.*, 2005; McNamara *et al.*, 2016; Ntiamoa-Baidu, 1998; Sackey, 2014; Swensson, 2005). Information on virtually all aspects of the bushmeat trade are, on the contrary, scarce for the northern parts of Ghana (Aalangdong, 2010). The northern part of Ghana is also interesting because it is a savannah ecosystem with different biotic and socio-cultural characteristics to the humid south. The trade in bushmeat in savannah areas is in general far less studied than in forest ecosystems (Lindsey *et al.*, 2013). The majority of savannah-focussed studies are in East and Southern Africa (e.g., Lindsey *et al.*, 2011; Nielsen *et al.*, 2014; Nielsen & Meilby, 2015).

This chapter therefore provides an in-depth study of the dynamics of three bushmeat markets in the Upper East region in northern Ghana. The study includes an assessment of species composition, numbers, seasonal variation, and prices in these markets, and also draws some general conclusions about the bushmeat trade in this understudied region.

4.2 Methods

4.2.1 Study sites

The study was conducted at the Sandema, Chiana and Fumbisi markets in the Upper East region of Ghana (see Chapter three for full description of the study sites).

4.2.2 Data collection

Surveys of the Sandema, Fumbisi and Chiana markets were conducted from October 2018 to October 2019. A three-member team (researcher, field assistant and trained local assistant) visited markets in the mornings before traders started selling their bushmeat and stayed throughout the day until traders departed from the market. To avoid double counting of bushmeat carcasses during each survey, each member of the team was assigned to a specific group of traders and stayed with them throughout the day's survey. Traders were assured that all information collected and their identity would be anonymous. During market surveys, the data collection involved direct observations of the species and count of bushmeat carcasses as described in Chapter three. In addition, data on the condition of meat (live, fresh or smoked), the weight and prices of carcasses were collected where available. Not all information could be collected on individual carcasses as some traders were in a hurry to sell their bushmeat or the smoked carcasses were too delicate to be handled or the traders did not consent to their bushmeat being handled. In such cases, only the species were recorded.

To maintain consistency with data collected, the same members of the survey team which collected data on bushmeat at each market were maintained throughout the survey period.

4.2.3 Data analysis

All statistical analyses were performed in the R environment, version 3.6.1 (R Core Team, 2019). Species diversity was estimated, following the methodology by Dupain *et al.*, (2012). Species diversity for each market site was estimated using the Shannon diversity index:

$$H' = -\sum P_i \ln P_i \quad Pi = \frac{n_i}{NI}$$

where H' represents species diversity, with higher values of H' being associated with greater diversity, n_i is the number of carcasses of each species recorded during all market sampling days for a particular market; and *N*, the sum of all carcases traded in that market.

A total of 41 market survey sessions were conducted across all the 3 markets (Sandema =18 days, Chiana = 10 days, Fumbisi = 13 days). Due to variation in the number of sampling sessions at the different markets, trade volumes (carcasses and biomass) are reported as mean quantity per sampling day within each market to standardise data and control for variation in sampling effort.

Biomass of bushmeat traded was estimated using the total number of individuals recorded per species on the markets, multiplied by the average adult body-mass (in kilograms) of the species as reported in the literature (Hoffman & Sales, 2007; Borrow & Demey, 2010; Sackey, 2014; Parr *et al.*, 2014; Kingdon, 2015). For those individuals that were not identified to the species level, the mean body mass of related taxa was assigned.

To estimate annual quantities of bushmeat traded within each market, the mean quantity of carcasses recorded per survey at each market was multiplied by the total number of market days per year for each of the markets (52 days for Fumbisi and Chiana, and 104 days for Sandema). Annual estimations of bushmeat traded were calculated this way because bushmeat was traded only during market days, outside of which no trading activities occur. Robust 95%

confidence intervals associated with these estimates were obtained by bootstrapping for 10,000 replications using the package "boot" (Canty & Ripley, 2017) in R (R Core Team, 2019).

Univariate analysis (Kruskal-Wallis test) was performed to test for differences in abundance of bushmeat recorded between different months. The study duration was then divided into the dry season (November to April) and wet season (May to October) and the number of animals sold in each season were compared to explore seasonal variations, if any. A significance test for differences in abundance between the two seasons was conducted using a Mann-Whitney U test.

Regression analyses were performed to investigate the effects of market (to account for differences in market trade patterns), climatic season (to account for trade variations between wet and dry) and taxonomic group of species (to account for differences in species compositions of taxonomic groups) on the variation in the number of carcasses and biomass of bushmeat recorded on the market.

For carcasses data, a generalised linear model (GLM) with Poisson errors was used because the response variable (number of carcasses per survey day) was count data. To test the statistical significance of each categorical variable, an analysis of deviance was carried out on the model.

For biomass data, a linear regression model was used to test the effects of season, market, and taxonomic group on the total biomass of bushmeat recorded per sampling day. Due to the extremely large numbers of amphibians recorded relative to other species and the potential of such large numbers swamping the rest of the data set, all univariate and regression analyses were performed on two data sets; one with amphibians and one without amphibians. All models were examined to ensure that model assumptions of homoscedasticity of variance and normality were met, using a residual versus fitted values plot, and a Q-Q normal plots respectively (Zuur *et al.*, 2009).

Average prices (per kg) of species were estimated from carcasses for which complete information on smoked weight, purchase price and retail price were obtained.

4.3 Results

4.3.1 Species composition

A total of 10,407 individuals of bushmeat carcasses belonging to at least 28 species was recorded during the study period (Table 4.1). The number of species could exceed this figure, as three bushmeat types were not completely identifiable to species level: monkeys, birds, and frogs. Frogs constituted the bulk (82%) of all bushmeat on sale during the survey, by number of individuals (Table 4.1). The edible bullfrog *Pyxicephalus edulis,* one of four frog species recorded, was the most numerous, with a total of 5,243 carcasses, representing about 50% of all bushmeat carcasses sold. The African savannah hare (*Lepus victoriae*) represented 7% of bushmeat by carcasses number, while rodents (four species) constituted 4% of the carcasses. Three species of birds (white-faced whistling-duck *Dendrocygna viduata*, double-spurred francolin *Pternistis bicalcaratus* and helmeted guinea fowl *Numida meleagris*) made up 3% of the total number of bushmeat carcasses recorded.

Carnivores, primates and ungulates which were among the least represented wild animal groups on sale, together made up 2% of all carcasses. Single individuals were recorded for five species of mammals; the African buffalo (*Syncerus caffer*), marsh mongoose (*Atilax paludinosus*), olive baboon (*Papio anubis*), red-flanked duiker (*Cephalophus rufilatus*) and roan antelope (*Hippotragus equinus*). With the exception of the Senegal flapshell turtle (*Cyclanorbis senegalensis*) which was traded alive, all other bushmeat recorded was sold as smoked meat.

Table 4.1. Species, number of carcasses and biomass of bushmeat traded in all three markets in the study period.

Taxonomic group	Species		Number recorded	Relative abundance (%)	Biomass (kg)
	Common name	**Scientific Name**			
Amphibians	Edible bullfrog	*Pyxicephalus edulis*	5243	50.38	262.15
	African Groove-crowned frog	*Hoplobatrachus occipitalis*	2950	28.35	147.5
	Dakar grassland frog	*Ptychadena trinodis*	323	3.1	9.69
	Kaanamunik***		4	0.04	
Birds	Helmeted guinea fowl	*Numida meleagris*	138	1.33	165.6
	Double spurred francolin	*Pternistis bicalcaratus*	137	1.32	68.5
	White-faced whistling-duck	*Dendrocygna viduata*	27	0.26	16.2
	Bird**		12	0.12	14.4
Carnivores	Common genet	*Genetta sp.*	26	0.25	58.5
	African civet	*Civettictis civetta*	4	0.04	33.6
	Marsh mongoose	*Atilax paludinosus*	1	0.01	3.17
Lagomorphs	African savannah hare	*Lepus victoriae*	459	4.41	1055.7
Primates	Monkey*		97	0.93	649.9
	Patas monkey	*Erythrocebus patas*	29	0.28	194.3
	Green monkey	*Chlorocebus sabaeus*	7	0.07	14
	Olive baboon	*Papio anubis*	1	0.01	17.9
Reptiles	Nile monitor lizard	*Varanus sp.*	128	1.23	256
	Senegal Flapshell turtle	*Cyclanorbis senegalensis*	30	0.29	135
Rodents	Giant rat	*Cricetomys gambianus*	539	5.18	636.02
	Striped Ground squirrel	*Xerus erythropus*	136	1.31	142.8
	Grasscutter	*Thryonomys swinderianus*	30	0.29	120.9
	Crested porcupine	*Hystrix cristata*	13	0.12	253.5
Ungulates	Grey duiker	*Sylvicapra grimmia*	26	0.25	468
	Bushbuck	*Tragelaphus scriptus*	17	0.16	308.38
	Common warthog	*Phacochoerus africanus*	16	0.15	991.68
	Kob	*Kobus kob*	4	0.04	362
	Waterbuck	*Kobus ellipsiprymnus*	4	0.04	920
	Aardvark	*Orycteropus afer*	3	0.03	183
	African buffalo	*Syncerus caffer*	1	0.01	637.5
	Red-flanked duiker	*Cephalophus rufilatus*	1	0.01	10
	Roan antelope	*Hippotragus equinus*	1	0.01	261.5
Total (individuals)			**10407**		
Total (Species)			**28**		

*Unidentified monkey **Unidentified bird ***Unidentified frog

4.3.2 Determinants of the number of bushmeat carcasses recorded

The three study markets varied in terms of numbers of carcasses and species recorded. Species diversity was highest in the Chiana and lowest in Sandema (Table 4.2). This difference could possibly be due to variations in bushmeat catchment area or trade preferences of participants, customers, traders or hunters. Nine species dominated the Chiana market, whiles the Fumbisi and Sandema markets were dominated by three and two species respectively (Table 4.2). Only seven out of the 28 species recorded were common to all three markets. Aardvarks (*Orycteropus afer)*, African buffalo, olive baboon and roan antelope were found exclusively in Chiana market. On the other hand, three species (edible bullfrog, marsh mongoose and red-flanked duiker) were unique to Fumbisi and one unidentifiable frog species ('kaanamunik') was unique to Sandema.

Table 4.2. Characteristics of bushmeat recorded in the three markets, classified into various taxonomic groups. *S= number of species recorded, N= number of individual carcasses recorded, H'= species diversity.*

Taxonomic group	Chiana			Fumbisi			Sandema			Totals	
	S	**N**	**%**	**S**	**N**	**%**	**S**	**N**	**%**	**S**	**N**
Amphibians				2	5289	80.0	3	3231	89.3	3	8520
Birds	1	3	1.7	3	216	3.3	3	95	2.6	3	314
Carnivores	2	4	2.2	3	14	0.2	2	13	0.4	3	31
Lagomorphs	1	23	12.7	1	315	4.8	1	122	3.4	1	460
Primate	3	90	49.7	2	44	0.7				3	134
Reptiles	1	7	3.9	2	115	1.7	2	36	1.0	2	158
Rodents	1	11	6.1	4	590	8.9	3	116	3.2	4	717
Ungulates	8	43	23.8	6	25	0.4	2	5	0.1	9	73
Total	17	181		23	6608		16	3618		28	10407
H'		**2.16**			**0.94**			**0.85**			

Plate 4.1. Smoked carcasses of variety of wild animals traded at the case study markets.

(a) African groove-crowned frogs Hoplobatrachus occipitalis (b) Striped ground squirrels Xerus erythropus and African savannah hares Lepus victoriae (c) Edible bullfrogs Pyxicephalus edulis (d) Monkeys.

The three markets differed in whether amphibians were traded or not, with the trade in Fumbisi and Sandema being dominated by amphibians, compared to that in Chiana where they were entirely absent (Table 4.2). Where amphibians were traded, they were present in large numbers. A total of 5,289 and 3,231 frogs, representing 80% and 89% of total trade, was recorded during the study in Fumbisi and Sandema respectively. However, the amphibian trade varied seasonally with peak in trade aligning with dry season. Generally, the Sandema market traded mostly in small-bodied species, mainly amphibians, lagomorphs and rodents with an average weight of species traded being 6.42 kg. Only 7% of ungulate carcasses traded across all markets were recorded in Sandema and no primates were recorded there. Chiana on the other hand, traded in the larger-bodied animals with an average weight of species traded of 80.5 kg. The majority of the primates (N=134; 67%) and ungulates (N=73; 59%) reported in this survey were recorded in Chiana. Primates comprised the bulk of the trade for this market, making up about half the animals records (N=90; 49.7%). Also, of all the ungulates recorded, the majority (N=43; 59%) came from the Chiana market (Table 4.2).

The differences between markets with regards to the number of carcasses traded per survey day were further highlighted in results from the GLMs, whether or not amphibians were included in the model; Chiana sold significantly fewer carcasses than the other two markets (Table 4.3). The number of carcasses recorded at the Fumbisi market was 6.32 times (exp {1.99} = 7.32) higher than Chiana, while the number of carcasses recorded for Sandema was 1.14 times higher than Chiana (Appendix 4). The number of carcasses of all other species groups was significantly higher than for ungulates, except carnivores for which there were significantly fewer carcasses. The wet season was associated with a significantly lower number of carcasses; on average 50.4% fewer animals were sold in the wet than the dry season. These results were similar whether or not amphibians were included, though the effects of market and season were more pronounced with amphibians included (Table 4.3)

Table 4.3. Results of Poisson GLM analysis assessing the effect of market, season, and taxonomic group on the number of bushmeat carcasses recorded per survey day, for two datasets (without amphibians and with amphibians).

Without amphibians						
Explanatory variable		**Estimate**	**Std. error**	**z value**	**Pr(>|z|)**	**Baseline reference**
Market	Fumbisi	1.99	0.08	25.06	< 0.01	Chiana
	Sandema	0.76	0.09	8.44	< 0.01	
Season	Wet	-0.70	0.05	-14.32	< 0.01	Dry
Taxonomic group	Birds	1.46	0.13	11.23	< 0.01	Ungulates
	Carnivores	-0.86	0.21	-3.99	< 0.01	
	Primates	0.61	0.15	4.18	< 0.01	
	Rabbits	1.84	0.13	14.59	< 0.01	
	Reptiles	0.77	0.14	5.46	< 0.01	
	Rodents	2.29	0.12	18.61	< 0.01	
With amphibians						
Explanatory variable		**Estimate**	**Std. error**	**z value**	**Pr(>|z|)**	**Baseline reference**
Market	Fumbisi	3.60	0.08	47.75	< 0.01	Chiana
	Sandema	3.00	0.08	39.32	< 0.01	
Season	Wet	-1.16	0.02	-50.49	< 0.01	Dry
Taxonomic group	Amphibians	4.76	0.12	40.49	< 0.01	
	Birds	1.46	0.13	11.23	< 0.01	Ungulates
	Carnivores	-0.86	0.21	-4.00	< 0.01	
	Primates	0.61	0.15	4.18	< 0.01	
	Rabbits	1.84	0.13	14.60	< 0.01	
	Reptiles	0.77	0.14	5.46	< 0.01	
	Rodents	2.29	0.12	18.61	< 0.01	

4.3.3 Biomass and estimates of volume of bushmeat traded

A total of 8,397.47 kg of bushmeat was sold at the three markets during the survey period (Appendix 5). Biomass per survey day differed significantly between markets (Kruskal-Wallis $\chi^2 = 33.81$, df = 2, p-value < 0.01). Chiana recorded the highest biomass of bushmeat traded per survey day (376 ± 421 kg) and Sandema recorded the lowest (55.5 ± 39.6 kg). This difference related to the type of species traded there, with Chiana and Fumbisi trading in substantially greater number of medium-to large-bodied species compared to Sandema (Figure 4.1). On average, ungulates contributed 41.4 ± 30.6% of the biomass over all markets, with the lowest percentage (17.8%) being in Sandema, and highest in Chiana (76.0%). Rabbits on average made up 16.4 ± 13.6% of biomass over all markets, ranging from a minimum of 1.4% in Chiana to a maximum of 27.9% in Sandema. Biomass of rodents averaged 14.3 ± 8.0% for all markets with the lowest in Chiana (5.7%) and highest in Fumbisi (21.5%). Sixty-four percent (64.0%) of the total biomass entering the markets was supplied by seven species; African savannah hare, common warthog, waterbuck, unidentified monkey spp., African buffalo, giant rat and grey duiker (total biomass ≥ 450 kg; Appendix 5).

Extrapolating these results to an estimate of annual trade, an estimated 48,277 bushmeat carcasses are traded each year in the three markets, of which an estimated 26,432 carcasses (95% CI: 8,960-52,716) are traded in Fumbisi, 20,904 (95% CI: 11,122-32,367) in Sandema and 941.2 (95% CI:540.8-1,398.8) are traded in Chiana annually. These estimated numbers correspond to an annual total biomass of 38.74 tonnes of undressed meat (of which an estimated 14.55 tonnes would be traded in Fumbisi, 5.77 tonnes in Sandema and 18.42 tonnes in Chiana). However, these estimates of annual trade may be higher or lower subject to seasonal changes.

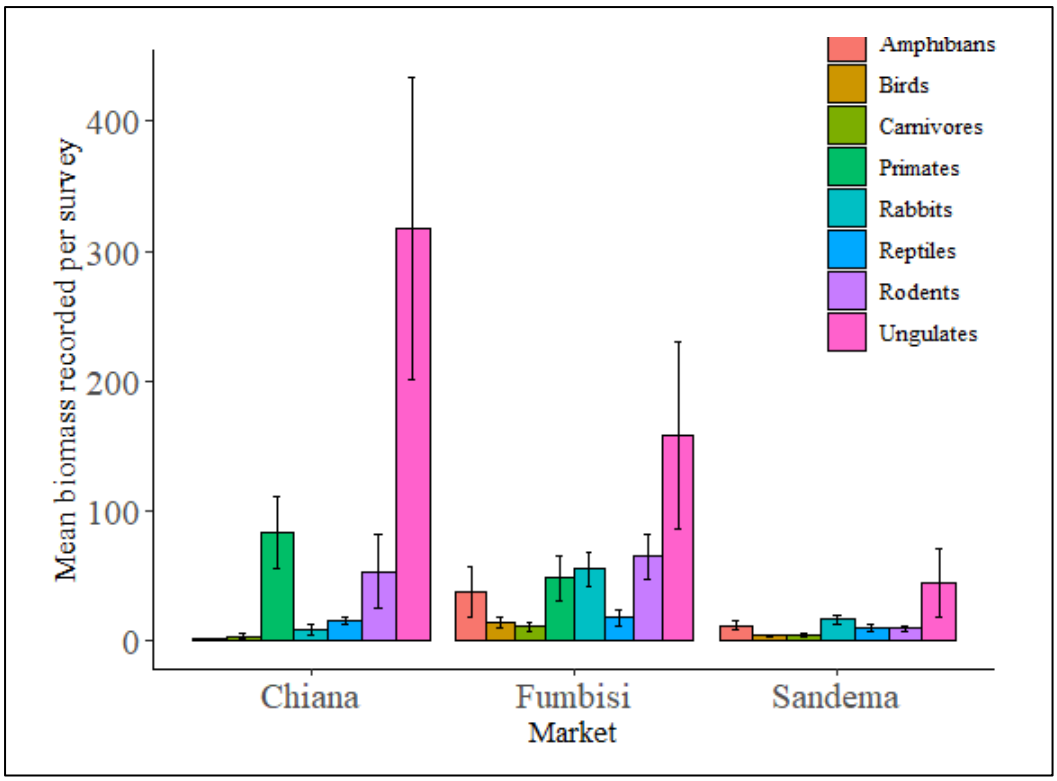

Figure 4.1. Average biomass per survey of various taxa of animals recorded for the three markets. *Error bars represent standard error.*

4.3.4 Temporal and seasonal patterns in species presence

Bushmeat carcasses were sold throughout the year in all three markets, with all species groups being traded in almost all months (Figure 4.2). The highest number of bushmeat carcasses per survey was recorded in the dry season months of February (992 ± 1468), followed by January (343 ± 440) and the least was recorded in the wet season month of September (32 ± 5.7). The high number of bushmeat carcasses recorded in February was largely contributed by amphibians, as this was the peak month for amphibian sales (1,247 ± 1,561.05). This peak in amphibian sales decreased to only a third in March (416 ± 368.52), with fewer carcasses on sale during the wet months from July to September.

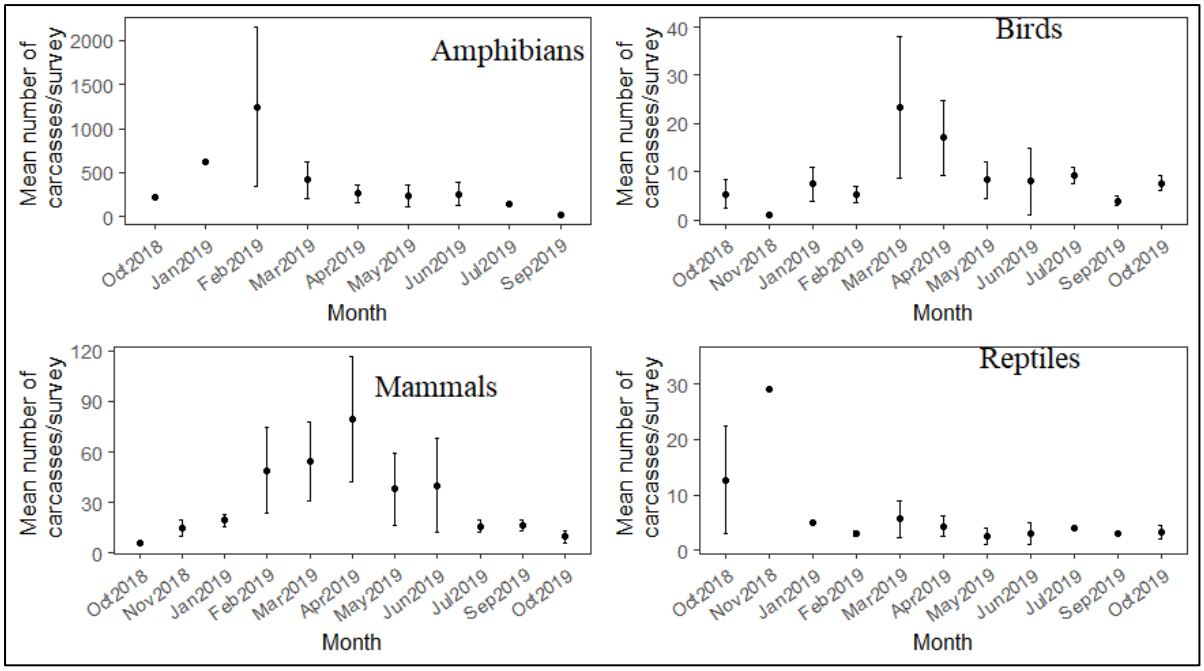

Figure 4.2. Monthly variation in the abundance of various taxa of animals recorded from October 2018 to October 2019 in the three markets surveyed. *Wet season (May to October) and dry season (November to April). Error bars represent standard error.*

The availability of mammals and birds appeared limited to the dry months of March and April. Similar patterns were observed across the three markets (Kruskal-Wallis $\chi^2 = 11.84$, df = 9, P = 0.22) and this did not change even with the exclusion of amphibians (Kruskal-Wallis $\chi^2 = 9.31$, df=9, P=0.41).

Combining the months into seasons showed that, as expected, there were higher numbers of animals on sale in the dry than wet season in all three markets (Poisson GLM analysis of deviance; $\chi_{(1,44)} = 9.77$, P<0.01). About 76% of bushmeat carcasses traded in the three markets were recorded during the dry season, which corresponded to 75% of total biomass traded. This seasonal difference in number of bushmeat was still evident even with the exclusion of amphibians from the analysis (Poisson GLM analysis of deviance; $\chi_{(1,38)} = 9.46$, P<0.01).

Twice as much bushmeat was recorded per survey day in the dry season as the wet season; 14.0 ± 22.9 vs. 7.28 ± 11.1 (Figure 4.3).

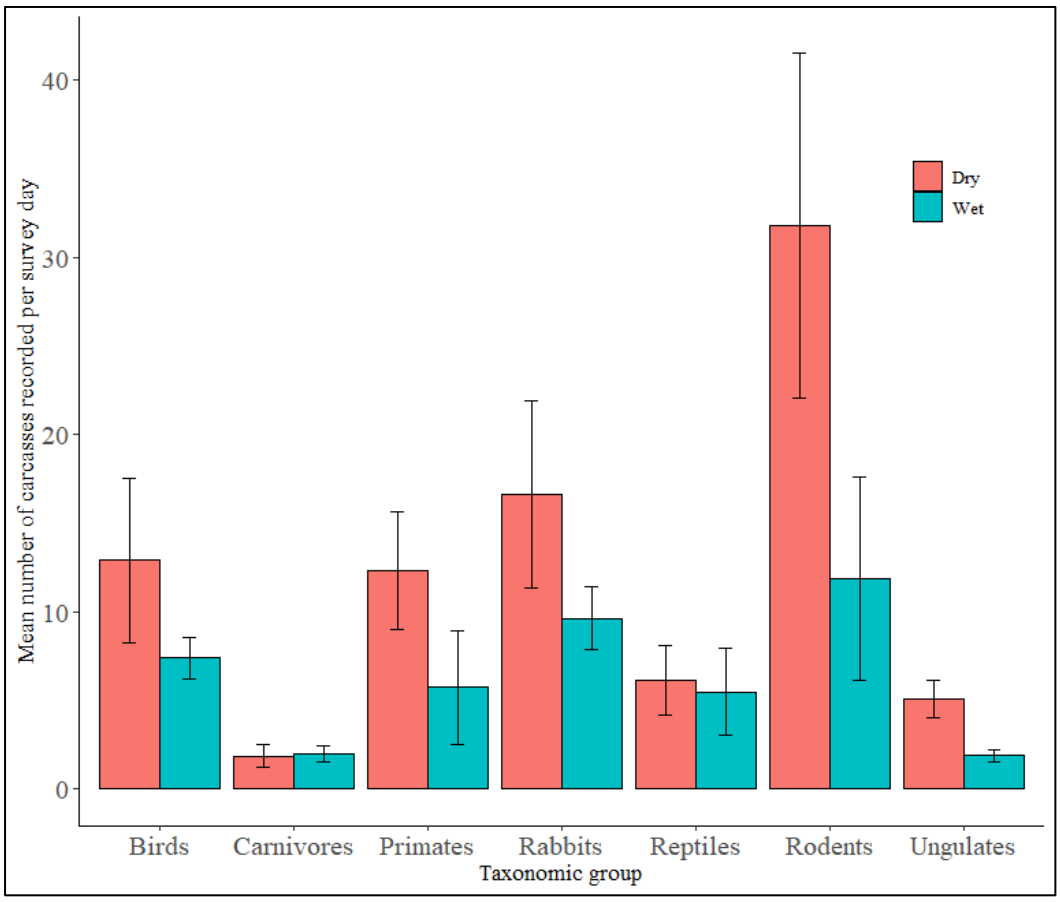

Figure 4.3. Distribution of the number of carcasses by season, broken down by bushmeat species group, across all the markets. *The wet season was May to October and the dry season was November to April. Error bars represent standard error.*

4.3.5 Price of bushmeat species

In all three markets, smaller species such as birds, reptiles, lagomorphs, rodents and even monkeys were sold as whole carcasses, while frogs were sold in bundles comprising 7-25 whole carcasses. Larger species, mostly mammals such as bushbucks *Tragelaphus scriptus,*

were sold in pieces or chunks of smoked meat and were mostly intended for longer-distance trade. The prices of mammal species ranged from a minimum of GH¢ 4.00[1] for a whole giant rat to GH¢ 42.00 per piece of common warthog meat. Based on the price of smoked meat (168 observations), the Helmeted guinea fowl (*Numida meleagris*) fetched the highest average price of GH¢ 33.70 ± 7.40 per kg (N=13) (Figure 4.4). These premiums are perhaps not surprising as domesticated guinea fowl is popular with consumers in urban areas and hence is high-priced. Overall, bushmeat was more variable in price, but more expensive than domestic meat like beef. Fish had a very consistent price of GH¢ 18.70 ± 1.90 per kg (N= 63), which was cheaper than most of the smaller-bodied bushmeat species like birds and rabbits, but more expensive than some bushmeat species like grey duiker and monkey (Figure 4.4). Furthermore, compared to bushmeat and fish, beef was the cheapest animal protein sold on the markets, with average sale price of GH¢ 10.20 ± 1.80 per kg (N=15).

The profit made per carcass depended on the species of animal. The available data limits our ability to assess the profits made by bushmeat actors on all species traded, as most of the time, the purchase and retail prices could not be obtained for transactions on each particular carcass. However, for nine species in the market for which complete information on smoked weight, purchase and retail prices of some carcasses were obtained, it was possible to compare the average wholesale and retail price per kilogram of smoked meat.

[1]US $1 equivalent GH¢ 4.76 in last quarter of 2018, *US $1 equivalent GH¢ 5.46 in last quarter of 2019

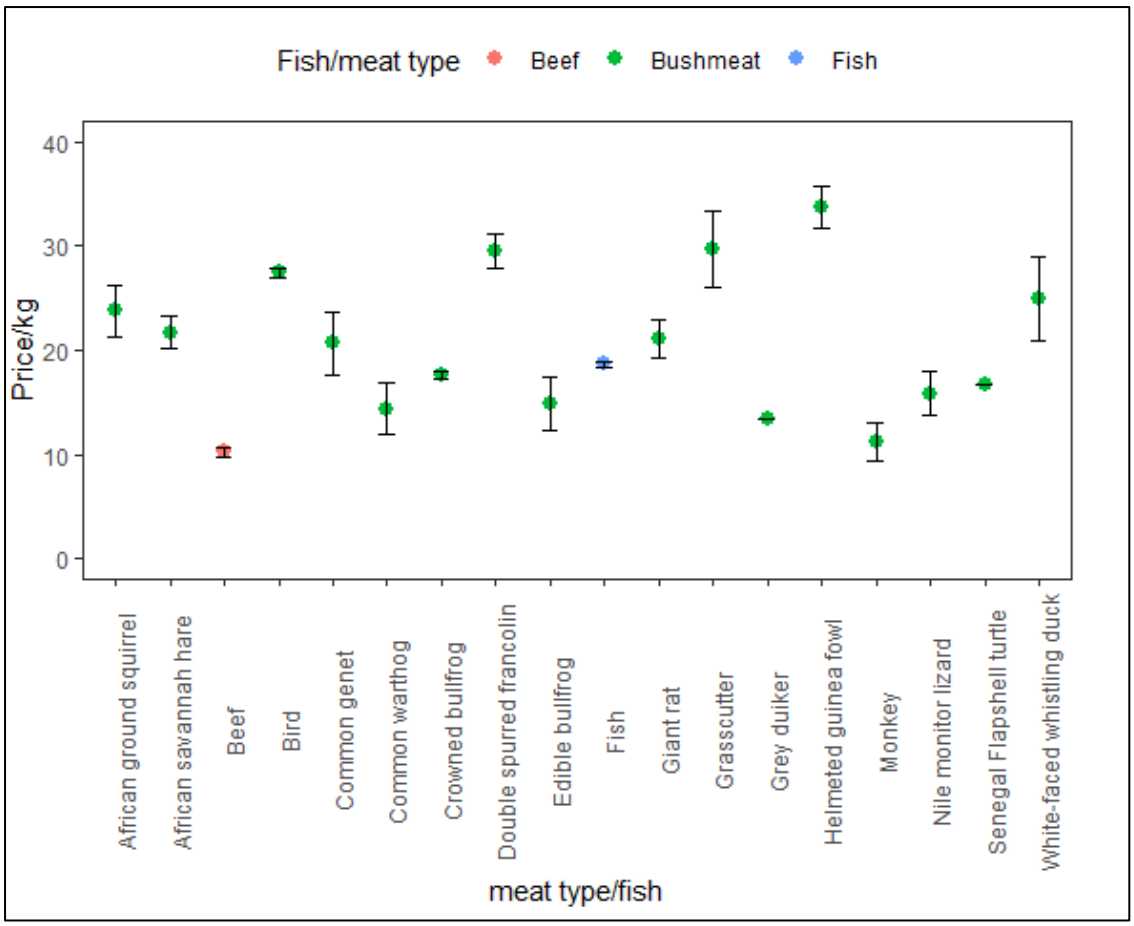

Figure 4.4. Average price* per kilogram of fish, beef and various bushmeat species on sale. *Error bars represent standard deviation. *US $1.00 equivalent GH¢ 4.76 in last quarter of 2018, *US $1.00 equivalent GH¢ 5.46 in last quarter of 2019.*

Although these figures reflect only the average sales price, and thus do not capture the price variation of transactions between particular actors, they still provide a useful guide to the profit margins made from selling bushmeat in these markets. For these nine species for which information was available, the total purchase and retail prices obtained during the 41 surveys were estimated at GH¢ 41,308.65 and GH¢ 57,572.36 respectively, yielding an estimated profit margin of about 39% (Table 4.4). Highly priced bushmeat did not always yield the highest profits. The highest profit margin per sale of a carcass was obtained on the giant rat (71%), followed by the Helmeted guinea fowl (61%). The grasscutter, which is among the most

popular meat types on most southern urban markets fetched a profit margin of 37% in the northern markets, compared with 65% in the Mankessim market in the Central region (Sackey, 2014). The White-faced whistling duck sold for GH¢ 25.00 ± 10.70 per kg, fetched the least profit of 7%. Although price data was not available for amphibians, it was observed that traders who sold frog meat made a substantial profit. Frog meat was sold also directly by collectors and was available in very small affordable portions as low as GH¢ 2.00[1] per bundle, providing the opportunity for high volumes to be sold and resulting in greater profits overall.

Table 4.4. Estimated value of bushmeat recorded to be traded at the three markets during the survey period. *Only species with available price information are shown.*

Species	Number recorded	Estimated total volume (kg)	Total Purchase Price (GH¢) *	Total Selling Price (GH¢) *	Profit margin (%)
Giant rat	539	636.02	8312.78	14234.13	71.20
Helmeted guinea fowl	138	165.6	3677.98	5935.10	61.40
Striped Ground squirrel	136	142.8	2353.34	3742.79	59.00
Grasscutter	30	120.9	3057.56	4201.28	37.40
Double spurred francolin	137	68.50	2088.57	2710.55	29.80
African savannah hare	459	1055.70	19900.00	24640.04	23.80
Bird	12	14.40	389.52	432.00	10.90
Common genet	26	58.50	1147.77	1267.11	10.40
White faced whistling duck	27	16.20	381.19	409.37	7.40
Total			**41308.7**	**57572.36**	

*US $1.00 equiv. GH¢ 4.76 in last quarter of 2018, *US $1.00 equiv. GH¢ 5.46 in last quarter of 2019.

[1] US $1.00 equivalent GH¢ 4.76 in last quarter of 2018, *US $1.00 equivalent GH¢ 5.46 in last quarter of 2019

4.4 Discussion

Bushmeat exploitation in Ghana, traditionally a subsistence activity, has now become an important commercial industry that threatens the survival of large a range of species and has caused several species to become heavily depleted (Asibey, 1974; Ntiamoa-Baidu, 1998; Cowlishaw *et al.*, 2005b; McNamara *et al.*, 2016). The current study suggests that these trends are in force in northern Ghana as elsewhere in the country. The results point at the importance of bushmeat as a significant source of income for rural populations in the studied area based on our mark-up estimates that demonstrate profit margins, and the significant volumes being traded. This suggests the trade is an important component of the rural economy in the study area. The following discussion looks at three aspects of the northern markets to gain insight into the underlying trade patterns. First, observed species composition and trade volumes. Second, seasonality with the trade, and finally price dynamics on the market.

4.4.1 Species composition and relative abundance

On balance species diversity observed in the study markets compared favourably to the species diversity observed elsewhere in Ghana. A wide variety of wild animals (ranging between 27 and 47 species) have been recorded on major bushmeat markets in southern Ghana such as the Kantamanto in Accra, Atwemonom in Kumasi, and the Takoradi and Techiman bushmeat markets (Ntiamoa-Baidu, 1998; Conservation International-Ghana, 2002; Cowlishaw *et al.*, 2005b; Crookes *et al.*, 2005; Swensson, 2005; McNamara *et al.*, 2016). A rapid one-week survey of bushmeat sold in Chiana, Sandema and Fumbisi that preceded this study in 2016, recorded a total of 16 species (Ntiamoa-Baidu, 2016). In this current study, a total of 28 species were recorded in the same three northern markets over a 12-month period. For a region in which trade and exploitation are largely under-reported and under-studied, this is significant

and highlights the potential contribution the bushmeat trade in northern area of Ghana makes to the national trade, and the implicit species conservation issues.

The four species of frogs recorded (edible bullfrog *Pyxicephalus edulis*, African groove-crown frog *Hoplobatrachus occipitalis*, Dakar grassland frog *Ptychadena trinodis* and "Kaanamunik") accounted for 82% of the total number of carcasses recorded. Two of these frog species that dominated the trade in this study, edible bullfrog and African groove-crown frog, have been previously reported to be traded in the Sandema and Fumbisi markets by (Howard, 2013) during an investigation of frog meat consumption in Ghana. Both these species of frogs have also been reported to be traded heavily in other parts of West Africa and were reported by Mohneke *et al.* (2010) as the most commonly caught and traded frogs in Benin. Similarly, in Nigeria, consumers reported a preference for African groove-crown frog, which was sold by all the traders interviewed. In some African countries, larger frog species are well documented to be commonly harvested on a local scale and traded in urban centres where they serve as an important source of protein (Gonwouo & Rodel, 2008; Mohneke *et al.*, 2010; Mohneke, 2011). However, in this study, the trade in frogs seems more likely to be for local consumption in the area. This conclusion is supported by the fact that frogs have not been reported in previous studies of urban markets in southern Ghana (e.g., Ntiamoa-Baidu, 1998; Conservation International-Ghana, 2002; Sackey, 2014, Cowlishaw *et al.*, 2005b; McNamara *et al.*, 2016).

There were also marked differences in the species composition of the trade between northern and southern markets. In bushmeat markets in southern Ghana, rodents and ungulates often dominate the trade and commonly make up over 90% of traded numbers. This has been reported in multiple large urban bushmeat centres such as in Kantamanto (Ntiamoa-Baidu, 1998), Takoradi (Cowlishaw *et. al*., 2005a), Techiman (Swensson, 2005) and Kumasi (McNamara *et*

al., 2016). In this study however, rodents and ungulates were less prevalent, making up only 14% of the total number of carcasses recorded, though, ungulates still make up the bulk of the biomass. This represents a major disparity between the markets in southern Ghana and the markets in the north.

There are two possible reasons why species compositions and numbers may differ between regions. Firstly, the natural species composition and abundance of ecosystems that the markets are drawing from. For example, for some species such as the lagomorphs, helmeted guinea fowl and African buffalo, it can be surmised that it is natural ecological differences since these species are native to savannah systems. Secondly, patterns of historical depletion may play an important role (Cowlishaw *et al.*, 2005a), and this may explain the low numbers of ungulates observed on the market.

While the observed low ungulate numbers in this study could be due to their naturally low populations in the area, this is unlikely, because savannah areas tend to have higher ungulate densities (Robinson & Bennett, 2004). Therefore, a more plausible explanation may be that the lack of ungulates is related to depletion. There is multiple evidence to support this conclusion. For example, it is recognised in the literature that in the 1930s, wild ungulate populations in northern Ghana were curbed under the Tsetse fly Control Programme in a failed attempt to reduce the incidence of Trypanosomiasis in the region. This is reported to have led to drastic declines of ungulate populations (Aalangdong, 2010). Even after the programme was aborted some 25 years later, populations of wild animals in this region continued to reduce mostly due to over-hunting, agricultural expansion and widespread bush burning (Acheampong, 2001; Aalangdong, 2010). Further, Mole National Park, which lies only about 60 km away from the study area, is one of Ghana's most emblematic savannah National Parks, supporting large numbers of grazing ungulates and wild carnivores that provides insight into the natural species

composition under low levels of hunting and habitat disturbance (Brashares *et al.*, 2001). Other National Parks in the region also highlight this trend. For example, the Nazinga Game Ranch in Burkina Faso, which is known to be relatively rich in wildlife, including large ungulates and primates (Bouché *et al.*, 2016) lies in south-central Burkina Faso in close proximity to the area of Ghana north of Chiana market. These observations, highlight the depletion that has likely occurred in the local landscape, and how the few remaining populations of ungulates are now restricted to the forest reserves and Wildlife Protected Areas (PAs) which are legally inaccessible to hunters.

The presence of these PAs may explain some of the trends observed in the study markets, notably the greater incidence of ungulates on the Chiana market. Protected wildlife populations are frequently important sources of bushmeat, especially for poor local communities living in close proximity to these areas (Rentsch & Damon, 2013; Lindsey *et al.*, 2014; Hema *et al.*, 2017). Within the wider study area there are reports of increasing poaching within the Nazinga Game Ranch, and surrounding buffer zones, with hunters coming from within Burkina Faso and Ghana (Bouché *et al.*, 2016; Hema *et al.*, 2017). Hence, it is likely that the large game species that are sold in the Chiana market could have been hunted illegally from the reserve and/or in the buffer zones, or from surrounding areas where wild animals may stray. This may explain why Chiana has more ungulate biomass than the other markets.

4.4.2 Seasonal fluctuations in bushmeat traded

Fluctuations in quantities of bushmeat appearing on markets is often tied to factors such as climatic seasons, behaviour of the hunted species, and the seasonal nature of hunting activities (Allebone-Webb *et al.*, 2011; Santos-Fita *et al.*, 2012; Sackey, 2014). The results of this study indicated a seasonal effect on the number of bushmeat traded, with fewer carcasses recorded

during the months of heaviest rainfall and an increase in bushmeat offtake and trade during the dry season.

In the case of frogs, the observed seasonality in numbers is likely to be a reflection of the species' behaviour. Many of these frog species, including the commonly traded *H. occipitalis*, accumulate at waterbodies during the dry season when water levels have decreased and this facilitates their collection in large numbers (Gonwouo & Rodel, 2008; Mohneke *et al.*, 2010). Elsewhere, frogs have been reported to be collected in large quantities mostly at dams, and in temporal ponds (Mohneke, 2011).

Seasonality could also be relevant to certain hunting practices in the study area. According to some hunters, the rapid growth of grass and forest vegetation during the rainy season inhibits visibility and therefore impedes hunting activities. In contrast, burning of the vegetation in the dry season opens up the terrain and facilitates hunting activities, a likely explanation for the peak in rodent harvests in the dry months, when the savannah undergrowth and grass vegetation is normally burnt. This finding is in line with those from other studies (e.g., Aalangdong, 2010; Sackey, 2014).

Further, hunting activities are usually subject to seasonal variations and this affects the volume of wild animals hunted and traded (Schulte-Herbruggen *et al.*, 2013; Sackey; 2014; McNamara *et al.*, 2016). The observed seasonal variation in the bushmeat traded therefore, may be due to differences in the time allocated to hunting efforts (Allebon-Webb *et al.*, 2011) which in turn is linked to timing of the farming season. Typically, most hunters in Ghana are primarily farmers (Sackey, 2014; Alexander *et al.*, 2015; McNamara *et al.*, 2016). Farmer-hunters are therefore busiest with farm-work during the rainy season, resulting in low bushmeat harvest at this time. In this study the peak hunting period, when the bushmeat trade peaked, coincided with the driest months (February to April) when less time is required for farm-work. This

provides strong evidence to suggest that seasonal variation in the bushmeat trade was due to variation in farm labour requirements. The observation of seasonal trade fluctuations was confirmed by the interviews with bushmeat traders, who revealed that they also devote time to farming activities to supplement their income from the bushmeat business.

4.4.3 Prices of bushmeat species

Prices and profitability of bushmeat could influence species and their abundance on the bushmeat markets. For example, species that are strongly preferred by consumers and which fetch high prices may be more abundant on markets than other less profitable species (Cowlishaw *et al.*, 2005b; McNamara *et al.*, 2016). There is notable evidence that such dynamics may be at play in the study markets presented here. For example, the giant rat was the most common rodent species on sale in the market and yielded a profit margin of 71% per kilogram of meat. Further, the helmeted guinea fowl which was the most commonly traded bird species commanded a 61% profit margin and is recognised by consumers throughout Ghana as being a speciality of the north. In contrast, the grasscutter which is highly priced and very profitable on most southern urban markets (e.g., Sackey, 2014; McNamara *et al.*, 2019) fetched a comparatively lower profit margin (37% on northern study markets and 65% on southern markets). This may explain in part their relatively low numbers recorded in the markets in this study.

Price may also play a role in explaining the prevalence of frogs on the market. Frogs were among the cheapest meats on the market, with only beef being cheaper on a per kilo basis and was available in small affordable portions. The current study area falls within the region with the highest extreme poverty rates in Ghana, with some of the lowest consumption expenditures, and thus it is not surprising that a cheap form of protein such as frogs are so abundantly traded.

Further, it was observed that traders who sold frog meat made a substantial profit despite these cheap prices, likely owing to the fact that frogs are relatively easy and inexpensive to harvest by hand (as opposed to other species that may require access to firearms for example).

These price dynamics underscore how preferences of market participants can shape the species composition of bushmeat markets. Other studies have highlighted how price, profits and trading relations can impact trade dynamics. For example, a study by Allebone-Webb *et al.* (2011) in Equatorial Guinea suggests that profitability could be one of these trade filters, whereby traders in certain locations would preferentially sell only those species on which they generated the most returns. In other locations, this power-balance favoured the hunter, whereby species that maximised hunter returns were favoured. These are complex dynamics that require further investigation, but they highlight the fact that animals appearing on markets may represent only a selective proportion of those encountered during hunting (Crookes *et al.,* 2005, Allebone-Webb *et al.,* 2011). The profit margins and presence of giant rats and guinea fowl on the market provides reasons to consider that similar filters may be in play in the study area.

However, notwithstanding the notable example of amphibians, bushmeat was in general more expensive than other domestic proteins such as beef and fish. This finding that bushmeat is expensive is somewhat surprising especially in this setting, as bushmeat has been found to be significantly cheaper than domestic meat and fish in areas close to sources of wildlife (Brashares *et al.*, 2011). Generally, it would be expected that bushmeat would be cheaper in rural areas which is typical of such areas at a range of other locations (Loibooki *et al*, 2002; Nielsen & Meilby, 2015). A likely explanation for this difference could be that bushmeat is either becoming scarce or harvesting costs are getting high, and hence making some species more expensive than alternatives like beef and fish (Cowlishaw *et al.*, 2005a). Further, the forms in which some bushmeat is traded could impact their affordability. For instance, some

bushmeat is costly per kilogram of meat, but it was observed that when available in very small affordable portions it appealed to consumers, providing the opportunity for high volumes to be sold and resulting in greater profits overall. Conversely, some species like monkey which was rather cheap meat, is traded in large pieces and therefore, majority of the local people may not have the financial capacity to afford such portions.

4.4.4 Concluding remarks

The data presented here provide the first detailed overview of the commercial bushmeat in northern Ghana. The results highlight several notable findings. The dominance of amphibians highlighting the importance of this affordable local protein source for both traders and consumers in a region that suffers from economic hardship. The low numbers of ungulates on the market are somewhat surprising given the expected ecological characteristics of savannah systems. However, despite their low numbers, they continue to account for a large proportion of the traded biomass, suggesting that even at low numbers the trade in ungulates makes an important nutritive and financial contribution to the local economy. Further, while caution must be used when using market data to assess the condition and status of fauna in the catchment areas supplying these markets, there is evidence that the local landscape may be depleted of large mammals and some indications that neighbouring PAs and reserves are acting as sources of much of what appears on the market. Seasonal fluctuations of quantities of bushmeat traded on these markets have also shown that the trade peaked outside farming season, indicating bushmeat hunting and trading tends to increase under conditions of economic hardships. This study has provided information for consideration in conservation planning and design of measures for management of bushmeat hunting and trade in northern Ghana. This includes providing supporting evidence to estimate the level of offtake of certain species and evidence

of the impact that overexploitation has had on wildlife populations in the area. Further work is required to better understand the fine detail of these mechanics, and some of these issues will be addressed in subsequent chapters.

CHAPTER FIVE

5.0 BUSHMEAT SUPPLY CHAINS IN NORTHERN GHANA: CHARACTERISTICS AND EXTENT OF TRADE

5.1 Introduction

Bushmeat supply chains are complex and often involve multiple actors (Cowlishaw *et al.*, 2005b). These actors play varying roles, from primary trade direct to consumers in local markets, to more complicated networks of middlemen, wholesalers and restaurants that serve longer supply chains in cities (Cowlishaw et al., 2005b; Ntiamoa-Baidu, 2016; Van Vliet et al., 2019). In some parts of Africa, these trade networks can extend hundreds of kilometres and are extending further each year as wildlife becomes depleted from nearby catchments (Wilkie *et al.*, 2016). Further, there is evidence that some of these networks transcend national boundaries. In Cameroon for example, dried and fresh bushmeat is transported to markets in Nigeria (Fa *et al.*, 2006). Mohneke *et al.* (2010) characterized an intensive large-scale, cross-border frog trade between Nigeria and its neighbouring countries. Also, evidence from the Kilombero Valley of Tanzania revealed a commodity chain supplying markets in neighbouring countries (Nielsen *et al.*, 2016).

Bushmeat that is transported over long distances is often preserved through methods such as smoking or salting. In a study of the bushmeat trade in Kumasi, Ghana, Falconer (1992) found that much of the smoked meat originated from species found not only in the local humid forests, but appeared to have been derived also from the dry northern savannahs. These long-distance trade networks may also be selective about which species are traded. In their study of the bushmeat trade in Equatorial Guinea, Allebone-Webb *et al.* (2011) found evidence that where

meat is transported over longer distances, especially from more remote communities with poor market access, species that maximised trader profits were more common.

The bushmeat trade in Ghana is well studied and supply chains are well described especially for larger markets in southern Ghana (Asibey, 1974; Falconer, 1992; Ntiamoa-Baidu, 1998; 2016; Cowlishaw *et al.*, 2005b). Although some earlier studies have reported that bushmeat from the savannahs of northern Ghana is often found on the markets of large southern cities (Falconer, 1992; Ntiamoa-Baidu, 1998), very little is known about the scale of this trade, the types of species traded, or the supply networks through which meat is traded and transported. Consequently, the commodity chain for the trade in northern Ghana is poorly described. To imply that a commodity chain in northern Ghana is similar in structure to that of the well-studied southern trade could be largely erroneous due to the variation in the socio-economic factors between northern and southern Ghana which typically influence commodity chains. With the exception of the rapid surveys in 2016 (Ntiamoa-Baidu, 2016) no studies have attempted to analyse trade dynamics in northern Ghana. Understanding these dynamics is vital for assessing conservation risk for target species. It is also important for understanding livelihood dependence of communities and actors, and ultimately for enabling regulatory initiatives to be directed towards key areas in the supply chain, in order to enhance its management (Cowlishaw *et al.*, 2005b; de Merode & Cowlishaw, 2006; Nielsen *et al.*, 2016).

This chapter describes the characteristics and extent of bushmeat supply chains in northern Ghana, with the aim of contributing to the development of a better understanding of the bushmeat trade in this region. Specifically, the Chapter seeks to:

1) Describe the composition and structure of the bushmeat commodity chain in the region;

2) Quantify the extent to which the trade from northern Ghana supplies large markets in urban centres; and

3) Explore evidence for cross-border trade with neighbouring West African countries, and its characteristics.

To achieve these objectives, a commodity chain approach, described in detail in section 2.4.3 was adopted. Data were collected on bushmeat hunting, trading activities and actors involved to map the flow of bushmeat traded within and beyond the local markets and the national boundary.

5.2 Methods

This component of the study was conducted from October 2018 to October 2019 in two hunter villages (Kayoro, Doninga) and three markets (Sandema, Fumbisi, Chiana) (Figure 5.1). Detailed descriptions of these study sites, as well as the interviews and market surveys are presented in Chapter 3. Data were also collected from another location, Buipe, which was identified during the study as a major commercial bushmeat trading hub. Data were collected using structured interviews, trader diaries, participant observation of actors along the bushmeat commodity chain, and opportunistic informal conversations.

5.2.1 Interviews

Structured interviews were carried out with 56 hunters (Kayoro N= 27; Doninga N = 29) and 21 bushmeat traders (Chiana N= 1; Sandema N= 7; Fumbisi N= 12; Kayoro N= 1) to obtain information for the description of the roles of different actors and the dynamics of the bushmeat commodity chain. Respondents were asked for personal details such as age, educational background, place of origin. Information was also collected on their involvement in the trade, including number of years in hunting/trading bushmeat, how respondents were introduced to

the trade, involvement in other livelihoods and peak of trading activities. In particular, hunters were asked for information about where they sold their catch (e.g., within their village, outside their village) and to whom (e.g., wholesaler, retailer, middle-man) they sold their catch. The interviews with bushmeat traders yielded information about where they bought and sold their bushmeat and how it moved through the supply chain. Some traders had been in the trade for a long time and hence had a good knowledge of the trading routes.

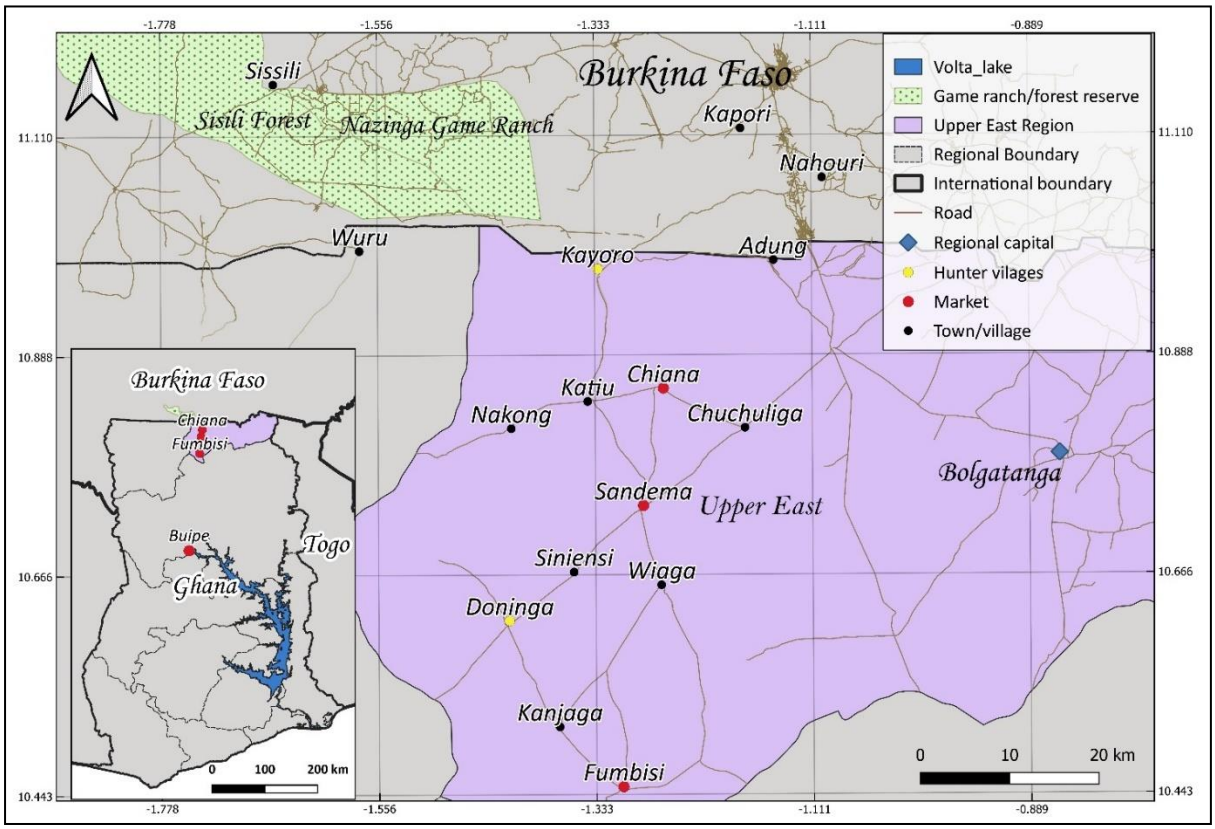

Figure 5.1. Map showing the location of the four market sites (red dots) and two villages (yellow dots) sampled.

Through the survey, one trader was identified as a wholesaler in the Chiana market, who transported her bushmeat to southern markets in Ghana. This trader was approached and

formally interviewed for detailed information about her bushmeat trading activities. Additional information was collected through opportunistic conversations held with her during market surveys.

5.2.2 Participant observation

During market surveys (detailed description in Chapter three) observations were made at key points of bushmeat sale in the three markets to identify source locations of bushmeat, volumes and species of meat traded and also to observe bushmeat flows. Further observations were carried out to obtain information on bushmeat trading activities, relationships among the different actors involved in the trade (hunters and traders), customer choices, storage and means of transportation to and from the market.

5.2.3 Trader diary

Through the hunter survey one trader was identified as a commercial bushmeat dealer in the Kayoro community, who was supplied with bushmeat from Burkina Faso. This trader was approached and formally interviewed for detailed information on bushmeat trading activities, and also agreed to keep records of bushmeat supplied to him from within his village and also originating from across the border. Thus, all bushmeat supplied to him directly by hunters from April, 2019 to September, 2019 were recorded, using a diary designed to capture information on source, species, state (fresh or smoked, whole or pieces), and the price for all supply. A local assistant from the village with secondary education monitored the trader diary and also checked data sheets regularly. In addition, the dealer's data collection and recording technique were checked regularly by the researcher (HNKS).

5.2.4 Buipe market surveys

It was evident from talking to traders in Fumbisi that the Buipe market was an important transit point for bushmeat originating from this region to urban centres in southern Ghana. Therefore, to build up complementary data on the trade from different perspectives in the commodity chain, additional data were collected from the Buipe market. Buipe is a small town and is the capital of the Central Gonja district, located in the Savannah Region of Ghana. It links the northern regions to the rest of the southern part of the country, due to the presence of an inland harbour on the Black Volta (Ghana Statistical Service, 2014c). Buipe hosts the biggest market serving the three Northern Regions and is also one of the largest food markets in Ghana, where food items, notably fish from surrounding small towns and villages, are brought for sale. The market attracts traders from several areas in Ghana, particularly Kumasi, Techiman, Sunyani, Yendi, Salaga, Tamale, Wa, Bolgatanga, and Bawku. It is also patronized by traders from other countries, including the neighbouring Burkina Faso, Togo and Niger. The market opens on Sundays and operates from about 5pm through to Monday.

Two rapid surveys were carried out at the Buipe market; one in July 2019 and the other in October 2019. Observations were conducted at key points of bushmeat sale in the market to collect information on species on sale, means by which the meat is transported to the market, characteristics of traders involved (i.e., who sells and buys the meat) and where possible, the sources and final destinations for the traded meat. Additional information was collected through opportunistic conversations with individuals involved in the trade and key informants.

5.2.5 Ethics

Respondents were open about their trade and were comfortable to talk about potentially illegal activities. To ensure this, respondents were assured that all personal information given would

remain strictly confidential. All data collected were anonymous and any information that could lead to any participant being identified have been anonymised.

5.2.6 Data analysis

By interviewing actors along the commodity chain for information on sources of bushmeat extraction to destinations for consumption, an understanding of the structure and pattern of bushmeat trade within the rural community was gained. Three primary trade networks were analysed: i) Local market networks, ii) Long-distance networks supplying meat to the southern markets, and iii) Cross-border trade originating from Burkina Faso. There was no observation of trade originating from Ghana into Burkina Faso.

The local commodity chain was described based on the data from the formal and informal interviews as well as market data collected in Sandema, Chiana and Fumbisi. The market data collected from the study were used to map out sources of bushmeat coming into the markets and the destinations of meat leaving the markets.

The long-distance southern trade network was described and mapped using data on trade volumes, sources and destinations of different bushmeat species gathered from market surveys and interviews with wholesalers in the market towns of Chiana and Fumbisi. The Buipe market was used as a focal point to map flow of trade from the Fumbisi market to other urban markets.

Mapping of the cross-border trade was based on data obtained from the Chiana market and data obtained from the trader diary in the hunting village of Kayoro. The Chiana market was also used as a focal point to map the flow of trade coming from Burkina Faso (and villages surrounding Chiana) to Kumasi and other areas. This trade network also represents a second

important trade route to the southern markets, in addition to that passing through Fumbisi and Buipe. Geospatial mapping of trade flows was carried out using QGIS version 3.12.1.

A descriptive analysis of trade composition was carried out using data on trade volumes and destinations of different bushmeat species gathered from market surveys and trader diary recorded by the trader in Kayoro. Biomass of bushmeat traded was estimated using the total number of individuals recorded per species and body mass (in kilograms) of the species as reported in literature (Hoffman & Sales, 2007; Borrow & Demey, 2010; Parr *et al.*, 2014; Kingdon, 2015). For those individuals that were not identified to the species level, the mean body mass of related taxa was assigned.

Descriptive statistics on demographics of actors and composition of the trade were carried out in SPSS and Microsoft Excel (Microsoft®), respectively.

5.3 Results

5.3.1 Key Actors in the bushmeat trade

The bushmeat trade in Sandema, Chiana and Fumbisi markets involves four key actor groups based on their roles in the trade: hunters, middlemen, wholesalers and local market retailers. These actor groups exhibit varying ages, years spent trading/hunting and educational backgrounds (Table 5.1).

Table 5.1. Primary actors in the bushmeat commodity chain. **Values are medians and ranges.*

Actor	Sample size, N	Age (years)*	Highest level of education	Time in trade (years)*	Alternative income sources
Hunter	56	46 (21-76)	None (43%) Basic (54%) Secondary (4%)	20 (3-50)	Yes (100%)
Middleman	3	35 (30-42)	None (33%) Basic (67%) Secondary (0)	10 (5-15)	Yes (100%)
Wholesaler	7	45 (40-60)	None (43%) Basic (14%) Secondary (43%)	20 (15-25)	Yes (86%) No (14%)
Local market retailer	11	45 (20-65)	None (43%) Basic (54%) Secondary (4%)	10 (2-25)	Yes (100%)

Hunters

Hunters harvest animals from the wild to supply bushmeat to traders in the chain (Figure 5.2, Table 5.2). Hunters actively participating in the supply chain are mostly based in surrounding villages and localities. All the hunters interviewed (N=56) in Kayoro and Doninga were men who had been hunting for periods ranging from 3 to 50 years (median = 46). All these hunters hunted part-time and had alternative income sources, with about 81% depending primarily on agriculture. Some hunters had younger boys who usually accompanied them on hunting trips.

These boys help with processing (dressing and smoking) the meat in the bush and transporting it home. According to respondents the meat is smoked for preservation because hunting expeditions usually last several days (average 4 days) and involve travelling long distances (average 45 km) from hunting sites to the village. Depending on their current needs for income, hunters decide the portion of the catch to sell and where to sell it. Only an estimated 13% of hunters interviewed sold their catches within their village, with the remainder selling their meat elsewhere. Hunters from Kayoro mostly sold their meat in Chiana or Sandema markets while hunters from Doninga sold their meat in Sandema or Fumbisi markets.

Bushmeat traders

Collectively, bushmeat traders (middlemen, wholesaler and local market retailers) acted as intermediaries between hunters and consumers (Figure 5.2, Table 5.2). The majority of the 21 traders interviewed in this study were women (90%). The median age of interviewed traders was 45 years and ranged from 20 years to 65 years. Two of the traders interviewed were men who acted as middlemen. Middlemen were identified as men and women who purchased their bushmeat initially from hunters and sold it to wholesalers, market retailers and occasionally, directly to the public. This group of traders often live in the hunters' villages and buy their meat at relatively cheaper prices from the source before transporting it to the markets for resale. A hunter's main reason for selling to a middleman seemed to be the avoidance of additional transportation and logistical costs, because such costs are then borne by the middleman.

Wholesalers were women operating from the market who purchased their bushmeat in bulk, directly from hunters or from middlemen and then stockpiled it. Many of these (wholesalers) were women from other towns who travel long distances to source their meat from the case study markets (hereafter local markets). Two groups of wholesalers were identified; one group

was made up of women who roam within the local market to purchase and stockpile bushmeat from market retailers, especially when meat was less abundant, to make their trip worthwhile. The second group of wholesalers were stationed at trading points in the local market and were supplied with bushmeat usually in bulk directly from their customer hunters and middlemen. All wholesalers interviewed (N=7) transported their meat to markets in other towns/cities (e.g., Navrongo, Bolgatanga, Buipe, Techiman and Kumasi) where the bushmeat was resold mainly to other traders (secondary wholesalers and chopbar operators).

Local market retailers were women who obtained their bushmeat from middlemen or directly from hunters and sold it directly to buyers within the market usually for home consumption. The local market retailers mostly traded small sized species, since most market customers only purchase small amounts of bushmeat. None of these retailers dealt solely in bushmeat, but had other alternative income sources. Some traded other products, notably smoked fish as well as grains and legumes (e.g., beans, rice, millet). All traders interviewed reported that they also generated income from crop farming.

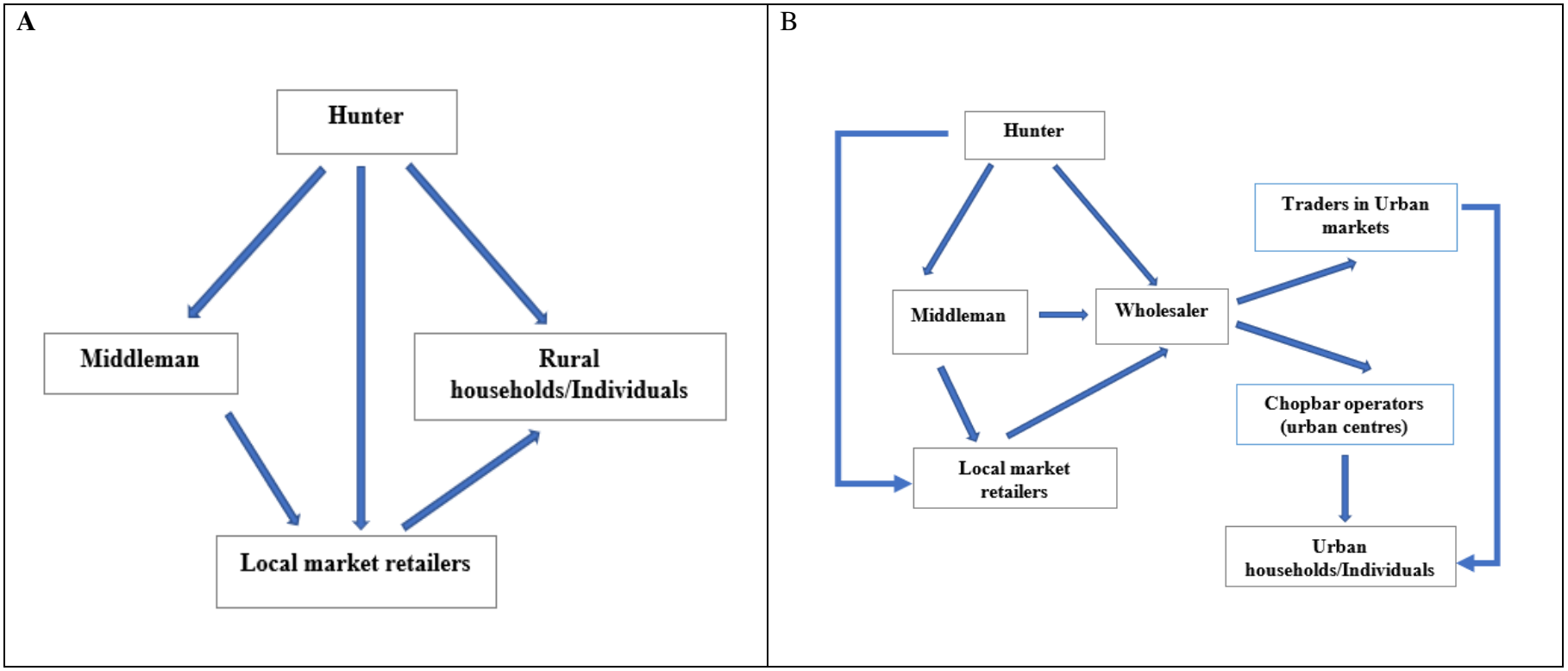

Figure 5.2. Structure of the commodity chain and relationship between actors involved in the trade of bushmeat in the studied markets.

A-local market trade network; B- Long distance trade network.

Table 5.2. Summary of key characteristics of actors of the bushmeat trade in northern Ghana.

Characteristic	Actor group			
	Hunters	Middlemen	Wholesalers	Local market retailer
Source of bushmeat traded	Primary source	Hunters	Hunters, Middlemen, Market retailers	Hunters, Middlemen
Who they sell to	Rural households, Middlemen, Wholesalers, Market retailers	Wholesalers, Market retailers	Urban traders, Urban Chopbar operators	Wholesalers, Rural households
Where they are based	Rural areas	Rural areas	Rural areas, Urban centres	Rural areas
Relative distance travelled	Shortest	Moderate	Longest	Moderate
Type of Bushmeat traded	All species groups, all sizes	All species groups, all sizes	Mostly large bodied species	Small bodied species

5.3.2 Local market trade network

The local supply chain is defined as that trade which passes from hunters through middlemen and market retailers to households for local consumption within the study area (Figure 5.2, Table 5.2). Bushmeat was traded freely between all actor groups. However, in certain cases, some hunters have exclusive relationships with some market traders and their meat is offered

to these women first. Prices of bushmeat carcasses were determined usually through a bargaining process. Some hunters would move between trading points (where traders gather within the market) until their desired price is met. Hunters obtain their lowest price from wholesalers, but these bulk dealers will typically buy the hunter's entire catch. On the other hand, due to the limitations imposed by available capital, local market retailers preferred the smaller sized animals like amphibians, rodents, birds and reptiles.

There were additional benefits for hunters trading through wholesalers. For example, wholesalers were able to offer informal credit arrangements through which funds were advanced to hunters in order to finance the purchase of cartridges and cost of transportation. Some wholesalers occasionally enhanced the loyalty of their customers (hunters) by providing them with cartridges which they pay later and soft loans for various purposes such as purchasing medicines and farming supplies. There was no special relationship between wholesalers and market retailers; the wholesalers would buy meat from whichever market retailer had meat to sell.

The distances covered by individual actors varied depending on their role in the supply chain. The road network within the immediate surroundings of the hunting areas is very undeveloped; as such, transport is mainly by bicycles and motorcycles. The main highway from Chuchuliga serves as the primary route used by all commercial buses transporting goods and people from rural areas in this region to the cities. According to one trader, groups of traders originating from distant towns (usually trading different goods) would organize a mini-van that transports them to and from the market. Actors would pay a standard passenger fare and an extra fare for each package of goods. For the hunters and market retailers, the transport costs were considered significant, although they were still lower than those incurred by wholesalers, who travel longer distances to supply meat to major urban markets outside the area, using mini-vans. Besides

transportation costs, traders also incurred other costs related to market fees and taxes to the local district assembly.

5.3.2 Long-distance trade networks

The second trade route is from hunters through middlemen and wholesalers to other traders (mostly wholesalers) and chopbar operators in city centres elsewhere in the country. A substantial amount of bushmeat trade occurs along this route and involves a large trade network. Unlike the local trade, for which the Sandema market was a central point, much of the long-distance trade originated from the Chiana and Fumbisi markets. Along this long-distance trade network, traders, and particularly wholesalers, sold a significantly larger volume of their stock almost exclusively to other traders in urban centres (85%, Fumbisi; 98%, Chiana).

A key trade route identified during this study involved meat which passed through Fumbisi to other urban centres via the Buipe market (Figure 5.3). The Fumbisi market received carcasses from at least 15 smaller towns and villages. It is possible that meat supplied to Fumbisi could be originating from more villages than were captured in this survey, as traders were not always certain about the sources of the meat. Of the 526 bushmeat carcasses (ca. 2052.36 kg of meat) purchased by wholesalers for which information on the destinations was obtained, the bulk (79%) of the meat was transported via road to Buipe market, located about 237 km south of Fumbisi. Another 11% of the meat was transported to Navrongo and 6% was transported over 500 km down south to Kumasi (Figure 5.3). Some meat was also transported even further down south to the capital Accra. Wholesalers in Fumbisi usually accompanied their meat on the four-hour journey to Buipe by road, whereas wholesalers selling in the Chiana market did not (see section 5.3.4).

Once the meat reaches Buipe market, it is distributed even more widely (Figure 5.3). Traders at Buipe market (mostly wholesalers) buy bushmeat to sell later in other major markets in the cities of southern Ghana particularly Kumasi, Accra and several markets in the Bono and Ahafo regions. The market has a section where smoked bushmeat is sold openly on a weekly basis. Informal interactions with some traders and key informants at Buipe revealed that, apart from Fumbisi, bushmeat was supplied to this market from eight other villages and small towns, including Yapei, Walewale, Wulugu and from as far as Yamah (about 245 km away). The finding that bushmeat flowed from the markets of northern Ghana to supply southern markets via Buipe was also corroborated through informal interactions with key informants and transport operators.

Plate 5.1. Bushmeat being smoked for long-distance transport to markets

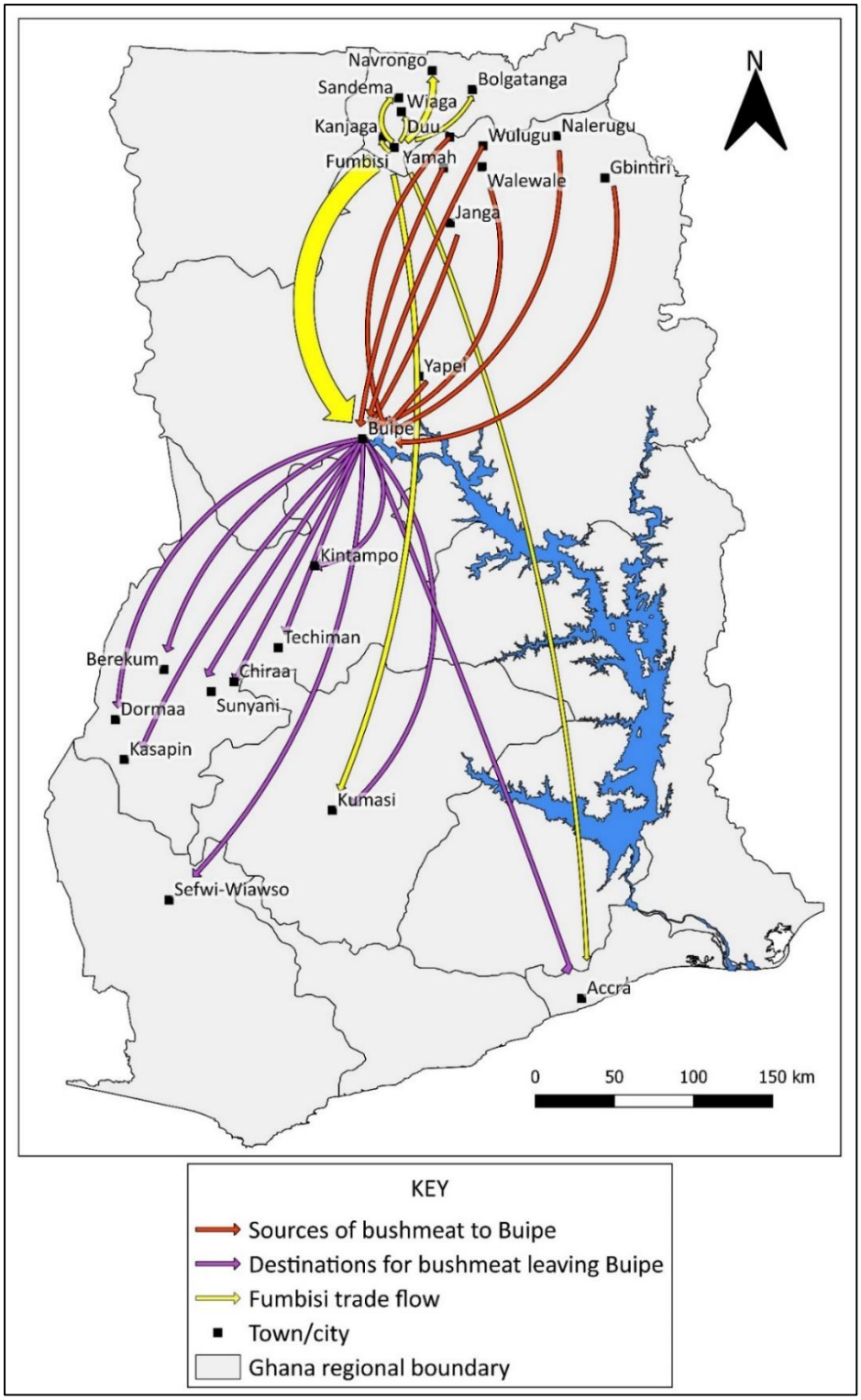

Figure 5.3.Trade flow patterns in the rural-urban commodity chain for Fumbisi and Buipe markets. *The arrows illustrate the direction of trade. The width of a yellow arrow is proportional to the volume of bushmeat traded.*

5.3.3 Cross-border trade network

A significant finding from this study was the confirmation of a cross-border bushmeat trade route. Bushmeat originating from Burkina Faso goes through Kayoro before being traded elsewhere, largely via Chiana, which was a particularly important hub for this trade network (Figure 5.4). Bushmeat transported through Kayoro was mapped using the data obtained from the trader diary kept by the trader based in Kayoro. This trader, hereafter referred to as "Trader A" learned the trade from his mother, and has worked as a bushmeat dealer for over 5 years. He reported that trading in bushmeat was capital intensive and hence many others who were previously in the trade had gone out of business due to financial limitations.

Meat is delivered to him by hunters in Kayoro and from villages in southern Burkina Faso, and transported using motorcycles along bush paths. The villages and towns in Burkina Faso from which these hunters originated are located approximately 30 km northeast of Kayoro (Figure 5.4). The meat was delivered either fresh or smoked as whole carcasses or pieces. When delivered fresh, he would process the meat by burning off the hair, cleaning and smoking for preservation for onward transportation. The smoked meat was stockpiled and transported in bulk by motorcycle to traders outside Kayoro village. The majority (>70%) was transported to wholesalers in Chiana and Chuchuliga (about 23km and 34 km from Kayoro, respectively) (Figure 5.4). Meat transported to Chuchuliga was reported to be delivered to a trader who would transport them to sell elsewhere. This link to the chain was not explored further in this study.

Bushmeat transported through Chiana was mapped using both market data and data collected by a wholesaler who agreed to participate in the study. This wholesaler, (hereafter 'Trader B') has worked as a bushmeat trader for about twenty years. The length of time in business of Trader B demonstrates how long this cross-border/trade from the north to south has been going

on. She supports her bushmeat trade with sales of domestic meat. According to Trader B, in the past she travelled to source her meat but due to scarcity of bushmeat these days, and also for logistical reasons, she now operates from the market. Trader A in Kayoro supplies trader B in Chiana with bushmeat. Trader B is also supplied with meat by hunters from the town as well as other neighbouring villages. Bushmeat was not always traded through official village markets. In cases where bushmeat was supplied to Trader B outside of regular market days, the meat was smoked with the help of two assistants and stored for later transportation down south.

Bushmeat recorded from the Chiana market during the market survey came from eight villages with the bulk (51.4%) coming from Kayoro, followed by Katiu (32.9%) located about 9km southwest of Chiana. Out of the 2,946 kg of meat recorded to be traded in the market during the study period, 91.5% was transported to the Central market in Kumasi (608 km away) and 7.5% to Sefwi-Wiawso in the Western region (ca. 720 km away) (Figure 5.2). Trader B's consignment to these destinations was unaccompanied and she only made the journey if she needed to travel for personal reasons. The meat was well packaged and labelled for easy identification on arrival by her customers (women with whom she had long-standing trading relationships). The cost of transportation was borne by her client depending on the arrangement. Prices were set by bargaining through phone calls and payment arrangements were made through local money transfers.

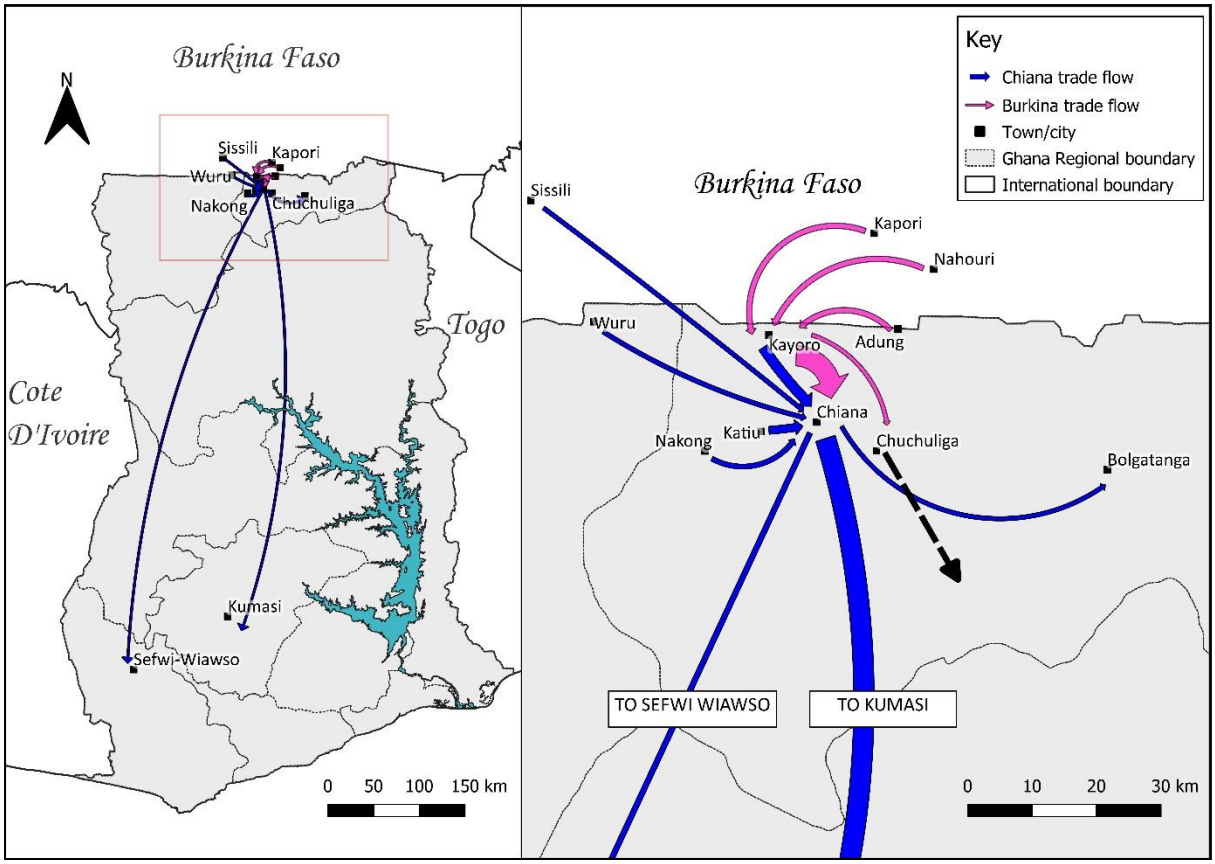

Figure 5.4. Trade flow patterns in the cross-border urban/rural commodity chain for Chiana market. *The arrows illustrate the direction of trade. Pink arrow represents flow of trade coming from Burkina Faso through Kayoro onto Chiana market and was mapped using data collected from the trader diary by Trader A in the hunting village of Kayoro. Blue arrow represents flow of trade through Chiana to Kumasi and other areas. The blue arrow was mapped using data collected from market surveys and Trader B in the Chiana market. The width of arrows is proportional to the volume of bushmeat traded.*

5.3.4 Composition of the trade

The profile of traded species varied between the trade networks identified. In the cross-border trade, a total of 705 bushmeat carcasses comprising 22 mammal species (nine ungulates, four primates, four rodents, four carnivores and aardvark) and two bird species were recorded (Table

5.3). Ungulates made up most of the carcasses, accounting for 41%, followed by rodents (18%) and primates (17%), respectively. Birds (13%) and carnivores (8%) contributed lower numbers of carcasses while aardvarks comprised the rest (3%). Of the total biomass supplied during the study period (33,501.60 kg), ungulates contributed the highest proportion (88% of total), followed by rodents (3.9% of total). Aardvarks comprised 3.6% of the traded biomass, primates 3.3%, and the remaining taxonomic groups together included another 1%.

Through local trade networks the majority (95%) of bushmeat carcasses traded were amphibians (three frog species; *Pyxicephalus edulis, Hoplobatrachus occipitalis and Ptychadena trinodis*) and smaller-bodied animals (Fig. 5.5). On the other hand, long distance trade networks were dominated by relatively larger animals and comprised mostly rodents (29%), ungulates (26%) and primates (21%). Long distance and cross-border trade networks accounted for the bulk of records in this study, with over 80% of total biomass passing through all markets being earmarked for destinations outside the local market. Amphibians were not purchased by wholesalers for long-distance trade to urban markets. By contrast on local markets aardvarks, primates and ungulates were largely absent.

Table 5.3. Species, number of carcasses and biomass of bushmeat originating from Burkina Faso and traded between April, 2019 and September, 2019.

Taxonomic group	Species	Scientific Name	Number of carcasses	Estimated biomass (kg)
Birds	Guinea fowl	*Numida meleagris*	66	79.2
	Francolin	*Pternistis sp.*	27	13.5
Carnivores	African civet	*Civettictis civetta*	24	201.6
	Common genet	*Genetta sp.*	14	31.5
	Slender mongoose	*Herpestes sanguineus*	11	6.6
	Marsh mongoose	*Atilax paludinosus*	7	22.19
Primates	Olive baboon	*Papio anubis*	38	680.2
	Patas monkey	*Erythrocebus patas*	34	227.8
	Tantalus monkey	*Chlorocebus tantalus*	28	168
	Green monkey	*Chlorocebus sabaeus*	17	34
Rodents	Crested porcupine	*Hystrix cristata*	58	1131
	Grasscutter	*Thryonomys swinderianus*	36	145.08
	Giant rat	*Cricetomys gambianus*	21	24.78
	African ground squirrel	*Xerus erythropus*	14	14.7
Ungulates	Grey duiker	*Sylvicapra grimmia*	69	1242
	Bushbuck	*Tragelaphus scriptus*	47	852.58
	Kob	*Kobus kob*	42	3801
	Roan Antelope	*Hippotragus equinus*	36	9414
	Warthog	*Phacochoerus africanus*	34	2107.32
	Waterbuck	*Kobus ellipsiprymnus*	30	6900
	Aardvark	*Orycteropus afer*	20	1220
	Red flanked duiker	*Cephalophus rufilatus*	16	160
	Hartebeest	*Alcelaphus buselaphus*	11	1837
	African Buffalo	*Syncerus caffer*	5	3187.5
Total			**705**	**33,501.6**

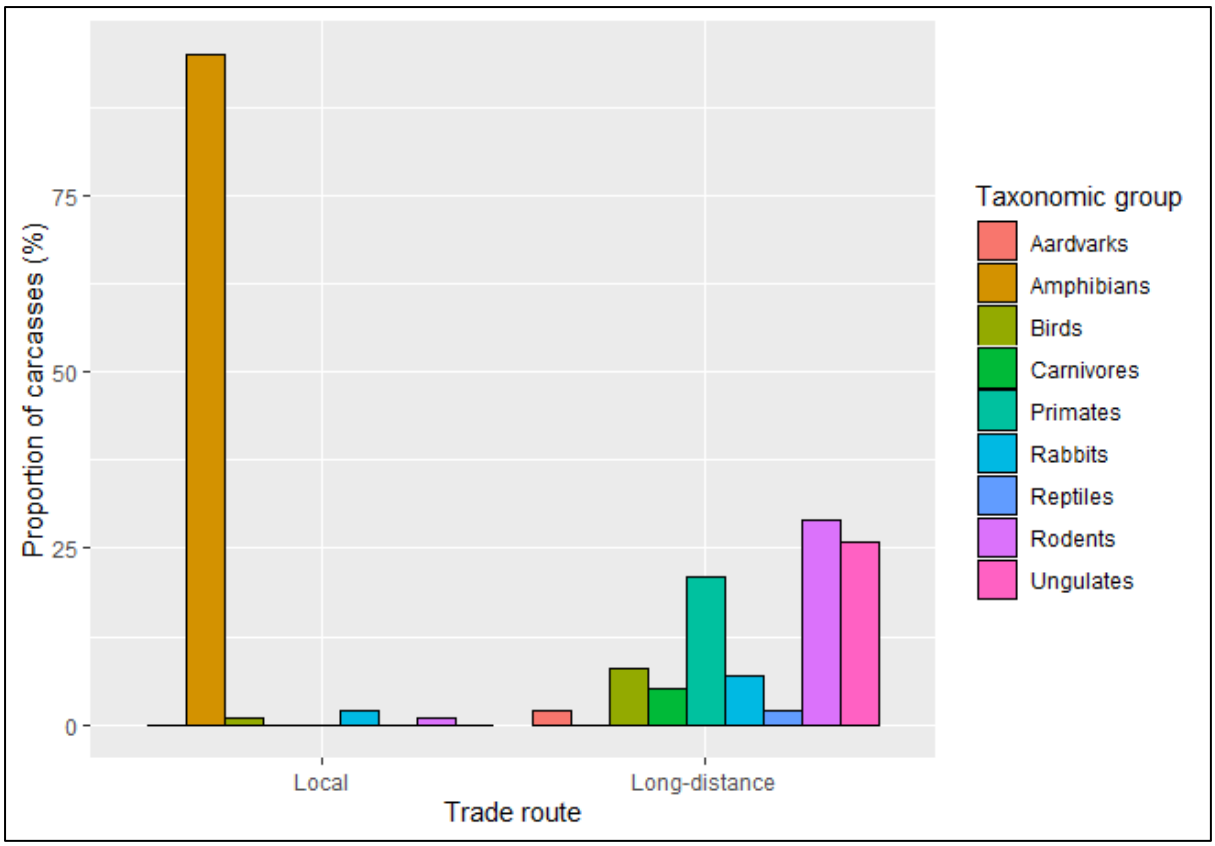

Figure 5.5. Composition of carcasses traded locally (N = 9,008) and long-distance (N = 989). *The local trade data are derived from survey records of carcasses traded by market retailers in Fumbisi and Sandema markets. The long-distance trade data are derived from survey records of carcasses purchased by wholesalers in Fumbisi and Chiana markets and the trader diary recorded by trader A in the hunting village of Kayoro. Double counting bushmeat (i.e., Trader A records and Chiana wholesaler) was avoided by crosschecking with wholesalers during each market survey.*

5.4 Discussion

5.4.1 Actors and trade along the local market chain

The bushmeat supply chain identified in this study comprised four key actor groups (hunters, middlemen, wholesalers and market retailers), each playing a specific set of roles which varied somewhat according to whether the trade was local or long-distance. This set of actors appear to be characteristic of typical bushmeat commodity chains, as described in previous studies in Ghana (Falconer, 1992; Cowlishaw *et al.*, 2005b; Sackey, 2014) and elsewhere (Nielsen *et al.*, 2016; van Vliet *et al.*, 2019). Although actors in the commodity chain remain similar in different markets/parts of the country, there are some notable differences in terms of operation and extent of the trade routes. Wholesalers and market retailers identified in commodity chains in northern Ghana combined the sale of bushmeat with other animal protein types such as smoked fish and domestic meat or other agricultural produce, an observation that was not characteristic of traders in southern parts of Ghana. Similar observations to this trading behaviour, whereby bushmeat is sold alongside other goods, have been reported among bushmeat traders in the Democratic Republic of Congo (van Vliet *et al.*, 2019). Trading in other items in addition to bushmeat creates a safety net for these traders. Alternatively, trading in bushmeat could be opportunistic, with traders selling what they get to supplement income from other traded items. Additionally, the high capital investment often required to trade in bushmeat (Cowlishaw *et al.*, 2005b) may cause these traders to trade in other items rather than solely in bushmeat.

Chopbars (local eateries) that typically prepare bushmeat dishes and are patronized by the general public were absent in the local node of the market chain in this study. This group of actors were among the most numerous actor groups in Kumasi and Takoradi markets in southern Ghana (Falconer, 1992; Cowlishaw *et al.*, 2005). It was observed that chopbars were

not patronized commonly in the northern study areas due to low demand for prepared food, in contrast to places like Kumasi and Takoradi where they are highly patronised and serve as avenues for bushmeat consumption among the general public (Falconer, 1992; Cowlishaw *et al.*, 2005).

Another notable difference in the trade in northern Ghana is that bushmeat was traded mostly as smoked meat, unlike in southern Ghana where meat is typically delivered fresh to the markets or as frozen unprocessed meat (McNamara, 2014; Sackey, 2014). Bushmeat dealers (middlemen) in hunter villages bought and kept bushmeat carcasses in freezers to preserve them until they have stockpiled large quantities of carcasses which are then transported in the frozen state to supply wholesalers at the Mankessim market in the Central region (Sackey, 2014). However, in this study, many of towns /villages where the meat originated had no access to electricity and most households lacked refrigeration equipment for meat storage therefore smoking was the available preservative method. According to van Vliet *et al.* (2012) and Nielsen & Mielby (2015), the proportion of smoked meat forming part of bushmeat trade chain could be an indication of the length of the distances over which meat is transported. Since hunters usually spent several days on hunting trips, meat harvested are pre-smoked to preserve them before they get back to their villages. Also, because the bulk of the meat harvested is sold over long distances, smoking appears to be the best option to ensure meat gets to the destination without going bad. This is mainly due to the lack of refrigeration equipment and other factors such as access to reliable transportation.

The structure of the bushmeat commodity chain contributes to local livelihoods in the region by providing direct income to actors involved in the trade. Moreover, the supply of bushmeat from the study area to major markets in southern Ghana clearly forms an important component of the country's bushmeat trade, considering the estimates of both number of individual animals

and biomass traded. In sub–Saharan Africa, including Ghana, the volume of bushmeat traded on urban markets, is usually greater than that traded on local markets, due to the price premium available on wealthy urban markets (Sackey, 2014; Wilke *et al.*, 2016). The findings in this study support this observation. The majority of bushmeat delivered to the Chiana and Fumbisi markets (measured by biomass; 91% and 79% respectively), fed the much larger Kumasi and Buipe markets, where bushmeat often commands a significant premium (pers. obser). For example, the price of a whole giant rat on the Buipe market was almost four-times that of the Fumbisi market (Buipe GH¢ 15.00-30.00 vs. Fumbisi GH¢ 4.00-7.00).

Local demand might be driving bushmeat hunting for some species (e.g., amphibians) but not others. Hunting of large-bodied species, like primates and ungulates which were largely absent from the local trade, appears to be driven by demand in urban markets where they sell for better prices. The influence that demands from urban centres has on the trade dynamics in the north is further emphasised by the fact that the biomass of bushmeat traded for local consumption was lower than that traded through long- distance trade routes. The large supply of bushmeat to southern Ghana could also be an indicator of growing demand in urban markets. This requires more attention to understand, but would be of concern if true, as urban demand has been identified as a strong driver of bushmeat hunting and trade (Cowlishaw *et al.*, 2005b; Allebone-Webb *et al.*, 2011; Cronin *et al.*, 2015).

5.4.2 Long-distance trade networks

This study highlights the complex nature of the long-distance supply chain through which bushmeat passes from the north to the south. It has been suggested that the complexity of bushmeat markets is directly dependent on the distance from source to the markets, and this study lends itself to similar findings (Wilkie *et al.*, 2016).

The majority of bushmeat is hunted in rural areas requiring transportation to market. Increases in distance from source imply an extra cost of transportation which might have an effect on net profits for some actors (Sackey, 2014). Therefore, wholesalers supplying distant city markets likely try to maximize the amount of meat they get for the cheapest price possible, to cover these higher transportation costs. Occasionally also, transportation costs to major markets are borne by the customers (urban market traders) to enhance their loyalty. These higher transportation costs will increase bushmeat prices as actors add their transportation costs to the price of the bushmeat (Mendelson *et al.*, 2003; Sackey; 2014; van Vliet *et al.*, 2019). The long transportation distances observed in this study might at least partially explain the high prices of bushmeat observed in major markets such as in Kumasi (McNamara *et al.*, 2016). However, high prices of fresh bushmeat on southern markets, which are typically sourced locally to these markets, likely also reflect the greater disposable incomes of wealthier urban consumers in the south. These price premiums may be incentivizing bushmeat traders from the north to supply these more lucrative southern markets, which may in part explain why the bulk of bushmeat is diverted into southern markets rather than local markets. Further investigation is required to quantify these dynamics.

5.4.3 Transboundary trade

This study presents the first attempt to quantify transboundary trade of bushmeat between Ghana and neighbouring countries. Although there are a few mentions of some bushmeat transported across the Ghanaian border (e.g., Asibey, 1980; Ntiamoa-Baidu, 1998) there have been no attempts to quantify or characterize the extent of this trade. A previous study reported trade in smoked bushmeat by Burkina Faso hunters to distant towns in other countries including Ghana (Spinage, 1983). Ntiamoa-Baidu (1998) also reported smoked warthog (*Phacochoerus*

africanus) meat traded in the Central market in Kumasi originating from Burkina Faso. It appears that this trade has been ongoing for a long time, considering that earlier reports date several decades ago. The fact that a trans-border bushmeat trade has been ongoing for a long time without gaining much attention highlights the geographical bias in bushmeat research for a well-studied country like Ghana.

A comparison of the trade volume (number of carcasses and biomass) originating from Burkina Faso (33,501.60 kg) with that of the three local markets (8,397.47 kg; section 4.3.2) shows that a significant volume of bushmeat could potentially go unreported if estimates of extraction levels are based only on surveys of established local markets. This illuminates the problems of market data not sufficiently representing the trade, and the importance of complementing bushmeat market studies in the source country with village-level surveys (Ntiamoa-Baidu 1998; Allebone-Webb *et al.*, 2011).

In Burkina Faso, although bushmeat consumption is common, established bushmeat markets are absent as they are prohibited by legislation (Hema *et al.*, 2017). This makes Ghana an obvious and less risky point of sale for wildlife illegally hunted in Burkina Faso, especially for hunters in close proximity to the Ghana border. Considering that Cote d'Ivoire also has a ban on wildlife hunting (Bassett, 2005; Gonedelé Bi *et al.*, 2017), it is predicted that similar cross-border trade of bushmeat along Ghana's western border may be occurring.

In West and Central Africa, similar trafficking of bushmeat across borders of several countries have been observed (Caspary, 1999; Fa *et al.*, 2006; Mohneke *et al.*, 2010). Unfortunately, bushmeat does not receive as much publicity as some of the well-known types of trafficked wildlife parts from high-profile species (e.g., ivory, horns), probably owing to these products being covered by international wildlife treaties and also because of the relatively localized

production, distribution and consumption of bushmeat (Clarke & Babic, 2016). This would increase the likelihood of such cross-border trade in bushmeat going unreported.

The existence of this trans-border bushmeat trade may not only infringe on national wildlife regulations of both Ghana and Burkina Faso, but also represents some potential infractions of international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All the internationally-traded primate species that were recorded in this study are listed as Appendix II species on CITES and require permits for their export between countries. Accurate identification of bushmeat trafficking routes would therefore help law enforcement agencies to target their efforts (Clarke & Babic, 2016).

The effect of such unregulated trade on biodiversity conservation or the infractions of national and international regulations may not be the only problem associated with transboundary trade in bushmeat. Such trade also presents a major issue of concern for public health, particularly with regard to zoonotic disease outbreaks, as some species may carry pathogenic agents of infectious diseases (Pigott *et al.*, 2014; Chiappelli *et al.*, 2015). Hence given the public health importance of bushmeat and its potential effects on both local and national economies, it has become even more important to gain an in-depth understanding of the transboundary trade, as there may be similar occurrences at other borders of the country. Such information could be used to provide recommendations to guide initiatives which aim at reducing the risky human-wildlife interactions which occur through the hunting and consumption of wild animals (Kamins *et al.*, 2015; Allen *et al.*, 2016; Booth *et al.*, 2020). In addition, bacterial and parasitic infection risks from wild meat consumption are likely to be of great importance due to the inappropriate hygienic conditions associated with processing, storage and transportation of wild meat (Ockerman & Basu, 2009; van Vliet *et al.*, 2012; Kurpiers *et al.*, 2015).

The bushmeat supply chain documented in this study provides useful information on the characteristics and extent of bushmeat harvest and trade in northern Ghana, and the international trade between Ghana and Burkina Faso. Findings of this study illuminate the key role of wholesalers in the supply chain and the need to consider their incentives for a more sustainable bushmeat trade. Often, recommendations for management interventions target either hunter or consumer behaviour (McNamara *et al.*, 2016; Chausson *et al.*, 2019) without considering intermediary groups. However, given the level of specialization of wholesalers in this chain and their knowledge of the rest of the supply chain, actions could target this group as well. Therefore, to effectively manage the bushmeat trade it is important to proactively engage all the key actors in the chain (Sackey, 2014), to support wildlife conservation and also ensure the sustainability of their livelihoods.

CHAPTER SIX

6.0 DETERMINANTS OF HUNTING BEHAVIOUR IN RURAL COMMUNITIES IN THE UPPER EAST REGION OF GHANA

6.1 Introduction

The value of hunting to local people, including its cultural value and its value as a source of meat and income, is widely recognized (Cawthorn & Hoffman, 2015; Nasi & Fa, 2015; Wilkie *et al.*, 2016). However, bushmeat hunting has been highlighted as one of the main causes for the depletion of wildlife populations (Petrozzi *et al.*, 2016; Wilkie *et al.*, 2016), leading to calls for stronger management measures to ensure sustainable levels of hunting.

Hunting as an activity is dependent on a complex mix of factors at the landscape, individual, community and societal levels (Coad, 2007; Kümpel *et al.*, 2009). To understand the impacts of hunting at the landscape level requires an understanding of the levels and determinants of hunting effort within a given area. For example, in order to maximise the return from hunting, a hunter needs to make decisions on the methods to use, where to hunt, how far to go, the timing and duration of their hunt and the type of prey to target (Kümpel *et al.*, 2009; Dobson *et al.*, 2019). Thus, an analysis of hunting strategies is needed in order to make accurate assessments of hunting offtake, the conditions under which this may vary and hence the overall impacts of hunting on ecosystems (Kümpel *et al.*, 2009; Dobson *et al.*, 2019).

At the local level, understanding which areas are selected over others for hunting is of particular interest, because it provides important information about the nature of those sites and their potential contributions to hunting impacts (Coad, 2007). Local species abundance (Jerozolimski & Peres, 2003) and prey accessibility (Wszola *et al.*, 2019) may influence

hunters' choices about where to hunt. For example, distance from the village has generally been used as a proxy for hunting pressure and hunters move further from the village as the wildlife resource of the immediate catchment is depleted (Coad, 2007).

Developing a nuanced understanding of the factors that influence hunting is critical for effective wildlife resource management because how hunters respond to changes in these factors may affect the sustainability of the resource (McNamara *et al.*, 2016; Dobson *et al.*, 2019). Therefore, gaining understanding of the characteristics of hunters and their different hunting practices, and on the factors that drive local hunting, will help in proposing measures to control exploitation and inform management of the wildlife resource.

This chapter examines the characteristics of hunters in northern Ghana and explores the factors that influence hunting behaviour and how they drive the local hunting system. It seeks specifically to;

1) Characterise the demography of hunters and obtain an understanding of the importance of hunting to their livelihoods.
2) Determine the predictors of hunting success, including both hunter-level and landscape-level variables.
3) Identify factors that influence a hunter’s choice of hunting site within the available landscape.
4) Assess hunters' perceptions of changes in bushmeat availability within the landscape in which they operate.

6.2 Methods

6.2.1 Study sites

This study was conducted in the two villages, Kayoro (10.9749884°, -1.3300520°) and Doninga (10.6192748°, -1.4217274°) in the Upper East region of Ghana. The vegetation consists primarily of savannah woodland with patches of forests and grassland. The area comprised various land use types including crop and livestock farming and forest reserves. A detailed description of the study sites and reasons for their selection are presented in Chapter three (Section 3.2).

6.2.2 Data collection

Data were collected from March to April, 2019 and in October, 2019 using structured interviews with hunters and householders, as well as participatory mapping with focus groups. The principal components of the questionnaire interviews are described in Chapter 3. Two types of hunters were identified; professional hunters for whom hunting is a major livelihood component, and farmer-hunters, who hunt opportunistically around their farms. Among both sets of interviewees, hunting was not a particularly sensitive issue and hunters were willing to discuss details of hunting and were comfortable about responding to questions about potentially illegal activities. Consent was obtained from each hunter prior to interviews and respondents were assured that all information collected and their identity would remain anonymous.

6.2.2.1 ***Household interviews***

A total of 471 households were interviewed in Kayoro and Doninga villages (29% and 49% of the total number of households in each village, respectively). A systematic sampling approach

was adopted for the household survey. The detailed information about how households were sampled is provided in Chapter three. The questionnaire (Appendix 3) asked a series of questions related to the livelihood activities of households. Of these, 76 households (Kayoro= 31, Doninga= 45) stated that they hunt on their farm. These households (designated "farmer-hunters") were specifically asked questions about their motives for hunting and methods used.

6.2.2.2 *Hunter interviews*

A structured questionnaire (Appendix 2) was used to interview 56 professional hunters (Kayoro= 27, Doninga= 29) about their hunting activities and practices. Professional hunters were identified using a snowball sampling technique (Newing *et al.*, 2010). Information was collected on demographic details such as age, level of education, place of origin and assets. Hunters were asked about their rationale for hunting and also to list and rank their livelihood activities in order of income generation. Information pertaining to their last hunting expedition was obtained, including the distance covered and hunting method(s), species hunted, number of animals caught, location and habitat type where the expedition was carried out, and the time of day that the hunt took place. Additional general questions focused on seasonality in hunting activities, targeted species, proportion of different prey items hunted that were eaten or sold, and to whom/where sold. Interviewees were asked to describe any perceived changes in prey abundance in terms of general numbers, specific species, distribution of wild animals, and changes in abundance over the period they have been hunting. The latter question was also asked in the trader interviews (Chapter 3), thus providing a useful check on the consistency of the responses.

6.2.2.3 *Participatory mapping*

A participatory mapping exercise was conducted in each focal village. This approach was effective as almost all of the participants had been involved in similar mapping exercises in the past. Small groups of 5-7 hunters with good knowledge of the village landscape, took turns in interactive sessions to locate and map out hunting locations by identifying and placing stickers on the map provided (Plate 6.1). These sessions involved a total of 21 hunters from Doninga and 22 hunters from Kayoro. Hunters were selected for focus groups based on their participation in the target interviews (Section 6.2.2.2) and willingness to participate in the mapping exercise. The maps indicated landmarks, key reference points within the boundaries of the villages, such as settlements, protected areas and forest reserves, roads, tracks and watercourses. Hunters were asked to identify their typically preferred and visited hunting locations. After the participatory mapping process, all hunting locations were digitized for further spatial analysis.

6.2.3 Data Analysis

All statistical analyses and tests were conducted using the R statistical package version 3.6.1 (R Core Team, 2019) and SPSS version 20.0 for Windows software. Significance tests were performed for frequency data using Chi-square tests and Wilcoxon rank sum tests were used to test for differences in the age of hunters in the different villages.

Plate 6.1. Hunting site mapping exercise being carried out by participants.

6.2.3.1 *Predictors of hunting success*

To investigate the predictors of hunting success, nine parameters (age, years spent hunting, village, area hunted (habitat type), distance travelled from village, time of day, time spent on hunting expedition, hunting method used, individual or group hunting) were assessed for their effect on hunting success of the last hunting expedition, using binomial generalized linear models (GLMs). Prior to the analyses, potential collinearity between the predictor variables was explored in a correlation matrix (Appendix 7). There was a strong correlation (r= 0.88) between hunter's age and years spent hunting. Hence, only years spent hunting was retained as it was of particular interest. Hunting success in the last expedition was classified as a binomial response where "1" represented a successful trip if the hunter killed at least one individual animal of any species and "0" represented an unsuccessful trip. The inclusion of the candidate variables in the model was guided by literature (Walker *et al.*, 2002; Nyahongo *et al.*, 2005;

Coad, 2007; Kümpel *et al.*, 2009). The analysis was run for data from 47 professional hunters who had been identified in the targeted sampling and for whom complete data on demographics and information on last hunting expedition had been obtained.

The full model was dredged for all subset models and the top model set were selected based on Akaike's information criterion corrected for small sample size (AICc), as the models within 2 AICc units of the top model (Symonds & Moussalli, 2011). The top model set contained 4 models and model averaging was then performed to provide unconditional parameter estimates and z statistics for parameter significance. The *importance* function from the *MuMin* package (Barton, 2009) was used to assess the relative importance of each explanatory variable in predicting hunting success.

6.2.3.2 *Spatial analysis and predicting hunting site selection*

For each focal village, hunting site selection was assessed by comparing characteristics of hunting sites (as selected by hunters during the participatory mapping) to a set of random (non-hunting) sites within the available area (Appendix 8). To define the available area for hunters, a circular plot was created around each village with radius equal to the maximum distance that hunters reported travelling away from their village on hunting trips (Kayoro= 76 km, Doninga= 77 km). A minimum bounding rectangle was then delineated around each circular plot to create the available area for hunters for each focal village.

Because hunters typically hunted within an area around the points identified as preferred sites, hunting sites were created by demarcating a circular buffer around each hunting point using a 6 km radius equalling the mean distance that hunters (N= 6) reported that they covered upon reaching preferred hunting grounds. Thus, each hunting site was demarcated as a 113 km^2 plot within the available area, representing the area actively used for hunting. Random (non-hunted)

sites were created by generating 100 random points within the available area for each hunting village and creating similar sized plots from these points as was done for the hunting sites.

For each hunted and randomly generated site, the distances (in km) to the closest water source (DW), the nearest road (DR), the closest settlement (DS) and the distance from hunter's village (DK-Kayoro; DD-Doninga) were extracted. Additionally, the average percentage tree cover within each hunting site and random site was extracted, using the MODIS Vegetation Continuous Fields data set (Hansen *et al.*, 2005) which provides percentage tree cover at a resolution of 500 m. All spatial analyses were conducted in QGIS version 3.12.1.

Prior to the analyses, a correlation matrix was used to test for potential collinearity between the predictor variables. A binomial GLM was then run using the characteristics of both hunting sites and random sites as predictor variables for site selection (1=selected, 0=not selected) to determine which of the variables best differentiated between selected hunting sites and the random sites and thus predicted site selection for hunting. GLM and model selection followed a similar procedure as was done for the prediction of hunting success.

All models were visually inspected using diagnostic plots to check for conformation to model assumptions.

6.3 Results

6.3.1 Hunting practices and the role of hunting as a component of livelihoods

Two categories of respondents were identified through the questionnaire interviews. The first group were the professional hunters (N= 56); individuals who regarded hunting as one of their livelihood activities, whether for food or income. The second group were farmer-hunters (N= 76); individuals who trapped opportunistically only on their farms for meat (subsistence) or as a means of pest

control. Reasons for engaging in hunting varied significantly between these two groups and villages ($\chi^2 = 22.23$, df= 3, P<0.05). In Kayoro most farmer-hunters hunted mainly for food and few reported hunting primarily to control pests (Table 6.1). Conversely, most farmer-hunters in Doninga hunted mainly for protection of their crops. Among all farmer hunters, 50% hunted primarily to control pests on their farms. Within both sites, typical crop pests reported included wild animal species such as monkeys, the African savannah hare and giant rat, which were said to cause damage to food crops, especially during the harvesting season. Among farmer-hunters, hunting method differed between the two villages and this appeared to reflect the species group targeted. Farmer-hunters in Doninga reported mainly using traps (65%), as targeted crop pests were mostly rodents, while in Kayoro, where monkeys constituted the majority of crop pests, farmer-hunters reported using mostly shotguns (71%).

Table 6.1. Primary reasons for hunting, reported by professional hunters (Kayoro= 27, Doninga= 29) and farmer hunters (Kayoro= 31, Doninga= 45). *Results for farmer-hunters are from the household survey; results for professional hunters are from the targeted hunter survey. The top responses for each group and village are boldface.*

		Farmer hunters		**Professional hunters**		
Village	**Reasons for Hunting**	**n**	**%**	**n**	**%**	**Overall %**
Kayoro		31		27		
	Income		16		**78**	45
	Food		**45**		7	28
	Pest control		23		0	12
	Other		16		15	16
Doninga		45		29		
	Income		0		**90**	35
	Food		13		3	9
	Pest control		**69**		0	42
	Other		18		7	14

In both villages, most professional hunters indicated that they primarily hunted for income (Table 6.1). However, only a few of these hunters depended on hunting as their primary source of income (Kayoro=30%; Doninga=10%) and none depended exclusively on hunting for a living. The bulk of the professional hunters' catch (74%) was sold for income whiles a small proportion (24%) was either eaten by the hunter's household or given out as gifts (4%). Birds and rodents were the most likely to be eaten at home. Only 24% of birds and 50% of rodents hunted were sold, unlike other species groups where at least 80% of carcasses were sold (Figure 6.1). Among the rodents, however, the larger species like grasscutter *Thryonomys swinderianus* and crested porcupines *Hystrix cristata* were sold. Hunted species and their legal status under Ghana's Wildlife Law and Regulation are listed in Appendix 9.

Hunting was done throughout the year but peaked during the driest months of the year (January-April). This peak hunting period occurred outside the major farming season (May to October) when there are few alternative livelihood opportunities for men in the village. During the period of farmland preparation, planting and crop harvesting, hunters who farm spent most time working on their farms relative to hunting activities.

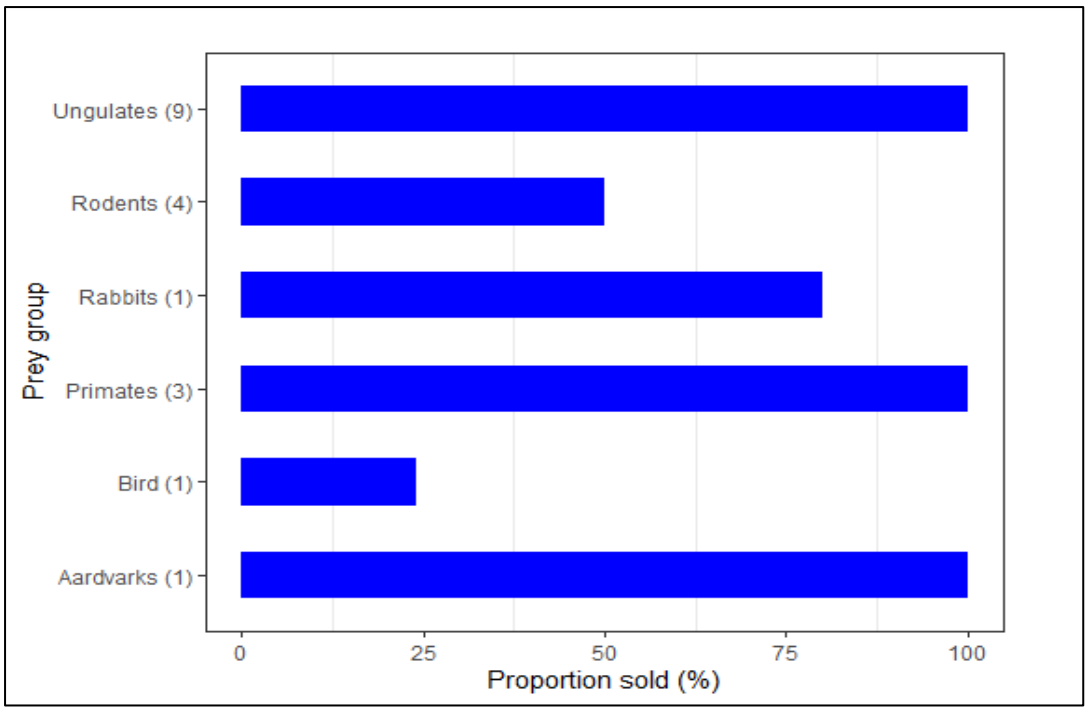

Figure 6.1. Proportion of catch sold by hunters for different groups of prey. *The figures in brackets indicate the number of species of each group. The proportion of catch sold is calculated from the total catch for each prey group obtained in the last hunt, using responses to Question 26 of the Hunter Questionnaire (Appendix 2). (Total catch= 76; Aardvarks=1, Birds= 21, Primates= 6, Rabbits= 5, Rodents= 8, Ungulates= 35).*

6.3.2 Characteristics of professional hunters

Hunting was an exclusively male activity. The age of the hunters ranged from 21 to 76 years, with a median age of 46 years. Although the mean age of hunters in Doninga (51 ± 18 years; N= 25) was higher than the mean age of hunters in Kayoro (44 ± 14 years; N= 26), this was not statistically significant (Wilcoxon rank sum test, W = 259.5, P = 0.2204). The number of years spent hunting ranged from 3 to 50 years with a mean of 26 ± 16 years (N= 25) in Doninga and 20 ± 12 years (N= 26) in Kayoro. The majority (86%) of respondents learnt the art of hunting from their fathers or grandfathers. All the hunters interviewed indicated that they

hunted part-time. The majority of them were crop farmers (98%) and were engaged in other livelihood activities like livestock rearing (82%), artisanry jobs such as masonry and mechanic (5%), collecting and selling of non-timber forest products from the bush (e.g., honey) (5%) and fishing (4%).

Hunters reported embarking on an estimated 3.8 ±3.0 hunting trips per month, with each trip lasting an average of 4.0 ±3.6 days. During a hunting trip, hunters could travel a mean distance of 45.5 ± 22.2 km from their village. This distance travelled varied between the two villages with hunters from Doninga covering an average of 54.2 ± 17.9 km whiles those in Kayoro travelled a mean of 36.8 ± 22.9 km from their village. The time of hunt (day, night or both) varied significantly between the two villages (χ^2= 8.45, df=2, P<0.05). Most hunters in Kayoro (52%, N= 27) hunted solely at night compared to daytime (15%) or both day and night (33%), while in Doninga, more hunters hunted solely during the day (43%) than during the night (18%) or both day and night (39%). This is probably because of the species they targeted. Most of the hunters interviewed hunted alone (73%) rather than in groups (27%). Hunters who reported hunting alone were usually accompanied by younger boys who transported their catch home. The hunting method used varied significantly amongst hunters and between villages (χ^2= 12.99, df=3, P<0.05). Although the majority of hunters used shotguns (75%, N=56), hunting techniques were more diversified amongst hunters in Doninga than Kayoro. Kayoro hunters mainly used shotguns (96%, N=27) but did not use trapping or dogs (Figure 6.2). Hunters who used a combination of methods used bow and arrow or catapults in addition to shotguns.

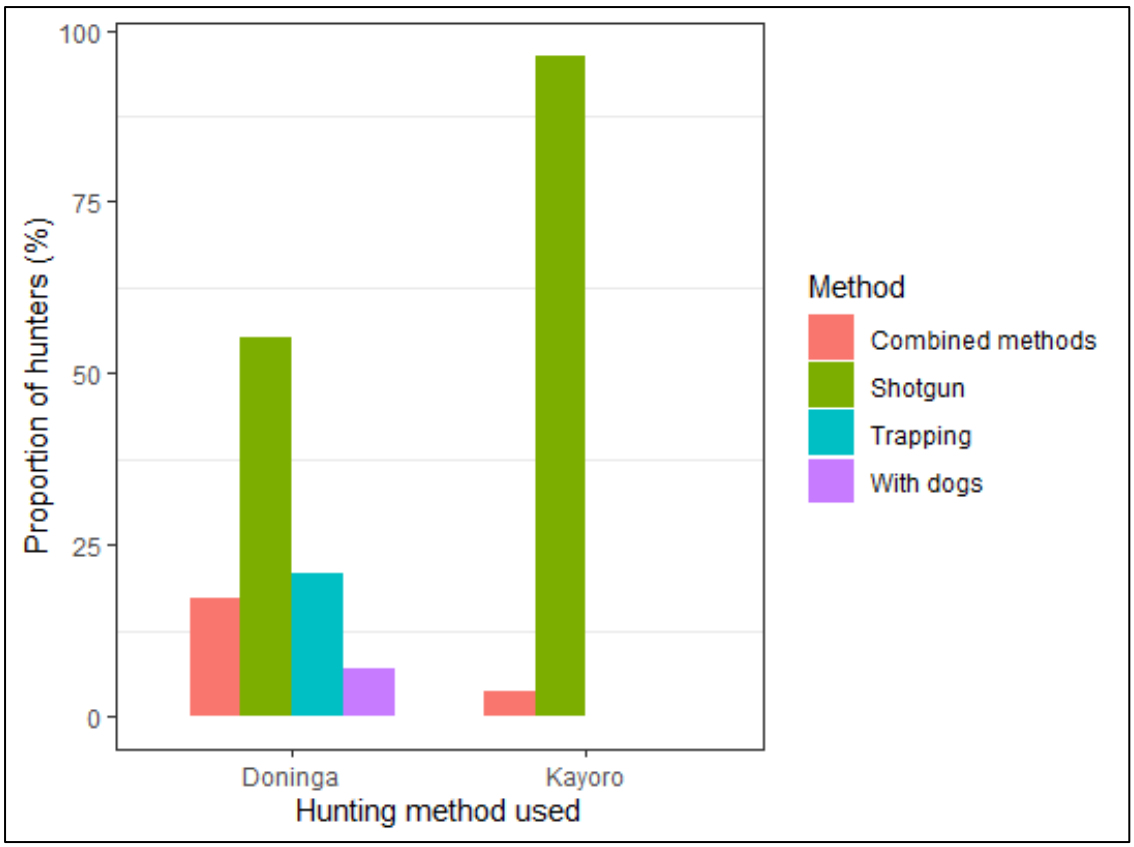

Figure 6.2. Hunting methods used by hunters in Kayoro (N= 27) and Doninga (N= 29).

Data obtained from response to question 25 in the Hunter questionnaire, Appendix 2.

6.3.3 Predictors of hunting success

Binomial GLMs were used to assess which factors predicted success in the last hunting trip. Model outputs showing the model AICc values, Akaike weights and model likelihoods for the top models (delta AICc < 2) are presented in Appendix 10.

Out of the eight parameters entered into the full model, only three were present in the top models; namely area hunted, hunting method and number of years spent hunting. The area hunted was by far the most important predictor of hunting success in the last hunting trip, with a relative importance of 1 (being present in all models) (Table 6.2). Hunting method had a 51%

relative importance, with the use of snares being associated with greater hunting success than shotguns and number of years spent hunting had a 33% relative importance (Table 6.2).

Table 6.2. Model-averaged parameter estimates and their relative importance across the top 4 models (delta AICc <2). **Baseline reference for explanatory variable.*

Explanatory variable		Estimate	Std. Error	z value	Pr(>|z|)	Relative importance
Area hunted (Near water body*)	Dense tree cover	0.12	1.39	0.08	0.9331	1
	Open tree cover	2.34	1.40	1.66	0.0966	
Hunting method (Combined methods*)	Shotgun	1.17	1.48	0.78	0.4348	0.51
	Trapping	1.84	2.26	0.81	0.4202	
Number of years spent hunting		0.009	0.02	0.45	0.6551	0.33

None of these parameters, however, were significant, indicating that there is very little support for these factors as good predictors of hunting success for the last hunting trip. This may be because success in any particular trip is likely to be stochastic, and with our relatively small sample size we do not have the power to separate signal from noise. Nevertheless, the odds of hunting success in a forest with open tree cover was 9.90 times (exp {2.39} = 10.90) higher than near a water body and 8.77 times (exp {2.39} – exp {0.12}) higher than forest with dense tree cover. The odds of hunting success in a forest with dense tree cover is only slightly 0.13 times (exp {0.12} = 1.13) higher than near a water body (Figure 6.3). Also, hunters who used shotguns or snares were more likely to be successful than those who used a combination of methods such as bows and arrows and catapults. This is probably because these are more likely to be professional hunters.

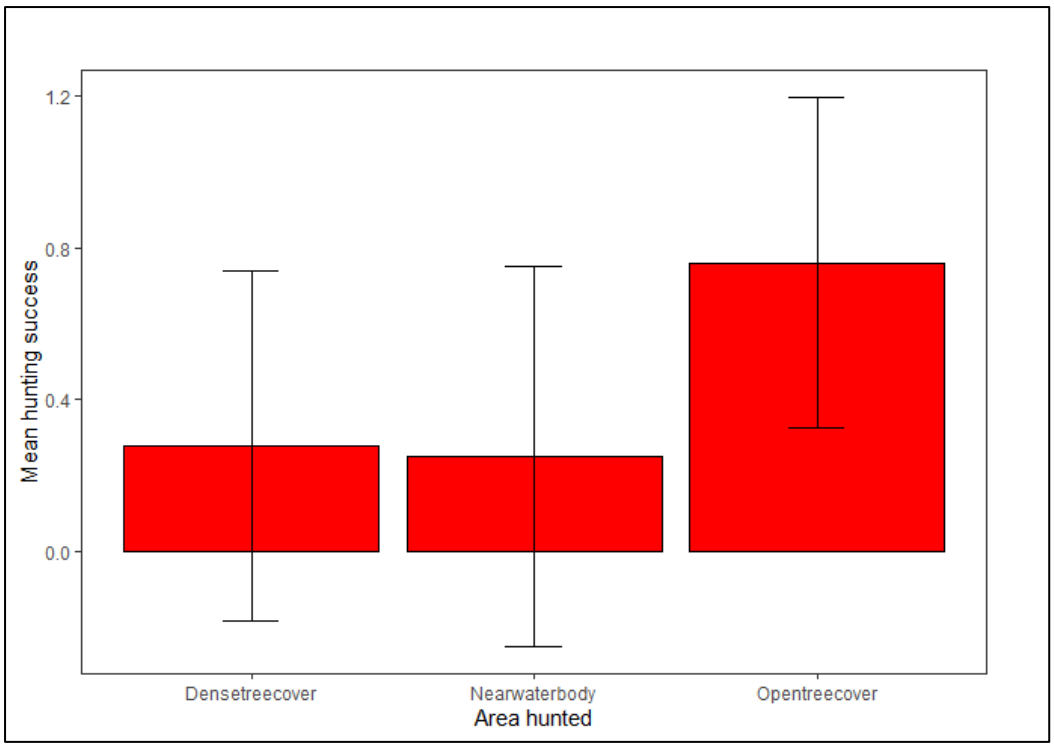

Figure 6.3. Relationship of hunting success to area hunted.

6.3.4 Participatory mapping and determinants of hunting site selection

The majority of the preferred sites as indicated by the professional hunters from both villages were either located very close to or lay within designated Community Resource Management areas (CREMAs) or forest reserves. For hunters at Doninga, some hunting sites were located around the Sissili Central, Gia, Pogi and Mawbia forest reserves (Appendix 8). For hunters at Kayoro, several of the selected sites were located near or within the Sissili forest and Nazinga Game Ranch across the Ghanaian border in Burkina Faso, and a few areas located near the Pudo and Chiana hills forest reserves (map not shown for ethical reasons and to respect confidentiality of respondents).

For hunters in both villages, distance from hunter's village significantly determined site selection (Table 6.3 and Table 6.4). The probability of selecting a particular site decreases the further away it is from the village. Preference for hunting sites starts to level off at about 40

km and 60 km away from Kayoro and Doninga, respectively. Percentage tree cover was found to be significant in predicting site selection in Kayoro but not in Doninga, with the probability of a site being selected increasing with increasing tree cover (Figure 6.4). Distance to road and distance to water were also important in predicting the selection of site in Kayoro (Table 6.3), with hunters being more likely to choose sites close to roads and away from water.

Table 6.3. Model-averaged parameter estimates and their relative importance across the top three models (delta AICc <2) for hunting site selection (predicting the binary response hunting site versus random point) for hunters in Kayoro (N= 22). *Boldface indicates significance at P<0.05.*

Explanatory variable	Estimate	Std. Error	z value	Pr(>|z|)	Relative importance
(Intercept)	-5.56	4.47	1.23	0.22	
Distance to Kayoro	-0.22	0.11	2.08	**0.03**	1
Percentage tree cover	1.93	0.97	1.97	**0.04**	1
Distance to road	-0.79	0.47	1.67	0.09	1
Distance to water	0.58	0.32	1.78	0.07	1
Distance to protected area	-0.19	0.16	1.13	0.26	0.78

Table 6.4. Model-averaged parameter estimates and their relative importance across the top 6 models (delta AICc <2) for hunting site selection (predicting the binary response hunting site versus random point) for hunters in Doninga (N= 21). *Only variables with Relative importance >0.4 are shown. Boldface indicates significance at P<0.05.*

Explanatory variable	Estimate	Std. Error	z value	Pr (>|z|)	Relative importance
(Intercept)	4.24	1.68	2.51	0.01	
Distance to Doninga	-0.14	0.03	4.63	**<0.01**	1
Distance to water	0.06	0.11	0.57	0.57	0.42

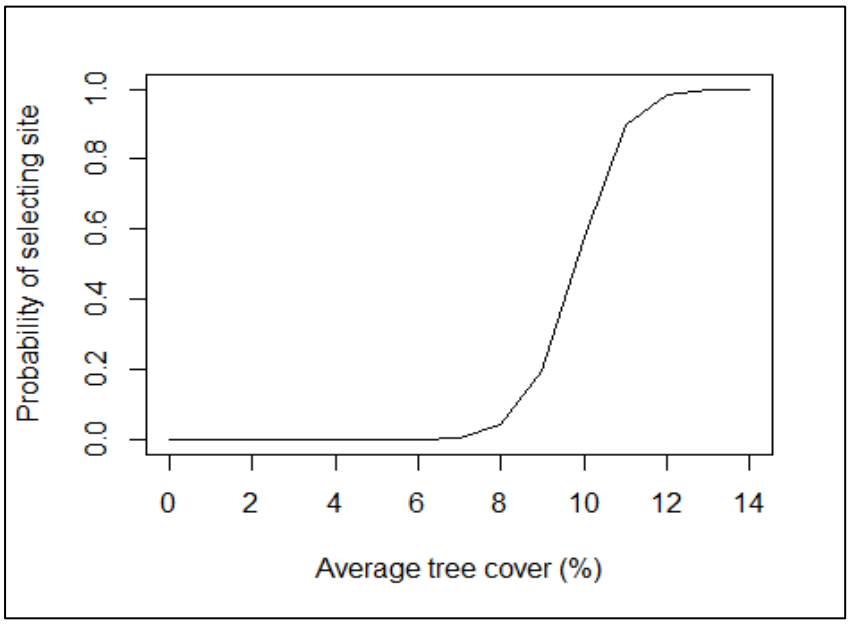

Figure 6.4. Relationship between the average tree cover and the probability of selecting site by hunters in Kayoro.

6.3.5 Local perceptions of changes in landscape and bushmeat availability

Ninety percent of the respondents (N= 52) in the hunter survey perceived that there had been changes in the landscape of their hunting area between when they started hunting and the present. The majority (87%) stated that there had been changes in the vegetation, with decreased tree cover, and the rest cited eroded lands or both. These observed changes were mainly attributed to deforestation and bushfires (Figure 6.5). Hunters also reported changes in the type of species hunted, with 73% of the respondents indicating increasing scarcity of certain animal species like aardvarks, African buffalo, elephants, hartebeest and roan antelopes.

Further, the majority (93%) of respondents reported decreases in hunting success nowadays, as compared to when they started hunting. According to them, getting a decent catch now required travelling over long distances. Older hunters corroborated the hunters' reports that there was more bushmeat found around the village when they were younger, compared to recent times. The reported changes in bushmeat availability and declining returns for efforts were largely linked to pressure from livestock herders (Figure 6.6). Respondents reported indiscriminate tree cutting by herdsmen to feed their cattle, with the excessive noise generated by large herds driving wild animals farther away. Other reasons attributed to the reported decline in hunter's catch included an increase in number of hunters (33%) and a general decrease in wild animal populations (29%).

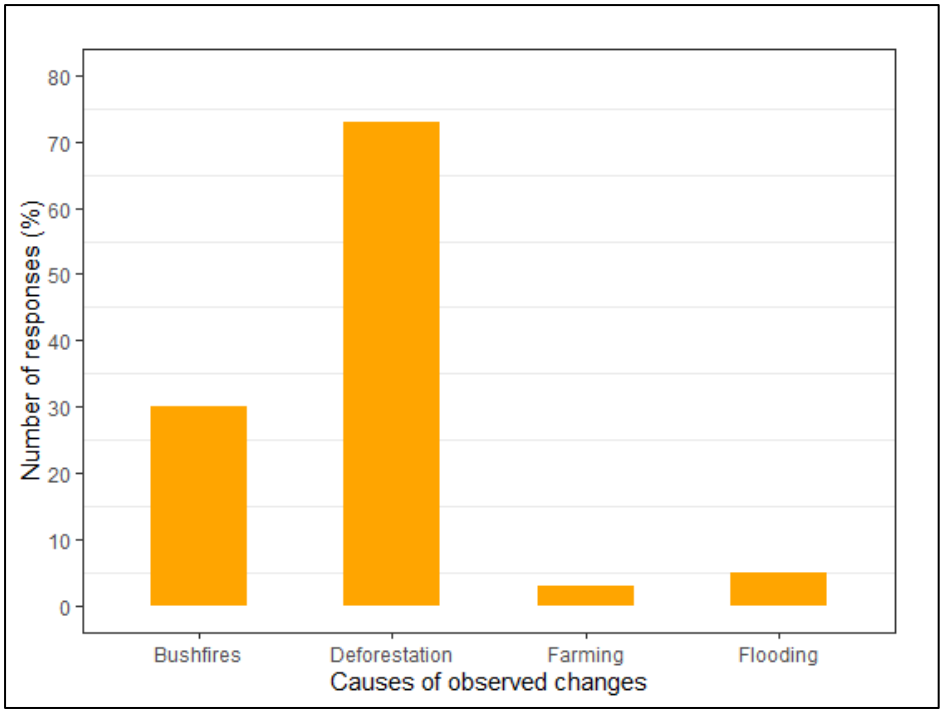

Figure 6.5. Causes of observed changes in the landscape as attributed by respondents.

Data were derived from responses of hunters who perceived a change (N=47).

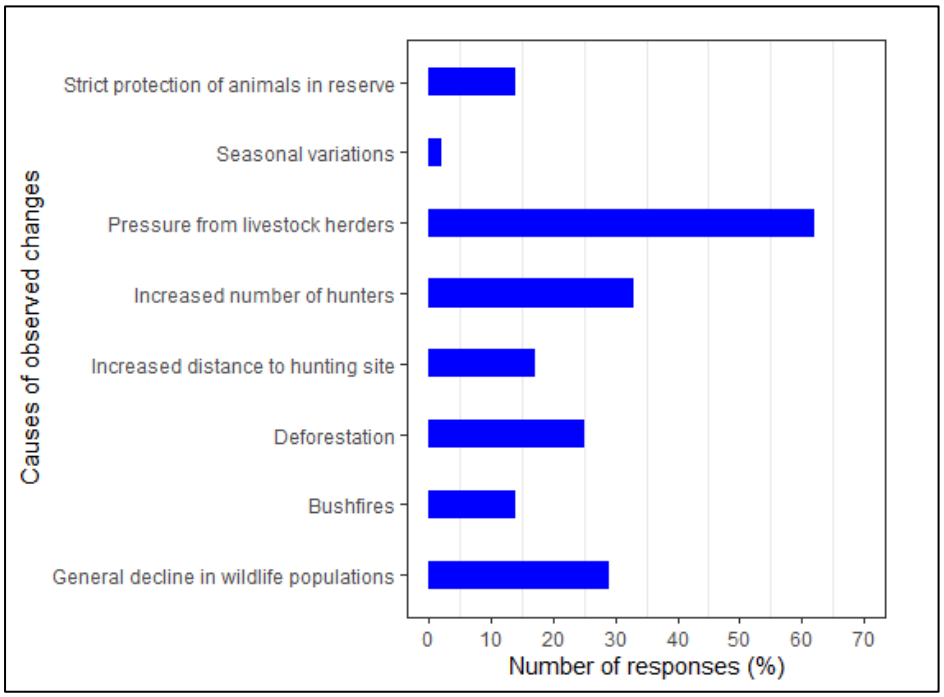

Figure 6.6. Causes of observed change in hunter's catch as attributed by respondents.

Data were derived from responses of hunters who perceived a change (N=52).

6.4 Discussion

6.4.1 Value of bushmeat hunting to rural households in northern Ghana

The persistence of bushmeat hunting despite the decline in wild animal populations perceived by respondents in this study suggests that hunting still plays an important role in rural livelihoods. Results of this study show that hunting in villages in northeast Ghana is practised for income, pest control and local consumption. Bushmeat however, seems to contribute relatively little to the hunters' livelihoods, compared to agriculture (crop and livestock farming) which was identified as the primary source of income for majority of respondents, as it is typical of hunters in most parts of Ghana (Cowlishaw *et al.*, 2005b; Sackey, 2014; Alexander *et al.*, 2015; McNamara *et al.*, 2016).

Patterns in agricultural activity explain the observed seasonal variation in hunting activities. The farming system in the study area was mainly traditional and undertaken by both men and women, unlike elsewhere where women are the main agricultural workers (e.g., Equatorial Guinea; Kümpel *et al.*, 2010). Most farming activities were carried out during the wet season (May-October), as farmers largely relied on rainwater. In contrast, hunting activities were reported to peak in the driest months (February to April) when less time is required for farm-work. The reported seasonality of hunting activities suggests that bushmeat provides a buffer against the effects of income shortage and acts as a safety net during seasonal income shortages. Similarly, Schulte-Herbruggen *et al.* (2013) identified hunting as an important alternative source of income for rural people in agricultural areas in southern Ghana during times of economic hardship. Switching to hunting in the absence of preferable alternative livelihood opportunities in the dry season (especially for men) would imply that provision of alternative livelihood sources in the dry season could help to reduce the level of hunting and therefore enhance species conservation efforts (Lindsey *et al.*, 2011). This could suggest further that

enhancing agricultural productivity and associated incomes (e.g., good markets for products) may have a beneficial impact on bushmeat exploitation if such improvements can generate more money per unit time spent than bushmeat hunting and trade.

The problem of crop raiding by wild animals has driven some farmers to hunt on their farms in order to protect their crops from damage. Aalangdong (2010) reported similar observations with farmers in the north of Ghana. Amongst crop-pests reported by farmers in the current study, rodents in particular are known to cause significant damage to a range of agricultural crops (Mwanjabe *et al.*, 2002; Mulungu *et al.*, 2003). Hunting crop pests might have some indirect benefits like contributing to household income by increasing crop yields and also meat yields as by-product (Alexander, 2011).

6.4.2 Hunter characteristics and hunting strategies

Hunters in West and Central Africa have been described as a heterogenous group consisting of a wide range of people using a wide range of methods (Coad, 2007; Kümpel *et al.,* 2009; Alexander *et al.*, 2015). Similar to this description, hunters in the case study villages exhibited different demographics and employed different hunting strategies. Hunters appeared to be relatively old. In addition, techniques and seasonal hunting patterns observed in the study were similar to those recorded in a previous study of hunting in some rural communities in northern Ghana (Aalangdong, 2010).

Shotguns were found to be the common hunting method employed to catch prey in both study villages. Gun hunting appears to be a popular method for bushmeat extraction in Ghana and elsewhere. Holbech (1998) reported that 78% of hunters preferred using guns for hunting in Bia Conservation area in the Western region, while Alexander *et al.* (2015) reported 86% preference for the use of firearms among professional hunters in three rural communities in the

Ashanti region. Guns were used in the majority (85%) of hunting trips recorded around Makokou in Northeast Gabon (van Vliet & Nasi, 2008). The high preference for gun hunting in this study could be because of its selective nature. Guns allow for a greater degree of prey selection in terms of both species and size (Kümpel *et al.*, 2009; Dobson *et al.*, 2019) and are reported to be efficient for ungulates and monkeys (van Vliet & Nasi, 2008). The prey types killed and sold by the hunters in this study suggests that bigger animals were the main targets.

Interestingly traditional weapons such as bow and arrow and cudgels are still in use in the study area, perhaps because they are part of cultural traditions, easily accessible or even offer a cheaper option, compared to use of guns which requires greater investment of money (Dobson *et al.*, 2019). The explanation given by some hunters for their infrequent use of traps compared to shotguns was because of the likely adverse impacts on domestic animals owing to their non-selective nature, particularly as livestock in the area are mostly kept on free range. This may also explain why, despite traps being found to be more effective than shotguns in the last expedition of hunters in this study, that shotguns continue to be markedly more popular. The reasons given for gun hunting trips in a study of bushmeat hunting in Gabon by Coad (2007) suggested that gun hunting yielded quick returns compared with trapping (in terms of timing and type of catches), and was often considered when a hunter needed to make money urgently. It is therefore not surprising that gun hunting has been identified to have played a key role in the escalation of the bush meat trade in the tropics (Dobson *et al.*, 2019).

Hunters have been observed to change hunting effort in order to maintain catch. For example, hunting farther from the village, laying more traps, hunting in a particular location or even hunting for longer periods of time (Coad, 2007; Kümpel *et al.*, 2009). The results of this study show that hunting success in the last expedition was higher in forest with open tree cover than forest with dense tree cover. A likely reason for this observation is that open vegetation allows

for easy sighting of prey as well as physical navigation through the landscape as compared to dense vegetation.

Although the parameters (e.g., number of years of hunting, time, methods, etc) tested in this study were non-significant predictors of hunting success, it is worth noting that the model was just based on the last hunting trips, which may not be typical of year- round scenarios. For instance, the majority of hunters (80%) confirmed that the time spent during the last hunting expedition was not typical of year-round situation. This observation is supported by the strong seasonal differences in hunting effort reported by hunters in this study, both in terms of time allocation, and landscape structure, with the dry season being associated with more open vegetation due to seasonal burning that facilitated sightings of prey. An additional consideration is that the binary nature of the response variable also meant that the model did not capture the number of animals hunted per successful trip. This would have likely captured a more nuanced picture of hunting success dynamics, potentially highlighting differences between experienced and inexperienced hunters more clearly.

In investigating important determinants of hunting success and understanding how these change over time, future work could adopt longitudinal approaches (e.g., Coad, 2007; Kümpel *et al.*, 2009). With large data samples, analyses could then be carried out separately for gun hunting and trapping, as the two techniques require different skills which are important for predicting hunting success (Coad, 2007; Kümpel *et al.*, 2009).

6.4.3 Determinants of hunting site selection

The observed selection of areas used for hunting in the two villages provide an example of how resource attributes can influence hunter decision-making and predictions of hunting site selection. Differences in the selection of areas by hunters may be largely dependent on the

availability or quality of the site (in terms of prey) and its accessibility (Wszola *et al.*, 2019). Distance to village was a strong effect in the model for both villages, implying that preferred hunting sites were closer to the focal villages but interestingly hunters still had to travel long distances away from the village to reach these hunting sites. Compared to studies by Alexander (2011), where hunters in forested regions of southern Ghana travelled on the average 7.7 km away from villages, or Coad (2007) where hunters in rural Gabon travelled up to a maximum of 10km away, hunters in Kayoro and Dominga travel an average of 17.9 km and 27.0 km respectively to preferred hunting grounds.

Unlike in Doninga, hunting at Kayoro is strongly focused towards areas with high tree cover as predicted by the model. A likely explanation for this could be that these are areas where remaining populations of large animals occur, or where animals seek refuge from the surrounding areas where most of the tree cover has been lost through anthropogenic activities (e.g., deforestation, seasonal burning). This scenario typically drives hunters towards such areas, especially where the surrounding catchments have been depleted of its large mammal fauna (Ripple *et al.*, 2016). Interestingly, most of these areas with high tree cover occurred in and around forest reserves and PAs, but the model did not show PAs to be a significant predictor of hunting site selection. Despite PAs not being a strong effect in the model, a visual inspection of the output of participatory mapping of sites used by hunters in this study show hunting sites which were located within or close to forest reserves and PAs, providing anecdotal evidence and support that PAs may be targeted. Globally, wildlife populations in terrestrial protected areas are increasingly being affected negatively by hunting pressures from surrounding communities (Geldmann *et al.*, 2013), despite high levels of formal protection. This often results in conflicts between park management and hunters who venture into PAs (Knapp, 2012; Lindsey *et al.*, 2015). At least two hunters recounted incidents where they had

previously been arrested for poaching within the Nazinga Game Ranch zone, and one hunter was reported to have been arrested during the study period.

Several CREMAs existed around the study villages, and some hunters actually described many as “empty”, possibly suggesting historical depletion of wildlife from these areas (Cowlishaw *et al.*, 2005a). Therefore, it is more likely that local hunters may be targeting wild animals which may stray from forest reserves and PAs to surrounding catchments. Unlike the PAs, which are under strict protection from the Wildlife Division of Ghana, the CREMAs are solely managed by community members and management efforts may not be as strong, hence likely to be encroached. As forest reserves and PAs appear to hold what is remaining of the important fauna typically hunted as bushmeat, such areas should be given the necessary management support to ensure their continued protection for wild animal populations.

6.4.4 Local perceptions of changes in landscape and bushmeat availability

The impact of overhunting on wildlife populations has been discussed extensively in the literature (Ripple *et al.*, 2016; Wilkie *et al.*, 2016; Dobson *et al.*, 2019), and hunting has been identified as a major factor driving many wild animal species towards extinction, particularly larger species (Fa & Brown, 2009; Ripple *et al.*, 2016). Although the impact of hunting on wild animal populations was not quantitatively investigated in this study, the findings provide information that could be used as a basis for conservation action and to inform management.

Perceptions of hunters in this study suggest that the population of most wild animal species in the area have undergone rapid decline. Over 90% of all hunters interviewed in this study reported decreased bushmeat catch in present times as compared to the past. This observation of decreasing returns could be a sign of wildlife depletion (Bassett, 2005; Cowlishaw *et al.*, 2005a). Some studies in Ghana have reported that many wild animal species which were

abundant in the country a few decades ago are either threatened or locally extinct now; at least two species, the manatee (*Trichechus senegalensis*) and the pygmy hippopotamus (*Choeropsis liberiensis*) have been extirpated (Ntiamoa-Baidu, 1987; Bakarr *et al.*, 2001; Conservation International-Ghana, 2002). According to respondents, larger species such as aardvarks (*Orycteropus afer*), African buffalo (*Syncerus caffer*), elephants (*Loxodonta africana)*, hartebeest (*Alcelaphus buselaphus*) and roan antelopes (*Hippotragus equinus*) have become increasingly scarce. Population trends of some of these species (e.g., African buffalo, roan antelope, hartebeest) show declines (IUCN, 2020).

Habitat deterioration is an important factor linked to declining wildlife populations (Ripple *et al.*, 2016). Generally, forest destruction and loss of biodiversity in Ghana have increased drastically (Dixon *et al.*, 1996; Hackman, 2014). The decreased catch by hunters and changes in the landscape of the hunting area reported in this study were related largely to wild animal habitat modification caused by pressures from cattle herders, deforestation and bushfires. The negative effects of increasing cattle populations on wildlife habitats in the area are likely to be very significant, given that explanations of wild animal depletion related to changes in animal habitats were mostly centred on the activities of Fulani herdsmen and their cattle. Bassett (2005) reported similar impacts of cattle expansion in a study of wildlife decline in northern Côte d'Ivoire. Cattle, particularly large herds, tend to open up dense vegetation depriving wild animals of refuge. Also, noise from large cattle herds frightens wild animals, thus forcing animal to move to 'safer' areas.

Activities such as deforestation and logging operations contribute to habitat loss and degradation. It appears there is heavy pressure on Ghanaian forests, mainly in response to demands for forest resources by the ever-growing population and agriculture expansion (Agyeman *et al.*, 2012). Bushfires are common in northern Ghana, often causing desertification

(Aalangdong, 2010). Seasonal bush burning as part of traditional agricultural practices and unintentional fires resulting from illegal activities of group hunters who sometimes start fires in order to flush out wild animals have been reported to have caused serious bushfires in the region (Aalangdong, 2010).

This study contributes towards our understanding of village hunting and practices in northern Ghana, and the societal and landscape level factors that influence hunting behaviour. The findings of this study have direct implications for conservation and wildlife management interventions in the northern savannah zone of Ghana. The majority of hunters are farmers and hunting intensity increases during periods when there is less time-commitment for seasonal farming activities, which would imply that providing alternative livelihood sources and income generating activities in the dry season could reduce hunting. The selection of areas used for hunting has highlighted wildlife areas at risk and hence an obvious need for regulation and monitoring of bushmeat hunting in the area. But this needs to go hand-in-hand with interventions to improve the quality of the landscape more generally for wildlife, including stopping tree clearance and over-grazing by livestock in key wildlife areas.

CHAPTER SEVEN

7.0 BUSHMEAT CONSUMPTION AND PREFERENCES OF RURAL HOUSEHOLDS IN THE UPPER EAST REGION OF GHANA

7.1 Introduction

Bushmeat is an important source of animal protein in many areas of Africa. However, hunting and consumption of wild animals is recognized as a significant driver of wildlife depletion (Ripple *et al.*, 2016). Furthermore, there is increasing global concern about the risks that trade and consumption of bushmeat pose to public health through the transmission of zoonotic diseases (Kamins *et al.*, 2015; Kurpiers *et al.*, 2015). Understanding factors influencing preferences for bushmeat and the patterns of consumption is important for developing management interventions aimed at reducing demand for bushmeat products and mitigating possible pathways for zoonotic disease spillover. Understanding the importance of bushmeat in household diets is also critical to address and take account of food security issues, particularly in rural settings (Cawthorn & Hoffman, 2015).

People eat bushmeat for multiple reasons. Numerous studies have highlighted the important contribution of bushmeat to dietary protein (Hoffman & Cawthorn, 2012; Nasi & Fa, 2015). It is also recognised as an important safety net, providing access to animal protein when alternatives are either not available or when household incomes are low; such as the seasonal lean period when agricultural production is limited. Reliance on bushmeat is determined by multiple factors such as household wealth (Fa *et al.*, 2009), household size (Albrechtsen *et al.*, 2007), ethnicity (East *et al.*, 2005; Ceppi & Nielsen, 2014) and livestock ownership (Ceppi & Nielsen, 2014).

Use of, and reliance on, bushmeat is well studied in various parts of Ghana. However, most of these studies are from the southern part of the country (Tutu *et al.*, 1996; Crookes *et al.*, 2007; Schulte-Herbrüggen, Cowlishaw, *et al.*, 2013; Alexander *et al.*, 2015; McNamara *et al.*, 2016), with limited reference to the northern areas. However, a comprehensive study of bushmeat harvest and use in the three major ecological zones of Ghana (forest, transitional and savanna) by Ntiamoa-Baidu (1998) found that bushmeat played a valuable part of the local diet in the northern savannah zone. Hence, the lack of information on the importance of bushmeat in diets in the northern territories of the country represents a notable gap in current knowledge.

This chapter provides insights into the importance of bushmeat in local diets, describing bushmeat preferences and consumption frequency, relative to the consumption of other animal proteins, among households in northern Ghana. It also provides a detailed understanding of the drivers of rural bushmeat consumption in the study area, information that is critical for demand management policies. The three primary objectives were to:

1) Profile households and their meat preferences, and explore factors influencing preferences for bushmeat.
2) Document composition of bushmeat species eaten.
3) Examine frequency of bushmeat consumption among households relative to domestic meat.

7.2 Methodology

Fieldwork was conducted from April to July 2019 in the two hunting villages of Kayoro and Doninga, in the Upper East region of Ghana. Detailed descriptions of these study sites, and the data collection methods, are presented in Chapter 3. Data were collected by a six-member team

(researcher, one field assistant and four trained local assistants), using household interviews. Prior to the main survey, four general group discussions were held in both villages (Kayoro = 2; Doninga N =2) to familiarise the research team with the community and collect general information about village life. Specific questions were asked about rural livelihoods, animal protein intake and bushmeat species being consumed in the study area.

Structured questionnaires (Appendix 3) were used to collect data on household demographics, livelihood activities, and animal protein consumption patterns. Specifically, respondents were asked basic details about the composition of the household, primary source of household income, hunting activities and whether or not the household reared domestic animals. Information on preferences and frequencies with which households consumed bushmeat and other meat types was obtained. Each participant was asked to state household preference from a choice of bushmeat and domestic animal meat. For the preferred meat type, respondents were further asked to state which species of bushmeat or type of domestic animal meat was preferred by the household. Respondents were also asked to report the frequency with which the household ate the preferred meat type using the categories: daily, weekly, monthly, occasionally and rarely. In addition, each respondent was asked to state and rank household preference amongst all of the different types of domestic and wild meat (i.e., beef, goat/sheep, poultry, pork), fish and bushmeat that were available to households in both villages.

Interviews were conducted with either the household head or the wife of the household head to ensure responses were representative of household consumption patterns. Data were not collected at the individual level on preferences and consumption of bushmeat, hence results represent household-level data only. This was done with the aim of gaining collective understanding of choices made for the household meal rather than preferences of individuals who might not have the power to act on those preferences. Prior consent was obtained from

respondents before the interviews. No household declined to be interviewed and respondents were comfortable to provide information on their households. Ethical approval for the study was obtained from the Ethics Committee for the College of Basic and Applied Sciences (ECBAS) of the University of Ghana (ECBAS 040/18-19).

7.2.1 Data analysis

All statistical analyses and tests were conducted using the R statistical package version 3.6.1 (R Core Team, 2019) and SPSS version 20.0 for Windows software. Significance tests were performed for frequency data using Chi-square tests.

Preference and consumption patterns for the different animal protein (domestic meat, bushmeat and fish) were assessed separately and differences between the two case study villages (Kayoro and Doninga) were explored. To provide an overall view of preference, a preference score was calculated for each of the six animal protein types by assigning a score that reflects the preference for that protein: 0 for 6^{th} choice (least preferred) and 1 if 1^{st} choice (most preferred). A total score for each animal protein type was calculated by summing preferences across respondents.

To investigate the factors influencing household preference for bushmeat, five parameters (village, household size, gender of household head, number of livestock and whether or not households hunted on their farm) were assessed for their effect on bushmeat preference, using binomial generalized linear models (GLMs). A household's bushmeat preference was classified as a binomial response where "1" represented preference for bushmeat and "0" represented no preference. The inclusion of the five variables in the model was guided by literature and hypotheses about their influence on bushmeat preference and consumption (Table 7.1). Hunting on the farm to protect crops from pests was observed to be more prevalent amongst

households in Doninga than Kayoro. Given that there are likely to be a number of differences between villages, including this one, 'village' was included as a factor.

The analysis was run on data from 342 households for which data on all five explanatory variables had been obtained. Potential explanatory variables like gender, age and education were individual-specific and hence were not included in the household-level analysis (Kümpel *et al.*, 2010). The full model was dredged for all subset models and the top model set (models within 2 AICc units of the top model) were selected based on Akaike's information criterion corrected for small sample size (AICc) (Symonds & Moussalli, 2011). Model averaging was then performed for the set of top models to provide unconditional parameter estimates and z statistics for parameter significance. The relative importance of each variable in predicting bushmeat preference was assessed using the *importance* function from the *MuMin* package (Barton, 2009).

Table 7.1. Summary of model variables selected for inclusion in the bushmeat preference model.

Model variable	Rationale for inclusion	Literature
Livestock (number of domestic animals owned)	Bushmeat preference will be lower in households that own more domestic animals, as livestock ownership may provide means of generating cash income and access to alternative sources of animal protein.	Loibooki *et al.,*2002; Ceppi & Nielsen, 2014
Household size (number of people in the household)	Bushmeat preference will be higher in large households. If bigger households have lots of young men in it, they may have surplus labour that enables hunting or may have higher income.	Albrechtsen *et al* 2007
Gender of the household head	Bushmeat preference will be lower in female headed households. Such households are more vulnerable particularly at times of economic hardships.	Schulte-Herbrüggen *et al.*, 2013
Farm-hunting	Bushmeat preference will be greater in households that hunt on their farm. Having a hunter in the household or hunting on the farm may provide easy access to bushmeat.	Ceppi & Nielsen, 2014; Alexander *et al.*, 2015

7.3 Results

7.3.1 Household characteristics

A total of 471 household interviews were conducted (Table 7.2). These comprised 275 interviews in Kayoro and 196 in Doninga. The inhabitants of Kayoro belong to the Kasena ethnic group and those in Doninga are Builsas. The majority (79%) of households were headed by males and household sizes ranged from five to 25 individuals per household. In both villages, families engaged in combinations of livelihood activities, with crop farming being the most common activity. Some households kept livestock in traditional production systems (e.g., goats, sheep, cattle, poultry). The majority of households interviewed listed crop farming as the primary source of income (Doninga= 80%; Kayoro=61%). Some interviewed households also relied on livestock as a main source of income (Table 7.2). Traditionally livestock are regarded as a sign of wealth accrual and in both villages interviewed households relied on livestock for additional income. This was often used to cover exceptional expenses or to solve family problems. Consumption of livestock is generally reserved for special occasions and during traditional ceremonies.

Less than 2% of households considered hunting as a primary source of income in both villages. The number of households who hunted as an alternative rather than a primary source of income was significantly higher in Doninga than Kayoro (χ^2=182.7, df =1, P<0.05). Some households also reported hunting opportunistically on their farms (76 households) as a way of protecting their food crops from damage by pests, this was significantly higher in Doninga (59% of households) than Kayoro (41% of households) (χ^2=10.4, df =1, P<0.05). Apart from hunting, some households engaged in seasonal collection and selling of non-timber forest products from the bush (e.g., shea fruits *Vitellaria paradoxa* and locust bean *Parkia biglobosa* fruits).

Table 7.2. Demographic characteristics of households in the two villages surveyed.

	Location	
Demographic parameter	**Kayoro (n=275)**	**Doninga (n=196)**
Household size (mean ± SD)	6.1 ± 3.0	6.3 ± 2.9
1-5	45.1%	42.6%
6-10	48.0%	50.3%
11-15	5.5%	6.2%
16-20	1.5%	1.0%
Primary source of income		
Crop farming	60.7%	80.1%
Livestock rearing	31.3%	6.6%
Hunting	1.8%	0.5%
Trade/shop/small business	2.9%	1.5%
Salary jobs	1.1%	1.0%
Collecting and selling products from bush	1.8%	8.2%
Other sources	0.4%	2.0%

7.2.2 Meat preferences and factors determining preference for bushmeat

Across all households, there was no statistically significant difference in preference between domestic meat and bushmeat. Slightly more than half (53%) of all households surveyed indicated a preference for domestic meat while the rest preferred bushmeat. In Kayoro, a significantly higher number of households preferred domestic meat to bushmeat (60%; χ^2 = 11.9, df = 1, p< = 0.05). In contrast, in Doninga there was no significant difference between preferences for bushmeat and domestic meat (56% bushmeat; 44% domestic meat; Appendix 11).

The results of the binomial GLMs (Table 7.3) showed that village, household size and farm-hunting were significant predictors of bushmeat preference among the households interviewed. Bushmeat preference was 0.57 times lower in Kayoro than Doninga, which could be linked to the higher prevalence of hunting on farms in Doninga than Kayoro, providing easy access to bushmeat. Household size was positively associated with bushmeat preference, with a unit increase in household size leading to a nine percent increase in bushmeat preference. Whether or not a household hunted on their farm also had significant effect on bushmeat preference, with households which engaged in farm-hunting 2.7 times more likely to prefer bushmeat than those who did not. Neither gender of the household head, nor number of livestock they owned were significant predictors of bushmeat preference.

Table 7.3. Results of Binomial GLM analysis assessing factors influencing bushmeat preference, based on the household surveys. *Results are model-averaged parameter estimates and their relative importance across top models (delta AICc <2). *Baseline reference for explanatory variable.*

Explanatory variable		Estimate	Std. Error	z value	Pr(>|z|)	Relative importance
Intercept		-1.07	0.51	2.09	<0.05	
Farm hunting (No*)	Yes	1.30	0.35	3.71	<0.01	1
Household size		0.09	0.04	2.14	<0.05	1
Village (Doninga*)	Kayoro	-0.85	0.28	2.96	<0.01	1
Gender of household head (Female*)	Male	0.61	0.47	1.30	0.19	0.8
Number of livestock owned		0.02	0.01	1.17	0.24	0.75

There were significant differences in the reasons why households preferred different meat types (χ^2=291.92, df =6, P<0.05). Bushmeat was mainly preferred for its taste (70%) and meat quality (i.e., relatively less fat; 20%), while domestic meat was preferred for its availability (82%) (Figure 7.1). Very few respondents (6%) cited availability of bushmeat as a primary reason for preferring it, suggesting that domestic meat was more readily available compared to bushmeat.

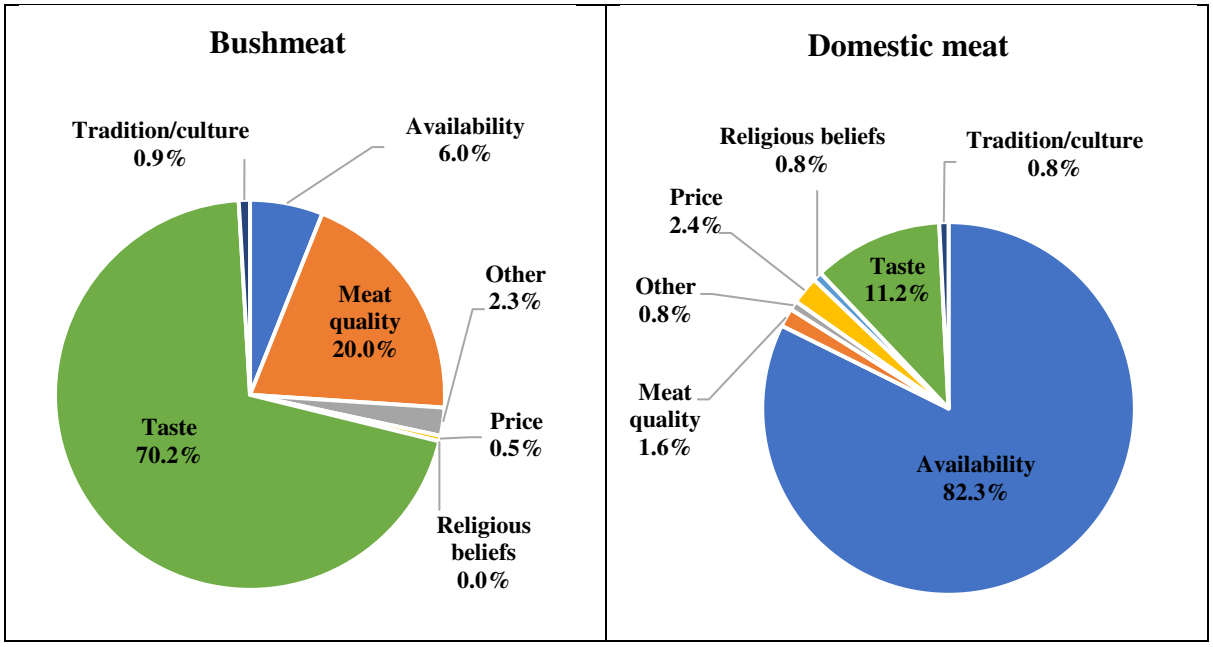

Figure 7.1. Reasons cited by respondents for household preference for either bushmeat (N=215) or domestic meat (N=249). *Data derived from stated primary reason for meat preference (question 24 of household questionnaire, Appendix 3) hence no more than one response was given.*

Fourteen species of wild animals were listed as the preferred bushmeat species, from a range of species groups (Figure 7.2). However, preferences were strongly focused on only a few species. The grey duiker (*Sylvicapra grimmia*) was the most preferred bushmeat species

followed by African savannah hare (*Lepus victoriae*). These two accounted for 38% of stated preference. The grasscutter (*Thryonomys swinderianus*), common warthog *Phacochoerus africanus* and helmeted guinea fowl *Numida meleagris* were the next three most commonly preferred species. Together, these five species accounted for 66% of all preferences. Preferences were not however uniform in both communities. In Kayoro the preferred species was the grey duiker followed by the grasscutter; while in Doninga the preferred species was the African savannah hare followed by the grey duiker (Appendix 12). The bushmeat preference data also reflected the existence of taboos. For example, monkeys and crocodiles were commonly regarded as tabooed animals in the study area, and were either not mentioned at all, or only occasionally referenced as being a preferred species type.

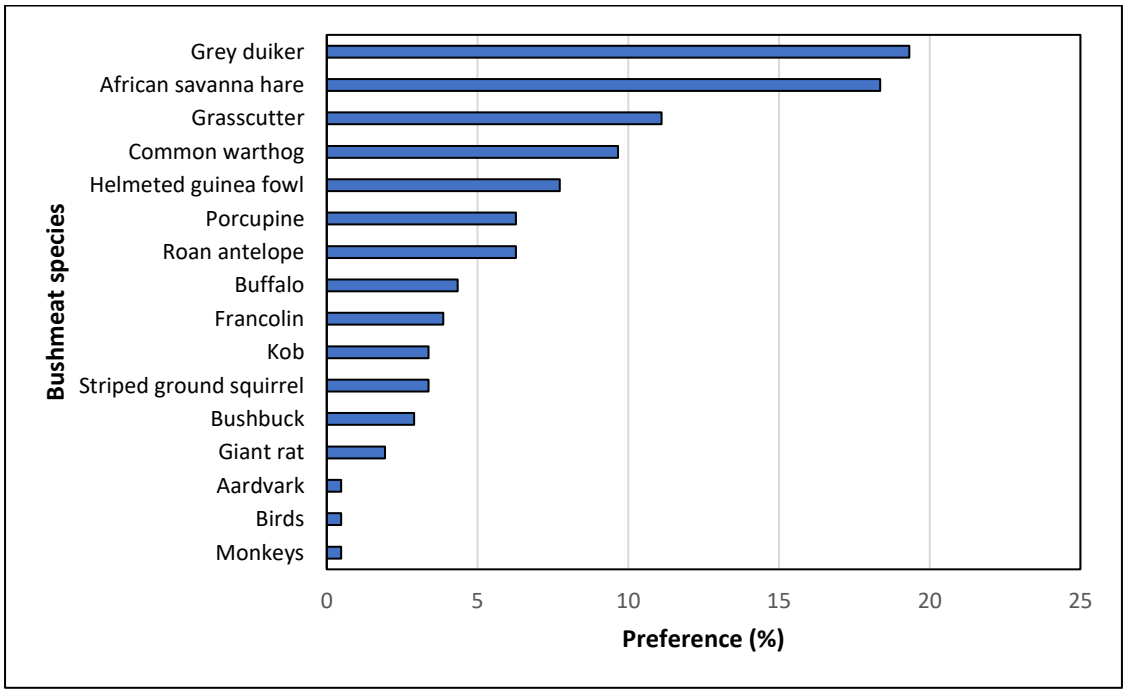

Figure 7.2. Bushmeat species preference by households interviewed. *Data is derived from combined responses (N= 207) obtained for households that stated a preference for bushmeat (question 25 of household questionnaire, Appendix 3).*

7.3.3 Ranking preferences

In the household interviews, respondents were asked to rank the six most common types of animal protein available to households, in order of preference, "1" being the most preferred and "6" the least preferred. Fish was the most frequently selected as a first-choice animal protein in Kayoro (33%), followed by poultry (26%) and bushmeat (16%). Mutton and pork were the least selected, in that order (Figure 7.3). In contrast, in Doninga fish and bushmeat were equally selected as the most preferred meat types (31% each; Figure 7.3) followed by poultry (18%).

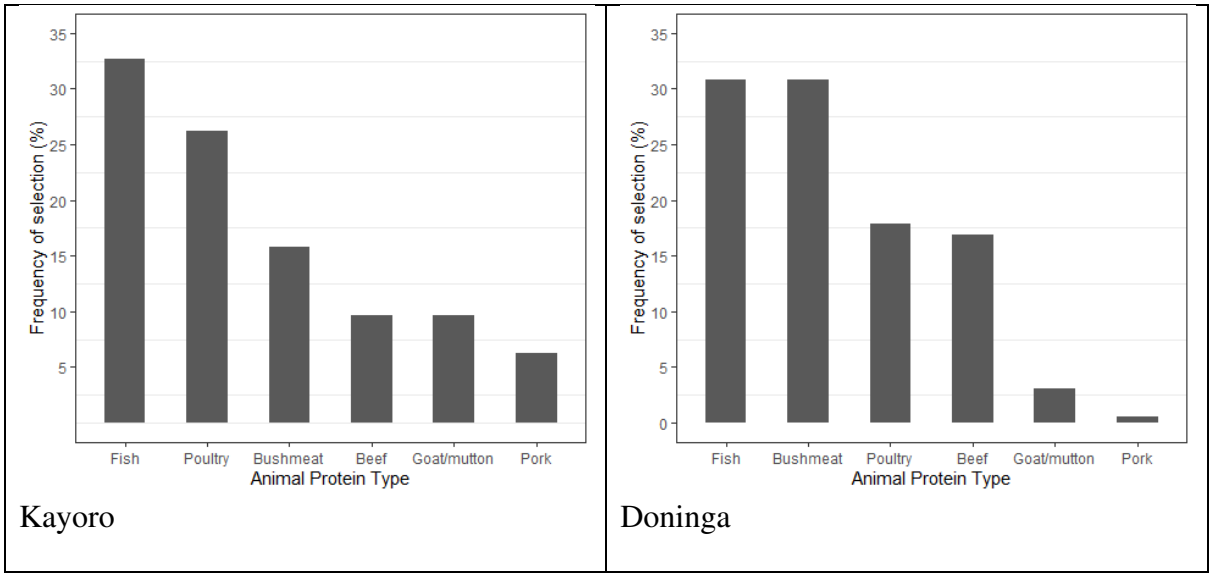

Figure 7.3. Stated preferences for fish and different types of meat among respondents (N= 455; Kayoro= 260, Doninga= 195). *Data were derived from stated preferred (first-choice) animal protein for different locations.*

In terms of preference scores however, for the overall survey, fish was ranked as the most popular animal protein, followed by poultry, then beef (Appendix 13). Bushmeat was ranked

the fifth most preferred animal protein, with pork being the least preferred in the two study villages.

7.2.3 Frequency of bushmeat consumption and general protein intake of households

Kayoro and Doninga exhibited distinct differences in domestic meat and bushmeat consumption frequencies (Figure 7.4). In Kayoro 39% of households ate domestic meat weekly and 3% ate it on daily basis. On the other hand, only 4% of respondents in Doninga ate domestic meat weekly, with the majority, 85%, reporting consuming it only occasionally, usually during celebrations and traditional ceremonies. The observed difference in consumption frequency of domestic meat between the two villages was statistically significant (χ^2=141.80, df =5, P<0.05).

Only 1% of households reported eating bushmeat on daily basis in Kayoro. By comparison, in Doninga no household reported eating bushmeat on a 'daily' basis (Figure 7.4). However, bushmeat was eaten irregularly and the consumption frequency differed significantly between the two villages (χ^2=46.30, df =6, P<0.05). Across both villages, 51% of interviewed households reported having eaten bushmeat at home in the six months prior to the interviews (53%- Kayoro; 48%-Doninga). Most households surveyed in both villages stated that they ate bushmeat 'occasionally' (45%-Kayoro; 76%- Doninga). A notable number of respondents in both villages stated that they 'rarely' ate bushmeat (28%- Kayoro and 15%-Doninga). Overall, it appears bushmeat was consumed less frequently than domestic meat, and less in Doninga than in Kayoro.

The observation of low bushmeat consumption was confirmed by the focus group discussions in both villages, which indicated that households rarely ate meat of any type, be it domestic meat or bushmeat. According to one participant *"within three months one may have eaten meat only once"* (focus group discussion in Kayoro, 27 May 2019). Participants indicated that

smoked fish (herrings) and plant proteins (primarily *dawadawa*- traditionally processed Locust beans *Parkia biglobosa*) were important components of household diets in both villages, with these being eaten more often.

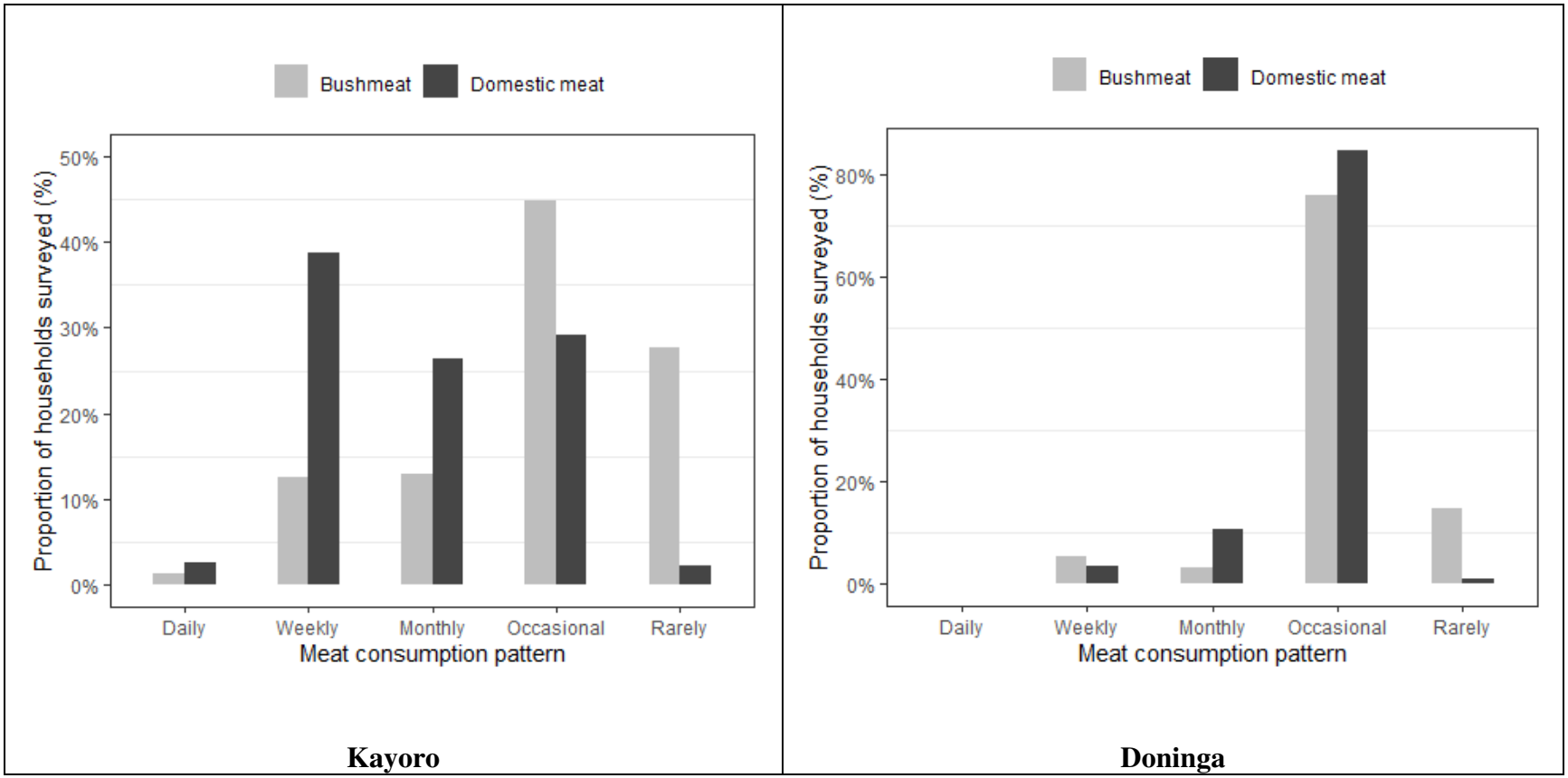

Figure 7.4. The frequency with which bushmeat and domestic meat is eaten by households in Kayoro and Doninga. *Data is derived from combined responses for the different types of meat (Bushmeat= 421, Domestic meat= 450) (questions 27 and 29 of household questionnaire, Appendix 3).*

7.4 Discussion

The results of this study show that bushmeat is not a widely eaten form of dietary protein in northern Ghana, as it has been shown to be in the southern part of the country (Ntiamoa-Baidu, 1998; Sackey, 2014). While fish was ranked the most preferred amongst households in this study, bushmeat was ranked only as the fifth most preferred animal protein. In Ghana more generally, although fish is a widely consumed animal protein, and typically constitutes the main source of animal protein for the majority of people in the country (Ntiamoa-Baidu, 1998; Brashares *et al.*, 2004; Alexander *et al.*, 2015; McNamara *et al.*, 2016), bushmeat was usually the most preferred among people when given the choice. For example, bushmeat was ranked as the most preferred source of animal protein by the majority of the respondents (63%) in a survey of consumers in the Mankessim area, in the Central region of Ghana (Sackey, 2014).

Location may influence the preference and consumption of bushmeat through availability (Jenkins *et al.*, 2011). Areas with high abundance of wild animals exploited as bushmeat may exhibit higher preference and consumption rates compared to localities where wild animal stocks have been depleted, where preference may be skewed towards those protein types that are more available (van Vliet *et al.*, 2014). For instance, in a wildlife-depleted farm-forest landscape in southwest Ghana, Schulte-Herbrüggen *et al.* (2017) found that fish, livestock and food crops constituted 85% of total protein intake. In most studies in Ghana there is a clear indication that the majority of people who eat meat would eat bushmeat if it were readily available (Owusu *et al.*, 2004; Alexander, 2011; Sackey, 2014). This is supported by the responses of people interviewed for this study. While only a few households interviewed cited availability as the reason for bushmeat preference, most households (82%) preferred domestic meat because of its availability, which could suggest that bushmeat was not widely available, and may be consumed more if it were.

Although differences between localities in species consumed may generally be a reflection of species availability within the locality, other factors including preference, taste and ethnic background may also determine such differences in preferences (Schenck *et al.*, 2006, Jenkins *et al.*, 2011). In this study, preference for a wide variety of species including birds, hares, rodents and ungulates was observed. This differs in other parts of Ghana. Falconer (1992) found that grasscutter was the most popular with consumers in Kumasi, followed by Maxwell's duiker and royal antelope. Reasons for this can be differences in vegetation, with the study area being a savannah zone, and hence variation in type of species found there. However, despite this variation, preferences were still dominated by only a few species. The two most preferred species among interviewed households were the grey duiker and African savannah hare. The grasscutter, common warthog and helmeted guinea fowl were the next most commonly preferred by households, but some difference existed between the two villages.

A wide variety of preferred bushmeat species has been reported previously among rural consumers in the savannah regions of northern Ghana by Ntiamoa-Baidu (1998). The findings of that study included the three species recorded as most preferred in the current study. Differences in preference for species consumed as bushmeat between localities could also arise from cultural beliefs and norms grounded in ethnic backgrounds. Fa *et al.* (2002) for instance provides an example of significant inter-tribe differences in harvest, preference and consumption of bushmeat between the Fang and Bubi ethnic groups in Bioko Island, Equatorial Guinea. Similarly, Morsello *et al.* (2015) identified that cultural attributes were a stronger predictor of bushmeat consumption and preference among Amazonian towns than socioeconomic factors. Within the two villages in this study, species such as monkeys were mentioned among the least preferred species as these were tabooed, highlighting the existence of cultural links to bushmeat consumption and preference.

Bushmeat has been described as a cheap form of animal protein, especially for poor rural households (Mgawe *et al.*, 2012; van Vliet *et al.*, 2012) and there is a general view that bushmeat plays an important role in the diets of rural people, constituting a substantial component of animal protein intake, especially in poorer households (Schulte-Herbrüggen *et al.*, 2017). Historically, in Ghana bushmeat was hunted mostly for household consumption; even when hunters' catches were sold for cash, smaller-bodied species were maintained for consumption within the hunter's household (Asibey, 1974; Ntiamoa-Baidu 1987; 1998). In recent times however, intense commercialisation of the trade is driving bushmeat prices up and causing hunters to sell to urban traders for higher value rather than on local markets. Hence within poor rural communities such as the ones in this study, the common source of bushmeat may likely be through purchase and not harvest.

A household's involvement in hunting or having a hunter within a household has been shown to influence access to bushmeat and consumption (Ceppi & Nielsen, 2014; Alexander *et al.*, 2015). In this study, hunting on the farm increased the likelihood of bushmeat preference, suggesting that such opportunistic ventures provide households with a free source of animal protein as it requires less investment of time and equipment than hunting in the forest, and at the same time offers protection for their farms from crop pests. More households hunted on their farms in Doninga than Kayoro, which could be related to the observed greater preference for bushmeat in Doninga than Kayoro. According to interviewed households, even when bushmeat is hunted mainly for the purpose of selling for cash, parts such as the head and internal organs may be retained within the household for consumption.

Taste preferences often influence bushmeat consumption (Schenck *et al.*, 2006; Sackey, 2014), and are commonly cited as a reason for the wide range of species eaten within West Africa (Alexander, 2011; Taylor *et al.*, 2015; Luiselli *et al.*, 2019). Bushmeat is described as a tastier

animal protein than domesticated meat and this drives the consumption of bushmeat in Ghana, particularly among urban dwellers in the south. The grasscutter, in particular, is a popular bushmeat species amongst consumers in Ghana, mostly because of its preferred taste. In most consumer surveys carried out in southern part of the country, the grasscutter was the most preferred bushmeat by a majority of the respondents followed by duikers (Ntiamoa-Baidu,1998; Owusu *et al*, 2004; Sackey, 2014). Taste preference for bushmeat species may be related to availability.

Even in the face of urbanisation and commercialisation of the bushmeat trade, the contribution of bushmeat to rural protein intake may still hold for some places, and the frequency of consumption may vary based on location. For example, East *et al.* (2005) found that bushmeat was an important component of the Equatoguinean diet and was eaten frequently. In Ghana, however, it appears that the dependence of rural people on bushmeat as a main source of animal protein has drastically declined (Tutu *et al.*,1996; Ntiamoa-Baidu, 1998; Alexander, 2011). Schulte-Herbrüggen *et al.* (2017), however, reported that bushmeat contributed substantially to protein consumption for some rural households in southwest Ghana. In this study, few people consumed meat regularly if at all. This finding is in line with findings of at least two other studies in Ghana. In a survey of bushmeat consumption across the country, Ntiamoa-Baidu (1998) found that over half of the respondents ate bushmeat irregularly, and the average frequency of consumption was lower in rural areas than urban. More recently, in a rural system studied by Alexander *et al.* (2015) in the southern part of the country, they found that bushmeat was not consumed regularly in any of the villages, even though the majority of households surveyed reported eating bushmeat. It appears the decreased bushmeat consumption is occurring in both rural and urban areas in Ghana, even though the rural-urban contexts might not be driven by similar factors. For instance, McNamara *et al.* (2016) reported a significant

decline in bushmeat consumption between 1990 and 2011, in a survey of consumer behaviour in Ghana's second largest city, Kumasi.

The low household-level consumption of bushmeat in this study is likely to revolve around a combination of factors including urbanisation, trade commercialisation and availability. The urbanisation and commercialisation of the trade may be causing rural poor communities with little money, the inability to sustain their diets on the now-expensive bushmeat. In fact, hunter-farmers and professional hunters may prefer to sell their entire catch for extra money, particularly to urban traders outside their villages where they fetch higher prices, rather than in their villages where the catch may have to be sold at relatively cheaper prices. The rural communities in northern Ghana have the highest poverty rates in the country (Aalangdong, 2010; Ghana Statistical Service, 2018) and hence, many households may not be able to afford bushmeat as part of a regular meal.

Economic factors such as household income and wealth may discourage bushmeat consumption. Indeed, studies have shown a direct link between wealth and bushmeat consumption in many places (East *et al.*, 2005; van Vliet *et al.*, 2012). In a cross-sectional study of the role of prices and wealth in consumer demand for bushmeat in Gabon, Wilkie *et al.* (2005) found that consumption of bushmeat, fish, chicken and livestock all increased with wealth. These economic factors restricting the preference and consumption of bushmeat do not apply only to rural areas but also persists in urban centres in southern Ghana. For example, in a study of three communities in southern Ghana, Tutu *et al.* (1996) found that scarcity and price were the most frequently cited reasons for decreased bushmeat consumption and thus bushmeat accounted for less than 5% of the total animal protein consumption in both rural and urban communities, while fish contributed the largest proportion. More recently, in a report of consumer behaviour in Kumasi, Ashanti region, McNamara *et al.* (2016) found significant

decline in stated preference for bushmeat between 1997 and 2011 due to high prices, with increasing preference for less expensive proteins. In this same urban setting, bushmeat demand was shown to be positively correlated with income (McNamara *et al.*, 2019).

The findings of this study provide useful information on bushmeat consumption among rural households in northern Ghana and can help inform management of the system. Farm hunting, location and taste were found to be important determinants of preference for bushmeat, and a wide variety of wild animals were preferred. However, distinct differences existed between the two villages studied in terms of household bushmeat preferences and consumption frequencies, with explanations for these differences being related to availability and access to bushmeat. Even though frequency of bushmeat consumption was found to be low in the two study villages, bushmeat still played an important role in household meat consumption, in addition to fish and plant proteins. In the absence of bushmeat, meat intake levels could even be lower in these rural households.

CHAPTER EIGHT

8.0 GENERAL DISCUSSION

Bushmeat hunting is widespread throughout sub-Saharan Africa and a vital component of people's livelihoods in rural communities. The harvest of and trade in bushmeat occurs at different scales, from harvest by subsistence hunters to organized commercial exploitation, for both local and national markets. Commercial hunting and trade have the advantage of generating significant income, with hunting particularly important for poor households, notably in periods when agricultural income is low (Schulte-Herbrüggen *et al.*, 2013). However, overexploitation of wild animals due to these commercial activities has been identified as playing a major role in escalating the bushmeat trade in West and Central Africa, driven in part by growing human populations. The bushmeat trade thus poses a significant threat to harvested wildlife and the livelihoods of those engaged in the trade.

Much of the research on bushmeat in West and Central Africa has shown the unsustainability of harvest rates and the consequent impact of bushmeat exploitation on species declines (Fa *et al.*, 2006; Abernethy *et al.*, 2013; Wilkie *et al.*, 2016). Across Africa, savannah ecosystems have been found to be among the most vulnerable to these challenges, yet have received little attention (Lindsey *et al.*, 2013; van Velden *et al.*, 2018). The drivers of bushmeat hunting and trade are complex and diverse, and this makes it difficult to attribute a decline in population of any individual species to a single driver or to safely assume that these drivers cut across regions. Knowledge of harvest patterns and factors influencing volume of trade and individuals' hunting and trading behaviour is therefore important for improving our understanding of the level and extent of hunting and trading of bushmeat, and therefore its potential impact, as well as the extent to which local people depend on it. Such an understanding is needed to inform

appropriate and equitable management strategies and interventions to reduce the supply and demand for bushmeat, and provide basis for recommendations on how best to manage the trade for the benefit of both people and wildlife.

This thesis investigated bushmeat hunting, trade and consumption dynamics in the Upper East Region of Ghana, undertaking the first comprehensive survey of rural markets and communities to understand both the human and ecological dimensions of the exploitation of, and trade in, bushmeat in the rural savannah zone of the country. The findings of this study are presented in four chapters;

- Market dynamics of bushmeat species in northern Ghana;
- Bushmeat supply chains in northern Ghana: characteristics and extent of trade;
- Determinants of hunting behaviour in rural communities in the Upper East region of Ghana;
- Bushmeat consumption and preferences of rural households in the Upper East region of Ghana.

The main findings of each chapter are discussed within them. This section of the thesis draws together the key findings and discusses the main factors driving bushmeat harvest, trade and consumption and the implications for species conservation and general management of wildlife resources.

8.1 Bushmeat exploitation, trade and wild animal population declines

Bushmeat hunting is an important driver of wildlife depletion, and the indication that the current scale of hunting poses a severe threat to many vulnerable wildlife species has been discussed extensively in the literature (Abernethy *et al.*, 2013; Petrozzi *et al.*, 2016). Ripple *et*

al. (2016) identified 301 threatened mammal species for which hunting by humans was identified as the primary threat. Indeed, the scale of the bushmeat trade in Ghana has been long-recognised as being of concern. Since the 1960s, concern has been raised about the sustainability of the bushmeat trade in the country (Asibey, 1966; 1974; Ntiamoa-Baidu, 1987; 1998). This study provides anecdotal evidence suggesting that wildlife populations in the study area may be depleted of large mammals (Chapter 4). Though caution must be used when using market data to assess the condition and status of fauna, analysis of the composition of species and volumes traded on markets can provide valuable insight and understanding of market dynamics, including wildlife extraction rates across landscapes and potential depletion (Fa *et al.*, 2006, Fa *et al.*, 2015; McNamara *et al.*, 2016).

Anthropogenic pressures have been found to negatively affect composition of species in bushmeat markets in Africa. The underrepresentation of large bodied species like ungulates in local markets that were surveyed, with a high prevalence of smaller animals dominated by frogs is suggestive of historical depletion due to hunting pressure on wild animal populations (Chapter 4). The observations in this study, along with reported decline in bushmeat availability (decrease in general numbers and specific species) by local hunters (Chapter 6) support the claim that the level of off-take is in decline and large-sized prey may be depleted. Similar reports of declines in the availability of large-sized mammals traded have been observed in other areas in Africa. Gonedelé Bi *et al.* (2017) found that the bushmeat sold in restaurants around Dassioko Sud Forest Reserve in Côte d'Ivoire comprised of a high proportion of small mammalian prey. This observation from their study was linked to increasing hunting pressure and impact of habitat degradation on mammals in the area. In a study of 79 bushmeat markets in an area of Nigeria and Cameroon, Fa *et al.* (2015) also observed that the proportion of large-bodied mammals (> 10 kg) decreased, with markets increasingly dominated by small-bodied mammals (< 1 kg) as human population density increases. Some earlier market surveys in

Ghana have also shown that the bushmeat trade is increasingly dominated by robust and fast reproducing species (Falconer, 1992; Ntiamoa-Baidu, 1998; Swensson, 2005; McNamara *et al.*, 2016). For example, Cowlishaw *et al.*, (2005a) recorded a higher proportion of carcasses of robust taxa such as rodents and small antelopes in the Takoradi market. Furthermore, McNamara *et al.* (2016) observed a shift in the profile of the bushmeat species entering the Kumasi market, reflecting an increase in the ratio of rodents to ungulates, from 1:4 in 1990 to 5:8 in 2011. The rodent: ungulate ratio can be a sign of depletion; depleted areas tend to have a higher proportion of rodents than ungulates (Rowcliffe *et al.*, 2003) as rodents tend to be more robust due to their high reproductive rates.

8.2 Drivers of bushmeat hunting, trade and consumption

There has been growing interest in understanding the sustainability of bushmeat use and factors that influence its harvest (Brugiere & Magassouba, 2009; Lindsey *et al.*, 2013). The drivers of bushmeat hunting, trade and consumption include: lack of alternative livelihoods; increasing demand for bushmeat, especially in large urban centres; and a lack of appropriately enforced legislative mechanisms (Cawthorn & Hoffman, 2015). Understanding these drivers is important in developing conservation and management strategies aimed at changing unsustainable hunting practices and trade, and improving the welfare of rural people.

8.2.1 Lack of alternative livelihoods for people

Hunting for bushmeat has been reported to be an important component of rural livelihood strategies in many areas of West and Central Africa (Kümpel *et al.*, 2010; Alexander *et al.*, 2015). The observed hunting and trading dynamics in the three case study markets and two villages provide an example of how other livelihood activities can influence an individual's

hunting and trading behaviour. The results provide strong evidence to suggest that seasonal variation in the bushmeat trade was linked to variation in labour requirements for agricultural activities. The comparison of bushmeat traded in the dry and wet seasons showed that the trade doubled in the dry season when agricultural production was limited (Chapter 4), suggesting that bushmeat hunting tends to increase under conditions of economic hardship (as also found by Nasi *et al.* 2008 and Schulte-Herbrüggen *et al.* 2013). This observation suggests that bushmeat may provide a buffer against the effects of income shortage and act as a safety net during seasonal income shortages (Schulte-Herbruggen *et al.*, 2013; Alexander *et al.*, 2015). Similarly, Kümpel *et al.* (2010) found that hunting was an important source of 'fall-back' income for men in rural Equatorial Guinea, in the absence of other alternative livelihood opportunities.

The economy of the study area is predominantly agricultural, which in turn is subject to seasonal variation, but as in most west and central African rural areas, the means of subsistence also include hunting, livestock rearing, fishing and gathering of products from the bush. Many rural people however, have limited alternative income generating avenues in the dry season. The seasonal reliance on hunting, implies that provision of alternative livelihood sources in the dry season could be of particular benefit in reducing the level of hunting and thereby indirectly supporting species conservation efforts. This is buttressed by the finding that the amount of time and resources that a household invests in hunting are dependent on the household's engagement in other livelihood activities such as agriculture (as also found by Schulte-Herbruggen *et al.* 2013 and McNamara *et al.* 2016). Hence, in a situation where livelihood opportunities are limited and often seasonal in nature, hunting provides an important level of livelihood security; this needs to be understood in order to design effective management interventions.

8.2.2 Urban demand, bushmeat exploitation and trade

Compounding the problem of the adverse impact of hunting on many wild animal species is the emergence of a booming commercial bushmeat trade and the existence of well-established networks supporting hunting and trading activities. It is clear from this study that long-distance trade networks play a vital role in the bushmeat economy of this part of northern Ghana and serve as a major driver of the entire bushmeat harvesting and trade system in this region. There is however, an existing but unmet local demand which is highlighted by the fact that local consumers, despite showing a strong taste preference for bushmeat, cannot access much of the locally harvested bushmeat (Chapter 7).

This local demand/preference is however overshadowed by a much larger, more lucrative and insatiable demand for bushmeat in the south. The comparatively poor northern economy simply cannot compete for bushmeat on a price basis and thus wholesalers and middlemen prefer to transport and sell much of meat harvested from the north to major markets in the south due to the price premiums available on these urban markets (McNamara *et al.*, 2016; HNKS, pers. obs.). This is supported by the finding in Chapter 5 that the majority of bushmeat delivered to the Chiana and Fumbisi markets (measured by biomass; 91% and 79% respectively), fed the much larger Kumasi and Buipe markets, where bushmeat usually commands a significant premium (pers. obs.).

It is also evident in the price mark-ups that were recorded at Buipe market. For example, a whole giant rat on the Buipe market retailed for about four times the price it was initially purchased for in the Fumbisi market (Buipe GH¢ 15-30 vs. Fumbisi GH¢ 4-7). The prices of bushmeat are likely to even go higher in southern parts of Ghana. The high prices in southern markets, being a consequence of higher demand, then creates a substantial outflow of bushmeat

from the north to the south. This outflow is characterised by large-bodied and more valuable species such as ungulates (Chapter 5), which the local market cannot afford. Hence local markets are dominated by abundant, but cheap amphibians (Chapter 4). The observed pattern of amphibians and small-bodied species dominating the local market is not just due to a preference for these species, but rather an outcome of affordability, with the implication being that the poorer local economy is unable to afford the "better" meat, which ends up therefore being diverted southward.

In addition, this study highlights an important landscape-level impact of the urban demand and trade. As the trade becomes increasingly large, urban demand in southern Ghana is now increasingly extracting higher value bushmeat, mainly larger bodied species such as ungulates, from increasingly large catchment areas; as historically productive areas become depleted with previous untapped areas increasing in return (e.g., McNamara *et al.*, 2015). Furthermore, trade networks have expanded into cross-border territories (Chapter 5). This takes what was observed in Kumasi (McNamara *et al.*, 2015) to a different scale, far larger than previously understood. The scale of this expansion of the catchment area has implications for wildlife not only in Ghana but also internationally (in this case, in Burkina Faso). The scale and importance of cross-border hunting for bushmeat has not been much recognised in the literature, but as the reach and pervasiveness of long-distance trade networks increase, research is urgently needed to address this knowledge gap and support international action at the regional scale to address bushmeat hunting and its impacts.

Advances in technology, access to electricity, and improvement in road networks across the country have contributed immensely to the sophistication of the dynamics of the trade and complexity of the networks. Such expansions of the trade are clearly seen in large urban centres such as the Atwemonom market in Kumasi and the Takoradi market (Cowlishaw *et al.*, 2005b,

McNamara *et al.*, 2016). Traders can now arrange for hunters' catch to be stockpiled in freezers and later brought to them via transport services; price negotiations are done on the phone while payments are also easily made through mobile money transfers (Ntiamoa-Baidu, 2016). This means that the trade in bushmeat may be more challenging to tackle by conventional means.

It is clear that the existence and development of these trade networks that link the north to the south are intensifying the already existing disparities in access to bushmeat, which has implications for the whole system, from hunting and trade to local consumption and wildlife depletion. This study has shown that factors such as on-farm hunting are important predictors of bushmeat preference, implying that only those who are able to hunt on their farms can access bushmeat often enough to prefer and regularly consume it (Chapter 7). The conversion of subsistence bushmeat harvesting into large-scale commercial trade is shaping local consumption and access to wild meat for local consumers in poorer parts of the country with potential issues for nutrition and health (Chapter 7). For particularly deprived areas such as the parts of northern Ghana where this current study focused, such impacts might be greatest. This region is among the poorest in the country with some of the highest stunted growth rates and the lowest protein intake levels (USAID, 2018). Also, incidence of acute malnutrition is much higher in the northern regions of Ghana, and 9% even higher within the study area (Upper East region) (USAID, 2018).

8.2.3 Law enforcement and regulation of bushmeat exploitation

Many aspects of bushmeat hunting and trade (e.g., use of snares, hunting of protected species, poaching) are illegal in much of Africa (Bokhorst, 2010; Lindsey *et al.*, 2011; Lindsey *et al.*, 2015). Although formal national legislation often exists to regulate hunting in countries where bushmeat is harvested, in practice hunting regulations are rarely enforced and local people are

often unaware of, or disregard, hunting laws (Crookes *et al.*, 2007; van Vliet and Nasi, 2008, Lindsey *et al.*, 2015). This problem has often been associated with poor governance and weak law enforcement efforts (Crookes & Milner-Gulland, 2006; Cawthorn & Hoffman, 2015). Bushmeat exploitation is usually regulated through a system of protected areas and regulations that govern the hunting of species, such as closed seasons, methods of capture restrictions and a quota system (Crookes & Milner-Gulland, 2006; Morgera, 2009). The market and hunter surveys in this study revealed a wide range of species that are hunted and openly traded on markets, including those that are protected (Chapter 4 and Chapter 6). For instance, species such as aardvarks and monitor lizards are classified under Schedule 1 of Ghana's Wildlife Conservation Act of 1971 (LI 685), prohibiting any person from hunting or being in possession of those species, yet both species were recorded in the surveys carried out in this study. Their appearance on the markets is an indication that wildlife laws are not serving as a deterrent to the hunting of these species for bushmeat purposes in Ghana and that laws are not being enforced. The marketing of smoked bushmeat also poses the problem of prohibited taxa being traded as unrecognizable meat portions. The use of snares is prohibited as a method of hunting in Ghana (Conservation International-Ghana 2002), yet these snares continue to be used illegally. These patterns of use and trade are not unusual and represent fairly universal challenges in similar markets that have reported illegal activities associated with hunting and trading bushmeat (Lindsey *et al.*, 2015).

There is indication that the local landscape of this study area may be depleted of large mammals, and that hunting may be occurring in neighbouring forest reserves and PAs, including across the border in Burkina Faso (Chapter 6), with these areas acting as sources of much of the bushmeat appearing on the market. While Community Resource Management Areas (CREMAs) have been initiated as a conservation strategy in order to devolve wildlife management rights to local communities in the area, it seems that the CREMA concept may

not be working efficiently for managing illegal hunting activities. This therefore supports a need to enforce adequate protection of wildlife species in protected areas (Macdonald *et al.* 2012) and to strengthen capacity within the existing CREMA initiative through training or livelihoods development, to enable these locally-led initiatives to be more effective. Furthermore, similar to evidence from this study (Chapter 5), trafficking of bushmeat across borders of several countries in West and Central Africa has been reported (Fa *et al.*, 2006; Mohneke *et al.*, 2010). The existence of a cross-border bushmeat trade infringes on national wildlife regulations of Ghana and there may be similar implications for the other countries involved. The cross-border trade also represents a potential violation of international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These findings support the need for more accurate identification of bushmeat trafficking routes to help law enforcement agencies to target their efforts (Clarke & Babic, 2016).

8.2.4 Poverty and food insecurity

Poverty provides a strong incentive for hunting for local people; bushmeat has been suggested to contribute to poverty alleviation by being a source of income generation for poor households and communities experiencing economic hardships (Schulte-Herbrüggen *et al.*, 2013)**.** The findings of this study show that the driving force for the hunters is to alleviate poverty (Aalangdong, 2010; Lindsey *et al*., 2013; Cawthorn and Hoffman, 2015), as bushmeat was more important for income generation than for subsistence (Chapter 5 and Chapter 6). In addition, observations from the household survey highlight the fact that bushmeat is not consumed regularly by rural households (Chapter 7). Although not assessed in the current study, the market price of bushmeat has been shown to influence its consumption by people in

both rural and urban areas (Cowlishaw *et al.*, 2005b; Wilkie *et al.*, 2005; McNamara *et al.*, 2019) and linkages have been found between bushmeat consumption and wealth. The current study area falls within a region with extreme poverty rates in Ghana, with some of the lowest consumption expenditures (Aalangdong, 2010; GSS, 2018), and thus it is not surprising that a cheap form of protein such as frogs are so abundantly traded (Chapter 4). Conversely, frogs were not included in the stated-preference for different bushmeat species by households, an indication that frog meat consumption was based on it being cheap rather than as preferred animal protein.

Furthermore, the dependence of rural people on bushmeat for their animal protein supply has fallen because it is either unavailable or expensive. Therefore, previous studies have shown that people rely mainly on fish for their animal protein (Alexander *et al.*, 2015; McNamara *et al.*, 2016). A similar observation was made in this study, which highlighted the low frequency of bushmeat consumption, and the general overall lack of meat consumption (Chapter 7). Even though bushmeat (and other meat types) were not consumed regularly, bushmeat still played an important role in household meat consumption, because in the absence of bushmeat, meat intake levels could even be lower in these rural households. This indicates that wildlife depletion will not only have negative impacts on biodiversity, but could also impact the food security of poor people, particularly those in rural areas (Fa *et al.*, 2004; Hoffman & Cawthorn, 2012).

8.3 Implications of findings for wildlife conservation in Ghana

This study has highlighted the extent of bushmeat exploitation in the Upper East region of Ghana, and how the bushmeat trade is economically important to rural people and urban traders in the country. The challenge for successful wildlife conservation in Ghana seems to be how

to balance the conservation objectives for wildlife with the socioeconomic needs of people who depend on it. There is clearly no one simple or straightforward solution to these challenges (Cawthorn & Hoffmann, 2015).

Many of the dynamics observed in this study appear to be largely a consequence of the commercialization of bushmeat. The implication is that intervention measures should be targeted at wholesalers given their level of specialization in the supply chain, and also at the 'root' causes of poor governance and regulatory failings (Fa *et al.*, 2006). Previous studies have reported that hunting and trade of bushmeat in many areas across Africa (including Ghana) are generally not well-regulated by either the state or local institutions (Cowlishaw *et al.*, 2005; Fa *et al.*, 2006; Lindsey *et al.*, 2013, Sackey, 2014). Hence, without interventions to improve the effectiveness of regulation in supporting a more sustainable bushmeat trade, the contribution of bushmeat to people (both cash income and subsistence) will decrease. From a livelihood perspective, the implications are that any intervention restricting hunting will have immediate adverse impacts on the actors in the bushmeat supply chain, as well as their families, because their livelihoods are tied to this rapidly depleting resource. Therefore, any management intervention measures should consider the important role of bushmeat for peoples' livelihoods.

Given that forecasts are for rapid human population growth in Ghana, this will invariably lead to increased demand for bushmeat if consumption patterns remain unchanged. the results of this study suggest that the wildlife resources in the study area could experience significant decline in the near future if management actions are not adopted to address the problems involved. Continued wildlife depletion may further impact the ecology of the study area, with negative effects on tree species, particularly those that depend on large-bodied vertebrates for dispersal of their seeds (Brodie and Gibbs, 2009; Petrozzi *et al.*, 2016). The potential decline or even loss of specific species may also have implications. For instance, declining frog

populations may have adverse impacts on the health and wellbeing of rural communities, due to increasing mosquito populations, negative effects on freshwater ecosystems and even decreased biological control of agricultural pests (Mohneke & Rödel, 2009).

Wildlife Protected Areas offer the best form of protection for wildlife species in Ghana. However, the problem of encroachment by local hunters into PAs and forest reserves will have a severe negative impact on Ghana's biodiversity if not given attention. Even though the hunting site selection model did not show PAs to be a significant predictor of hunting site, hunters strongly preferred sites with high tree cover and most of these areas occurred in and around PAs. These areas are likely to become increasingly vulnerable targets of hunters with increasing hunting intensity, especially as surrounding areas become increasingly depleted.

CHAPTER NINE

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The overall aim of this study was to generate new knowledge of bushmeat hunting, trade and consumption dynamics in northern Ghana and to understand factors influencing individuals' hunting and trading behaviour. The specific objectives of the study were to;

1. Examine the characteristics of bushmeat markets and associated trade in northern Ghana;
2. Describe bushmeat supply chains and explore the extent of long-distance and cross-border trade of bushmeat;
3. Examine the characteristics of hunters in northern Ghana and factors that influence their hunting behaviour and how they drive the local hunting system;
4. Investigate how bushmeat contributes to meat consumption within households in northern Ghana.

The study showed that the bushmeat traded on the Sandema, Fumbisi and Chiana markets comprised of at least 28 species of wild animals. The trade was dominated by amphibians, with three species; the Edible bullfrog *Pyxicephalus edulis*, African Groove-crown frog *Hoplobatrachus occipitalis*, and Dakar grassland frog *Ptychadena trinodis* accounting for 82% of the total number of bushmeat carcasses recorded.

The three study markets varied in terms of species and numbers of carcasses traded. Significantly, lower numbers of carcasses were sold in Chiana than the other two markets. However, the trade in Chiana comprised of relatively larger-bodied wild animal groups such

as primates and ungulates and thus it accounted for the greatest share of recorded biomass traded. The number of carcasses recorded per survey at the Fumbisi and Sandema market were 6.29 and 1.14 times higher than Chiana respectively. Sandema market traded mostly in small-bodied species. Ungulates were uncommon on the Sandema market, with their occurrence being significantly lower than all other species groups, except carnivores.

Across the three markets an estimated 48,277 bushmeat carcasses are traded each year, corresponding to an annual total biomass of 38.7 tonnes of undressed meat (of which an estimated 14.6 tonnes were traded in Fumbisi, 5.8 tonnes in Sandema and 18.4 tonnes in Chiana).

There were significantly higher numbers of bushmeat carcasses on sale in the dry than wet season in all three markets ($P<0.01$). Twice as much bushmeat was recorded per survey in the dry season compared to the wet season; 14.0 ± 22.9 per survey vs. 7.3 ± 11.1 per survey. These results were similar whether or not amphibians were included in the analyses.

The price of bushmeat was more variable, yet more expensive than domestic meat like beef. Fish had a very consistent price, of GH¢ 18.7 ± 1.9/ kg (N= 63), which was cheaper than most of the smaller-bodied bushmeat species like birds and rabbits, but more expensive than some bushmeat species like grey duiker and monkey. Compared to bushmeat and fish, beef was the cheapest animal protein sold on the markets, with average sale price of GH¢ 10.2 ± 1.8 per kg (N=15).

This study is the first to describe the large supply networks in northern Ghana and also the first to quantify and characterize the cross-border trade between Ghana and neighbouring countries.

The bushmeat trade in Sandema, Chiana and Fumbisi markets involves four key actor groups based on their roles in the trade: hunters, middlemen, wholesalers and local market retailers.

Bushmeat is supplied to the three markets from a large catchment involving several small rural communities and villages within the study area and northwards across the Ghana-Burkina Faso border. The bulk of the bushmeat (in terms of numbers and biomass) traded at the Fumbisi and Chiana markets is fed to the Buipe and Kumasi Central markets, respectively, being two of the major markets in Ghana.

This study has highlighted the socioeconomic importance of the bushmeat trade as a livelihood source for the people involved in it, and provided useful information on the extent of bushmeat harvest and trade in northern Ghana. This study also highlights the key role of wholesalers in the supply chain and the need to consider the incentives of this key intermediary group when planning management interventions for a sustainable bushmeat trade.

Hunting in villages in northeast Ghana is undertaken exclusively by men and is practiced for income generation, pest control and household consumption. The majority of hunters are farmers and hunting increases in the dry season when there is less time needed for seasonal farming activities and agricultural production is low. Shotgun was the most common method used for hunting and the degree of tree cover was the most important in predicting success in the last hunting expedition. Distance to village (Kayoro- $P<0.05$; Doninga- $P<0.01$) and percentage tree cover (Kayoro- $P<0.05$) were significant determinants of hunting site selection, with more densely forested hunting sites being preferred. The areas selected for hunting by local hunters in this study emphasised the wildlife areas at risk where improved regulation and monitoring of bushmeat hunting activities may be beneficial. Perceptions of hunters in this study suggest that the population of most wild animal species in the area have undergone rapid depletion, resulting in a decreasing return on hunting efforts.

Bushmeat is a preferred source of animal protein for rural households interviewed in this study, however, the frequency of consumption is low, and is impacted by affordability and availability

of cheaper substitutes for animal protein. The grey duiker and the African savannah hare were the two most preferred bushmeat species among households in the study area. Bushmeat is less widely consumed than alternative plant and animal protein sources.

The findings from this study highlight the level and extent of bushmeat hunting and trade in northern Ghana, the potential negative effects of increased hunting intensity on wild animal populations, the implications for species conservation and the urgent need for increased enforcement of wildlife regulations in the area and the country as a whole.

9.2 Recommendations

The following recommendations are made based on the findings from the study:

9.2.1 Management needs

- The significant role of bushmeat in the livelihoods of the rural poor need to be recognized and information on bushmeat utilization should reflect in national statistics to promote its role as a contributor to national food security.

- The significant reliance on bushmeat, particularly in the lean season when agricultural products are limited, implies that providing alternative livelihood sources and income generating activities in the dry season could reduce hunting.

- There is a need to promote educational and awareness campaigns that explicitly target the various bushmeat actor groups, to emphasize the values (direct and indirect) of wildlife and the scientific basis for ensuring sustainability of their livelihood source.

- In particular, there is a need to promote public sensitization and awareness emphasizing the role of amphibians and the ecosystem services they provide (for example in mosquito control which is important for public health), to promote sustainable harvests.

- There is a need for increased wildlife law enforcement efforts in the area, particularly within PAs and forest reserves.

9.2.2 Research needs

- Further investigation and detailed research are urgently needed on frog meat exploitation, including the value of the frog trade for collectors, the source locations and the drivers of demand for frog meat, in order to develop management interventions for sustainable harvests and if possible, explore breeding programmes aimed at providing cheap alternative proteins and livelihoods for current frog collectors.

- Further research is needed to accurately identify bushmeat trafficking routes to help law enforcement agencies to target their efforts, including cross-border trade.

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APPENDICES

Appendix 1. Questionnaire for trader interviews.

Bushmeat Hunting and Trade Dynamics in northern Ghana

(Trader Survey)

I am a student at the University of Ghana doing my PhD on bushmeat trade. The aim of this study is to increase knowledge of hunting and explore the extent of trade in bushmeat in northern Ghana. The study seeks to describe bushmeat supply chains and obtain informed idea about factors influencing volume of trade and individuals' hunting and trading behaviour. Findings from this study will provide basis for recommendations on how to best manage trade for the benefit of people and wildlife, but I am not working for the Wildlife Department or any NGOs, and so my work is for my own academic interests and not to inform particular policy.

All your responses will remain confidential and anonymous. I will not collect or reveal any information that can be used to identify you. Questions on this survey and further information on the project may be addressed to Hannah N K. Sackey (0243214963) of the Department of Animal Biology and Conservation Science.

Questionnaire No.:	Date:	Locality:
Name of Interviewer:		

Consent: I …… confirm that the purpose of this survey has been explained to me and that I voluntarily offer to participate in this study. Signed ……

<u>Demographic Information</u>

1. Sex of respondent: [....] 1=Female 0=Male
2. Age of respondent: [……]
3. Highest level of formal education of respondent: [ ]
   0=None;1=Basic(Primary/JHS/Middle); 2=Secondary (Secondary/Vocational)
   3=Tertiary (Training college/Polytechnic/University)
4. Place of origin of respondent [ ] 1=Native 2=Settler3=Migrant 4=Other (specify)

5. If non-native, how long have you been staying in this community? [……]

6. Which of the following properties do you own? [1] A house [2] A parcel of land [3] Tricycle [4] Motorbike [5] Bicycle [6] Crop farm [7] Livestock [8] Radio [9] TV

Respondent Involvement in bushmeat trade

7. How many years have you been trading? [.....]
8. How were you introduced to bushmeat trading? [0=family] [1=Friend] [2=others, specify] .....
9. Is trading your full time job [1=YES] [0=NO].
10. If NO, what else do you do in addition to trading? [List.....]
11. Which of these will you consider as your

    1. Primary occupation? .....
    2. Secondary occupation? .....
    3. Tertiary occupation? …….

12. Do you trade specific bushmeat species? [1=YES] [0=NO].
13. If/. YES, what are they? [List.....]

Bushmeat Trading activities

14. Do you sell other types of meat? [1=YES] [0=NO].
15. Rank the top 5 meats you sell by value. (in order with 1 being most valuable)
16. Rank the top 5 meats you sell by volume. (in order with 1 being most voluminous)
17. What did you earn from bushmeat trading last week? […….GHC]
18. Is this earning typical? [0=Yes; 1=No]
19. If NO, explain any variations over time
20. Where do you source your bushmeat?
21. From whom do you source your bushmeat?

    [0= hunters] [1= middlemen] [2= other traders] [3= Other, specify……..]
22. To whom do you usually sell your bushmeat?

    [0= middlemen] [1= other traders] [2= Other, specify……..……]
23. Do you travel to buy the meat, or do people come to you?
24. Do you sell bushmeat all year round? [1=YES] [0=NO].
25. If NO, what do you trade/engage in when not selling bushmeat?
26. If NO, what months do you trade bushmeat?
27. What are the peak months for trading bushmeat?
28. What is the most preferred species by consumers?

Perception of changes in volume of bushmeat

29. Do you perceive any changes in the volume and type of bushmeat in recent times and e.g., 5 years or more ago? Pls. tick as appropriate [1=Yes] [2=No]
30. If YES, describe the changes in terms of e.g., general numbers, specific species; smoked/fresh, etc.
31. What do you think are the causes of the observed changes?
32. Are these changes positive or negative for your own income and why?

Awareness of trading/hunting legislation

33. Do you know about laws governing trading/hunting of bushmeat? [0=Yes] [1=Don't know] [2= Prefer not to answer]
34. If yes, can you name/describe any such laws?
35. Could you tell me whether each of these laws applies for trading or hunting of bushmeat, and if so, for what species and places?

    a. Closed season for bushmeat hunting:

    [ ] All species
    [ ] Some species [specify: …….]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……...]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    b. Requirement of a license for hunting/trading of bushmeat:

    [ ] All species
    [ ] Some species [specify: ……]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……..…]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    c. Prohibition on hunting locations:

    [ ] All species
    [ ] Some species [specify: ……]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……..]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    d. Restrictions on hunting methods:

    [ ] All species
    [ ] Some species [specify: …… ..…..]

[ ] No species
[ ] All places
[ ] Some places [specify: ……]
[ ] No place
[ ] Don't know/ prefer not to answer

END……

Appendix 2. Questionnaire for hunter interviews.

Bushmeat Hunting and Trade Dynamics in northern Ghana

(Hunter Survey)

I am a student at the University of Ghana doing my PhD on bushmeat trade. The aim of this study is to increase knowledge of hunting and explore the extent of trade in bushmeat in northern Ghana. The study seeks to describe bushmeat supply chains and obtain informed idea about factors influencing volume of trade and individuals' hunting and trading behaviour. Findings from this study will provide basis for recommendations on how to best manage trade for the benefit of people and wildlife, but I am not working for the Wildlife Department or any NGOs, and so my work is for my own academic interests and not to inform particular policy.

All your responses will remain confidential and anonymous. I will not collect or reveal any information that can be used to identify you. Questions on this survey and further information on the project may be addressed to Hannah N K. Sackey (0243214963) of the Department of Animal Biology and Conservation Science, University of Ghana.

Questionnaire No.:	Date:	Locality:
Name of Interviewer:		

Consent: I …… confirm that the purpose of this survey has been explained to me and that I voluntarily offer to participate in this study. **Signed** …….

<u>Demographic Information</u>

1. Sex of respondent: [....]
2. Age of respondent: [……]
3. Highest level of formal education of respondent: [ ]
   0=None;1=Basic(Primary/JHS/Middle); 2=Secondary (Secondary/Vocational)
   3=Tertiary (Training college/Polytechnic/University)
4. Place of origin of respondent [ ] 1=Native 2=Settler3=Migrant 4=Other (specify)
5. If non-native, how long have you been staying in this community? [……]
6. Which of the following properties do you or your household own? [1] A house [2] A parcel of land [3] Tricycle [4] Motorbike [5] Bicycle [6] Crop farm [7] Livestock [8] Radio [9] TV

Respondent Involvement in bushmeat hunting

7. How many years have you been hunting? [.....]
8. How were you introduced to bushmeat hunting? [0=family] [1=Friend] [2=others, specify] .....
9. What is your main reason for hunting bushmeat [1] meat for self/family; [2] income; [3] farm protection; [4] other (specify) ……
10. Is hunting your full time job [1=YES] [0=NO].
11. If NO, what else do you do in addition to hunting? [List.....]
12. Which of these will you consider as your
    1. Primary source of income? .....
    2. Secondary source of income? .....
    3. Tertiary source of income? …….
13. Do you hunt specific bushmeat species? [1=YES] [0=NO].
14. If YES, what are they? [List.....]

Bushmeat hunting Activities

15. How often do you go hunting? [.....in a week]
16. What time of day do you normally go hunting [....] 1=Night time; 2= Daytime; 3= Day & Night]
17. How many times did you go hunting last week (*if hunter did not do any hunting in preceding week, use information from the last time he went hunting*)?
    [1] once [2] Twice [3] Three times [4] more than three times
18. How long did each hunt last? i) ……. ii) …… iii) …… (hrs)
19. Is the number of times and the hours spent hunting last week typical of year-round situation? [1] Yes [2] No
20. If "No", do you normally spend more or less time? [1] More time ……(hours) (2) Less time …… (hours)

Are there certain periods that you spend more/less time hunting? If yes indicate time of year: [1] Less time ……. [2] More time ……

21. How far from the village did you go to hunt? [..... km]
22. In which area did you hunt during this particular expedition? (hunter will be asked to indicate villages/areas on topo sheet and estimate area covered in a week)
    [1] Farms; [2] primary forest; [3] secondary forest/Fallow lands
23. Do you have a preference for hunting in certain landscapes?
    [0=YES] [1=NO] [2=don't know/ prefer not to say]

If Yes, please explain why What species of animals (and how many of each) did you catch on your last hunting expedition?

	Species (No. caught/killed)	**Sold**				**Given away**	**Eaten**
		Price (Cedis)	**to whom**	**where**	**State of meat**		
1							
2							

24. a. What method did you use on your last hunting expedition? [...] [1=shooting (gun); 2= trapping/snaring; 3=burning; 4= Other …….]
    b. Was this method typical?
25. a. Did you hunt alone or in groups? [.....] [1=alone] [2= in groups]
    b. Was this typical?

Perception of changes in distance and availability of bushmeat species

26. Is there any difference between today and when you started hunting in where you go to hunt? [0=YES] [1=NO] [2=don't know/ prefer not to say]
27. If YES, describe the changes …….....
28. Are there any differences in the species that you hunt today compared to when you started hunting? [0=Yes] [1=No] [3=Do not know/ prefer not to answer]
29. If YES, describe the changes.
30. Is there any difference in the number of animals you bring home each time you hunt today compared to when you started hunting? [0=Yes] [1=No] [2= don't know/prefer not to say]
31. If YES, describe the changes.
32. How do the above changes affect you?

Awareness of trading/hunting legislation

33. Do you know about laws governing trading/hunting of bushmeat? [0=Yes] [1=Don't know/ prefer not to say]
34. If Yes, can you name/describe any such laws?
35. Could you tell me whether each of these laws applies for trading or hunting of bushmeat, and if so, for what species and places?

    a. Closed season for bushmeat hunting:

    [ ] All species
    [ ] Some species [specify: …….]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: …….....]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    b. Requirement of a license for hunting/trading of bushmeat:

    [ ] All species
    [ ] Some species [specify: ……]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……..…]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    c. Prohibition on hunting locations:

    [ ] All species
    [ ] Some species [specify: ……]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……..]
    [ ] No place
    [ ] Don't know/ prefer not to answer

    d. Restrictions on hunting methods:

    [ ] All species
    [ ] Some species [specify: ……..]
    [ ] No species
    [ ] All places
    [ ] Some places [specify: ……]
    [ ] No place
    [ ] Don't know/ prefer not to answer

END……

Appendix 3. Questionnaire for household interviews.

Bushmeat Hunting and Trade Dynamics in northern Ghana

(Household survey)

I am a student at the University of Ghana doing my PhD on bushmeat trade. The aim of this study is to increase knowledge of hunting and explore the extent of trade in bushmeat in northern Ghana. The study seeks to describe bushmeat supply chains and obtain informed idea about factors influencing volume of trade and individuals' hunting and trading behaviour. Findings from this study will provide basis for recommendations on how to best manage trade for the benefit of people and wildlife, but I am not working for the Wildlife Department or any NGOs, and so my work is for my own academic interests and not to inform particular policy.

All your responses will remain confidential and anonymous. I will not collect or reveal any information that can be used to identify you. Questions on this survey and further information on the project may be addressed to Hannah N K. Sackey (0243214963) of the Department of Animal Biology and Conservation Science, University of Ghana.

Questionnaire No.:	Date:	Time:
Name of Interviewer: Household ID:		

Consent: I …… confirm that the purpose of this survey has been explained to me and that I voluntarily offer to participate in this study. Signed …….

<u>Demographic Information</u>

1. Number of people in household [ ] Adults [F: M:] Children (<16)
2. Gender of respondent [0=Female] [1=Male]
3. Are you the household head? [0=Yes] [1=No]
4. Age of respondent: […….]

5. Highest level of formal education of respondent: [ ]
0=None;1=Basic(Primary/JHS/Middle); 2=Secondary (Secondary/Vocational)
3=Tertiary (Training college/Polytechnic/University)

6. Ethnic group: [……]

7. Place of origin of respondent [ ] 1=Native 2=Settler3=Migrant 4=Other (specify)

8. If non-native, how long have you been staying in village? [……]

9. Highest level of formal education of respondent: [ ]
0=None;1=Basic(Primary/JHS/Middle); 2=Secondary (Secondary/Vocational)
3=Tertiary (Training college/Polytechnic/University)

10. Which of the following assets is owned by the household?

Area of land […… hectares]

House type: [0=Mud] [1=Wood] [2=Concrete]

Roofing type: [0=Thatch] [1=Sheets] [2=Asbestos]

Number of domestic animals owned: [……]

Vehicle type owned [0=Bicycles] [1=Motorbikes] [2=Tricycles] [3=Cars]

Mobile phone: [……]

Others (specify): …….

Livelihood screening and expenditure

11. What are the livelihood activities carried out by household members? (Thick options)

[0=Crop farming] [1=Livestock rearing] [2= Hunting] [3= Trade/shop/small business]

[4=Salary jobs] [5= Collecting and selling products from bush] [6= Other sources

(specify) ……]

12. Who does each of these activities?

13. How often do they do them? [0=Daily] [1=Weekly] [2=Monthly] [3=Seasonal]
[4=Rarely]

14. Which of these livelihood activities is your household's

1. Primary source of household income? .....

2. Secondary source of household income? .....

3. Tertiary source of household income? ……

15. How long has household been involved in the main livelihood for?

[0=less than 5 years] [1=less than 10 year] [>10 years]

16. Estimate total monthly household income from all sources: [……. GHC]

Specific questions for farmers (Main livelihood)

17. How much land does your household own and cultivate? [……]

18. What months are the major harvest seasons for cultivated crops?

19. What is your primary reason for farming? [0=Food] [1=Income] [2= Food and income] [3=Other, specify ……..]
20. What is the household income per year from farming? […….GHC]
21. Do you hunt on your farm? [1=Yes] [2=No]
    - If Yes, how? [1=Traps] [2=Guns] [3=Other ……..]
    - If Yes, why do you hunt? [1=Food] [2=Income] [3=Pests] [4=Other……..]
    - If Yes, what species do you hunt? […….]
22. How many animals did your household catch in the last month? […….]
23. What proportion of the catch was
    [Sold= ……] [Eaten by household=……] [Given away as gift=…….]

Household protein consumption

24. Do you prefer to eat domestic animal meat or bushmeat?

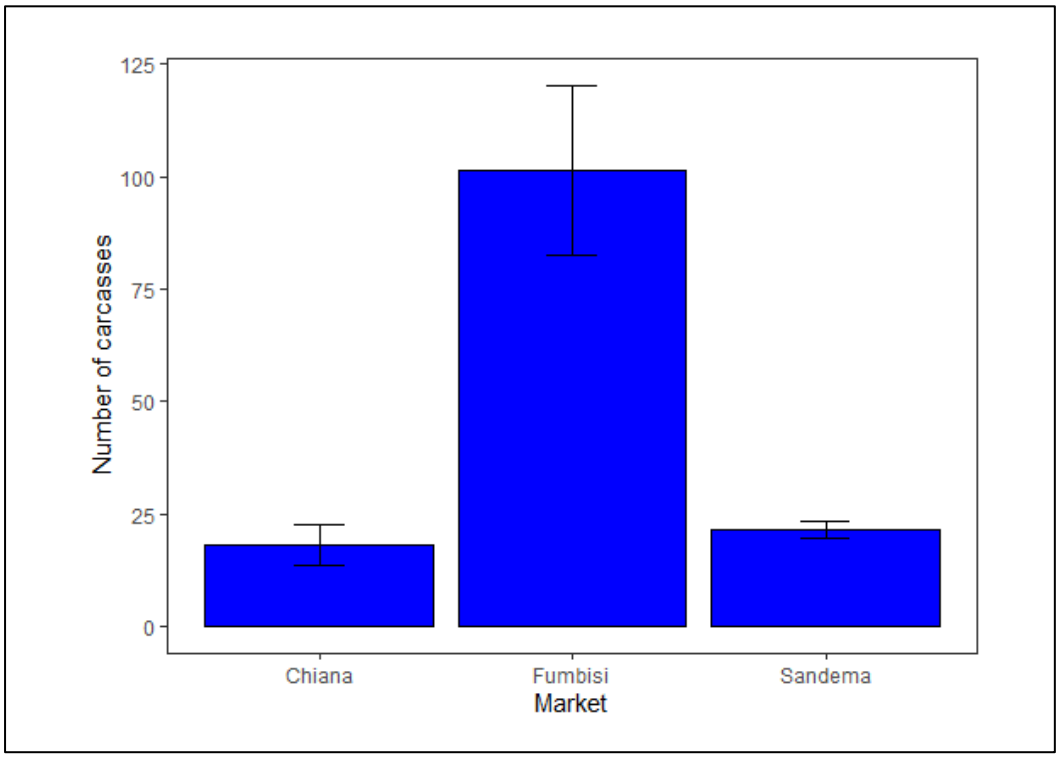
Preference	
Primary reason for preference:	

Code: 1=price, 2=availability, 3=taste, 4=meat quality, 5=tradition/culture, 6=religious beliefs, 7=others (specify)

25. If bushmeat, which wild animal species?
26. If domestic animal meat, what type of domestic meat?
27. How often does your household eat bushmeat at home?
    [1=daily] [2=weekly] [3= weekly] [4= monthly] [5=occasional] [6=never]
28. When was the last time you ate bushmeat at home?
29. How often does your household eat domestic animal meat at home?
    [1=daily] [2=weekly] [3= weekly] [4= monthly] [5=occasional] [6=never]
30. When was the last time you ate domestic animal meat at home?
31. Please rank the following animal protein based on a preference scale of 1 to 6 (one being the most preferred, 6 being the least preferred):
    Fish……. Poultry…… Goat/mutton……Pork…….Bushmeat…….. Beef

END……

Appendix 4. Mean number of carcasses recorded per survey for each market. (amphibians excluded).



Appendix 5. Estimated volume of bushmeat recorded to be traded at the three markets during the survey period.

Species	Number recorded	Mean weight (kg)	Estimated total volume (kg)
African Savannah hare	459	2.3	1055.70
Common warthog	16	61.98	991.68
Waterbuck	4	230	920.00
Monkey*	97	6.7	649.90
African buffalo	1	637.5	637.50
Giant rat	539	1.18	636.02
Grey duiker	26	18	468.00
Kob	4	90.5	362.00
Bushbuck	17	18.14	308.38
Edible bullfrog	5243	0.05	262.15
Roan antelope	1	261.5	261.50
Nile monitor lizard	128	2	256.00
Crested porcupine	13	19.5	253.50
Patas monkey	29	6.7	194.30
Aardvark	3	61	183.00
Helmeted guinea fowl	138	1.2	165.60
Crowned bullfrog	2950	0.05	147.50
Striped Ground squirrel	136	1.05	142.80
Senegal Flapshell turtle	30	4.5	135.00
Grasscutter	30	4.03	120.90
Double spurred francolin	137	0.5	68.50
Common genet	26	2.25	58.50
African civet	4	8.4	33.60
Olive baboon	1	17.9	17.90
White-faced whistling duck	27	0.6	16.20
Bird**	12	1.2	14.40
Green monkey	7	2	14.00
Red-flanked duiker	1	10	10.00
Dakar grassland frog	323	0.03	9.69
Marsh mongoose	1	3.17	3.17
Kaanamunik***	4	0.02	0.08
Total			**8397.47**

***Unidentified monkey** ****Unidentified bird** *****Unidentified frog**

Appendix 6. Purchase and retail prices of bushmeat traded. *Only species with available price information on smoked meat are shown.*

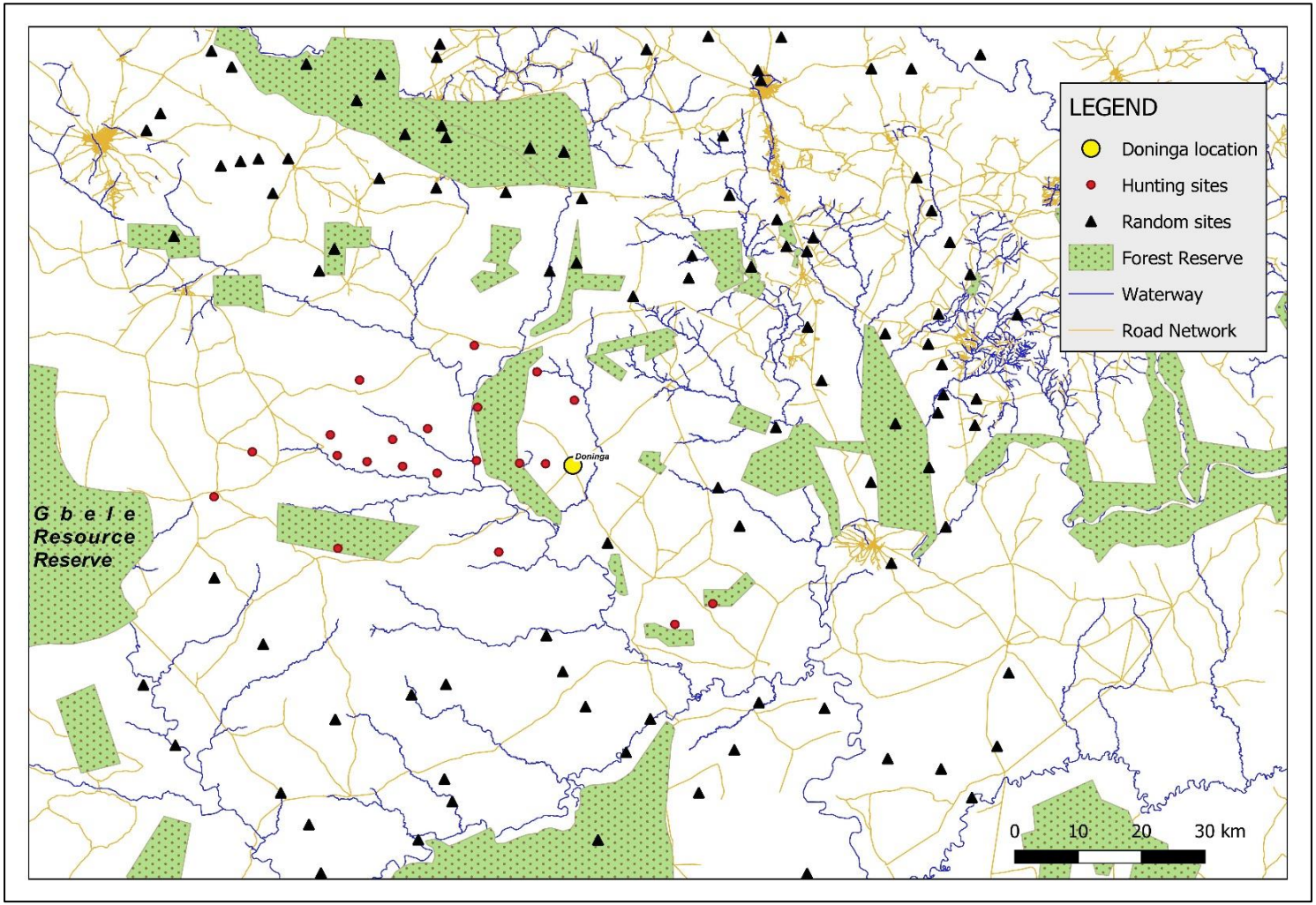
Species	Mean (± SD) purchase price/ kg (GH¢)	N	Mean (± SD) selling price/kg (GH¢)	N
Striped ground squirrel	16.48 ± 3.17	4	26.21 ±6.6	8
African savannah hare	18.85 ± 14.44	13	23.34 ± 5.15	23
Bird	27.05 ± 0.8	6	30	1
Bush guinea fowl	22.21 ± 1.23	2	35.84 ± 6.36	6
Common genet	19.62 ± 6.69	5	21.66 ± 10.77	4
Common warthog	14.4 ± 3.39 (2)	2	-	
Crowned bullfrog	17.66 ± 1.93	26	-	
Dakar grassland frog	14.86 ± 6.36	6	-	
Double spurred francolin	30.49 ± 7.75	17	39.57 ± 1.27	7
Giant rat	13.07 ± 0.8	2	22.38 ± 6.58	13
Grasscutter	25.29 ± 7.66	4	34.75 ± 3.89	2
Grey duiker	-		13.33	1
Monkey	11.15 ± 3.14 (3)	3	-	
Nile monitor lizard	15.83 ± 4.78 (5)	5	-	
Senegal flapshell turtle	16.67 (1)	1	-	
White faced whistling duck	23.53 (1)	1	25.27 ± 11.69	6

*US $1 equiv. GH¢ 4.76 in last quarter of 2018, *US $1 equiv. GH¢ 5.46 in last quarter of 2019

Appendix 7. Correlation matrix of hunting success model variables. *Values are Pearson correlation coefficients.*

	Age	Number of years spent hunting	Distance	Time spent
Age	1.000	**0.881**	-0.103	0.162
Number of years spent hunting	0.881	1.000	-0.139	0.080
Distance	-0.103	-0.139	1.000	0.072
Time spent	0.162	0.080	0.072	1.000

Appendix 8. Output of participatory mapping with hunters showing hunting sites (Red dots) as selected by hunters in Doninga and generated random sites used in predicting hunting site selection.



Appendix 9. List of bushmeat species killed by hunters in the last hunt. *Legal status is the species' protection under Ghana's Wildlife Law and Regulation.*

Species	Scientific name	Legal status[1]	Red List status (population trend)[2]
Aardvark	*Orycteropus afer*	First Schedule	LC (Unknown)
African buffalo	*Syncerus caffer*	Second Schedule	NT (Decreasing)
African savannah hare	*Lepus victoriae*	Second Schedule	LC (Stable)
Helmeted guinea fowl	*Numida meleagris*	Third Schedule	LC (Stable)
Bushbuck	*Tragelaphus scriptus*	Second Schedule	LC (Stable)
Common warthog	*Phacochoerus africanus*	Second Schedule	LC (Decreasing)
Crested porcupine	*Hystrix cristata*	Second Schedule	LC (Unknown)
Giant rat	*Cricetomys gambianus*	Third Schedule	LC (Stable)
Grasscutter	*Thryonomys swinderianus*	Unscheduled	LC (Unknown)
Grey duiker	*Sylvicapra grimmia*	Second Schedule	LC (Decreasing)
Hartebeest	*Alcelaphus buselaphus*	Second Schedule	LC (Decreasing)
Kob	*Kobus kob*	Second Schedule	LC (Decreasing)
Olive baboon	*Papio anubis*	Third Schedule	LC (Stable)
Patas monkey	*Erythrocebus patas*	Second Schedule	NT (Decreasing)
Red-flanked duiker	*Cephalophus rufilatus*	Second Schedule	LC (Decreasing)
Roan antelope	*Hippotragus equinus*	First Schedule	LC (Decreasing)
Striped ground squirrel	*Xerus erythropus*	Third Schedule	LC (Stable)
Tantalus monkey	*Chlorocebus tantalus*	Second Schedule	LC (Stable)
Waterbuck	*Kobus ellipsiprymnus*	Second Schedule	LC (Decreasing)

[1] L.I. 685-WILDLIFE CONSERVATION REGULATION, 1971 and L.I. 1357-WILDLIFE CONSERVATION (AMENDMENT) REGULATION, 1988: First Schedule, hunting prohibited; Second Schedule, prohibited in closed season and no hunting of young/adult with young; Third Schedule, prohibited inclosed season; Unscheduled, no restrictions.
[2]LC, Least Concern; NT, Near Threatened (source: IUCN, 2020).

Appendix 10. AIC Values, Akaike weights and likelihood for top models (delta AICc < 2) that explained probability of hunting success.

Model	Variables	df	logLik	AICc	ΔAICc	weight
1	success~area+method	5	-24.157	59.8	0	0.342
2	success~area	3	-26.661	59.9	0.1	0.325
3	success~area+method+number of years spent hunting	6	-23.549	61.2	1.42	0.168
4	success~area+ number of years spent hunting	4	-26.139	61.2	1.45	0.165

Appendix 11. Stated preference for bushmeat by surveyed households in the two villages.

Location	N	Bushmeat	Domestic meat	Preferred bushmeat (%)	Chi-square
Kayoro	273	108	165	40	$\chi^2 = 11.90$, df = 1, p< = 0.05
Doninga	196	110	86	56	$\chi^2 = 2.94$, df = 1, p>0.05
Total	469	218	251	46	$\chi^2 = 2.32$, df = 1, p>0.05

Appendix 12. Household stated preference for different types of bushmeat species.

		Community		
Species	**Scientific name**	**Kayoro**	**Doninga**	**Total**
Aardvark	*Orycteropus afer*	1	0	1
African buffalo	*Syncerus caffer*	3	6	9
African savannah hare	*Lepus victoriae*	9	29	38
Birds		0	1	1
Bushbuck	*Tragelaphus scriptus*	5	1	6
Common warthog	*Phacochoerus africanus*	10	10	20
Francolin	*Pternistis bicalcaratus*	0	8	8
Giant rat	*Cricetomys gambianus*	3	1	4
Grasscutter	*Thryonomys swinderianus*	17	6	23
Grey duiker	*Sylvicapra grimmia*	18	22	40
Helmeted guinea fowl	*Numida meleagris*	6	10	16
Kob	*Kobus kob*	6	1	7
Monkeys		1	0	1
Porcupine	*Hystrix cristata*	12	1	13
Roan antelope	*Hippotragus equinus*	13	0	13
Striped ground squirrel	*Xerus erythropus*	0	7	7
Total		**104**	**103**	**207**

Appendix 13. Ranked preference for different animal protein types by households surveyed. *The figures represent the number of households that stated the animal protein types in order of preference. Preference score was calculated for each of the six animal protein types: [least score =0 (least preferred) and highest score =1 (most preferred)]. The scores are calculated as follows: Score = ((1st choice/total) *1) + ((2nd choice/total) *0.8) + ((3rd choice/total) *0.6) + ((4th choice/total) *0.4) + ((5th choice/total) *0.2) +((6th choice/total) *0).*

Example Score (Fish) = ((145/442) *1) +((94/442) *0.8) +((65/442) *0.6) +((69/442) *0.4) +((62/442) *0.2) + +((7/442) *0) = 0.68.

Animal protein type	Frequency of response for preference						Total response	Score	Rank (Score)
	1st choice	2nd choice	3rd choice	4th choice	5th choice	6th choice			
Fish	145	94	65	69	62	7	**442**	**0.68**	1
Beef	58	81	109	87	44	4	**383**	**0.61**	3
Goat/sheep	31	93	115	90	42	9	**380**	**0.58**	4
Poultry	103	122	86	66	40	9	**426**	**0.67**	2
Bushmeat	101	35	33	43	126	56	**394**	**0.49**	5
Pork	17	17	19	17	32	149	**251**	**0.22**	6