Protected Areas and Rural Livelihoods: Contrasting Systems of Wildlife Management in the Democratic Republic of Congo

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Abstract

This multi-disciplinary study examines the ecological, social and economic consequences of wildlife management within the Garamba ecosystem in the north east of the Democratic Republic of Congo. This protected area system comprises a national park, which is formally managed by state conservation authorities and where human resource use and settlement is prohibited. The national park is surrounded by hunting reserves, which contain resident human populations. The wildlife in the reserves is informally managed by socially defined user groups who derive financial and other benefits from wildlife resources. These systems are used to compare how different wildlife management practices meet conservation and local development objectives.

Long term ecological data are used to examine spatial and temporal variations in species distribution and abundance in relation to wildlife management and human related activities. Using ground transect and remote sensing techniques, spatial variations in species richness and abundance are compared to the presence of agricultural communities, local markets and wildlife protection areas. Sampled aerial count data, collected over two decades by the Park authorities, are analysed to compare the temporal variations in animal abundance under different wildlife protection regimes. These ecological findings indicate that centralised wildlife protection meets conservation objectives because regulation is associated with high species richness and abundance. However, an analysis of local resource use priorities indicates that the existing protectionist approaches implemented by the centralised authorities cannot contribute to local development objectives.

Against this ecological background, several hypotheses are tested to examine the extent to which existing forms of wildlife management and utilisation can meet both conservation and development priorities. Analyses, using survey data from local households, hunters, and markets, provide the basis for examining the significance of wild foods to local livelihoods and the potential for sustainable harvesting and local regulation of wildlife offtake. Patterns of resource use at the household level are analysed to understand the relationship between wealth status and resource use. Conservation behaviour amongst hunters is examined by testing the evidence for restraint during the hunt. These modes of enquiry provide a basis for understanding people's motivation to exploit natural resources sustainably. Analysis of the bushmeat trade using anthropological methods (exploring bushmeat commodity chains, or *filières*) and economic models shows that the use of bushmeat is socially regulated by local power relations between traditional, civil and military authorities. The period of intense conflict in the region between 1996 and 1997 reveals the patterns of wildlife offtake in the absence of state and informal regulatory systems.

The combination of long term ecological data with detailed socio economic variables provides an innovative approach to examining the impacts of centralised and informal systems of wildlife management. This study makes a direct contribution to current debates surrounding the impact of regulatory and consumption based models of wildlife management.

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Abbreviations

ADMADE	Administrative Management Design for Game Management Areas
AFDL	Alliance des Forces Démocratique pour la Libération du Congo-Zaïre
ANOVA	Analysis of Variance
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CWM	Community-based Wildlife Management
DRC	The Democratic Republic of Congo
FAO	Food and Agriculture Organisation
FAZ	Forces Armées Zaïroise
GIS	Geographic Information Systems
GPS	Global Positioning System
GLIM	Generalised Linear Interactive Modelling
ICCN	Institut Congolais pour la Conservation de la Nature
IUCN	The World Conservation Union
NGO	Non-Governmental Organisation
NTFP	Non-Timber Forest Products
PCA	Principal Component's Analysis
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
SPLA	Sudanese People's Liberation Army
SPSS	Statistical Package for the Social Sciences
UNHCR	United Nations High Commissioner for Refugees
WFP	World Food Programme
WWF	World Wide Fund for Nature

Author's note

The views and opinions expressed and conclusions reached in this thesis are those of the author alone and do not necessarily represent the individual or collective views of any of the supporting or funding organisations. Maps have been prepared for the convenience of readers by the author and do not imply any judgement of the legal status of the boundaries shown.

Chapter 1

Introduction

When should the use of wildlife resources be regulated, and by whom? This question frames much of the current debate surrounding conservation management in sub-Saharan Africa. This thesis examines the ecological and social aspects of resource use by drawing on multidisciplinary research undertaken in a central African protected area. The resource in question is an assemblage of large mammals which has multiple uses and multiple associated management strategies. The protected area consists of a national park surrounded by hunting reserves. The national park is centrally managed by the Congolese national wildlife agency, but centralised management does not extend into the hunting reserves. The use of wildlife resources in the hunting reserves is controlled by rights of access which are determined by a number of socially defined control mechanisms based on status, social relations and coercion. The outcome is that wildlife utilisation is regulated by specific local groups. This amounts to a system of wildlife management which operates with minimal external intervention.

The situation at, and around, Garamba provides an opportunity to explore centralised and local systems of wildlife management, and to test specific hypotheses about the extent to which they meet current wildlife policy objectives (Figure 1.1). This chapter reviews the literature which provides the background to this research. More detailed reviews are provided within each chapter.

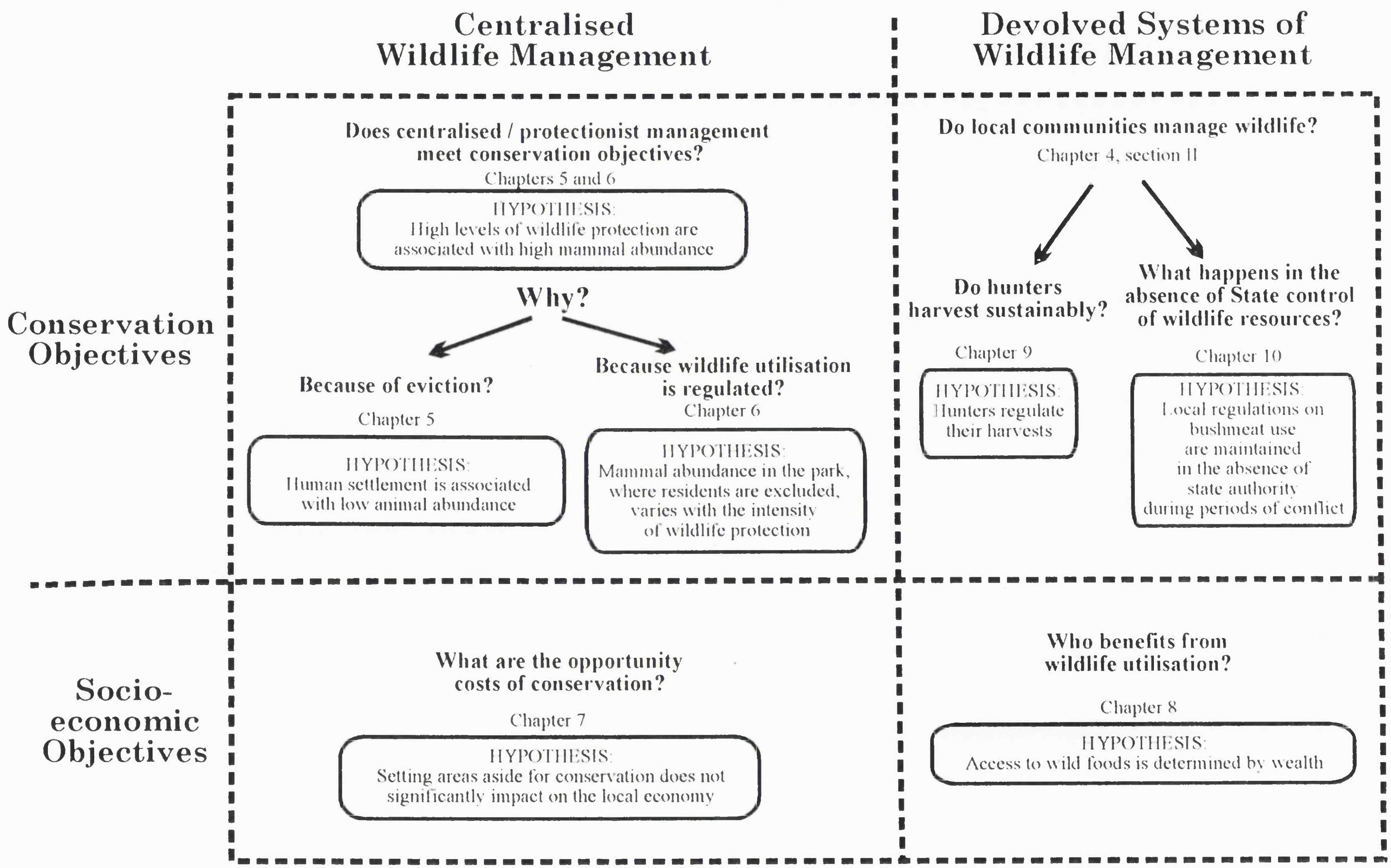

Figure 1.1. Research structure: questions and hypotheses.

1.1 Background: protected area policy and practice

Policies relating to the protection of biological diversity take place at different levels. At the broadest level, international conventions, such as the Convention on International Trade in Endangered Species (CITES), aim to achieve sustainable offtakes of wild resources by regulating trade. At the national level, legislation is passed whereby extensive areas of land are set aside for conservation. At the local level, the outcome of these policies is the establishment and maintenance of protected areas.

Protected areas are a widely established tool for conservation management. The Yellowstone National Park framework for protected area management, established in the last century, is still broadly applied today (IUCN 1994). This approach is best described as legislation that restricts the human use of land, primarily by local residents and to a lesser degree by visitors (Munthali 1996). Whilst the justification for protected areas is vigorously debated, and will be discussed below, there is little doubt about their significance. Currently, 5.2 percent of the Earth's land area is designated protected areas (WCMC 1992), and this is likely to increase. One of the conclusions of the Fourth World Congress on National Parks and Protected Areas (IUCN 1994) was that more, and better managed, protected areas were urgently required. The Convention recommended that all countries should aim to designate ten percent of each biome within its boundaries as a protected area. The Global Environment Facility, an outcome of the United Nations Conference on Environment and Development, has objectives which reflect a strong emphasis on the improved management and growth of protected areas (Ghimire and Pimbert 1997), and the World Conservation Union also encourages its member states to develop their protected area systems (IUCN 1994). Thus, the use of protected areas as a tool for biological diversity conservation is extensive, and likely to increase in future.

The last two decades have seen significant changes in the policy objectives of protected area systems. The World Conservation Strategy (WWF, IUCN & UNEP 1980) was one of the first of many documents to link conservation with development agendas. The new integrated conservation and development agenda has raised an overwhelming number of conceptual problems about the compatibility of these two agendas, and has instigated numerous debates about the appropriate processes for achieving these dual objectives. This thesis explores the capacity of two systems of management, centralised and devolved, in meeting these two objectives within the specific context of the Garamba protected area system in the Democratic Republic of Congo.

1.2 Dominant paradigms in African Conservation

The priority placed on the growth of protected areas by the IUCN's World Convention on Protected areas (WCPA) hides the difficulties of developing a unified national and international policy on protected area legislation. Indeed, globally, there are over 140 names that have been used to describe protected areas (IUCN 1994). This results partly from the contrasting paradigms that have evolved with conservation science and practice. Currently two approaches to wildlife management appear to dominate the conservation debate (Blaikie and Jeanrenaud 1997). The first operates through state institutions and involves the nationalisation of wildlife resources and their centralised management. The second approach can broadly be defined as the devolution of wildlife management authority to local institutions. The following sections define these systems of wildlife management, and outline some of the assumptions that will be tested in this thesis.

1.3 Centralised wildlife management

Centralised management has traditionally been founded on a concern for nature preservation and has thus tended towards protectionist approaches to wildlife conservation. This classical form of conservation has been described as seeking "*environmental solutions to perceived environmental problems*" and is sometimes referred to as "*fortress conservation*" (Blaikie and Jeanrenaud 1997). Historically, most protected areas in developing countries are founded on protectionist principles (Pimbert and Pretty 1995). The theoretical rationale for centralised wildlife management using protectionist policies is largely founded on a 'reduction of threats' approach to conservation (Margolius and Salafsky 1998). The principle threats are believed to be human presence, which is addressed by the eviction of populations from protected areas (West and Brechin 1994, Brockington 1998), and unsustainable offtake, which is addressed by instituting and enforcing restrictions on wildlife utilisation. Protectionist policies are also believed to be founded on a history of colonial hegemony in developing countries (Brockington and Homewood 1995), expediency (Ghimire and Pimbert 1997), and to a lesser extent on the philosophical arguments relating to the intrinsic right for species to exist (Nash 1970).

Conventional protected area planning and implementation in Africa involves a centralised intervention by an agency, such as a government department or an international organisation. Other institutions and individuals have a stake in the natural resources within the protected area, but centralised bodies usually have the greater legislative and financial backing. Thus, non local institutions often have the greatest influence on wildlife management policies. Consequently, wildlife protection tends to be highly centralised and capital intensive.

1.3.1 Assumptions of centralised management and research questions

a. Human presence threatens biological diversity

An underlying assumption of state intervention in wildlife management is that unchecked human activity poses a threat to the integrity of an ecosystem. Early notions of community ecology reinforced the Malthusian notion that human population pressure invariably de-stabilised the 'balance of nature'. In the context of savanna ecosystems, ecological studies emphasised stability and equilibrium as the dominant forces shaping species abundance relationships (eg. Lamprey 1963, Bell 1971[1]). In the minds of these ecologists, resource partitioning and niche differentiation produced stable states where species interacted, but were maintained within relatively static levels of population abundance. Thus, population abundance was seen to be controlled by density dependent factors, and the carrying capacity of

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[1] Bell has since revised many of his earlier concepts of ecosystem dynamics, and addresses non-equilibrium processes (eg. Bell 1987).

the environment determined the limits to population growth (Nicholson 1954, Diamond 1975). Human populations exploiting natural resources were also believed to be subject to density dependent factors, but unlike other species, are capable of exceeding the carrying capacity of the environment. Without the consequent negative feedback mechanisms constraining human pressure, permanent environmental damage was envisaged. This understanding underpins, both implicitly and explicitly, the policies aiming to exclude human residents from protected areas.

Some authors have presented evidence to suggest that human presence, associated with higher levels of hunting, can result in depleted wildlife resources. In a broad assessment of the impact of hunting in the Neotropics, Redford (1992) established that mammal densities, in areas that are moderately or heavily hunted, are between 80.7 and 93.7 percent lower than in unhunted areas. Long term studies of hunting communities have shown that bushmeat yields decline over time, suggesting that the resource base decreases when associated with utilisation (Vickers 1980, 1988). Stearman (1990) compared the intensity of hunting in the neo-tropics to population growth models and found that offtake, at the time of study, was unsustainable.

More recently, new approaches to savanna ecosystem dynamics have been used to question the logic that human presence systematically provokes resource depletion (for example, Leach and Mearns 1996). The formulation of non-equilibrium theories in rangeland ecology questions the very concept that any single factor, such as human pressure, is sufficient to provoke a systematic change in habitat quality or a reduction in animal abundance (Walker 1981, Dublin 1991). The principle of dynamic disequilibrium suggests that the driving force in the ecology of some systems is the effect of stochastic environmental events. For example, in arid environments, the effects of irregular rainfall override the density dependent population regulation of species contained within an ecosystem (Behnke *et al* 1991). Other stochastic events include disease and fire (Dublin *et al* 1990, Sinclair and Arcese 1995), and in central Africa, war has been described as a stochastic event which drives rapid ecological change (Hart *et al* 1997, de Merode *et al* in print). Whilst war is a human induced phenomenon, the ecological consequences of war would suggest that a Malthusian explanation for resource decline is inadequate. In other words, population pressure, *per se*, may be insufficient to cause of biodiversity loss.

The results of several studies argue against a causal relationship between human presence and the depletion of mammal populations. Indeed, in the Ituri Forest, less than three hundred kilometres to the south of Garamba, Wilkie and Finn (1990) have shown that certain mammal densities increase at closer distances to settled areas. Similar results are described by Johns and Skorupa (1987) in a global review of the evidence for primate population depletions in relation to habitat disturbance. They conclude that although severe habitat disturbance, such as logging, has a direct impact on populations, moderate human disturbance, such as shifting cultivation which is common to most of central Africa, is not associated with mammal population depletion.

In spite of the paucity of evidence showing the link between human presence and low biological diversity, there is an increasing body of evidence to suggest that protected area policy implementation is founded on an assumption of resource degradation by resident human populations (Leach and Mearns 1996). It has been argued that protected areas in Africa are the product of historical legacies based on the specific values of political elites, and have little to do with current efforts to limit the loss of biological diversity (Anderson and Grove 1987, Munthali 1996). For example, Western (1994) point out that many African protected area systems were established during the late colonial period. The prospect of imminent independence created an urge within the existing administration to legislate and gazette extensive areas as a means of ensuring the maintenance in perpetuity of 'pristine' environments. Or, as expressed by Bell (1987) *"the West found in Africa the Garden of Eden of its romantic imagination"*. The distinction between biodiversity conservation and the protection of 'pristine' environments is made by Soulé and Kohm (1989):

> *it is important to understand that protecting biological diversity, as a practical matter, is independent of the pursuit of the Holy Grail of "pristine". Just because a system is not pristine does not mean it is of*

no value for conservation. The task of conservation is not to preserve some ideal, pristine nature. Rather, its task is to preserve diversity.

The research framework adopted in this study examines biological indicators (mammal species richness and abundance) and assesses the extent to which perceived threats are indeed associated with a reduction in those indicators. Thus, the impact of factors such as human presence can be explored in terms of biological factors that are a measure of conservation success.

b. The contribution of protected areas to development

Protected areas are said to provide important benefits to society (IUCN 1994). For example, they may provide habitat for harvested species (Cumming 1990), regulate and purify waterflow, and provide income locally through eco-tourism (Child 1996). However, a protected area is primarily a legal construct, and can either limit local access to resources, or enhance access by ensuring that resources are used sustainably. In practice, the eviction of local residents from their land and stringent regulations limiting local access to resources are often used as tools for protected area management. In this context, the link between conservation practices and local development is tenuous.

The local social and economic costs of exclusion have been documented by a number of authors. Turnbull's account of social collapse amongst the Ik people of Northern Uganda, following their eviction from Kidepo Valley, is perhaps one of the most cited examples (Turnbull 1972). In the Democratic Republic of Congo, Nzabandora (1984) documents the consequences of eviction for agriculturalists in the North Kivu region, following their eviction from Albert National Park (now Virunga National Park) without compensation for the loss of land. Thus, it is increasingly recognised that protected areas, in themselves, do not necessarily constitute an asset for local development. This study explores the compatibility of established wildlife management practices with local development interests by contrasting the land-use planning of the centralised conservation authority with local resource use priorities around Garamba.

1.4 Devolved systems of wildlife management

Increasingly, there is a change of emphasis in wildlife management from centralised to local management. This section describes the rationale for this change of emphasis, and the two approaches that are most commonly cited for achieving devolved wildlife management. The move towards local management appears to be the result of two independent processes:

- generally, decentralisation is part of a wider process of structural adjustment to limit government spending, particularly in developing countries (UNDP 1997, Lutz and Caldecott 1996);
- more specifically, international concern for the welfare of protected area adjacent populations in developing countries has instituted attempts to link wildlife management to local livelihoods and community development (IUCN/WWF/UNEP 1980).

Thus, two themes are emerging in the conservation debate. First is the principle of subsidiarity, whereby the central authority performs only those tasks that cannot be achieved effectively at a lower level. Second, is the promotion of human welfare. Two dominant approaches to devolved wildlife management have had varied success in meeting conservation and development objectives: participatory and neo-liberal.

1.4.1 Participatory

These approaches, also referred to as community based conservation (Western and Wright 1994, IIED 1994), or populist conservation (Blaikie and Jeanrenaud 1997), have evolved, particularly in developing countries, from a concern that protected area adjacent populations are politically and economically marginalised. This marginalisation is believed to be compounded by the local social and economic costs that are imposed by the establishment and maintenance of protected areas. Consequently, it has become part of the conservation agenda to address community interests as an integral part of sustainable resource management.

Central to community based conservation is the concept of participation in wildlife management. Participation is a term which has evolved and continues to be used and misused in the jargon of conservation professionals (Ghimire 1997). Pretty (in Dalal Clayton and Dent 1993) produced a typology of participation in development initiatives consisting of seven classes of participation ranging from manipulative participation through to self mobilisation. This raises a number of issues concerning the nature of participation in complex socio-political environments which are discussed in section 1.4.3.

1.4.2 Neo-liberal

This approach seeks market solutions to environmental problems. The underlying concept is a simple one: wildlife is a financial asset, and for wildlife conservation to succeed, sustainable wildlife management must be economically preferable to other forms of land use (Swanson and Barbier 1991, Rasker *et al* 1993, Child 1996). Western and Wright (1994) suggest that this approach to conservation is not new, but was adopted by traditional societies as viable economic strategy for satisfying human needs. According their analysis, the maintenance of sustainable wildlife yields provided the optimal resource use strategy for traditional societies. However, it does represent significant departure from an approach to conservation founded on ecological thinking, to one where pricing and tenurial rights become the basis for decision making (Child 1996).

Management strategies based on the consumptive use of wildlife have been championed as the 'third way' for integrating conservation with development. Two early programmes have been used as evidence for the feasibility of consumption driven conservation (Swanson and Barbier 1992, IIED 1994): in Zimbabwe, the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) (Metcalfe 1995), and in Zambia, the Administrative Management Design for Game Management Areas (ADMADE) (Lewis and Alpert 1997).

1.4.3 Assumptions of devolved management and research questions

a. The value of wild resources

Wild resources are believed to make an important contribution to rural subsistence. There is an extensive literature reviewing the use of wild resources. The primary contributions of wild resources to local subsistence have been summarised by Falconer and Arnold (1991), focusing specifically on forest products:

- improving subsistence production: increasing diet quality and diversity, supply of fuelwood, income generation through commercial use of wild products, (see also Falconer and Koppell 1990, Scoones *et al* 1992).
- supplementing seasonal short falls (see also Fleuret 1979, Chambers *et al* 1981).
- providing additional security during periods of stress, such as famine or war (see also Vaughan 1987, de Waal 1988, Sullivan 1998).

However, the significance of wild resources to rural subsistence has rarely been quantified. Indeed, the drive to merge community interests with a conservation agenda may have over-emphasised the importance of wild resources to local communities (Luxmore 1994). Whilst community based conservation satisfies the need to develop a conservation agenda 'with a human face' (Bell 1987), the precise benefits to rural people are not always clear. Misconceptions regarding the economic contribution that wildlife makes to the rural economy is compounded by the value that is attributed to large mammals by external influences, such as conservation lobby groups: "where there is a spark of interest in wildlife conservation, the flimsiest of economic arguments may be sufficient to fan it into life" (Luxmore 1994). This has resulted in a number of failed attempts to conserve wildlife on the, often spurious, assertion that 'wildlife can pay its way'.

Thus, the question remains as to whether the theory and practice of grassroots/community participation in conservation actually provides an alternative approach to conservation, or merely represents a new discourse within an entrenched protectionist mindset. This question is raised by Homewood *et al* (1997): "it is not always clear whether the aim of bringing the benefits of conservation to local people is an end in itself, or a means to make conservation agendas and wilderness preservation more successful".

Furthermore, the integrated conservation and development agenda faces severe social challenges: community participation, self mobilisation and natural resource management are not always compatible in highly heterogeneous communities. The strongly hierarchical organisation of rural societies may exclude marginalised groups, such as women and the poor from access to resources (Burnham 1993, Homewood *et al* 1997, Guijt and Shah 1998). In certain cultural and economic contexts, the concept of community conservation may contain inherent contradictions, particularly if it includes community ownership of wildlife resources through existing institutions and power relations (Pimbert and Pretty 1995). Thus, despite the strong emphasis on 'market driven conservation' and 'participatory conservation' there remain a number of unanswered questions as to whether these approaches can bridge the gap between conservation and development.

This study uses wealth status to examine the contribution of wild resources to local residents. Clearly, wealth is only one of many characteristics which differentiate a community. There are many others including gender, residence, ethnicity etc., but wealth is used in this study because it is linked to these other characteristics (Chambers 1997). General observations during the pilot phase suggested that female headed households and temporary residents (such as refugees) tended to be the poorest groups, while long established households were wealthier. Furthermore, there was a substantial and obvious wealth differential which appeared to explain access to, and use, of wild resources. Finally, poverty elimination has become a central goal in development (see for example UK Department for International Development White Paper, November 1997). Therefore an understanding of how wealth affects access to and use of resources can refine current thinking on how development based on wild resource utilisation can contribute to the elimination of poverty.

b. Resource use as wildlife management

The difficulties in achieving financial and institutional sustainability in community based approaches to wildlife management have resulted in a situation whereby recognised community conservation programmes are strongly donor driven and dependent on external sources of funding for their continuity (eg. IIED 1994). This raises important questions as to whether these approaches can accurately be described as devolved systems of wildlife management. Garamba offers an opportunity to test the existence of community level systems of wildlife management in the absence of centralised sources of funding.

This thesis examines the existence of local systems of wildlife management. The application of market solutions to wildlife management makes two key assumptions. First is that the solutions provided by participatory and free market management can be applied equally successfully to all resource tenure regimes (Caughley 1993). Second is the assumption that sustainable yields represent the optimal resource use strategy.

The thesis uses the distinction made by Alvard (1994, 1995) between passive 'epiphenomenal' conservation, and deliberate wildlife management. Epiphenomenal conservation occurs in the absence of any active form of conservation, and is simply the use of wildlife which does not significantly threaten bio-diversity. Epiphenomenal conservation may be the outcome of low demand resulting from particularly low human population densities. This form of 'conservation' is of limited value in highly differentiated and dynamic societies, which are susceptible to rapid demographic change, mainly through immigration. Therefore the questions being asked in this thesis are not just "do humans cause a reduction in wildlife species richness and abundance?", but also "do wildlife users respond to resource decline by deliberately regulating offtake?". This question is addressed directly by examining hunters' choices regarding the sizes of their harvests, and indirectly by exploring the power relations associated with access to wildlife resources. Therefore, the thesis examines the extent to which social constraints are imposed on the volume of harvests by particular groups in the community (Figure 1.2).

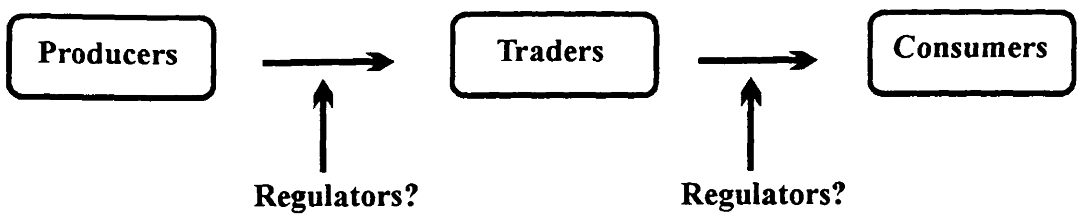

Figure 1.2 Identifying active management as part of local wildlife utilisation

1.5 Conclusion and thesis structure

This introduction provides an overview of the current debates surrounding protected area management. The chapters that follow make a contribution to this debate through a detailed examination of the interactions between some of the biological, social and institutional components of a protected area in north eastern Congo. Chapter 2 provides a background to the Garamba Ecosystem, where the above issues are examined in the context of the local environment. Chapter 3 describes and discusses the use of multi-disciplinary methods as a means of addressing the key questions posed above. Chapter 4 describes and analyses the centralised and devolved administrations at Garamba.

The subsequent chapters use a combination of quantitative and qualitative techniques, analysing multi-disciplinary field data collected in the Garamba ecosystem, to test some of the main assumptions used in the protected area debate. Chapters 5 and 6 use ecological techniques to explore the ecological patterns associated with human presence and the protectionist policies endorsed and implemented by international and state institutions. The first of the two chapters tests the assumption that human presence has a negative impact on mammal populations. Spatial variations in mammal abundance are analysed in relation to the distribution of various human related factors. Chapter 6 examines the temporal variations in mammal abundance in relation to known wildlife protection regimes.

Chapter 7 explores the assumption that protected management makes a contribution to the local economy by analysing local people's landuse priorities. Chapter 8 uses detailed and long term household consumption data to examine wildlife utilisation patterns. Household wealth status is used as a measure to test the evidence for equity and participation in community based wildlife management.

The final two analytical chapters examine informal, community level, wildlife management practices: Chapter 9 examines the incentives for sustainable wildlife management by analysing the patterns and outcome of hunts undertaken with members of the community. Chapter 10 explores the relationship between wildlife protection and utilisation. It compares market data on monthly volumes of bushmeat with data on national park patrols collated to reflect the level of wildlife protection over time.

The final concluding chapter re-examines the issues discussed in this chapter in relation to the results of the analytical chapters. Options for wildlife management at Garamba are discussed in the context of the findings presented in this thesis.

Chapter 2

Background

2.1 Summary

The Garamba ecosystem is a region well suited to an investigation of centralised and devolved wildlife management. First, several distinct resource management practices can be identified for a single resource, large mammals. Second, the resource has significant value to the groups who have a stake in wildlife management, such as the Congolese state, international aid agencies and local residents. Finally, the protected area contains discrete areas (the park and the hunting reserves) where each of the two approaches to wildlife are practised.

This chapter outlines the biological and socio-economic characteristics of Garamba National Park and the hunting reserves. It summarises the history and structure of centralised and devolved management in and around Garamba. First, the management history of the park by the Congolese conservation agency and external aid organisations is described. Second the history of local administration around Garamba is summarised and discussed in the context of wildlife utilisation and management.

2.2 Introduction

Garamba National Park, gazetted in 1938, was one of the first national parks to be established in Africa (Offerman 1940). The park is situated in the north east corner of the Democratic Republic of Congo[1], on the border with Sudan, between the latitudes 3° 8' and 4° 4' north and longitudes 29° and 30° west (Figure 2.1). The national park was established to protect significant populations of large mammals, in particular elephants and rhinoceros (Hillman Smith 1989). The establishment of the park, under Belgian colonial administration, was closely tied to the Elephant Domestication Centre, developed in the early 1920s at the park station of Gangala na Bodio (Troupin 1956). Residents within the boundaries of the park were evicted from the park, and the area has since been managed using a strict wildlife protection strategy. In 1981 the ecosystem was declared a UNESCO World Heritage Site, and is currently managed by the Institut Congolais pour la Conservation de la Nature (ICCN).

The park is surrounded by three hunting reserves or *domaines de chasse*. These include Domaine de Chasse Azande in the west, Domaine de Chasse Gangala na Bodio in the south and Domaine de Chasse Mondo Misa in the east. The reserves were established at the same time as the national park for the regulated use of wildlife resources by resident populations (Hillman Smith 1989). The Domaine de Chasse Mondo Misa had an additional clause to allow sport hunting (Atalia *pers comm.*).

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[1] Henceforth, the Democratic Republic of Congo (formerly Zaïre) will be referred to as Congo. The People's Rebublic of Congo will be referred to by its full name.

Figure 2.1. Central Africa and the Garamba ecosystem in the north east of the Democratic Republic of Congo

2.2.1 Climate and topography

The study site is part of an undulating peneplain intersected by a dense network of rivers and streams (Hillman Smith *et al* 1995). The altitude varies between 710 and 1060 metres. The larger rivers flow throughout the year, and are fed by numerous freshwater springs. The northern boundary of the park forms part of the watershed between the Zaïre and Nile river catchments. The soil is relatively sandy and poor in the park, though with a higher humus content in the hunting reserves. The soils are predominantly of lateritic origin.

The climate is tropical semi-humid characterised by a long wet season between the end of March and early December, followed by a short dry season. There is also a moderately dry period between July and August. Annual precipitation is around 1300 mm (mean annual precipitation between 1980 and 1986 was 1265 mm, Hillman Smith 1989). The mean annual temperature during the same period was 24.4°C. The primary climatic parameters are shown graphically in Figure 2.2.

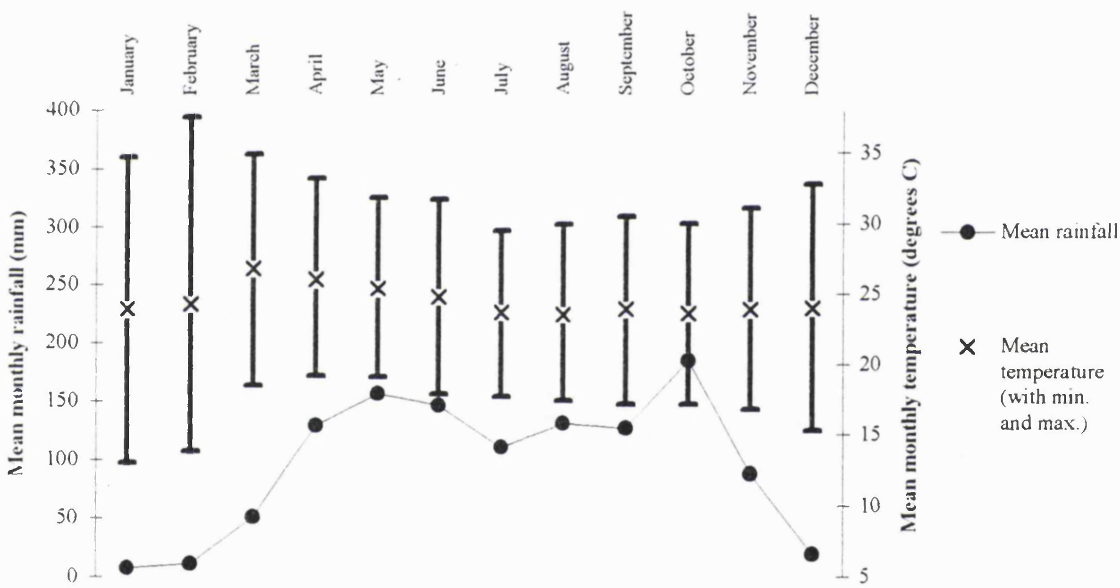

Figure 2.2. Rainfall and temperature readings at Nagero (Garamba National Park, 3°46'N, 29°32'E) from 1980 to 1986 (raw data from Hillman 1989).

2.2.2 *Ecology*

Much of the research undertaken at Garamba has been intensive ecological inventory and survey work. Three major programmes have been implemented. First, was the expedition led by de Saeger between 1950 to 1952, which included detailed inventories of most of the plant and animal families in the park and hunting reserves (de Saeger 1954, Troupin 1954, Verschuren 1958). In the 1970s, wildlife survey work was undertaken in the Park through a Food and Agricultural Organisation project (Savage *et al* 1976). Finally, between 1983 and the present, continuous ecological monitoring of the mammal populations and the vegetation was undertaken by a team of Congolese researchers co-ordinated by Hillman-Smith, the project chief technical advisor, and Atalia, a senior conservation officer. Much of their survey work is consistent in its methodology with the survey undertaken by the FAO in 1976. Thus the surveys undertaken at Garamba provide one of the longest series of systematically collected ecological data for a protected area in central Africa.

The protected area falls within the Sudano Guinean phyto-geographical belt (White 1983). Habitat structure has been described in detail by Hillman Smith and Ndey (1996) and habitat distribution by de Merode and Likango (1996). The habitat classification used for Garamba ecosystem is shown in Appendix 2. In summary, the southern part of the park is predominantly grassland savanna, dominated by the long grasses *Loudetia arundinacea* and *Hyparrhenia* spp. with scattered trees. The north gives way to mixed woodland dominated by *Mitragyna stipulosa, Terminalia mollis* and *Vitex doniana*. The hunting reserves contrast sharply in their habitat characteristics, being predominantly dense bush savanna, mixed woodland and gallery forest. The contrast in habitat structure between the park and the hunting reserves is illustrated in Figure 2.3.

The large mammal assemblage consists of a mixture of savanna and forest species. Mammal community structure, abundance and distribution are described in greater detail in Chapters 5 and 6. An inventory of species identified in the national park and hunting reserves is provided in Appendix 1. The park's position on the forest-savanna boundary is believed to have contributed to the presence of two endemic large mammal subspecies that have attracted considerable attention from conservationists: the northern white rhinoceros (*Ceratotherium simum cottoni*) and the Congo giraffe (*Giraffa camelopardalis congoensis*).

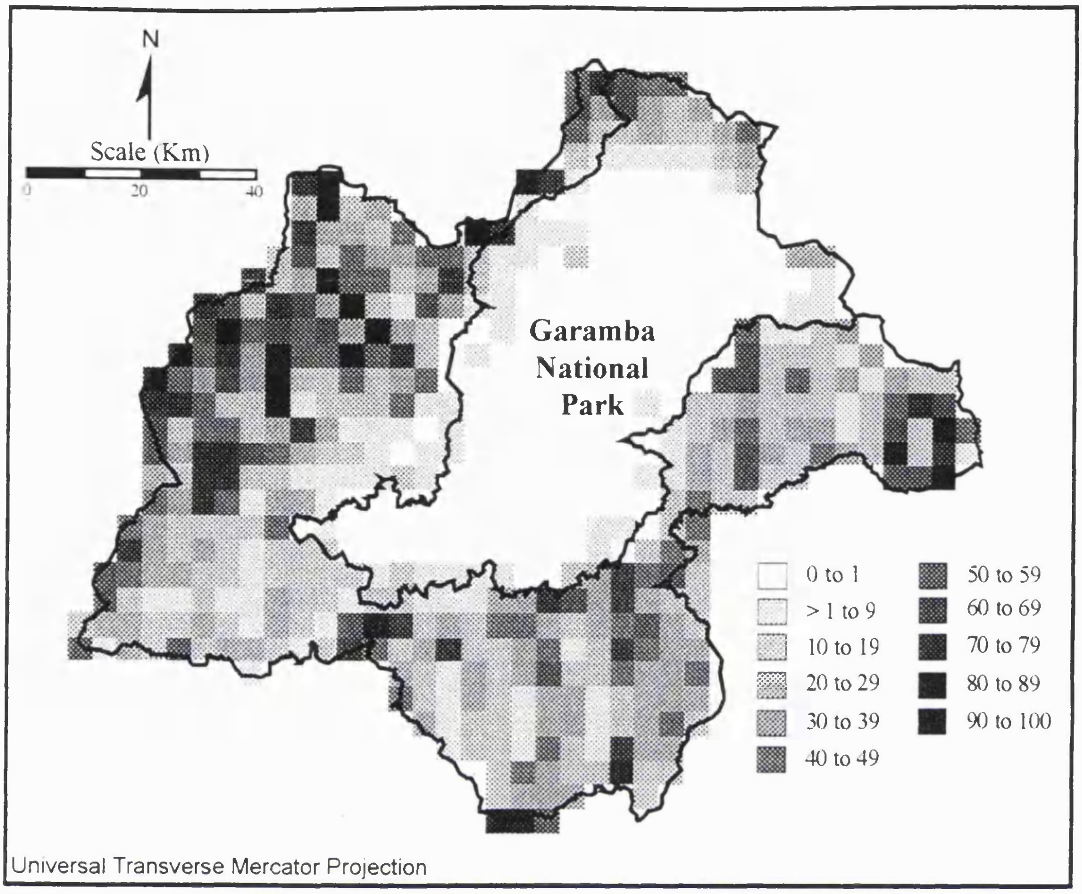

Figure 2.3. Percentage tree cover estimates for the Garamba ecosystem derived from standard reconnaissance flight data, based on 5 by 5 kilometre sub-units (compiled using GNPP aerial count data, May 1995).

2.2.3 Ethnic composition of the protected area

The resident populations of the Garamba region are composed of several ethnic groups. The Logos dominate in the east and the Azande in the west. The Azande are the most important ethnic group in the region in terms of their numbers. There are approximately 800,000 Azande in central Africa, of which the majority, approximately 500,000, are in Congo (Salmon 1988). The present study focuses on the management practices of the Zande people in the Azande hunting reserve in the West of the National Park. Within the hunting reserve, the detailed research was undertaken in the *groupement Ungua* which covers most of the Azande hunting reserve.

2.2.4 *The demography and economy of local people adjacent to the national park*

The Garamba region forms part of what is sometimes referred to by demographers as the 'infertility belt' in central Africa (Laurentin 1974). More recent demographic studies covering the *Zone* of Dungu also point to a low fecundity and population density as a result of the prevalence of endemic venereal diseases (Bilusa-Baila 1988, Romaniuk 1980). Dubois (1990) explains the unusually low population densities in the Haut Uele sub-region as being the result of out-migration to Ituri sub-region, whose population increased by 41.8% between 1970 and 1984, and Kisangani, which increased by 20.8% during the same period.

Since 1984, human population estimates for the region are unavailable. Nevertheless, estimates can be calculated based on aerial settlement counts (de Merode and Likango 1993) and from the education statistics available through the Dungu Doruma Catholic Diocese (Dubois 1990). Both of these estimates indicate a population density of less than 2 per km^2. This represents one of the lowest population densities in Congo (Bilusa-Baila 1989).

Because of the relatively low population densities, demand for land does not appear to impact on local livelihoods around Garamba as it does in other parts of Congo. For example, 53% of all 5 by 5 kilometre sampled sub-units overflown in the hunting reserves during the 1993 aerial count did not contain any settlement. This is consistent with the fact that access to wildlife resources, and not land loss, was the main complaint raised during a rapid appraisal of local attitudes towards conservation undertaken in the hunting reserves (de Merode *et al* 1993).

The most detailed published accounts of Zande agricultural practices are based on field data collected before 1965 (Sauter 1975, Singer 1972, Evans-Pritchard 1971, Reining 1966, de Schlippé 1956). de Schlippé's work, based on several years field work at Yambio, forty kilometres to the north of Garamba, provides valuable insights into Zande agricultural practices, many of which are still practised (personnal observation). Shifting agriculture remains the dominant form of agriculture, although permanent plots are cultivated closer to, and within, the urban centres. Manioc

(*Cassava spp.*) is the main staple, but maize, ground nuts, sweet potatoes and rice are also important. A large variety of additional crops are planted: 39 different crops were counted in 518 fields during field work (see Chapter 8). Fields are dispersed, some are up to several kilometres away from the household. Although agricultural activities are the dominant economic activity for the majority of the population, increasing numbers of people are involved in petty trade as part of a rapidly growing informal economy (see below).

2.3 Focal study sites

Research was undertaken in four key areas (Figure 2.4):

2.3.1 Kiliwa

The village of Kiliwa is the *chef lieu* (administrative centre) for the Ungua *groupement*, in the Azande hunting reserve. About 3500 people live permanently in the village (chef Sangbalenze *pers comm*). Kiliwa provided the focus for most of the research described in this thesis for a number of reasons. First, the village was understood to provide an important centre for the bushmeat trade. Second, the village was situated near the town of Dungu, which provided an opportunity to study the urban markets. Finally, the traditional administration in Kiliwa was able to assure the security required for a long term study involving extended residence in the area.

2.3.2 Dungu

Dungu is the administrative centre of the district containing the Azande Hunting Reserve. It is also the largest town in the region and contains a population of approximately 25000 people. Much of the bushmeat obtained from the park and the hunting reserves was believed to be for the urban markets in Dungu. These markets were a focus for this study.

2.3.3 Mamba

Located in the Azande hunting reserve, Mamba is a village made up of dispersed settlements on the western boundary of Garamba National Park. The village is smaller than Kiliwa, although the inhabitants were not enumerated during the study. Mamba is situated in an area of high large mammal abundance. Therefore, hunting practices in this village were studied to complement those in Kiliwa, where the abundance of mammals is lower.

2.3.4 Nagero

Nagero is the field headquarters for Garamba National Park where most of the ICCN personnel are stationed. Research with wildlife officers and Garamba National Park Project personnel was undertaken at Nagero.

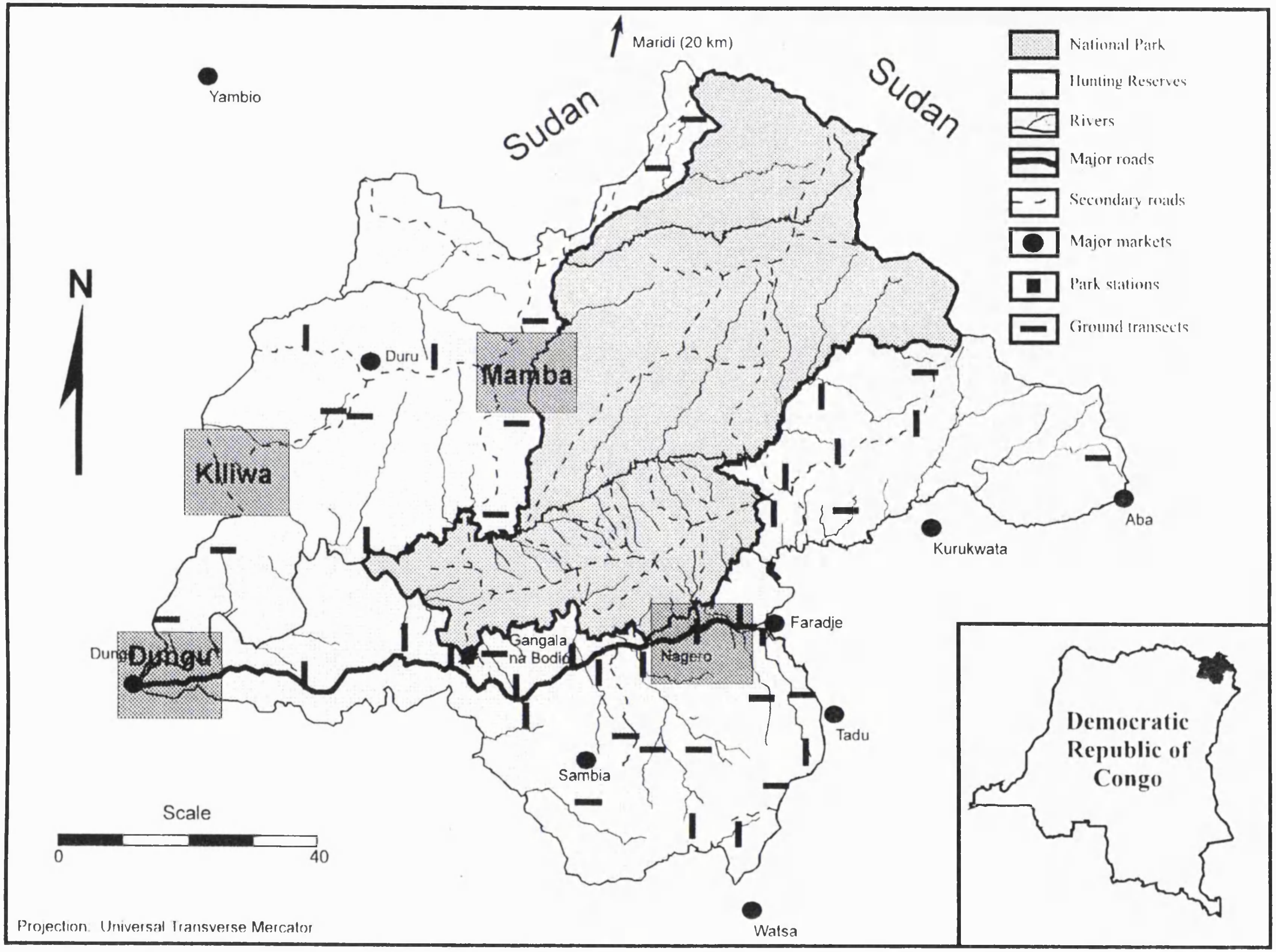

Figure 2.4. The Garamba ecosystem and the study sites

2.4 A history of centralised management: Garamba National Park

2.4.1 The state control of land and resources in Congo

Centralised control of the national park and its resources was instituted in 1938, as stated in the royal decree of 28 July 1936:

> *"les terres domaniales situées dans les territoires visés à l'article 3 (les parties des territoires du Congo-Belge et du Ruanda-Urundi réservées à la poursuite des buts de l'institut des Parcs Nationaux du Congo-Belge) restent la propriété de la colonie ou du Ruanda-Urundi. Elles ne peuvent être ni cédées, ni concédées; elles ne peuvent recevoir d'affectation contraire au buts de l'Institution tels qu'ils sont indiqués à l'article 2 du présent décret"*[2]
>
> (cited from Strouvens and Piron 1943)

This formed the basis for the establishment of a state conservation agency, the Institut National pour la Conservation de la Nature, now the Institut Congolais pour la Conservation de la Nature (ICCN). The agency, whose mandate is to promote nature conservation, research and recreation in Congo's network of protected areas, is centrally controlled from the capital, Kinshasa. The laws surrounding the protected areas in Congo are part of wider legislation on land and resources which, in theory, strengthen centralised control (Box 2.1)

2 "lands that are targeted for the implementation of article 3 (areas of the Belgian Congo and Ruanda-Urundi that are set aside to for the implementation of the objectives of the National Parks Institute of the Belgian Congo) remains the property of the colony, or of Ruanda-Urundi. They cannot be given up or handed over: they cannot be used for anything other than meeting the objectives of the Institute, as they are described in the present document" (Author's translation)

Box 2.1

The legal basis for state control of land and resources in Congo

Whilst the political regime has recently changed in Congo, the legislation covering the resource issues addressed in this thesis are based on existing legal texts. The legislation which defines tenurial rights can largely be drawn from the following publications: l'Ordonnance-Loi N° 66-343 of 7 June 1966, la Loi N° 71-008 of 31 December 1971 and la Loi N° 73-021 of 20 July 1973, together with the 1980 amendment (Loi N° 80-008). Forest resource use and hunting rights are also included in the Decree of 11 April 1949.

Land Tenure:
1980 Amendment states:

1. *L'Etat possède toutes les terres*
2. *Les droits fonciers accordés par l'Etat aux personnes (physiques et morales) le sont sous forme de concession perpétuelles ou ordinaires et qui sont un droit de jouissance de la terre.*
3. *Les terres occupés par les communautés locales et exploités individuellement ou collectivement, conformément aux coutumes et usages locaux deviennent des terres domaniales (art. 385 et 386) mais par ailleurs les droits de jouissance regulièrement acquis sur ces terres seront réglés par une ordonnance du Président de la République (art. 387).*[3]

Resource use
Forestry legislation was enacted through the decree of 11 April 1949. The law, based on the 1949 decree guaranteed communal tenurial rights, through the provisions of access certificates. Instead, the regulations concerning the use of natural resources are covered by the *Guide de l'exploitant forestier* (Republique du Zaïre 1986).

Selon le Décret du 11.4.1949, la catégorie de "domaine classé des indigènes" *permet l'occupation indigène après obtention d'un certificat délivré par l'administration mais la désuétude du décret de 1949 aboutit à ce que la forêt zaïroise en dehors des parcs nationaux revient toute entière à l'Etat.*[4]

(Source: Commission Européenne 1993).

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[3] 1. All land belongs to the State.
2. Rights of tenure constitute a lifetime lease which confers the right to exploit the land.
3. Land that is occupied by local communities, and which is exploited individually or collectively, based on local custom and use become part of the public domaine (art. 385 and 386. Rights of access to these lands will be settled by an ordnance of the President of the Republic (art. 387).

[4] According to the Decree of 11.4.1949, the category "domaines set aside for indigenous peoples" allows for local use of land after a certificate has been obtained from the civil administration. However, after the decree of 1949 became obsolete, Zaïrian forest resources, outside protected areas belongs entirely to the state.

(Author's translations).

2.4.2 International funding and centralised management

The history of wildlife management at Garamba is one of intermittent periods of active wildlife protection. The national park was established in 1938 to maintain the high densities of large mammals noted in the area (Offerman 1940). There appears to have been high investment in conservation until shortly after independence in 1960, reflected in the sophisticated infrastructure of park roads and buildings developed during this period. The findings from the de Saeger Expedition to Garamba between 1950 and 1954 indicate high densities of large mammals in the park. The Simba rebellion of the mid 1960s produced political instability and appears to have been associated with unsustainable levels of animal offtake from the National Park, resulting in the reduction of the rhino population from an estimated 1300 in 1963 to 490 in 1976 (Hillman Smith 1989).

A Food and Agricultural Organisation (FAO) funded project began in 1970 which provided support to the National Park Authorities to re-establish an effective wildlife protection system at Garamba (Savidge *et al* 1976). This project lasted until 1976, after which poaching in the national park is reported to have increased substantially until 1984 (Hillman Smith 1989). In 1984, the Garamba National Park Project was established, with funding from various international donors. The project's activities focused primarily on rebuilding the National Park's infrastructure for more effective wildife protection.

2.5 A history of devolved management: the Zande Kingdom of Wando, and the collapse of state authority.

This section traces the development of local systems of administration around Garamba, and introduces one of the key arguments developed in this thesis: it is only in the context of underlying social, economic and political processes that it becomes possible to understand the functioning of wildlife management, and hence, to explain many of the associated ecological dynamics.

2.5.1 The establishment of Zande administration

Zande political history and organisation has been extensively documented, largely because of its unique and extensive expansion through Central Africa during the middle to late nineteenth century (Salmon 1988, Cordell 1983, Evans-Pritchard 1971, Singer 1972, de Calonne-Beaufaict 1921 in Salmon 1988).

In brief, Zande history can be summarised in a number of phases. Between 1600 and 1720, a period of Zande expansion took place to the west of the Mbomu river, on the border of the Central African Republic and Congo. Territorial consolidation followed between 1720 and 1780. Political cohesion was largely achieved under the rule of Ngura who is believed to have devised the 'Paix Zandéenne' (de Schlippé 1956): a system of administration which proved to be extremely effective and facilitated the assimilation of neighbouring ethnic groups. Although the military power of the Azande enabled them to spread rapidly, it was their political organisation and sophisticated administrative systems, which relied largely on the Avongara ruling clan, that led to a uniquely stable tribal territory. Zandeland became a mosaic of autonomous kingdoms. The king, whilst being an autocrat, delegated his power through a highly effective administrative hierarchy (Evans-Pritchard 1972). Individual status did not depend merely on kinship, but could be accessed by members of newly assimilated clans through an ability to attract a following, whilst impressing the chief, such that "*economic reciprocity was of paramount importance in the* *political and jural organisation of Zande society*" (Singer 1972). The result was an effective local administration.

Vongara domination of the area around Garamba occurred after the Mahdist revolt in southern Sudan in 1883, when European influence was temporarily at a low ebb. The Kingdom of Wando formed in the West and the Kingdom of Gbudwe to the north (in Sudan) of what is now Garamba National Park. The Moru ethnic group were subjugated during this period of expansion (Salmon 1988).

2.5.2 Colonial influences on local administration

From the late nineteenth century, however, Zande political structures were deeply influenced by the wider political developments in Central Africa. This was associated with an increase in conflict between adjacent Zande Kingdoms, and with dynastic rivalries within the kingdoms themselves (Salmon 1988). Thus, "*the original impact of the European on the way of life of the Azande was a political one, although more an impact of chaos than one of uniform change*" (Singer 1972). The conflicts within the Zande political structure were compounded by the influence of international political divisions: the stand-off between Marchand and Kitchener at Fashoda in 1898 put an end to French political influence in Sudan. British imperial ambitions in the region were further reinforced by the 1906 treaty when Léopold II, King of the Belgians, renounced any proprietal claim to the Nile Basin (Martin 1983). The result of these negotiations was a territorial division which fractured Zande territory along the watershed of the Nile and the Congo basins, and in the west along the border of French Equatorial Africa (CAR).

All three colonial powers, Belgium, Britain and France, practised a policy of 'divide and rule' as a means of consolidating the territory acquired through negotiations in Europe. Vongara chiefs gradually fell in line with their respective European colonisers, and were drawn into wider conflicts which further fractured one of the most cohesive African political systems (Salmon 1988). In a succession of battles between 1892 and 1905, Zande chiefs fought against external troops and against each other. In the south, chiefs fought for the Independent State of the Congo (the private estate of King Leopold II of the Belgians until 1906), and in the north, with Anglo-Egyptian troops. Others fought with the *Mahdists* in their dwindling efforts to maintain the slave trade. The last truly independent Vongara chief, Yambio-Gbudwe, was killed by Sudanese troops under British command at the battle of Yambio in 1905 (Salmon 1988).

Against this background of political transition came a process of social upheaval instigated by both British and Belgian colonial powers. From the 1920s, political and legal restrictions were imposed on the population at large. One of the most dramatic changes came with the imposition of new systems of cultivation and residence. In southern Sudan, resettlement schemes regrouped Zande households along roads in a largely unsuccessful attempt to promote cotton yields. Households, which were traditionally dispersed to enhance access to uncultivated land and to facilitate rotation, were replaced by large and concentrated resettlement schemes (Reining 1966). In the Belgian Congo, between 1920 and 1935, traditional systems of cultivation were replaced by a system of cotton production that serviced wider industrial interests. A decree in 1918 legalised the use of force by colonial administrators at the point of production (Likaka 1995). The limited ability of the colonial administration to manage the imposition of cotton production led to the recruitment of traditional authorities to enforce cotton production.

This policy is reflected in a letter from the *Governeur Générale* of Congo to the provincial governors in 1931, in the context of the programme aimed at boosting cotton production: *"le rendement trop limité des indigènes doit faire place au travail collectif sous l'impulsion de chefs qui ne seraient plus seulement des autorités politiques, mais aussi des intermédiaires chargés d'une propagande active en faveur de la production"* (in Salmon 1988)[5]. In practice, the traditional administration became the lowest rank of a centralised system aimed primarily at boosting cotton production. Administrative control was shared by a combination of private sector and

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[5] "The very limited yields produced by the natives must be increased through collective work encouraged by the chiefs. The chiefs would become more than mere political figures, but would have the role of intermediaries for an active propaganda programme to encourage production." (author's translation).

colonial agents whose *"policy was to get the leading members of local communities into the lower colonial administrative positions; these leading citizens were then trained to impose a rigorous work schedule and to use a wide array of punishments against peasants failing to perform work obligations"* (Likaka 1995). Cotton production became the financial backbone of a subjugated traditional administration. In 1930 - 1931 Ngilima, King of Wando, received 21,000 francs in cotton production premiums, compared to the average household in the Collectivité Wando, who received 67 francs from cotton production (Sparano 1931, cited in Likaka 1995).

2.5.3 Political conflict and the rebirth of a devolved administration 'by default'

Congo's colonial era saw the traditional administrative structures of Wando drawn into wider commercial and political spheres. Congo's post-colonial era saw the gradual disintegration of national political, administrative and economic structures (MacGaffey 1991). The collapse of the formal administration led to new form of local administration, closely tied to the 'informal economy' discussed in the next section.

During period between the fall of the Tshombe Government in 1964 to the collapse of the Mobutu regime in 1997, the north east of Congo has been characterised by intense conflict interspersed by periods of gradual decline of the state and other economic institutions. The army mutinied in Stanleyville (now Kisangani) in 1964, and again in 1967 (Gott 1996). This was accompanied by the Simba rebellion, a movement defined by a mixture of Maoist philosophy and violence. During this period, north eastern Congo became a bloody playground for foreign ideological and economic aspirations and attracted such contrasting characters as the militant socialists Chou En-lai and Che Guevara and the mercenaries Hoare and Tavernier (Gott 1996). This was followed by a period of relative political stability, but economic collapse, for the three decades under the Mobutu regime (with the exception of two years of conflict in Shaba in 1978 - 1979).

The relative political stability in Congo (then Zaïre) was not matched in southern Sudan, with the first and second civil wars in 1968 to 1972 and 1983 to the present.

The Garamba ecosystem, situated on the Sudanese border, was directly affected by these conflicts. Political instability in Sudan since 1983, and more specifically the fall of Maridi and Yambio to Sudanese People's Liberation Army (SPLA) troops in 1990, has led to the forced migration of southern Sudanese to north-eastern Congo. Predominantly of Azande origin, the Sudanese refugees have settled in a host region which also comprises Azande communities. However, the Kingdoms of origin of the two communities differ. The refugees are from the Kingdom of Gbudwe yet they have, on the whole, been welcomed by the traditional authorities of the host Kingdom of Wando. The shared cultural origins of the hosts and refugees has 'softened' the impact of the refugee presence, according to the UNHCR Field Coordinator, Claude Gambale, himself Azande (pers. comm.). The relative ease of assimilation of over 90,000 Sudanese displaced people in the region is testimony to the adaptability and functionality of the new administration in the region (WFP and UNHCR 1993). However, the type of settlement strategy adopted by refugees is a key determinant of the ease and level of integration (see below).

Communities in a situation of crisis are entitled to protection (in terms of food and personal security) by their national governments. Should this fail, as with refugees, the mandate of the United Nations (implemented by UNHCR) is to intervene on their behalf. In the case of the Zande refugees in Dungu, neither national nor international support has been maintained due to the political and economic isolation of this region. Food provisioning was halted in February 1995, forcing complete dependence on local resources. In the absence of alternative support, it is the traditional authority that has been instrumental in facilitating the integration of refugee and host communities. The cohesive adaptability of the Zande culture, despite its erosion by the legacy of colonial rule, underlies the survival strategies adopted within the refugee affected area.

The refugees show three major patterns of settlement. Firstly, clanic affinities have led many Azande refugees to self-settle with relatives in Azande villages. The clan related settlements match the Zande traditional pattern of social organisation: the refugee is a "brother" and guest, facilitating assimilation (Gambale pers. comm.).

Secondly, refugees from an urban background, have settled in the larger trading centres, such as Dungu, where they subsist largely from trade. Finally, UNHCR official settlements have been allocated by local and national government officials[6]. These contain basic amenities and infrastructure: primary schools, health centres, markets etc.. Each household receives residential and agricultural land but households are settled with no regard to their origin or background. Their interactions with the host communities are also complex but the refugees, even the Azande, tend to be considered foreigners. A similar account of refugee - host interactions is provided by Leach (1991) in Sierra Leone. She also stresses the importance of existing existing ties in resolving some of the potential difficulties faced by displaced people.

The planned refugee settlements are situated outside the hunting reserves, whilst the settled refugee families appear to have been assimilated within the resident population. During this study, individuals of Sudanese origin could not easily be distinguished from the resident populations without a thorough understanding of the language. Occasionally, small details, such as people's names, would reveal people's origins. For example a woman in Kiliwa was named Namba Wane. The English derivation of her name, 'number one' or first born, revealed her Sudanese origins. Nevertheless, it seemed that neither her material belongings nor her activities in Kiliwa could be used to distinguish her from the Congolese community in which she lived, by anyone other than local residents. For this reason, this study does not explicitly draw the distinction between host communities and refugees.

Recent conflicts in Congo between September 1996 and May 1997, which led to the collapse of the Mobutu regime, have had profound social and ecological consequences for the region. The conflict, originating in the Great Lakes region, on the border with Rwanda, initially extended northwards on two fronts with the objective of capturing Kisangani. The Garamba region was situated on the path of

[6] This description of refugee settlements is partly based on a three week pilot study undertaken as part of this study in Kakal refugee settlement outside Dungu in 1996. The work was discontinued because of methodological and security difficulties.

the eastern advance of the conquering *Alliance des Forces Démocratique pour la Libération du Congo-Zaïre* (AFDL). Ahead of the AFDL advance, retreating troops of the *Forces Armées Zaïroise* (FAZ) engaged in extensive looting and vandalism in the region. Although the period of conflict was relatively short lived, it had profound effects. For the theme of this thesis, the discussion focuses on resource use and the management capacity of the national park (GNPP 1997, Smith and Smith 1997). Only the region to the north of the Dungu River (the Azande hunting reserve) was not extensively looted. This is understood to be because traditional chiefs in the hunting reserve insisted that soldiers of the FAZ should not cross the Dungu River (Gambale *pers. comm.*).

2.5.4 The informal economy and an associated 'shadow administration'

The growth of the informal sector is both a symptom of, and a response to the collapse of centralised authority in Congo. MacGaffey's study of the informal economy in Congo (1991) estimates that unrecorded trade consists of as much as three times the official GDP. The growth of the informal sector is, ironically, associated with a process of centralisation and nationalisation of the productive sector which began the state taking possession of the *Union Minières*, the vast Belgian copper mining company, in 1967. This was followed by the decrees of *Zaïrianisation* in 1973 whereby nationals were entitled to take possession of all foreign-owned businesses, and *Radicalisation* in 1975, when the state took over all large-scale enterprises. The decrees of *Retrocession* in 1976 tried, and largely failed, to stem the collapse of the national economy by attempting to encourage external investment by allowing shared ownership of national companies with foreign investors (Young 1984). By the late 1970s the official marketing system had become almost defunct, infrastructure was deteriorating and for petty producers, prices were becoming *"derisory in terms of purchasing power"* (MacGaffey 1991) as a result of soaring inflation. However, most Congolese were not waiting for the political elites to re-establish the state structures.

With rapidly increasing demand for food and other commodities from the growing urban centres, new opportunities were developing to produce what Beckman (1987) refers to as the "*new food frontier*". The important feature of the informal sector is that it is sufficiently fluid to escape the control of a ruling 'parasitic' political elite. "*Rural and urban marketplaces are inundated daily with persons of both sexes who buy and sell at prices arrived at by haggling and impossible to control*" (Mukohya 1991). Impressions can be gained of the informal economy by observing the armies of cyclists travelling between the main towns around Garamba with loads of palm oil and other products weighing up to 150 kg. Figure 2.5 shows the flows of wild foods, and counterflows of manufactured commodities to and from the Garamba region.

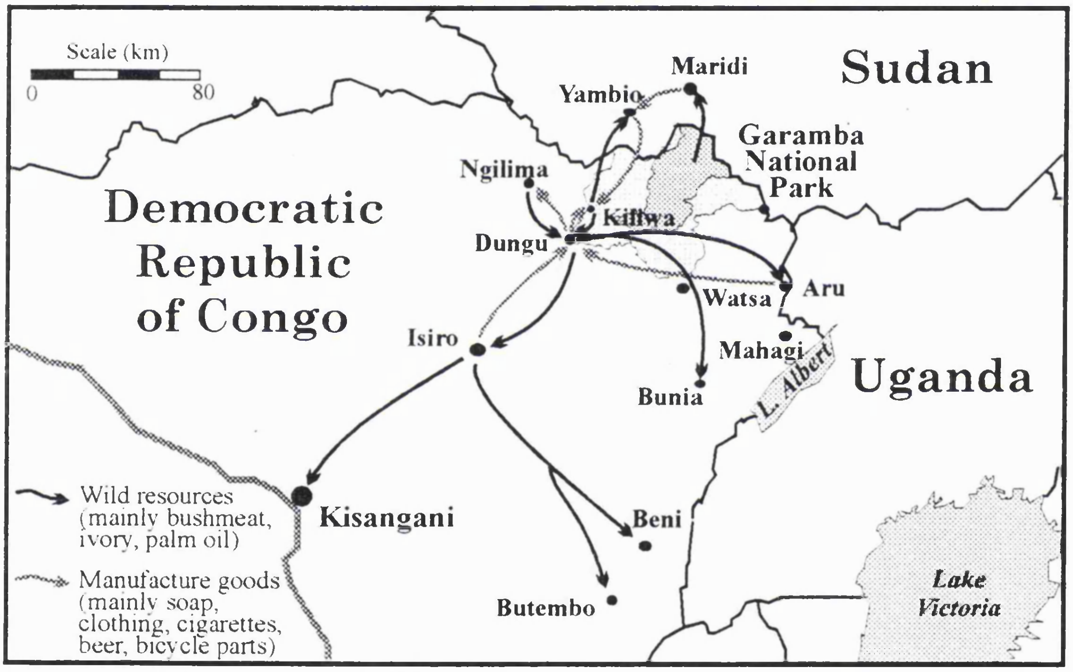

Figure 2.5 Trade routes of the informal economy: principal wild resources exported, and manufactured commodities imported to the Garamba region (source: fieldwork interviews with traders, 1996).

Whilst the informal sector has been described as providing "*local solutions to local problems*" (Mukohya 1991), it also involves trade networks which cover extensive areas, with traders often covering distances of several hundred kilometres. Bushmeat, in particular, has become a central component of this new and rapidly growing economy. Bushmeat is especially valued in the urban centres, and its high profit margins and relatively low weight encourages traders to cover large distance (Trefon 1997).

Just as the traditional administrations responded rapidly to the challenges resulting from the influx of displaced people from Sudan, traditional authorities have also adapted to the opportunities offered by the informal economy. For ambitious and enterprising traditional chiefs, the opportunities are only too obvious (chef Sangbalenze *pers. comm.*): with the dramatic growth of the informal economies came a demand for appropriate arbitrators. For the majority of the population, the government is "*capricious and oppressive*" whilst the "*local administration is out of reach of central Government whose decrees it does not always implement*" (MacGaffey 1991). Traditional authorities hold one key advantage over higher ranking officials: state officials are regularly moved from post to post, preventing them from developing long term, stable trade relations. As a result, traditional chiefs are in a position to provide the one service that is perhaps in greatest demand in Congo, and which is conditional for economic growth: stability.

2.5.5 The law on local access to wildlife resources

As in most central African countries, resource tenure in Congo is based on a mixture of customary law and state legislation. The evolution of Congolese legislation concerning resource tenure is outlined in Box 2.2. In summary, traditional rights of access to wild resources were enshrined in the Royal Decree of 1949. Jewsiewicki (1983) explains this emphasis on an 'indigenous law for the natives' as a mechanism for social engineering:

> *The rural world was administered by a native chief, with a native tribunal and a complementary native tax system. Paradoxically, the economic and administrative territory of the colony was progressively unified after 1920, while* 'indigenisation' *simultaneously divided people into small cultural units ... all Africans were excluded from credit, from private ownership of land and from the right to hire employees.*

Whilst the maintenance of communal law was used as a tool for alienating the vast majority of the indigenous population from positions of economic and political strength, it may have served to legitimise people's access to natural resources. Communal laws were superseded by post colonial legislation which strengthened the role of the state. Consequently, communal access to wild resources was no longer explicitly addressed. Conservation was one of the reasons used to justify the new emphasis on state control: *"les droits coutumiers étaient limités par l'administration lorsqu'ils compromettaient la conservation forestière[7]"* (IUCN 1988). Thus, some post-colonial legislation reflects an effort to replace traditional systems of resource management with state regulation. However, the reinforcement of the legal role of the state was not matched by the capacity of state authorities to administer natural resource management (Hart *et al* 1997). The collapse of the world copper prices in 1973 undermined the national economy and marked the beginning of the dismantlement of the state administration, with a corresponding growth of *de facto* communal law at the expense of *de jure* legislation.

Box 2.2

Hunting legislation
The hunting legislation is unclear, largely as a result of a decision made by the *Conseil Executif* to suspend sport and commercial hunting in 1982. Whilst this ruling is unambiguous with regards to commercial and sport hunting, it is more difficult to define the legal status of traditional hunting (IUCN 1988).

Selon la loi de 1982 (art. 54, 55, 56) la catégorie "permis collectif de chasse" permet aux habitants de la collectivité de chasser en groupe sous la responsibilité du chef de la localité dans les limites de leurs terres et de leurs besoin alimentaires. Néanmoins, il n'est pas encore possible, dans l'état actuelle des choses, d'établir des territoires de chasse villageois. Les permis de chasse collectifs limitent leurs bénéficières aux terres sur lesquelles ... ils ont d'après la coutume la faculté de chasser (art. 55), aucune disposition n'interdisant aux titulaires de permis de venir chasser sur ces mêmes terres. Il n'existe donc pas d'exclusivité d'accès aux ressources de la faune établie au profit de la communauté coutumière.[8]

[7] "Traditional rights were constrained by the civil administration if they posed a threat to forest conservation" (author's translation).

[8] "The Law of 1982 (art. 54, 55, 56) states that the category "collective hunting permit" allows residents of the *collectivités* [traditional adminstrative units] to hunt in groups under the overall responsibility of the chief. Hunters are forbidden to hunt beyond their lands or for more than is required to meet their nutritional requirements. Nevertheless, it is not possible under the current legislation to establish village hunting territories. Collective hunting permits only allow people to hunt on the land according to their customary habits (art. 55). Thus there are no provisions for exclusive communal rights of access to wildlife resources." (Author's translation)

2.4 Garamba ecology: a synthesis of historical resource management and political processes

Habitat and animal community structures are interdependent (Sinclair 1995, Dublin *et al* 1990). As described in Section 2.2, the national park contains grassland savanna, whilst the surrounding reserves are composed of dense bush savanna with extensive gallery forest. These habitat characteristics are known to precede the establishment of the national park (Verschuren *pers comm*, in Hillman Smith 1989) and have a profound effects on current mammal community structure and abundance. However, there is no comprehensive explanation for the contrasting habitat characteristics of the park and the surrounding hunting reserves: the topography, geology and climatic characteristics appear to be homogeneous throughout the ecosystem. Preliminary pedological research suggests that soil samples collected in grassland and dense bush savanna sites do not differ significantly (Likango *pers comm.*). Whilst the development of African savanna habitats are known to result from the interaction of such factors as elephants, fire and *termitaria* (Dublin *et al* 1992, McNaughton and Banyikwa 1995), there is no tested hypothesis for the occurrence of savanna habitats in the park as opposed to the surrounding reserves.

An explanation for the disjunct habitat types relates to the landuse history of the region (Hillman-Smith pers. comm.): the savanna grassland forms a north south belt which corresponds fairly accurately with the eastern extremity of Zande expansion during the late nineteenth century (Evans-Pritchard 1971). Thus, the area now included in the national park was an inter-tribal zone, prone to political conflict, and with correspondingly low human population densities. This may have resulted in fire regimes which differed consistently from those of the surrounding areas. In the populated areas, now contained in the hunting reserves, fire is used as an agricultural tool (de Schlippé 1954). As such, fire is carefully managed and used primarily in the early dry season, which prevents fire from reaching the high temperatures necessary for the conversion of forest to savanna habitat.

Le feu est l'outil le plus important dans l'agriculture zande. Il faut distinguer les feux de brousse qui s'attaquent de façon non contrôlée à la végétation en saison sèche et constituent un des facteurs les plus graves de dégradation des sols et le brulis de défrichements qui est considéré comme un outil[9]

(de Schlippé 1954)

In contrast, the area contained in the national park would have had lower densities of agricultural populations. Thus, fire would not have been managed on an annual basis, resulting in the accumulation of combustible material followed by less regular but devastating late dry season fires. de Schlippé makes direct reference to the Garamba habitat structure to illustrate this:

Il est intéressant de constater qu'en beaucoup d'endroits non habités soumis au feux intempestifs, tels le parc national de la Garamba au nord du Congo, la végétation semble plus dégradée que dans les régions voisines peuplées où l'homme protège ses cultures en plaçant des barrières contre l'extension du feu.[10]

(de Schlippé 1954)

Hillman Smith (1996) suggests that the habitat characteristics of the park reveal patterns which could be associated with a savanna vegetation recently derived from forest. This supports the hypothesis of declining woody vegetation in the park. These characteristics include gallery forests, consisting of species typically associated with ombrophile forest (e.g. *Chlorophora excelsa, Khaya grandifolia*). Whilst the 'more people, more trees' explanation for habitat change is only one of several possible hypotheses in the Garamba ecosystem, it is consistent with empirical studies of the interaction between forests, savannas and people (see for example, Fairhead

[9] "Fire is the most important of Zande agricultural tools. Bush fires, which burn the vegetation indiscriminately during the dry season and which degrade the soil, have to be distinguished from the fires used to clear fields, which are used as a tool." (Author's translation).

[10] "It is interesting to note that in uninhabited areas subject to uncontrolled fire, such as in Garamba National Park, the vegetation seems more degraded than in neighbouring populated areas where people protect their fields by creating fire breaks." (Author's translation).

and Leach 1996, Chenevix-Trench 1997). Certainly, de Schlippé's depth of understanding of indigenous resource management, and technical knowledge was well ahead of its time, which is perhaps why it was not well received by his contemporaries, and he had to self-finance the original publication of *eco-cultures d'Afrique* (Dupriez 1953).

Current paradigms on the dynamics of savanna ecosystems have embraced non-equilibrium explanations of change in species community structure and abundance (Sinclair 1995, Dublin 1995). These were explained in Chapter 1. Whilst these processes have tended to focus on the effect of high variability in physiological (eg. rainfall, groundwater levels), or biological factors (eg. disease), it follows that socio-economic factors can also be highly variable and stochastic and have significant ecological repercussions. An important example of this is war, which is explored in Chapter 10.

2.5 Conclusion

This chapter outlined the socio-economic and ecological characteristics which provide a background to the thesis. The systems of management were outlined in their historical and legal contexts. Centralised management covers the role of the state in wildlife management. Congolese law vests most of the rights over wildlife management to the Government institution, ICCN. However, a legacy of conflict and economic collapse in Congo has limited the ability of state institutions to assume effective authority over wildlife management. At Garamba National Park, long term financial and technical support has enabled the centralised authority to operate, but its activities do not cover all parts of the protected area. The centralised wildlife authorities have only limited influence on wildlife management in the hunting reserves. Local administrations exist in the hunting reserves, but these have also been deeply influenced by historical legacies. These include efforts by colonial and commercial interests to coerce traditional authorities into imposing cotton production on the agricultural communities. Post colonial history saw the re-establishment of local systems of authority, largely from the vacuum left by a declining state administration. The local systems of administration are now closely tied to a rapidly growing informal economy, which largely revolves around the supply of food to urban markets. Bushmeat is an important part of these systems of trade.

Finally, this chapter outlined the current theories that show the linkages between the historical landuse, political and ecological processes in the Garamba ecosystem. These illustrate the significance of social processes in understanding wildlife ecology. Thus, the human dimensions of animal ecology provides the main focus for this study.

Chapter 3

Methods

This chapter provides an outline of the techniques used to understand the process and outcome of wildlife management practices of the Garamba ecosystem. More detailed methodologies are provided in each chapter. The research methods are predominantly quantitative, as the approach is hypothesis driven. Nevertheless, qualitative material is drawn on to frame the research questions and to contextualise the discussion. All techniques were pilot tested prior to the main field work period. The thesis draws on a combination of inductive and deductive approaches to analyse wildlife utilisation patterns.

The Introduction to this thesis emphasised the role of received wisdom in shaping the nature of protected area policy and practice in sub-Saharan Africa. A number of authors have shown that this is compounded by a lack of objectivity of scientific method, particularly in the study of ecological processes (Chambers 1983, Leach and Mearns 1996). This, combined with a growing recognition of the anthropic landscape, where human factors both shape the ecosystem and are an integral part of it, has resulted in the increased use of multi-disciplinary research techniques to understand resource use issues (Commission Européenne 1993, Abbot 1996, Fairhead and Leach 1996, Chenevix-Trench 1997, Sullivan 1998). The approach combines techniques from the social and natural sciences so that evidence for causal relationships can be established through a process of triangulation (Lambin 1994).

3.1 Ecological patterns and wildlife management

The first part of this thesis (Chapters 4 and 5) examines the relationship between animal ecology and wildlife utilisation and management. The working definition of animal ecology used in this thesis is the distribution and abundance of mammals (Andrewartha and Birch 1954). A 'natural experiment' framework is used (Diamond and Case 1986), whereby natural variations in ecological and socio-economic parameters are used to test cause-effect hypotheses. However, in practice, natural experiments rarely provide a rigorous basis for distinguishing causation from correlation. This is because landscapes are infinitely complex, and all factors influencing animal distribution and abundance cannot be controlled. A solution to this problem is to analyse correlations across two axes of variation: space and time. The strength of the results depends on how much the different analyses concur.

The data used in the analysis of animal ecology were collected both as part of the field work for this study, and by the Garamba National Park's research and monitoring programme (Table 3.1). Spatial variations in animal abundance in the hunting reserves are drawn from the raw data collected by Nicolas and Ndey (1995) using ground transect techniques. These are compared to the spatial distribution of agricultural populations, drawn from the analysis of Landsat TM satellite. Other spatial factors are drawn from topographic charts using geographic information system (GIS) techniques (Johnston 1998).

Data representing the temporal variations in animal abundance were available through the regular ecological monitoring undertaken by the Garamba National Park Research and Monitoring Programme. The unpublished sampled aerial count data were re-analysed to show patterns of variation in animal abundance in the park between 1976 and 1995, under known wildlife management regimes.

Table 3.1. Summary of data used to analyse ecological patterns.

Question	Data	Sources / Sample size
Spatial variations of animal abundance (Chapter 5)	Animal distribution	42 line transects (5km each)*
	Agricultural intensity	3 processed Landsat TM scenes (18 ground truthing sites)
	Distribution of markets and administrative boundaries	Topographic charts, site visits
Variations in animal abundance (Chapter 6)	Aerial wildlife census	6 Aerial counts, 1976 to 1995 (9.6% sampling intensity)*

* Raw data made available through the Garamba National Park Research and Monitoring Programme.

3.2 Wildlife utilisation and management

A qualitative understanding of wildlife management practices was developed from interactive research with conservation practitioners at Garamba, and semi-structured interviews and participant observation (Pelto and Pelto 1978) with wildlife users in the hunting reserves. This material was analysed as follows: geographic information systems (GIS) were used to present the current and planned management practices of the national wildlife authorities. Local use and management of wildlife resources were analysed using access mapping (Ribot 1998).

Quantitative analyses of resource use was based on household, hunting surveys and market surveys. The distribution of benefits from wildlife resources was examined using household wealth as means of differentiating the community. Access to wild foods was measured using household monitoring Marr (1971). Wealth was evaluated using wealth ranking techniques (Grandin 1988) and questionnaire surveys, and agricultural surveys (Casley and Lury 1981). Focal subject sampling (Altmann 1974) was used to explore harvesting patterns of local hunters living in the hunting reserves. Hunters were accompanied and data was recorded from direct observations during the hunt. Market surveys (Martin 1995) and interviews with traders were used to examine the relationship between wildlife protection and wildlife utilisation.

Table 3.2. Summary of data used to analyse wildlife utilisation and management.

Question	Data	Sources / Sample size
Management strategies (Chapter 4)	Aerial count data	1993 aerial count (9.6% sampling intensity)*
	Elephant surveys	42 line transects*
	Rhino monitoring	Intensive monitoring (1984 to 1995)*
	Community access mapping	Rapid rural appraisals / informal interviews
Hunting patterns (Chapter 7)	Hunter surveys (automatic rifles)	19 hunts
	Hunter surveys (shotguns)	87 hunts
	Hunter surveys (nets)	13 hunts
	Harvest surveys (snares)	52 households (236 weeks)
Household consumption patterns (Chapter 8)	Dietary recall	121 households x 14 (1694 interviews)
	Household budgets	121 households x 14 (1694 interviews)
	Wealth ranking	121 households
	Agricultural land holdings	121 households
Marketing Patterns (Chapter 9)	Market surveys	374 surveys
	Trade surveys	931 interviews
	Law enforcement data	Monthly patrol reports (1991 to 1997)*
Landuse priorities	Food preference ranking	121 households
	Key informant interviews	4

*Raw data made available through the Garamba National Park Research and Monitoring Programme.

3.4 Interpretation and analysis of results

Statistical tests were used to bring a degree of analytical rigour to the observations made during fieldwork. In this thesis, statistical analyses are used both to test specific hypothesis (deductive research) and to explore data to identify relevant issues (inductive research). A number of analyses are specific to particular chapters. These are outlined in the Methods sections in the respective chapters. Throughout the thesis generalised linear models were found to provide the most robust statistical tests available for this study (see Box 3.1), but non parametric tests, using SPSS, were used when parametric assumptions could not be met.

Box 3.1

Generalised Linear Interactive Modelling (GLIM)

Generalised linear models provides a powerful set of statistical tools for describing and testing the significance of the relationship between ecological and socio-economic variables (Dobson 1990). They are particularly useful for data which have complex interactions that rarely meet the assumptions of conventional parametric statistical tests. These assumptions relate to the error distribution of the relationship between the explanatory (eg. wealth) and response (eg. wild food consumption, hunting frequency) variables. The conventional technique for resolving this problem is to transform one or several of the variables in the model, or else to use non-parametric statistics. However, transforming variables alters the error distribution, thereby making it impossible to assess the validity of the test, and the use of non-parametric tests can lead to 'type two errors' (incorrectly accepting the null hypothesis). Generalised linear modelling software (GLIM4) transforms the data without altering the error structure by using a link function (Crawley 1993). The assumptions of equal variance and normal distribution of errors are evaluated by plotting standardised residuals against the fitted values and the standard normal deviates.

For example, this study found that that the relationship between food consumption and wealth rank is not strong (Chapter 8, Table 8.3, $r^2 < 0.1$). This finding is typical of studies in highly heterogeneous communities, where behaviour is determined by a large number of factors. In statistical terms, this is referred to as overdispersion (Manly 1985). To some extent, this has been compensated for by a relatively large sample size ($n = 121$) which makes it possible to identify minor relationships that are significant. However, overdispersion increases the probability of obtaining a 'type one error' (falsely rejecting the hypothesis that wealth has no effect on wild food consumption). Scaling the sample size by the model's Pearson X^2 value divided by the degrees of freedom increases the standard error. This provides a more realistic significance test for overdispersed data (Crawley 1993), and was used when the residual sum of squares was significantly greater than the degrees of freedom.

3.5 Research assistants and language

Interviews were conducted in French and Bangala. A number of households spoke only Pazande, in which case local interpreters were used. A team of four local researchers were used to assist with the market and household surveys. The research assistants had all completed secondary education, but none had had prior research experience. Training in interview and survey techniques was undertaken during the pilot phase.

3.6 Research programme summary

This chapter has summarised some of the techniques used to develop an understanding of the wildlife management strategies and their ecological and social consequences. The research schedule for the study is as follows:

- **October 1994 to April 1995**

  Literature review and development of field methods. Existing ecological data from Garamba were re-analysed and compiled (de Merode 1994, de Merode and Likango 1995).

- **April 1995 to October 1995**

  Pilot study and preliminary fieldwork, undertaken at Kiliwa, in the Dungu Refugee settlements and at the National Park headquarters at Nagero. Relevant authorities were visited and presentations were made at village markets. Pilot studies were undertaken to test the feasibility of the household and hunter surveys. In addition, a training programme in GIS, remote sensing and statistics was organised and carried out for ICCN research staff. Participatory analysis of ICCN management strategies at Garamba was undertaken at Nagero.

- **November 1995 to February 1996**

  Analysis of preliminary results and presentation of a report outlining research schedule for the remaining field work. Re-appraisal of research methods.

- **February 1996 to July 1996**

  Main research period undertaken in the Azande Hunting Reserve, at Kiliwa, Dungu and Mamba. Household consumption was monitored over 8 months in Kiliwa. Market surveys were undertaken on a weekly basis in Dungu and Kiliwa. Hunts were followed around Kiliwa and Mamba. Fieldwork was interrupted by conflict in the region.

- **August 1996 to July 1997**

  The data were analysed and the thesis was compiled in London.

- **August 1997 to September 1997**

  Return to Congo to complete data collection and thank those who supported the study.

- **October 1997 to July 1998**

  The remaining data were analysed and the thesis was completed.

Chapter 4

Centralised and Devolved Systems of Wildlife Management and Utilisation at Garamba

4.1 Summary

Chapters 1 and 2 described two levels of wildlife management: centralised and devolved. This chapter explores these two approaches using the results of focused enquiries during field work. The chapter presents a qualitative appraisal of wildlife management which sets the context for the subsequent analytical chapters. The research was interactive and efforts were made to allow people to define and modify the research agenda.

The first part of the chapter explores the protectionist policy and practice of the wildlife authorities, supported by international donors. This was achieved through a collaborative, GIS based planning and zoning exercise with wildlife officers and project staff. Management zones are described, presenting present and future management priorities for the protected area.

The second part of this chapter examines the local systems wildlife management. Participation in wildlife management is assessed by disaggregating the community to understand who are the beneficiaries of wild resource use and trade. This is achieved by presenting bushmeat trade networks, or *filières*, developed from the technique of commodity access mapping (Ribot 1998). The *filières* reveal a sophisticated management system with regulatory mechanisms based on control and patronage, which is maintained by power relations between the groups.

Part I

Centralised wildlife protection in the national park

4.2 Introduction

An understanding of centralised wildlife protection was achieved by taking an active part in the national park's research and monitoring programme. The research project presented in this thesis included a training programme for ICCN wildlife officers and project staff in geographic information systems and data analysis. This exercise was used as a basis for encouraging wildlife officers to outline the current and planned wildlife management activities at Garamba.

Protected area management policy, to date, at Garamba is outlined in the 'Draft Framework Document for the development of a Management Plan for Garamba National Park' produced in September 1995 (GNPP 1995). The document states that the management of the protected area centres around two objectives. First, a broader "Development Objective" is to "maintain and develop the management capacity of the park". Second, an "immediate objective" is to "reduce the level of poaching to within defined acceptable levels". Acceptable levels were defined as a complete absence of rhino poaching, and no poaching in the southern part of the park. Furthermore, levels of poaching throughout the national park had to be reduced to "below the levels experienced in 1994".

The approaches to implementing the above policies can be explored by examining the conservation activities, both current and planned, that are listed in the framework management plan (GNPP 1995). To this end, Figure 4.1 classifies park activities according to whether they meet wildlife protection objectives (such as patrol support, and infrastructural development in the Park), or local development objectives (such as tourism development, or outreach programmes), and the time frame over which they will be implemented.

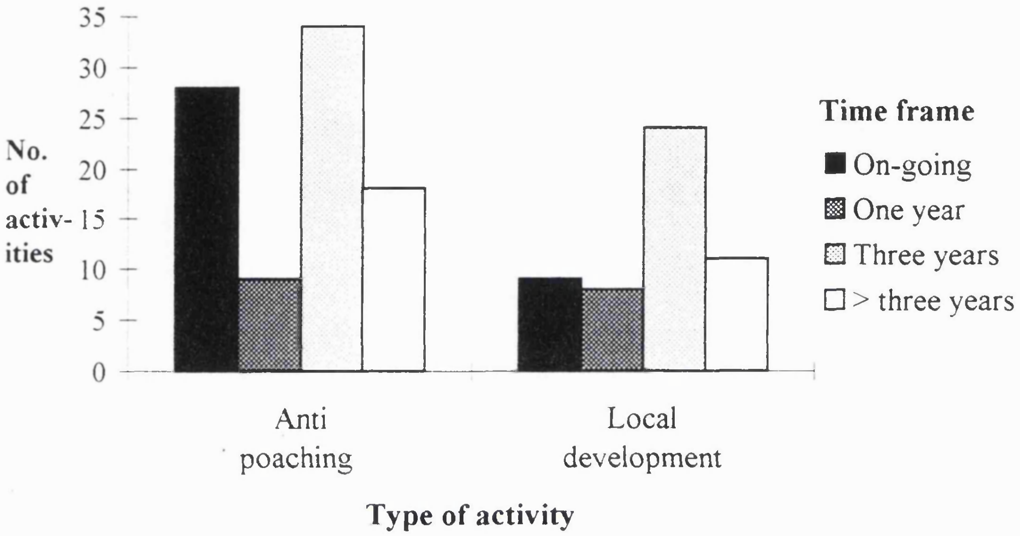

Figure 4.1. The time frame for activities planned by the Garamba National Park Project Management Unit (based on GNPP 1995)

Figure 4.1 shows that on-going and planned activities as stated in the draft framework document are focused on anti-poaching as a means of meeting conservation objectives. The current and projected activities include the maintenance of law enforcement patrols as a means of meeting the wildlife protection policies, and the development of the infrastructural capacity to support wildlife protection within the Park. The document justifies the policy on the basis that the "problems encountered by the park stemmed from the local population living in and around the *Domaines de Chasse*" (GNPP 1995). It is nevertheless recognised that the focus on anti-poaching is an attempt to "deal with the symptoms, not the causes of these problems". Thus the report states that a formal 'community orientated' approach to conservation would have to be implemented within three years. Hence, the document justifies its priorities by defining them as solutions to immediate problems. This is reflected in Figure 4.1 which shows a planned increase in local development activities within three years of the development of the Garamba National Park Project.

The results should be treated with some caution because they give no indication of the scale, in terms of financial or other investment, of a particular activity, nor of the likely impact of those activities. Nevertheless, Figure 4.1 does reflect priorities as defined by local management personnel. The time frame also indicates the priority that is placed on a particular activity, although this may also be influenced by the availability of financial resources (a very costly, high priority activity may be planned at a later date because the financial resources were not available at the time).

4.3 Understanding wildlife protection: management zonation of the protected area

Central to planning the current conservation regime is the protectionist perspective of wildlife managers on local conditions and broader landscape characteristics. Thus, an improved understanding of policy formulation and implementation can be achieved by examining the criteria they use to prioritise the zonation of a protected area.

A simple decision support tool was developed as part of this study to display the distribution of resources and other factors considered important by wildlife managers (de Merode *et al* 1996). GIS technology was used to facilitate the decision making process by integrating a variety of features related to the development of land-use policy, such as indicators of ecological value and human presence. The outcome was a protected area zonation which classified the landscape into optimal land use units for meeting conservation objectives. The process is described below to illustrate the development of the protected area zonation at Garamba which reflects current policies.

4.4 Data sources

The following types of data were identified by a team of three wildlife officers as being important to develop an effective zonation map of the protected area:

4.4.1 Rhino population status

The rhino population, as the main focus of the research and monitoring programme, has been intensively monitored since 1984 (Smith and Smith 1991). Regular data collection is undertaken on rhino ecology and behaviour. A counting technique based on individual recognition is used and positions are recorded from the ground or from an aircraft to a precision of at least one kilometre. Radio telegraphy has been used over limited period using both radio collars and transmitters fixed in the rhino's horns.

4.4.2 Illegal activities

These data are primarily collected by the national park guards and are collated by the Park's Research and Monitoring Programme. They provide information on illegal activities encountered by guards patrolling the Park. The data collection techniques are based on Bell (1984) and are analysed in greater detail in Chapter 10. They were used as part of the zonation to indicate the distribution and intensity of illegal activities in the national park.

4.4.3 Elephant distribution in the park and hunting reserves

The primary source of data is derived from the systematic sampling aerial counts flown over both the park and the reserves on a regular basis. These techniques are described in detail in Chapter 6. As aerial count techniques do not provide accurate elephant counts for areas of high tree canopy cover, such as in the reserves, ground transects measuring the frequency of elephant faecal counts were used (Nicolas and Ndey 1995; a description of the techniques is provided in Chapter 5). These produced an indication of relative elephant distribution in the hunting reserves. The data was interpolated to the whole reserve area using a weighted distance interpolation (Eastman, 1995).

4.4.4 Human population distribution

No reliable demographic data exist for this area, and therefore hut counts made during the aerial survey were used to estimate human population distribution. A ground truthing exercise was carried out in the communities to determine the average number of people per hut (de Merode *et al* 1996).

4.5 Results: data integration

Arc/Info and Idrisi GIS software were used to collate the data in a concise form that could easily be interpreted. Figure 4.2 presents the integration of extensive protected area monitoring data into a single map, reflecting the Project Management Unit's understanding of the processes taking place in the ecosystem. Poaching is concentrated in the northern half of the park, close to the border with Sudan. At the time of analysis, poaching was largely absent in the more intensively monitored rhino sector in the south (depicted by an outer convex polygon joining the most peripheral rhino observations, estimated to contain the rhino home range). The elephant population is also concentrated in the south. In the hunting reserves, elephants were taken to be a keystone species representing areas of high conservation value. Human population distribution is shown in the reserves, along with known refugee settlements and those areas known to be exploited for gold.

Figure 4.3 represents a preliminary zonation based on these data. The management of the park is entirely focused on anti-poaching. A rhino sector is contained within the central southern area, which is intensively monitored and patrolled. It can change in size according to the ranging behaviour of the rhino population. A central northern area is covered by two northern sector patrols. This area acts as a buffer to prevent the high levels of poaching in the north of the national park from impacting on the rhino sector. To the north of this is a peripheral area that is effectively abandoned as far as patrolling effort is concerned because the area is considered excessively dangerous for guards on patrol.

The hunting reserves are considered important by the wildlife authorities for the management of the park, but are not actively managed because of limited resources. Several project proposals have been developed to initiate conservation activities in the hunting reserves by the wildlife authorities. To manage the hunting reserves two land use categories were established by members of the Project Management Unit. 'Conservation Priority Areas' were defined according to high elephant distribution in the hunting reserves. This zone is adjacent to the national park and is also determined by a relatively low level of human settlement. Conservation Priority Areas were considered essential to the successful management of the national park, and were believed to require a management regime involving the regulation of wildlife utilisation, and limited human presence. The authorities responsible for managing the Conservation Priority Area were not defined. Areas that were further away from the national park, that were less frequently used by elephants and that had higher human population densities where classed as 'Human Priority Areas'. The Human Priority Areas were designated to provide the focus for integrated conservation and development initiatives, for which funds would be sought by the wildlife authorities from international donors.

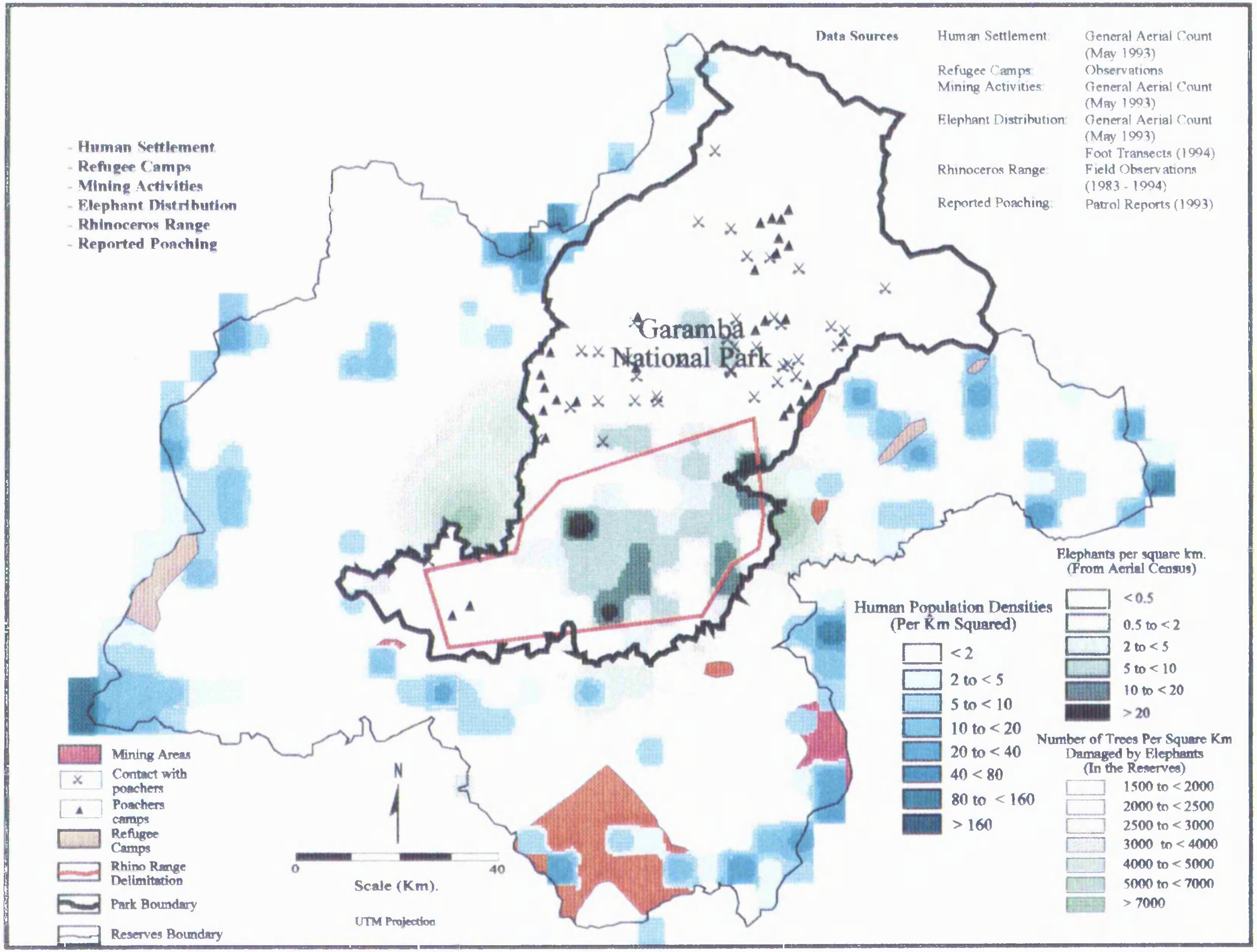

Figure 4.2. Factors used for the zonation of Garamba National Park and the surrounding Reserves

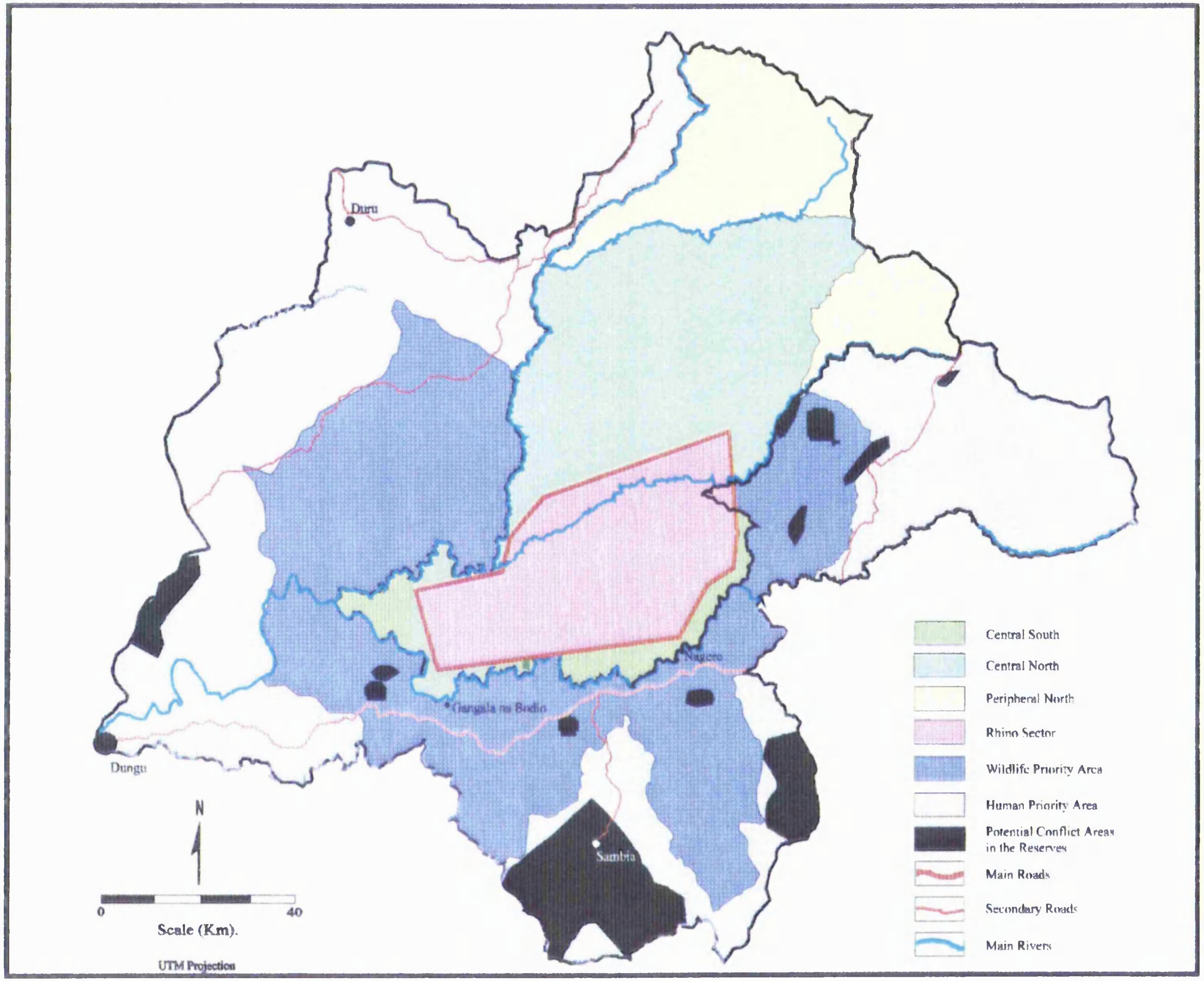

Figure 4.3. Defined Management Zones in Garamba National Park and surrounding hunting reserves.

Part II

Devolved Wildlife Management in the Azande Hunting Reserves

4.6 Background

This section summarises wildlife utilisation and management in the hunting reserves. The data were collected during a period of nine months living in Kiliwa village. The broad objective was to develop an understanding of the social groups that had a stake in wildlife utilisation and the power relations that had developed over access to bushmeat resources. The investigation revealed a number of internal regulatory mechanisms relating to the exploitation of wildlife. This supports the notion that, as a resource, wildlife is actively managed by key groups amongst the local residents. Wildlife management is driven by significant financial incentives for trading in bushmeat. Thus, wildlife management by local residents in the hunting reserves can be described in terms of both the local participation and market driven paradigms described in Chapter 1. This section serves only as a summary, because the relationship between wildlife populations and resource use and management is explored in greater detail in subsequent chapters.

4.7 Developing an understanding of local resource use: the bushmeat commodity chain

The activities and relations that surround the use of wildlife resources can be understood in terms of the bushmeat commodity chain. In his analysis of the charcoal trade in Senegal, Ribot (1998) describes a commodity chain as an ensemble of interlinked exchanges through which a product passes from when it is harvested until it is traded and finally consumed. The commodity chain approach to studying trade in resources represents a departure from formal neoclassical approaches to economic modelling as the emphasis is on power relations rather than supply and demand. This approach is increasingly used to understand the reality of peoples' livelihoods in countries, such as Congo, where economic activities have been driven underground by constraints of a "*parasitic*" formal economy. Tracing commodity flows has been used successfully to "*analyse the connections between individual survival strategies, wider social networks and the macrolevel political economy*" (Nkera and Grundfest Schoepf 1991). This provides a useful basis to understand the socio-political context of wildlife utilisation in order to explore the management practices that have evolved around what seems to be a highly lucrative trade.

The commodity chain approach was used here to contextualise the use of wildlife within relevant social relations and hierarchies. This engenders a broad approach to wildlife regulation. A formal *de jure* analysis of the regulatory mechanisms that determine wildlife utilisation would emphasise the role of the state, and in particular the wildlife authorities. However, an accurate understanding of wildlife regulation can only be understood by considering the broad spectrum of socially mediated restrictions on access to resources.

4.8 Methods

The field work techniques used to understand access to, and control of, wild resources were initially based on a selection of Rapid Rural Appraisal (RRA) tools widely used in development interventions. These included mapping, ranking and scoring of different wild resources to understand the constraints to people's resource use (FAO 1989, Chambers 1993). The research was undertaken with focal groups, and three sessions were completed during the initial phases of the field work. The work produced valuable insights into people's harvesting and trading patterns, but was felt to be intrusive and demanding of participants' time. While the time expected of participants might be justified in the context of a development intervention which promises tangible benefits for the participants, such outcomes could not be provided in this case. Instead, a semi-structured enquiry was undertaken over a prolonged period consisting of regular, informal interviews with a range of individuals who were present at the Sunday market in the village of Kiliwa. Most of the results described below are drawn from these exchanges at the market place.

The discussions were diverse and instructive. Exchanges typically consisted of discussions about why people had come to the market, what they had come to buy or sell and exploring some of the problems relating to the marketing and purchasing of food products. Bushmeat was not explicitly introduced into the conversation, but the theme was developed when mentioned by the participant. Purchasing meat provided a catalyst for generating discussion around the use, and the benefits derived from the use of wildlife. A large shelter had been built adjacent to the market by the *chef de groupement* to encourage trade in the village, and this provided a useful environment to develop an understanding of the workings of the bushmeat trade. The key themes from these conversations were recorded after the market, usually the same evening, and structured, several months later, to form a coherent picture of local wildlife utilisation.

4.8.1 Access mapping

Access mapping (Ribot 1998) was used to conceptualise wild resource use. The following steps were used to structure the information gathered during the Sunday Markets at Kiliwa:

1. groups involved in the extraction, processing, exchange, transport, distribution, sale and end use of bushmeat were identified;
2. the key mechanisms by which benefits were drawn from wild resources were documented;
3. the distribution of benefits among and within groups was traced to build a picture of how access to bushmeat is maintained and controlled.

(modified from Ribot 1998)

4.9 Findings: wildlife benefits, access and control

This section outlines the benefits, or value, drawn from wildlife resources by the key groups described above. Ribot (1998) underlines the fact that 'value' can take multiple forms, such as "*currencies, symbols, other persons, ... or any object of appropriation or use*". In this study cash income and profits are used as the primary measures of the benefits derived from wildlife. These provide useful measures of the benefits, can be discussed with members of the local populations, and can easily be analysed. Nevertheless, a number of other benefits are associated with wildlife utilisation, such as prestige and the recreational value of hunting. A number of secondary benefits also exist. These arise from the way in which wildlife is exploited, including factors such as immunity from prosecution through developing social networks that provide privileged rights of access for key individuals. This increases demand for wildlife and adds financial value to bushmeat for those key individuals.

The main groups identified, and the mechanisms used to maintain access to, and manage, the resource are described below. The patterns described are outlined graphically in Figure 4.4.

4.9.1 Producers

Hunting appears to be exclusively undertaken by men. The techniques used are diverse, as are the derived benefits. Hunting ranges from small scale harvesting, using traditional techniques such as nets and snares, to the extraction of large volumes of meat by targeting the larger, protected mammals using automatic rifles. The latter requires a high level of organisation (see Chapter 9).

Armed groups from Sudan are considered to be important users of wildlife. They are believed to hunt mainly in the park, but pass regularly through Kiliwa to trade supplies in Dungu. It was alleged that a number of Kiliwa households facilitated the activities of poaching groups by providing porters and safe houses (*maisons d'acceuil*), where arms and ammunition could be stored to minimise the risk of encounters with Congolese authorities. None of the individuals encountered during the Sunday market claimed to have direct contact with the armed groups from Sudan. Congolese soldiers belonging to the *Forces Armées Zaïroise* (FAZ) were allegedly involved in large scale hunting, although these tended to be lower ranking soldiers. A small garrison of about 60 soldiers was based near Wilibadi in the north, and these were believed to be hunting mostly in the park. Military officers did not actively hunt, but were widely said to co-ordinate and regulate hunting activities (see below).

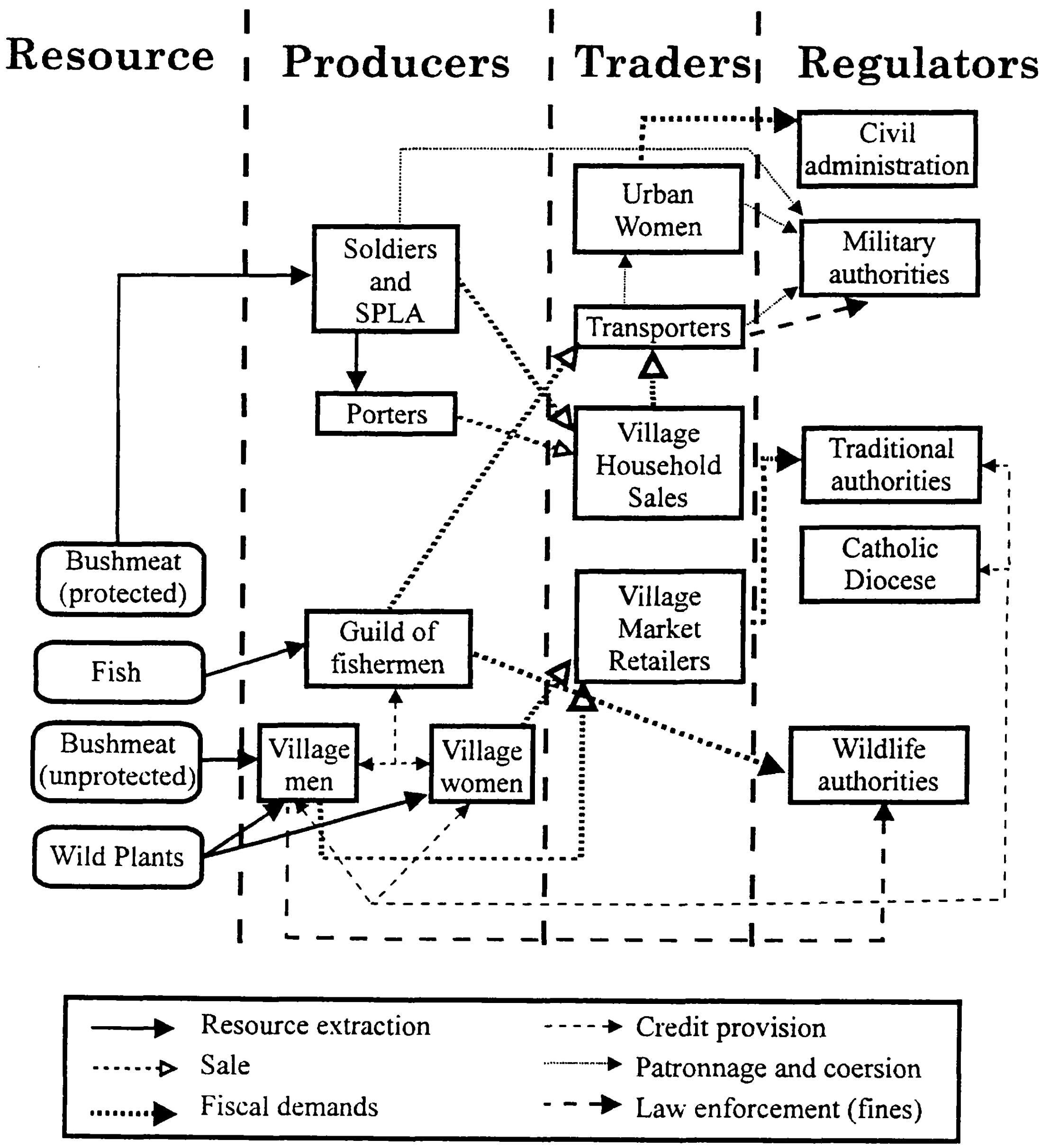

Figure 4.4. Conceptual framework showing the beneficiaries and the power relationships associated wildlife resources amongst residents in the Garamba ecosystem.

4.9.2 *Traders*

There appear to be two clearly defined parallel trade networks operating from Kiliwa. Small scale hunters usually sell a proportion of hunted meat directly at the village market, the remainder being kept for household consumption. This trade is open and considered to be authorised by the law. Nevertheless, on the few occasions when national park guards were present in the village, the stalls used for selling meat were empty.

A more important trade was said to operate outside the Kiliwa markets. Two groups of traders use Kiliwa as a base for trading in meat from large mammals. First, a small group of relatively wealthy women are the main actors selling bushmeat in urban markets. These women come to Kiliwa from the town of Dungu accompanied by groups of up to fifteen male porters on bicycles. They exchange meat for commodities that are imported from Uganda, such as soap and clothing. It was alleged that a small number of households in the village sell large quantities of meat to these women on a regular basis. The meat consists largely of protected species that has been procured outside the village, close to, or within the national park. The exchange is concealed and it was difficult to identify the participating households. However, the women traders from the town appear to make little effort to conceal their activities and it was alleged that they had close ties with military officers in the town.

Second, are village meat traders who appear to conceal their activities because they are acting as agents for the bushmeat hunters who hunt illegally. These bushmeat hunters are men who have access to automatic rifles and are able to kill large protected mammals. The SPLA hunters, in particular, were believed to sell their products through village traders because their presence in Congo was illicit. Both the hunters and the village traders risk prosecution if they bring their products directly to the urban markets - especially as they would then be competing with the urban women traders. Instead, they sell their meat to urban women traders at a much reduced rate. Thus, Kiliwa served as a trading post where 'illegal' meat was sold to women who were able to bring the meat to the urban markets without fear of prosecution because of their ties with military officers. The flow of bushmeat is examined in greater detail in Chapter 10.

4.9.3 Regulators

The revenues generated from the bushmeat trade do not come from the buying and selling of meat alone. Revenues were also collected by indirect means, such as through taxation, fines, interest on loans and coercion. Various authorities intervened as regulators on the bushmeat trade (Figure 4.5).

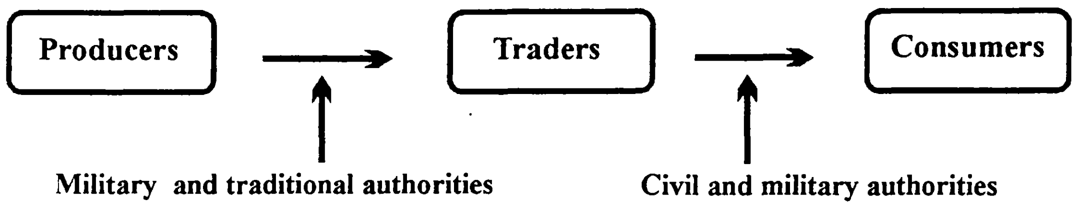

Figure 4.5 The role of regulators in the bushmeat commodity chain

The only wild food producers to be taxed directly are commercial fishermen. The wildlife authorities in Gangala na Bodio are responsible for raising taxes through monthly fishing permits for all those fishing in the hunting reserves. These are collected through the patrol posts on the periphery of the national park. However, government officials cannot raise taxes officially from commercial hunting, which is theoretically illegal in the hunting reserves, without being seen to condone the practice. Nevertheless, a system of *autofinancement* operated in Congo during the time of study, whereby state officials were expected to generate local revenues for financing civil administrations. The bushmeat trade provides an important opportunity for raising money, and officials have adapted their fiscal mechanisms to capture some of the revenues from the trade, whilst remaining within the law. This is achieved by taxing commercial activity, and not the commodities themselves.

The traditional authorities collect stall permits from all those selling products at the market. Whilst most stall owners manage to avoid paying for the permits, stalls selling bushmeat or other expensive commodities are specifically targeted by the chief's officers, and rarely avoid paying the tax. In Kiliwa, local taxes were used to maintain the chief's personnel, which included a clerk and five *gendarmes*. Fiscal benefits also extended to other members of the village: the stall permit revenues were used to maintain the local school, and a dispensary was built at Paika, about 15 kilometres to the north of Kiliwa using stall permit revenues.

Commercial taxes are imposed by the Civil authorities in Dungu. The town of Dungu is the administrative centre for the *Zone de Dungu*, and a significant number of civil servants reside in the town. Revenue for this administration is secured by imposing taxes on commercial activities in the town. The fiscal arrangements are similar to those in the villages, but on a larger scale. Bushmeat itself is not taxed because it is technically illegal to exploit bushmeat. Nevertheless, bushmeat traders are specifically targeted by tax collectors because the revenues generated from the sale of meat are considered to be exceptionally high.

At the time of study, military personnel benefited from the sale of meat by coercing traders into relinquishing money or possessions. Road blocks were established regularly and travellers were stopped. The amount of money handed over to the soldiers managing the road block usually depended on a prolonged process of negotiation. Not all travellers were stopped, but those with visible signs of wealth, such as traders, would normally be required to provide money or other possessions. Fines also provide revenue for wildlife authorities. Whereas the fines imposed by military personnel covered a range of offences, including the sale of bushmeat, wildlife authorities were known only to have fined individuals for fishing without licences. Less frequently, an individual might be found in illegal possession of an automatic rifle by the wildlife authorities. This would also result in the offender being fined.

This study also revealed that conflict over control of the markets existed between the various levels of authority. This had significant implications for the organisation of the bushmeat trade. Discussions with the chief in Kiliwa revealed that he actively discouraged a military presence in the village military by writing to senior officers in

Dungu and Isiro to denounce specific acts of indiscipline on the part of soldiers in his *groupement*. There are two reasons for this: first, during the late stages of the Mobutu regime the FAZ rarely received their salaries. The incapacity of lower ranking soldiers to engage in alternative income generating activities resulted in the regular pillaging of the civilian population. Consistent remarks such as "*les FAZ ne sont la que pour nous ravire nos biens*" suggest that this habit in the military in the region had become institutionalised. Regular complaints to the chief by people from the village placed him under pressure to address the problem. Indeed, during the period of study, two local chiefs from the region, including the senior *Chef de Collectivité*, were suspended for their alleged ineptitude in addressing local needs. Second, the presence of the military discouraged local trade. This was pointed out by the chief himself, who claimed that since 1988, when he began addressing the problem of indiscipline in the military, three new markets were established in the area. This substantially increased his earnings from stall taxes.

There was obvious evidence for the authority of the chief over lower ranking soldiers. He hosted soldiers staying overnight in the village, fed them and provided them with shelter. In so doing, he closely supervised their activities during their presence in the village. On four occasions during my field work, I found myself engaged in unpleasant discussions with soldiers over how much money I was carrying. In each case it was possible to resolve the issue by suggesting that the chief should intervene.

The outcome of these power relations between the military and the traditional authorities in Kiliwa was that soldiers trading in bushmeat were discouraged from passing through the village. This further reinforced the role of women traders, who had privileged access to bushmeat producers as a result of their relationships with senior ranking military officers.

A system of patronage exists between hunters and wealthier individuals in the population. The system of patronage also involved hunters being provided with credit or equipment to hunt. Military officers were said to act as patrons for large numbers of hunters, who are given rifles and ammunition and immunity from prosecution by the military. Hunting can involve a high level of risk, particularly when meat is obtained from the national park. The client-patron relationships allow wealthy individuals to benefit from the revenues generated by wildlife utilisation while significantly reducing the risks involved in illegal hunting. The hunters benefit from the credit that is made available, together with a level of protection provided by the patrons who often hold positions of authority.

Another source of credit was the Catholic Diocese. The credit that is made available by the diocese is not specifically targeted to hunters. However, relatively high rates of interest have to be paid on the loans, and bushmeat is an important income generating activity that can be used to service the loan.

4.10 Discussion

The mapping of benefits down the commodity chain, from the hunt to the urban market, shows that the resource use activities are varied in their socio-economic, ecological and geographical characteristics. Two geographical scales can be identified. One operates at the village level and targets small locally procured species, which are used for domestic consumption or for trade in the local market. The second operates on a much larger scale. This trade network targets larger mammals, particularly where they are most abundant, such as in the national park. This form of resource use involves an assortment of social groups with differing access to and control over the flow of resources. Meat is a high value commodity and different parts of that value are captured at several stages in the flow of resources from its extraction to its consumption. Different sectors of the community are represented at different stages of the commodity chain. These are discussed below in terms of the different social groups by wealth, gender and origin. This is followed by a discussion on informal wildlife regulations and their implications for conservation.

4.10.1 Wealth

The residents in the hunting reserves are highly differentiated in terms of wealth. The wealthiest sectors of the community, such as the urban traders, or those in positions of authority are largely based in the urban centre in Dungu. Generally, they are not directly involved in the extraction of bushmeat. Instead, they use their authority, or their connections with people in authority, to control the most lucrative links in the trade: access to the urban markets and the taxes and fines that are imposed on smaller scale traders. In the village, bushmeat is largely used for subsistence purposes, with some being sold in the local market. While a number of people in Kiliwa use and trade bushmeat, the poorest members of the community rarely have access to bushmeat resources: they do not possess the capital to buy the rifles or snares required to hunt animals, and do not have a sufficient income to purchase meat at the market. The patterns of wild resource use in relation to wealth at the village level are examined in Chapter 8.

4.10.2 Gender

Hunting is primarily a male dominated activity. The male bias in hunting appears to be a feature of many cultures. Bailey and Aunger (1989), provide an exception when they describe the strong participation of women in net hunting in the Ituri Forest in Congo. Net hunting is practised around Garamba, and large groups are usually involved, but women were never present at the hunts observed during this study.

But, women are not excluded from the benefits that bushmeat offers. Women's participation in the bushmeat trade appears to be greater than that of men. At the village level, most of the bushmeat procured by village hunters is said to be consumed by the hunter's household. Women are prominent traders in the markets, both at the village level and trade to urban markets. Indeed, observing people's activities at the Sunday markets in Kiliwa suggests that the market is a social forum for men and a commercial centre for women: while the men congregate at the periphery of the market, women appear to manage most of the stalls.

However, it is unclear whether the distribution of the profits after the market benefits the women. This point is raised by MacGaffey (1991), who suggests that Congolese commercial society is exceptionally male biased. This bias is enshrined in the Family Code of Congo (Decret 87-010), which states that a wife must relinquish her belongings to her husband if he can show that her ownership of assets *'portent atteinte à l'harmonie et aux inérêts pécuniraires du ménage'*[1]. In practice, this gives men the legal basis to control their wives' assets. So, while women are prominent in the trading of bushmeat commodities between Kiliwa and Dungu, they consisted of only a small group (almost certainly fewer than 12) who were, in any case, tied into highly restrictive client-patron relationships with male military officers.

4.10.3 Residency

The groups benefiting from wild resources in the Azande hunting reserve are differentiated according to whether they reside locally or elsewhere. The larger proportion of the financial benefits that are derived from the use of wildlife are collected by non residents. Local hunters tend to select smaller mammals, with correspondingly lower returns. In contrast, hunters who exploit large mammals usually hunt far from their place of residence. Chapter 9 describes the characteristics of hunters in Kiliwa. Only one hunter from the sample of 128 households studied in Kiliwa (see Chapter 8) was recorded as exploiting large mammals. Trade in bushmeat was described as operating at two levels. At the village level, small mammals such as, duikers and primates, were marketed openly. At another level, greater volumes of meat that were derived from larger protected mammals were passing through Kiliwa as a concealed trade. Urban traders operating through Kiliwa acquired most of the meat for the Dungu markets and beyond, and the considerable fiscal revenues and fines extracted from these traders were drawn on by non-local authorities (the civil and military authorities in Dungu).

This pattern of wildlife use is not uncommon and has been described elsewhere: Colell *et al* (1995) data from Equatorial Guinea show that only a small proportion of bushmeat (less than 10%) is retained at the village level, and that this is composed largely of the smaller mammals. Colyn *et al* (1987) also suggest that larger, more lucrative mammals are rarely exploited at the village level in Congo. Juste *et al* (1995) explain the emphasis on urban markets not in terms of availability, but because

[1] "*goes against the household's harmony and monetary interests*" (MacGaffey's translation)

of the significantly greater purchasing power, and therefore demand for meat, in the urban markets.

4.10.4 Informal regulation

From the point of view of this research, perhaps the most interesting aspect of this study of bushmeat commodity chains, and the power relations governing access, is the influence of regulators, namely the traditional, civil and military authorities. What was evident from the observations was that the power relations were dynamic and sometimes volatile "*in what were clearly changing and open, rather than stable and closed social systems*" (Guyer 1993): for example, the influx of automatic weapons into the region following the periods of intense conflict around Yambio and Maridi in 1990 and 1991 was said to have broadened local involvement in the bushmeat trade because a wide range of men were able to access these weapons and substantially increase their harvests. This is said to have reduced the ability of regulators to tax those exploiting wildlife because the various authorities could not identify those exploiting wildlife (chef Sangbalenze *pers comm.*).

Between 1991 and 1996 the park, military and traditional authorities were involved in the recovery of automatic weapons. Over two hundred automatic weapons were known to have been recovered from the Azande hunting reserve during this period. With reduced access to automatic weapons, those exploiting wildlife were more evident to the authorities. Increased demand led to higher profit margins which could contribute to tax revenue, and to servicing client-patron relationships between hunters and traders and military officers. Changing power relations are examined quantitatively in Chapter 10 where the flows of bushmeat are analysed during periods of peace and conflict. During periods of conflict, the ability of the state wildlife regulatory body (ICCN) to control trade in bushmeat was almost non existent. This provides an opportunity to study the dynamics of resource use, and the changes that occurred in how the traders were dealing with hunters in the absence of various key regulators.

There is a growing debate in the anthropological literature on the nature of wealth and the pathways of commodities through differentiated social systems. This can be helpful in understanding the particular role that bushmeat represents for local elites. For example, an interesting analogy can be drawn between the pre-colonial iron smelting industry described by Guyer (1993) and the production and acquisition of bushmeat. Both are high prestige enterprises. Thus, the value of labour, or "*self realisation*" (Guyer 1994) is high for these commodities. This value is out of proportion with their market value, and, as de Maret (1985) points out, the ironmaster and blacksmith have considerable prestige which is associated with chieftaincy in several parts of central Africa. A changing economic and political environment has altered the 'prestige' associated with many commodities such as, for example, the processing of iron among the Azande:

> *"it was one thing to marry a girl with twenty spears when it was extremely difficult to gain possession of them. It was another thing when spears could be bought at a shop for ten piastres each and the whole twenty could be bought by money earned by about two months' labour in the service of a European administrator."*
>
> (Evans Pritchard 1967)

In the case of bushmeat, however, the control of the trade is almost inseparable from real authority, and more so than any other commodity, other than gold (chef Sangbalenze *pers comm.)*. ~~Bushmeat is a prestigious commodity, and the incentive to~~

4.11 Conclusion

It is commonly assumed that wildlife management only occurs when it is underwritten by external aid interventions. This is reflected in the emphasis that is placed on project work in a number documents that review conservation and development issues (e.g., IIED 1995, NRI 1997). Some wildlife management activities at Garamba are underwritten by external aid interventions. Currently these are concentrated within the national park and focus on wildlife protection based on the 'fortress conservation' model. However, wildlife protection by a government authority, with technical and financial support from external aid agencies, constitutes only one aspect of the wildlife management practices undertaken in the Garamba ecosystem. This chapter has shown that community based wildlife management, in the form of bushmeat utilisation and its associated socially defined regulatory mechanisms, occurs alongside the protectionist activities of the national park authorities. Groups of individuals residing in the hunting reserves practise forms of wildlife management that are both community based and market driven. The remainder of the thesis explores some of the ecological and socio-economic consequences of the various forms of wildlife management in the national park and surrounding reserves.

Chapter 5

Spatial Variations of Animal Abundance.

5.1 Summary

This chapter uses quantitative and statistical analyses of wildlife census and remotely sensed data to explore the relationship between human activity and the distribution of wildlife populations. Broad scale ecological patterns are explored in relation to three variables which are used to describe human activity: the presence of agricultural communities, proximity to urban markets and proximity to effective wildlife conservation areas. The analysis takes advantage of the spatial heterogeneity of the hunting reserves to examine variations in mammal presence and community structure under differing levels of human activity. The area studied was extensive and wildlife sampling and satellite image processing techniques were used to generate data on wildlife distribution and the explanatory factors. The results show complex patterns because of the diversity of the species assemblage. Nevertheless, it can be shown that the distribution and abundance of wild mammals are significantly affected by the National Park, but not by the presence of agricultural populations.

5.2 Introduction

There are two dominant paradigms in African wildlife conservation. One restricts the use of wildlife. This approach is centrally controlled and usually involves the application of wildlife regulations through law enforcement in protected areas. The other approach is driven by economic considerations associated with human subsistence and commercial demands. Much debate has questioned the utility of protected areas, and an array of ecological, ethical and economic criteria have been used to justify these arguments (IIED 1993, Western and Wright 1994). This research contributes to the debate by examining the influence that differing levels of human activity have on wildlife distribution and abundance.

The mammal populations of the Garamba ecosystem are influenced by a variety of human related factors. This provides a good basis for assessing the impact of human presence and utilisation on wildlife populations. In the National Park, an active law enforcement programme has been implemented for several decades. In the Hunting Reserves, surrounding the National Park, wildlife is not actively protected. These areas contain resident human populations who hunt and market wild mammals with varying degrees of intensity. There are significantly higher large mammal densities in the National Park than in the surrounding Reserves (Hillman Smith 1989). Aerial count data have shown that there are statistically significant differences between selected large mammals densities in the Park and in the Reserves (Table 5.1).

However, it is not clear how much of the difference can be attributed to wildlife protection, because there are also important habitat differences between the two areas which may influence animal abundance. For instance, Hillman Smith *et al* (1995) have shown at Garamba that there is a statistically significant negative relationship between elephant abundance and tree cover when aerial count data are analysed for the whole ecosystem. Yet habitat differences can partly be explained by high elephant densities in areas that are protected, because elephants are known to be important agents of habitat change (Dublin 1995). Thus, the factors that contribute to high animal abundance are complex, but need to be understood to improve the management strategy for the ecosystem.

Table 5.1. Independent samples T-tests to show the differences between selected large mammal densities in the Park and in the Hunting Reserves (N is the animal estimate. n (transects) = 37, from Hillman Smith et al 1995).

Species*	*N*	Park density	Reserves density	*t*	*P*
Elephant	11,175	1.92	0.07	3.39	< 0.01
Buffalo	25,242	4.57	0.05	87.69	< 0.001
Giraffe	178	0.03	0.005	1.49	NS (< 0.07)
Kob	6,601	0.44	0.09	2.02	< 0.05

* aerial count data in the reserves are subject to an undercount bias because of the high canopy cover. Thus, only large mammals, with a high detection rate, are displayed in this table.

At a broad scale habitats are relatively homogenous in the Hunting Reserves whereas human populations are unevenly distributed as are the centres of commercial activity where bushmeat is traded. Therefore, the approach used in this research is to compare the presence of wild mammals against measures that represent the level of law enforcement, human presence and commercial activity at different locations within the Hunting Reserves, thereby testing the effect of human related variables on animal populations under relatively homogenous habitat conditions.

Subsistence and commercial hunting will inevitably have a degree of impact on animal populations (Robinson and Redford 1994). Yet, not all mammal species are equally susceptible to hunting pressure. In general, populations of species with low intrinsic rates of growth are more likely to diminish when hunted, because they often occur at lower abundance prior to the disturbance and require more time to recover (Freese *et al* 1982). This is compounded by the preference that hunters have for larger species because they represent greater returns for the cost of hunting (Leader-Williams *et al* 1990).

It is also argued that some animal populations may increase in hunted areas. This may result from reduced competition from other species that are selected by hunters (Johns and Skorupa 1986). However, the importance of resource competition between mammals in determining a species' abundance has been questioned (Andrewartha and Birch 1954, Inamdar 1996). Another explanation is that improved habitat quality results from slash and burn agriculture. This increases the quality of habitats for specific animal species close to human settlements because of the greater predominance of secondary forest (Eisenberg and Seidensticker 1976, Wilkie and Finn 1990).

In summary, the distribution of mammal assemblages is likely to be complex, and population densities of individual species may differ substantially according to their physiological and lifehistory traits. Therefore, this study examines the relationship between human factors and mammal community structure. First, species richness (the total number of mammal species present at a site) is used as a simple measure of community structure which can be compared to the explanatory variables. Second, species within the mammal assemblage are grouped according to meaningful physiological, behavioural and habitat characteristics, and these are compared to the explanatory variables.

5.3 Hypothesis

This study examines the correlation between a number of indicators of human activity with the distribution of wildlife populations in the Hunting Reserves. It is hypothesised that the presence of agricultural communities, proximity to urban markets and conservation practices impact upon two characteristics of population distribution: the presence (range) and community structure of large mammal populations.

5.4 Methods

This section describes the animal distribution data and the variables used to explain the distribution.

5.4.1 Animal distribution

Patterns of wildlife abundance in the Hunting Reserves were examined by analysing the unpublished raw ground transect data collected by Nicholas and Ndey (1995) between February and May 1994 (Hillman Smith *et al* 1995). Counting animals in the Hunting Reserves presents a number of difficulties. The geographical extent of the Garamba ecosystem precludes a total count of wildlife. Furthermore, counting animal observations is unreliable in a densely vegetated environment. Thus, sampling techniques are used to reduce the survey effort, and counts are made of spoor, which is more easily detected. These are standard techniques used by White (1992) and Prins and Reitzma (1989).

Line transect methods were used to estimate mammal presence based on the methods used by Burnham, Anderson and Laake (1980). Forty two transects were covered, each of five kilometres in length, using a stratified random sampling scheme. Data were collected by three observers walking abreast along the transect line. Each observer recorded observations within a two metre strip width either side of his centre line, to produce an overall sampling width of 12 meters. Distances along the transect line were measured using a *topofil* thread meter. Two types of observations are used: wildlife tracks and faecal material. This approach produced relative abundance data across the transects for 31 mammal species.

5.4.2 Explanatory variables

Contextual data collected during the transect exercise, such as human presence and habitat types, were only gathered at close proximity to the transect line. These data are of limited value in explaining the presence or absence of animals because of the mobility of the species in question. Thus, alternative techniques were used to generate explanatory data that represented a broader area around the transects. These explanatory data focus primarily on human activity, but also include a simplified measure of habitat type (tree cover densities).

a. The presence of agricultural communities

The presence of agricultural communities is a difficult explanatory variable to quantify. Human population census data are unavailable for this region since 1984, and census across the Reserves would have been a prohibitively time consuming exercise. However, the population density of agriculturalists can be related to the proportion of land that is covered by agricultural fields. The processing of satellite data provides a means of obtaining an estimate of field cover in the areas around the transects (see Box 5.1).

Normalised difference vegetation index (NDVI) data were generated from three geo-corrected scenes of Landsat TM data as a means of detecting agricultural land as an indicator of human presence (Mather 1987, see Box 5.2). The NDVI image enables the detection of agricultural land cover (an assessment of the accuracy of this method is provided in the appraisal of methods below).

All three scenes were scanned in December, which coincides with the post-harvest period when there is likely to be a higher proportion of exposed soil on agricultural land (de Schlippé 1953, Lambin 1994). Thus, low index values were produced for agricultural land relative to the surrounding vegetation. A geographic information system (GIS) was used to select areas within five kilometres of the transects. These measured 149.5km^2. The average NDVI value within these areas was used as an index of field cover.

Figure 5.1 shows one of the NDVI scenes representing a land surface of 200 by 180 kilometres containing most of the Garamba ecosystem. The histogram below the image shows that the data is bimodal. The darker areas on the image, corresponding to low values, appear to represent three types of land features: open water (major rivers), burned savanna vegetation cover and areas that cluster around settlements. Low NDVI values around settlements are hypothesised to correspond to exposed agricultural soil following the early dry season harvest.

Box 5.1

Obtaining data on landscape features using remote sensing techniques

Remote sensing is associated with the recording and interpretation of electromagnetic radiation reflected from the earth's surface by means of a sensor (or scanner) mounted on a satellite or aircraft. A remote sensing scanner measures the radiation intensity for a given area and converts this to a number generally between 0 and 255. As such, it is in digital form which is computer readable and can be manipulated and displayed using specialised software. The Landsat satellites move in a near polar orbit (at 98° to the equator) with the sensors scanning the ground below in an east - west sweep. Each sweep of the scanner produces a scanline which is made up of measurements of radiance taken at regular intervals. These single units of measure for areas of a given size are known as pixels. As the satellite moves in its orbit, a picture is formed of the earth's surface. A given number of scan lines produces a scene which can be interpreted as a large number of pixels arranged in a raster (or grid) format.

Multi-spectral imaging:
When trying to detect land surface features, the atmosphere acts as a source of interference for the sensor and complicates the subsequent analysis of the data. Radiation can be affected by scattering and absorption by the gasses and particles suspended in the atmosphere. Certain bands along the range of energy wavelengths (known as the electro-magnetic spectrum) are relatively free from interference with the atmosphere, and these are known as "atmospheric windows". Earth observation satellites will select these bands so that the nature of the radiation received by the sensor is mainly determined by the surface of the earth and not by the atmosphere. A multi-spectral sensor, such as Landsat TM used in this study, collects data on several bands.

Land feature detection
Incoming radiation which has not been absorbed or scattered by the atmosphere will reach the earth's surface where it will be either reflected, absorbed or transmitted. The extent to which this occurs depends on the absorptive properties of the surface (the albedo) for the wavelength. A given surface, such as grassland or forest, will have differing reflective properties for different bands. Likewise, a given band will be subject to different degrees of reflection according to the surface. This summarises the most important aspect of multi-spectral remote sensing: a given pixel will have a particular value on each band. A particular surface will have different reflective properties for different bands of the electromagnetic spectrum. This produces an often unique signature for a particular surface which can be used to identify specific categories of landscape features.

Digital image processing
Using digital satellite imagery involves a number of procedures: the 3 Landsat TM scenes are collated and geo-corrected using topographic charts. Finally atmospheric correction are applied to standardise the atmospheric conditions for all scenes.

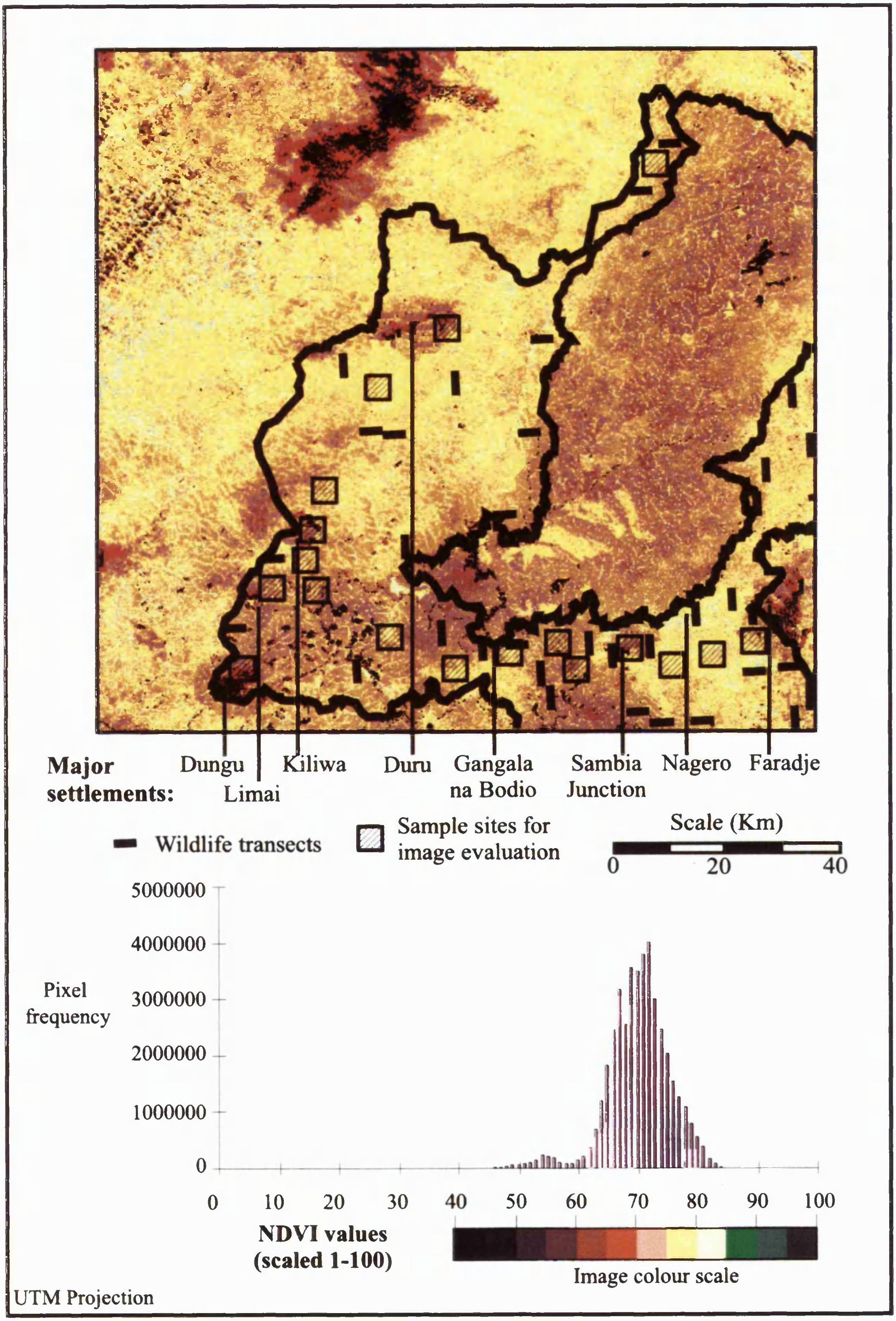

Figure 5.1. Landsat TM NDVI image of the Garamba ecosystem showing the sample sites and frequency histogram for pixel values

Box 5.2

Normalised Difference Vegetation Index (NDVI)

NDVI is an image transformation of the bands corresponing to the red and near infrared range of reflectance values (Landsat TM bands 3 and 4), and is highly correlated with photosynthetic intensity in the vegetation (Mather 1987).

$$NDVI = \frac{Band4 - Band3}{Band4 + Band3}$$

b. *The effects of urban markets*

Distances between each of the transects and the main markets in and around the Reserves (Figure 5.2b) were used as an indicator of the influence of markets on the local wildlife population. Markets are defined as large commercial centres estimated to have resident populations of more than 4,000. Each of the markets, with the exception of Yambio and Maridi in Sudan, and Watsa in the south, have been visited by the author.

c. *The effects of conservation practices*

Conservation efforts in the Garamba ecosystem have concentrated on the National Park rather than on the Reserves surrounding it. These efforts consist of anti-poaching patrols whose objectives are to enforce the conservation laws. Law enforcement has been sporadic and unpredictable in the Reserves. Therefore, the analysis tests whether distance from the National Park, where intensive law enforcement has taken place for over twelve years, affects variability in wildlife distribution in the Reserves (Figure 5.2c).

d. *Habitats.*

Tree cover estimates in 1993 are used to distinguish between the main habitat categories (grassland savanna, bush savanna and forest). Percentage tree cover was estimated during the aerial count for five by five kilometre subunits surrounding the flight lines (Figure 5.2d) (Norton-Griffiths 1978, Hillman Smith *et al* 1995). The subunit measure in which the centre of the transect was located was used as the estimate of tree cover for that transect.

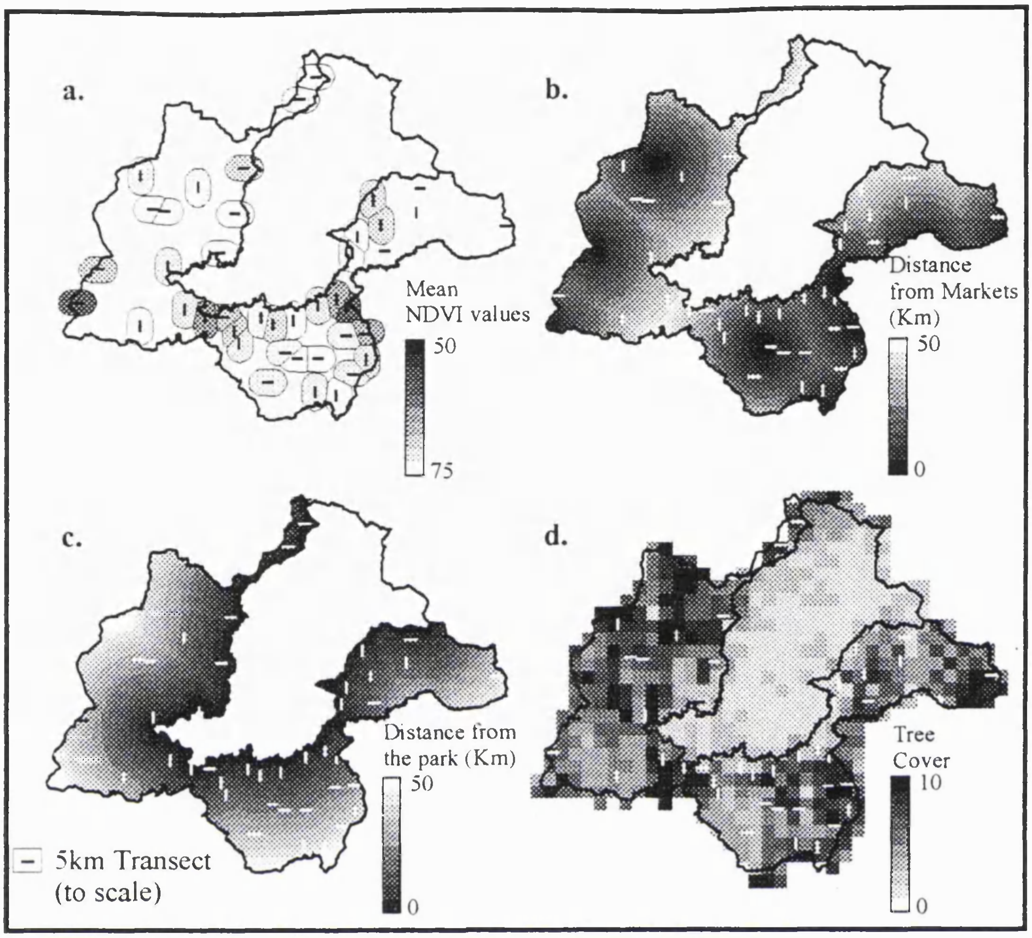

Figure 5.2. **Explanatory variables used to explain animal abundance**
a. NDVI values used as an estimate of agricultural land cover (low NDVI values indicate high field cover) (Landsat TM imagery).
b. Distance from main markets.
c. Distance from the national park.
d. Estimated percentage tree cover (systematic aerial count, April 1993).

5.5 Appraisal of the methods used

The validity of the data used in these analyses are evaluated according to three criteria:

1. are the variables meaningful in biological and/or socio-economic terms?
2. are the factors being accurately represented by the measures used?
3. are any of the variables confounded by other variables?

5.5.1 *Dependent variables*

Inferring animal density measures from faecal counts can produce spurious results. The problems involved in calculating population densities from faecal material and spoor have been extensively documented (e.g. Barnes *et al* 1995, Plumptre and Harris 1995). Underestimation is caused by low detection rates caused by dense understorey vegetation cover. Barnes *et al* also stress the extent to which detection is affected by species specific parameters, such as faecal size and decomposition rates, together with site specific variables, such as rainfall and canopy cover. Furthermore, Morrison *et al* (1992) suggest that a minimum of forty faecal observations on a transect are required to obtain an acceptable density estimate for a particular species. This is relatively rare for any of the species in the dataset. Furthermore, there appear to be only two examples in the literature where precise population densities for a large assemblage of African tropical moist forest mammals have been calculated using indirect observations (Prins and Reitsma 1987, White 1992).

Given the difficulties involved in drawing population densities from spoor and faecal material, presence or absence data and relative abundance are used in this study to test hypotheses about the possible causal factors of wildlife distribution. Using presence and absence data does, of course, have important limitations when trying to answer a species performance question (the local success of a species). However, a relatively large sample size is used (42 transects) which validates the approach. Analyses of relative species abundance is based on faecal densities.

5.5.2 *Explanatory variables*

a. The presence of agricultural communities

A number of questions may be raised in assessing the presence of agricultural communities. First, does variation in agricultural land cover correlate with agricultural population density? The variance of total field size per household was found to be small for a sample of 121 households surveyed (see Chapter 8 for a description of field measurements). The mean landholding per household is of 0.83

hectares ± 0.12, (95% confidence intervals, n = 121). Therefore, the percentage field cover is likely to be closely correlated to agricultural population density.

A second question relates to the validity of using NDVI as a measure of field cover. To test this, eighteen sample sites of five by five kilometres were selected on the image. Nine of these corresponded to areas known to contain relatively high human population densities. The other nine were of unsettled areas. All sites had been visited at least once by the author between 1993 and 1996. Mean pixel values were calculated for these sites. The results are shown in Table 5.2. Settled areas have significantly lower NDVI values, and this validates the use of NDVI as a measure of field cover.

Table 5.2. The difference in mean NDVI pixel values for sites that are settled and unsettled.

Mean NDVI value	Standard errors	Mean difference	*DF*	*t*	*P*
62.03 (Settled)	1.32	8.43	16	4.35	< 0.001
70.47 (Unsettled)	1.42				

b. *Distance as an indicator of market and conservation influences*

Local species abundance is compared with the intensity of conservation and market activity using distance from the Park and from markets as indices of the intensity of those factors. Clearly, distance does not provide a perfect quantitative representation of these factors. However, it does provide the best available measure of the effect of these factors at the transect location.

c. *Tree cover*

Tree cover values are based on an observer's estimate of the percentage tree canopy cover for an area corresponding to approximately five by five kilometres. Observations are made from a light aircraft at approximately 300 feet. As a result, the measure is relatively crude. The problems associated with aerial measurements are well documented (Inamdar 1996). However, these data allow the distinction to be made between the primary habitat categories, namely, forest, grassland savanna and woodland savanna.

An important final consideration is the presence of confounding explanatory variables. False conclusions can be drawn from the effect of one variable on species abundance if that variable is strongly correlated with another explanatory variable. Table 5.3 crosstabulates the correlations between all of the explanatory variables. The only variables to be significantly correlated are tree cover and the estimated number of fields. None of the human related explanatory variables are correlated. Thus, their effects are unlikely to be confounded.

Table 5.3. Spearman rank correlations to test for confounding explanatory variables amongst those used to explain species distributions

	Distance from the Park	Field cover	Distance from markets
Field cover	0.156 p = 0.351		
Distance from markets	0.261 p = 0.113	-0.056 p = 0.74	
Estimated tree cover	-0.156 p = 0.351	0.372 p = 0.02	0.161 p = 0.334

5.6 Analysis

The relationship between species presence and the explanatory variables is examined using measures of association. Mammal community structure is analysed in relation to the explanatory variables using richness indices and according to the physiological, behavioural, habitat and life history traits of the species assemblage.

5.6.1 Species presence

Jaccard's Index of association is used to examine the relationship between the presence of two species, or one species and one binary explanatory variable (A and B) (Ludwig and Reynolds 1988):

$$JI = \frac{a}{a+b+c}$$

where a is the number of transects where both species occur, b is the number where species A occurs but not species B, c is the number where species B occurs but not species A. The technique requires a more or less equal number of transects for each of the two outcomes, that is, where the animal is present or absent. As a result, only a sub-sample of species surveyed could be used in these analysis. The rarer species, such as chimpanzees and bongos, which are absent at most transects, and the very common species, such as duikers, which are present at most transects, were removed from the analysis. The explanatory variables were converted to binary format by classifying variables into high or low values. Analytical requirements determined the partitioning of data (each category, high or low, had to be represented by a more or less equal number of transects). Table 5.4 shows the classification used to convert the explanatory variables into binary format.

Table 5.4. Conversion of explanatory variables to binary format

Variable	high	low
Proximity to the Park	0 to 10 km	more than 10 km
Estimated agricultural land cover	NDVI < 66.25	NDVI > 66.25
Proximity to markets	0 to 8 km	more than 8 km
Estimated tree cover	0 to 60 percent	more than 60 percent

Species are plotted on two axes using polar ordination (Kent and Coker 1992), and the resulting biplot displays the species and explanatory variables in terms of association distance. The significance of the relationships described on the biplot is assessed using Pearson's chi squared independence tests[1].

5.6.2 Species richness

Richness indices provide a single measure to represent the importance of the transects in terms of the number of species present (Ludwig and Reynolds 1988). Emmons' study (1984) of the geographical variation of mammal densities in Amazonia showed that "the observed pattern of variation in numbers of individuals is mirrored by species richness differences". Thus, species richness provides a simple but effective measure to analyse the effect of the explanatory variables on species distribution.

5.6.3 Species abundance and community structure

So far, species presence has been used to test the effects of the various explanatory variables. Species presence is used because it provides a reliable indicator of distribution. However, presence alone does not provide the detail required to describe fully animal distribution. Therefore the relative abundance of the species assemblage is analysed in relation to the explanatory variables. 31 species and three explanatory variables constitute a complex dataset which is analysed using muli-variate techniques known collectively as ordination (see Box 5.3).

Box 5.3

Understanding complex species assemblages using multi-variate analysis: Ordination.

Testing the effects of various explanatory variables on the abundance of a large species assemblage is complex because of the number of dependant variables (species) that make up the dataset. Multiple dependant variables can be analysed using techniques collectively known as ordination (Kent and Coker 1992, ter Braak 1995). These provide a useful means of exploring the patterns of variance in the distribution of the 31 mammal species recorded in the hunting reserves in relation to wildlife management related factors. The benefits of using ordination are that the data retain a high level of detail by analysing all the species as well as the frequency of observations at each of the sample locations.

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[1] Logistic regression would have produced a more robust analysis for these data (eg. Hill *et al* 1998), but the distributions did not meet the assumptions of the logistic model, as defined by Crawley (1993).

Box 5.3 (continued).

Typically, a species will respond to an environmental variable that is influencing its distribution in the following way (ter Braak and Looman 1995): Species densities will peak at an optimal level of a particular environmental variable. Above and below, on the environmental scale, the species performance is inferior, and therefore densities are lower. At a certain point either side of the optimum, a threshold is reached beyond which the species cannot survive. This pattern produces a Gaussian curve referred to as a unimodal response curve. A central question of this thesis is the extent to which human related environmental factors determine this unimodal response curve in the distribution of large mammal species. It is probable, however, that over a limited area, such as this study site, the explanatory variables do not reach the full range of values needed for the species to follow the complete unimodal pattern. In this case, the pattern can be interpreted as linear. This affects the choice of analysis that should be used to identify the distribution pattern.

A first step in using ordination analysis is to define the distribution parameter (ter Braak and Prentice 1987). This value describes the distribution pattern in the species data. The distribution parameter is based on a tolerance value which is roughly analogous to the standard deviation of a normal distribution (this being the unimodal abundance distribution). Thus the unimodal curve rises and falls over a range of approximately four times the tolerance value.

Principal Components Analysis (PCA) is an ordination procedure used when the underlying species abundance patterns are linear. It arranges the species along a series of axes according to the variation in the abundance of those species at each of the transects. Equally, it will arrange the transects along axes according to how they vary in their species composition. The first axis, or component, uses a least squares algorythm to minimise the residual sum of squares of the distribution of all species. This is equivalent to fitting a line of best fit through multi-dimensional space, with each dimension being a species distribution across the transects. Each species has a value on this axis, according to how well its distribution is correlated to it. Eigenvalues represent the relative contribution of the axis to the overall distribution of species. The significance of using PCA is that the first few components are expected to reflect non-random variation in the overall distribution of the species assemblage. As such, they represent a "latent structure" in the data. Thus, if any of the environmental variables are strongly correlated with the principal components, this provides evidence to suggest that they are the underlying factor that affects wildlife distribution.

5.7 Results

5.7.1 Species presence

Figure 5.3 shows the polar ordination biplot using Jaccard's index of association. The biplot shows that buffalo, kob and elephants are more frequently encountered close to the Park, whereas baboons, porcupines and warthogs are shown at greater distances from the Park.

The results of the chi squared analysis confirm the patterns shown in the polar ordination biplot, and are shown in Table 5.5. The most important of the factors is proximity to the park which is significantly associated with the presence of cob and elephants and buffaloes. There is a danger of obtaining spuriously significant results when tests are repeated several times (in this case, four times for each species). However, the statistical significance of the association between the Park and elephants and kob is unlikely to be the result of a type one error because the significance is extremely high ($p < 0.001$). These results are consistent with the aerial count data for the whole ecosystem in Table 5.1.

Table 5.5. Pearson's chi-square to test for the independence between selected species and explanatory variables (n = 38, df = 2).

Species	Park distance		Agricultural land*		Market distance		Tree cover	
	x^2	p	x^2	p	x^2	p	x^2	p
Black and white colobus	0.93	NS	0.03	NS	093	NS	3.02	NS
Serval cat	1.22	NS	1.99	NS	3.77	NS	0.07	NS
Porcupine	0.84	NS	1.38	NS	0.23	NS	0.05	NS
Kob	13.07	< 0.001	5.14	< 0.05	2.54	NS	0.18	NS
African elephant	15.2	< 0.001	0.42	NS	0.42	NS	0.42	NS
Olive baboon	3.14	NS	0.18	NS	1.2	NS	0.06	NS
Warthog	3.52	NS	1.2	NS	0.06	NS	0.18	NS
Buffalo	5.98	< 0.05	0.84	NS	0.84	NS	6.63	< 0.01
Cane rat	0.91	NS	2.59	NS	2.59	NS	0.1	NS

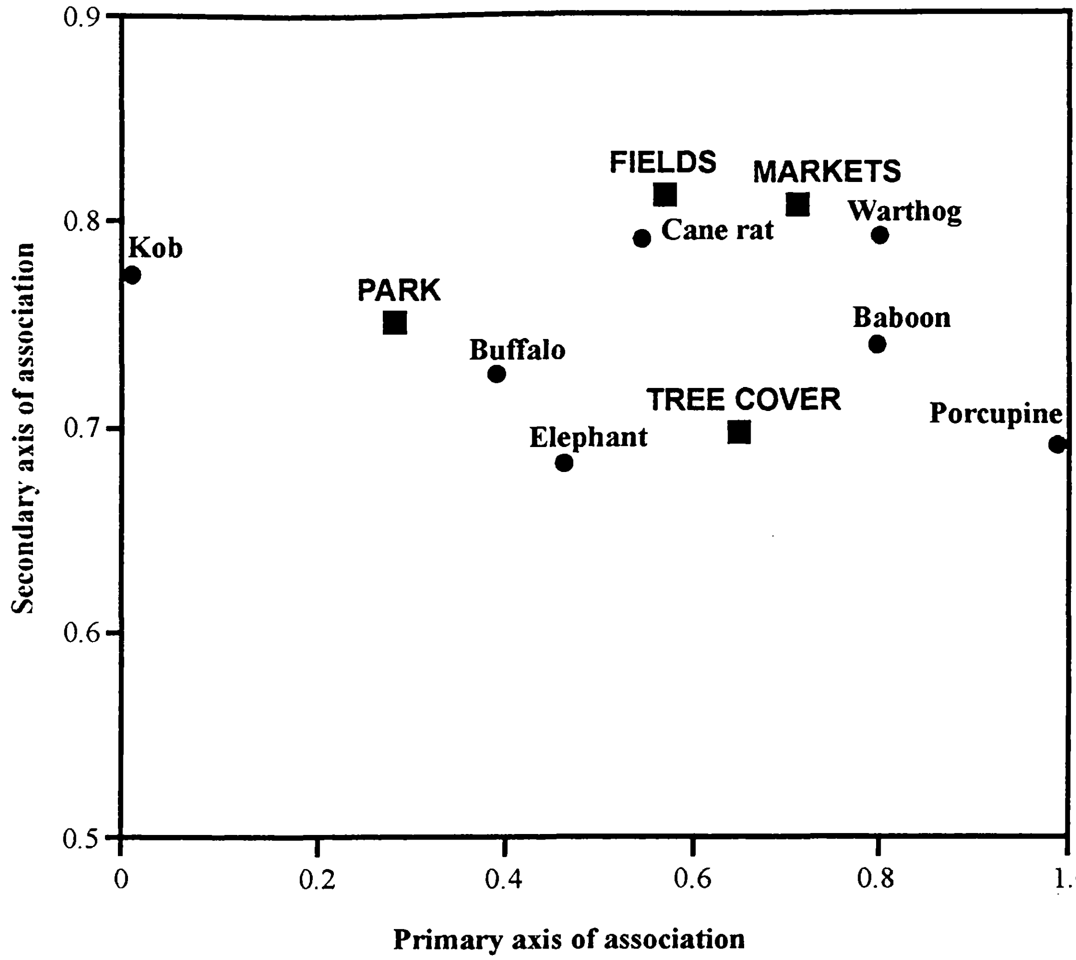


Figure 5.3. Polar ordination biplot using Jaccard's index of association on five species and four explanatory variables.

5.7.2 *Species richness*

The results of the regression models are shown in Table 5.6. The effect of the distance from the Park significantly explains variation in species richness. This confirms the importance of the Park as a major determinant of wildlife distribution. Agricultural presence does not influence species richness.

Table 5.6. Linear regression coefficients and significance for the relationship between species richness and the explanatory variables.

Explanatory variable	*B* *(Slope)*	r^2	*p*
Field cover	-0.03	0.04	0.19
Distance from markets	0.03	0.019	0.41
Distance from the Park	-0.11	0.38	< 0.0001

5.7.3 Species abundance

The first two components of the PCA yielded eigenvalues of 0.657 and 0.145 respectively. This means that the first two components explain more than eighty percent of the variance in the species abundance. The relationship between transect values on the first two axes and the explanatory variables is shown in Table 5.7.

Table 5.7. Matrix for Spearman's rank correlation coefficients between the transect scores on the first two principal components and explanatory variables.

	PCA First Axis	PCA Second Axis
Distance from the Park	-0.47 (n = 42, p = 0.001)	-0.11 (n = 42, p = NS)
Estimated % field cover	0.26 (n = 38, p = NS)	-0.25 (n = 38, p = NS)
Distance from main markets	-0.03 (n = 42, p = NS)	0.28 (n = 42, p = NS, 0.075)
Estimated tree cover	-0.11 (n = 42, p = NS)	0.03 (n = 42, p = NS)

Transect values for the first component are significantly correlated with distance from Park. This suggests that most of the variance (65.7 percent) in species abundance across the transects is explained by the distance from the National Park (Table 5.7). None of the other explanatory variables correlate with the first principal component.

There are no statistically significant relationships between the second principal component and any of the explanatory variables, although the distance from the main markets approaches significance (Table 5.7).

5.7.4 Community structure

These results asses the effects of the explanatory variables on the whole species assemblage. All species do not, however, conform to the same patterns of distribution. In order to examine the effects of a species' biological and behavioural attributes, a number of characteristics including body size, home range size, type of social organisation, diet, preferred habitat and activity time were obtained for each species from a review of the literature (see Table 5.8).

Species were also characterised according to the way that they are exploited locally. The dominant hunting techniques in the Reserves include the use of firearms (automatic weapons and locally constructed shotguns, known as *fabrications*) and traditional techniques using nets (which includes the use of dogs and spears) and various traps and snares. The hunting techniques associated with each species (see Table 5.8) are derived from tracking 59 hunts. Both successful and unsuccessful stalks were used to associate a hunting technique with a particular species. In addition, semi structured interviews with hunters were used to identify the principal hunting technique for that species. If this failed to produce an association, the species was considered unexploited.

Figures 5.4 shows how species are distributed on the first two component axes when they are grouped according to various characteristics. The first principal component is highly correlated with distance from the Park (Table 5.7). Species groups that have values that deviate significantly from zero indicate groups that contribute substantially to the variation contained in the principal component. 95 percent confidence intervals for the mean values for species scores are also shown to distinguish those groups that have significantly different scores to the rest of the species. Thus, the species that are more influenced by the first component include species hunted using firearms, have large home ranges, use savanna habitats, are large bodied, diurnal, cover dependent and are browsers or folivores. Species that are strongly influenced by the second component include traditionally hunted species, species that have small home ranges, are non cover dependent and are browsers or folivores.

Table 5.8. The ecology, social and reproductive characteristics of large mammal species encountered in the Reserves, with an indication of local hunting preferences.

Name	English	H	S	R	O	Di	Ha	C	A	Sources
Artiodactyla										
Redunca redunca	Bohor reedbuck	n	45	2	m	g	fl	y	n	Heindrichs 1975. Estes 1992.
Tragelaphus euryceros	Bongo	sh	270	3	a1	b	gf	n	n	Reuther 1967, Kingdon 1982. Hillman 1986.
Alcelaphus buselaphus	Hartebeest	r	134	3	a2	g	g	n	d	Gosling 1974. Estes 1992.
Syncerus caffer	Buffalo	r	631	4	a2	g	g	n	d	Sinclair 1977. Mlosweski 1983.
Tragelaphus scriptus	Bushbuck	s	72	2	s	b	fe	y	b	Allsop 1971. Waser 1974. 1975.
Cephalophus spp.	Duiker	n	22	2	m	f	gf	y	b	Dubust 1983, Estes 1992, Kingdon 1982.
Hylochoerus meinertzhageni	Giant forest hog	sh	205	-	f	b	gf	n	n	Kingdon 1979.
Giraffa camelopardalis	Giraffe	r	900	4	a1	b	ws	n	b	Pellew 1984a, 1984b, Leuthold and Leuthold 1972, 1978.
Hippopotamus amphibius	Hippopotamus	r	1900	3	a2	g	sp	n	n	Laws 1984. Olivier and Laurie 1974.
Potamochoerus porcus	Bushpig	sh	70	2	f	o	of	y	n	Skinner 1976. Estes 1992.
Kobus kob	Kob	sh	78	2	a2	g	g	n	b	Kingdon 1982, Leuthold 1966.
Phacochoerus aethiopicus	Warthog	sh	74	3	f	mf	s	n	d	Cumming 1973.
Kobus ellipsiprymnus	Waterbuck	r	205	2	a1	g	sp	n	b	Spinage 1982, Hanks *et al* 1969.
Proboscidea										
Loxodonta africana	Elephant	r	4000	5	a2	mf	m	n	b	Laws 1970, Hillman Smith *et al* (1995), Moss and Poole (1983)
Tubulidentala										
Orycteropus afer	Aardvark	s	-	2	s	i	m	y	n	Kingdon 1980.
Rodentia										
Poelagus marjorita	Rabbit	s	2	1	a2	h	s	y	n	Kingdon 1980.
Thryonomys spp.	CaneRat	s	1	1	s	o	m	y	n	Kingdon 1980.
Hystrix spp.	Porcupine	s	3	1	m	mf	s	y	n	Kingdon 1980.
Primates										
Papio cynocephalus	Baboon	sh	17	4	a2	o	s	n	d	Altmann 1980, Altmann and Altmann 1970.
Pan troglodytes	Chimpanzee	sh	35	3	a2	o	gf	y	d	Goodall 1983, Suzuki 1969.
Colobus abyssinicus	Colobus	sh	10	2	p	fo	gf	y	d	Mckey 1978, Dunbar and Dunbar 1976, Rose 1978.
Cercopithecus mona	Mona	sh	6	3	p	fo	gf	y	d	Estes 1992.
Erythrocebus patas	Patas	sh	8	3	p	fo	ws	n	d	Hall *et al* 1965.
Cercopithecus aethiops	Vervet	sh	5	m	a2	o	ws	n	d	Hall and Gartlan 1965, Cheney and Seyfarth 1986.
Carnivora										
Civettictis civetta	Civet	s	14	3	s	o	gf	n	n	Ewer and Wemmer 1974.
Genetta felina	Genet	sh	2	3	s	c	ws	n	n	Wemmer 1977.
Panthera pardus	Leopard	x	47	4	s	c	ws		b	Bertram 1976.
Panthera leo	Lion	x	157	5	a1	c	s	n	b	Schaller 1972, Packer and Pusey 1982.
Atilax paludinosus	Mongoose	n	3	2	s	c	sp	y	n	Kingdon 1977. Estes 1992.
Felis serval	Serval	sh	12	3	s	c	s	n	d	Geertsema 1976. Estes 1992.
Crocuta crocuta	Hyaena	x	65	4	a2	c	s	n	b	Frank 1986, Kruuk 1972.

H associated hunting techniques (sh shotgun. r=automatic rifle. n=nets. s=snares. x=not hunted)
S Species size (kg)
R Home range (1 = < 0.01 km^2. 2 = 0.01-1km^2. 3 = 1-25km^2. 4 = 25-100km^2. 5 = >100km^2. m = migratory/not territorial)
O Organisation (s = solitary. m = monogamous pairs. f = family unit. p = polygamous groups. a = aggregated (1 = 3-10. 2 = $\geq$ 10))
Di Diet (g=grazers. b=browsers. mf = mixed feeders. f = frugivores. o = omnivorous. fo = folivores)
Ha Preferred habitat (m=mixed habitats. fl=floodplains. s=wooded and grassland savanna. g=open grassland. ws=woody savanna. sp=specialised (in/near water). gf=gallery forest. fe=forest edge)
C Cover dependent (y = yes. n = no)
A Time of activity (d = diurnal. n = nocturnal. b = both)

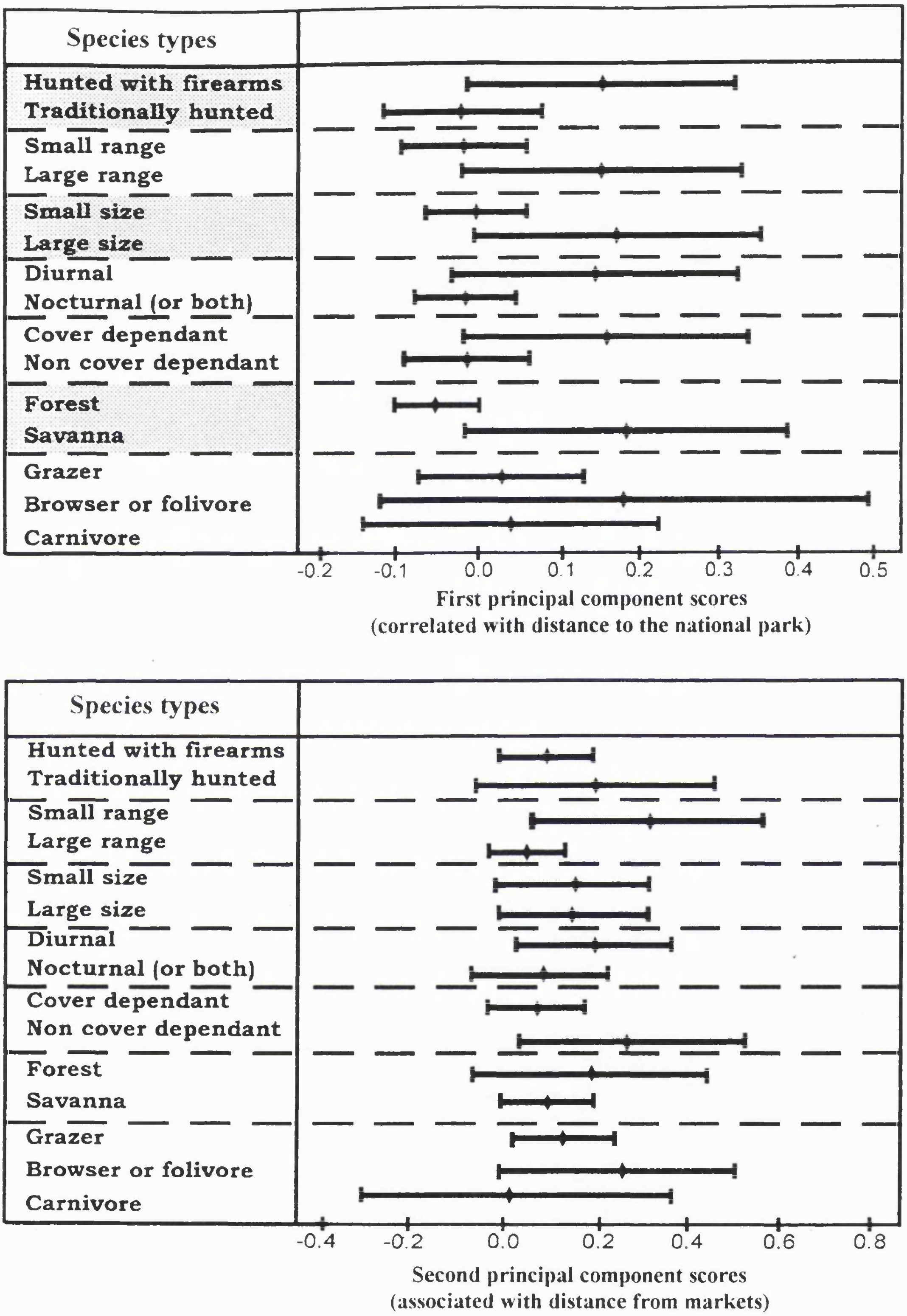


Figure 5.4. Means and their 95% confidence intervals for species categories on the first and second principal components (the higher the value of a species category, the more those species contribute to the principal component. Groups of species with significantly different mean PCA values are shaded in grey, two-tailed t-test).

5.8 Discussion

Two measures, presence and relative abundance, have been used to assess the effect of human activity on mammal distribution. Mammal presence is a reliable measure, but does not provide the detail required to understand fully the relationship between the performance of the population and the explanatory variable. Furthermore, only a limited selection of mammals could be included in some of the analyses used. Conversely, faecal counts, as a relative measure of abundance, describe the relationship between the explanatory variables and animal performance in much greater detail than presence alone. However, they are unlikely to provide a reliable measure of mammal abundance, because of the problems of inferring animal density from faecal counts.

Nevertheless, there was a high level of consistency between the analyses of presence and abundance. Of the three variables representing human activity, distance from the National Park appears to have the strongest influence on the distribution of wildlife. The chi-squared analysis showed that the presence of both elephants and kob was significantly associated with proximity to the National Park. Mammal species richness is also highly correlated with distance from the Park. Finally, the first principal component, which accounted for 65.7% of the variation of the abundance of all species across the transects, was highly correlated with distance from the Park.

5.8.1 Markets and mammal distributions

The relationship between distance from markets and mammal distribution was non-significant. However the correlation between the second principal component, which accounts for 14.5% for the variation in the density of faecal counts, and the distance from markets approached statistical significance ($p = 0.075$). This suggests that markets may influence the distribution of hunting intensity. Furthermore, both the distribution of species on the second principal component axis (Figure 5.4) and the polar ordination (Figure 5.3) suggest that some of the smaller species, such as baboons, warthogs and porcupines, are negatively associated with proximity to markets. This has ecological repercussions for wildlife populations. A number of authors have shown that the monetary value of bushmeat varies spatially as a function of transport costs (see Godoy and Bawa 1993). The urban profit margin makes it more beneficial to exploit non-timber forest products at closer proximity to markets (Abbot 1996). This suggests that wildlife population densities will vary as a function of distance from urban markets and from principal transport networks leading to those markets. The distribution of markets, and the roads that connect them potentially subdivides animal populations and can lead to population fragmentation. Fragmentation is fundamental to the process of species extinction (Maurer 1994), and therefore, the potential for markets to fragment wild mammal populations appears to be important.

By contrast, Gadsby (1990) suggests that market factors alone do not explain hunting intensity. The higher profits associated with hunting in close proximity to the market are offset by the fact that people in these areas can profitably market agricultural products. These products are bulkier than bushmeat, and they have prohibitively high transport costs at greater distances from the markets. Thus, hunting provides one of the few income generating activities for isolated communities who are unable to transport their high volume agricultural products profitably. Thus, there may be a higher incentive to exploit bushmeat at greater distances from markets because transport costs are not significant.

5.8.2 Agriculturalists and mammal distributions

The presence of agricultural communities is not associated with a statistically significant decrease in the presence and abundance of mammals. Indeed, the presence of agricultural communities is associated with a non-significant increase in mammal species richness. Wilkie and Finn (1990) have studied the relationship between human presence and the diversity and abundance of terrestrial mammals of the Ituri Forest, in Congo. They found that forest clearing associated with agricultural activity did not significantly affect 16 of the 19 mammal species examined. The other three species, okapi, yellow backed duikers and leopards, are less abundant in secondary forest. The larger ungulates appeared to be less abundant near villages, but they suggest that this could equally be due to increased hunting pressure near the markets. They conclude that secondary forest is probably able to support populations at similar or greater densities to climax forest, and refer to Eisenberg and Seidensticker's (1976) findings to support their claims. This South Asian study suggested that mosaic habitats, consisting of secondary, post agricultural vegetation and climax forest, support a greater animal biomass than mature tropical forest. Johns and Skorupa's (1987) review of the effects of habitat modification on primates show that moderate habitat disturbance from agriculture is unlikely to provoke a decline in primate populations.

5.8.3 The national park and mammal distribution

Distance from the National Park consistently explained animal distribution and abundance. It is difficult to disassociate the effects of habitat from those of wildlife protection because the two are spatially correlated. One plausible explanation is that the higher species richness at distances nearer the National Park can be attributed to the unique habitat of the area, whilst the high abundance of large mammals can be attributed to the protection regime in the National Park. Indeed, the 31 large mammal species recorded in the Reserves is unusually high for an African ecosystem, if compared to both forested habitats (Prins and Reitzma 1989, Wilkie and Finn 1990, White 1994), and savanna habitats (Lamprey 1964, Dowsett 1966, Montford 1972, Leuthold and Leuthold 1976). The explanation may lie in the habitat structure of the ecosystem. The area closest to the National Park represents a forest savanna boundary, where both savanna and forest mammals coexist. This may explain the significantly higher species richness associated with proximity to the National Park: past inventories have recorded a total of 46 mammals in the Reserves compared to 35 in the Park (Verschuren 1958, Hillman-Smith 1989).

The abundance of large savanna mammals at close proximity to the National Park is perhaps best explained by the protection regime within the Park. This agrees with the assessment of animal distributions as a whole, based on the aerial counts, which show the greatest abundance of large mammals to be concentrated in National Park (Hillman-Smith *et al* 1995). A number of studies have shown that investment in anti-poaching contributes to the higher abundance of large targeted mammals (Leader-Williams and Albon 1988, Jachman and Billiouw 1997). The comparison between animal densities inside the Park, where investment in conservation is high, and in the Reserves, where investment is low, supports this (Table 5.1). Even giraffes, whose more suitable habitat is in the Reserves, are more abundant in the Park. Similar patterns were revealed when mammal community structures were examined in relation to the explanatory factors. The principal components analysis showed that the mammals whose abundance varied the most with distance from the Park were typically large savanna species. This was also shown by the polar ordination (Figure 5.3). These species are also targeted by hunters, and their abundance is likely to be greatest in the National Park where off-take through poaching is restricted.

Whilst the exact causes of variation in mammal distribution and abundance are difficult to establish from these data, what has become clear from this analysis is that the low density presence of subsistence agricultural populations does not have a significant impact on wildlife distribution within the Reserves. This is an important finding if human communities are to be perceived as an integral part of a sustainable ecosystem.

5.9 Conclusion

Although the National Park has an overwhelming effect on the abundance of certain large mammals, the results of this study show that human presence, as indicated by agricultural field cover, does not appear to affect mammal distribution. The consistent absence of any relationship between the presence of agriculturalists and animal presence and abundance suggests that this result is not an artefact of an inadequate sample size. The results contribute to an increasing body of evidence which suggests that, contrary to the received wisdom, human presence alone does not provoke wildlife depletion. The effects of markets on the distribution and abundance of species only approaches statistical significance. This is insufficient evidence to state that markets are having an impact on animal distribution. However, a larger sample size would be required to answer this question appropriately.

Proximity to the National Park was taken as an indicator of the effects of conservation activities on wildlife distribution and abundance. The variable is highly correlated with animal presence and abundance, emphasising the importance of the National Park for protecting large mammals. The exploratory analysis of mammal community structure suggests that the National Park boundary represents a niche overlap for forest and savanna type species. This would explain the greater species richness which occurs near to the Park. The significantly greater large mammal abundance close to the Park would appear to result from the Park's quality as a 'sanctuary' for these species.

Chapter 6

Temporal Variations of Animal Abundance

6.1 Summary

The previous chapter showed that high mammal abundance was positively correlated with proximity to the National Park. Two features characterise the National Park in contrast to the surrounding Hunting Reserves. First, the National Park is the focus of intensive wildlife protection activities. Second, the National Park is composed of savanna grassland habitat, which is known to be selected by large mammal populations (Sinclair and Arcese 1995). By contrast, the surrounding habitats are more densely wooded. Thus, both the management practices within the National Park and the habitat structure of the ecosystem as a whole could explain the unusual spatial variations in large mammal abundance. This contributes to a dilemma frequently encountered in the ecological research of complex environments, whereby causation cannot easily be distinguished from correlation (Inamdar 1996). The present chapter addresses this question by analysing temporal and spatial variations in large mammal abundance in relation to known management practices. These analyses show that the abundance of most mammals is correlated with management intensity, both temporally and spatially.

6.2 Introduction

This work analyses change in the large mammal community in Garamba National Park during periods of known management regimes. Data from seven aerial wildlife surveys flown between 1976 and 1995 are used to identify trends in estimated abundance of mammal populations.

6.2.1 Management regimes

This research examines the changes in the abundance of wildlife populations during two periods of wildlife management: 1976 to 1986, which represents a period of low investment in conservation, and 1986 to 1995, representing a period of relatively high investment. Investment in wildlife protection also varies spatially, according to three areas within the National Park (see Figure 6.1).

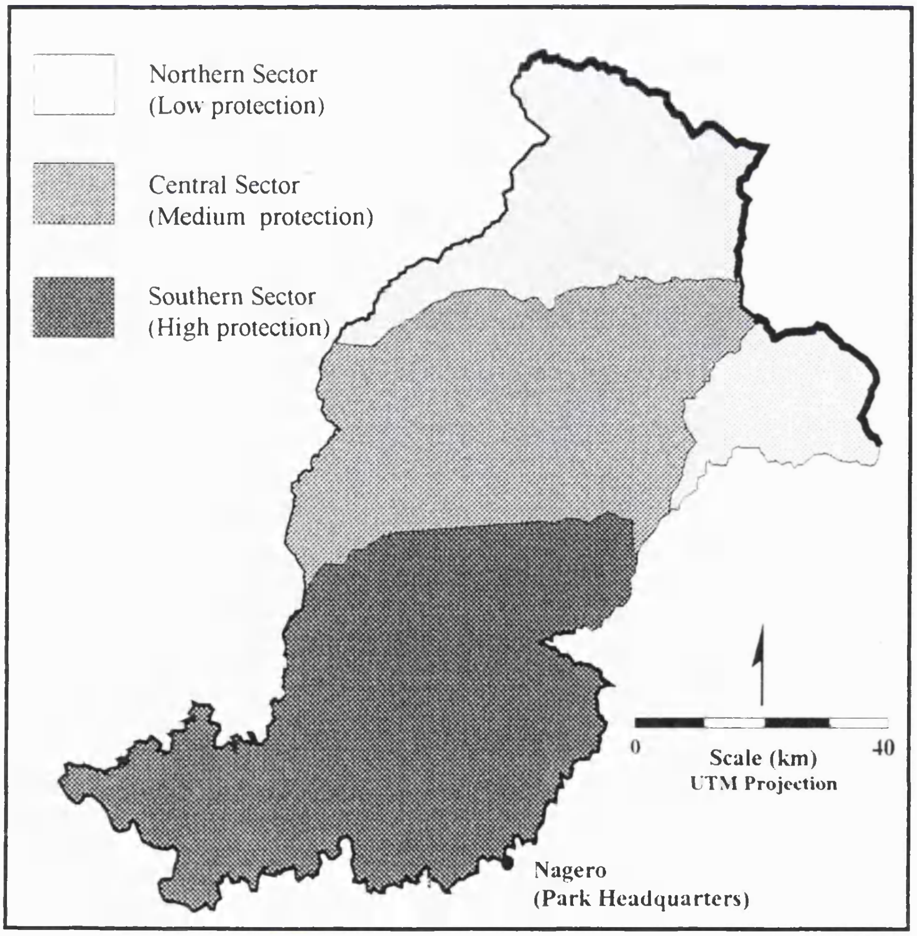


Figure 6.1. Management zones in Garamba National Park

The management regimes in each of the three sectors are described in Chapter 4, but can be summarised as follows: the Southern Sector contains the core and extended range of the rhinoceros population and is the focus of intensive wildlife protection. The Central Sector is protected as a buffer to the Southern Sector, but experiences higher levels of poaching because of its greater proximity to the border with Sudan, from where much of the poaching pressure is believed to originate. The Northern Sector receives little or no patrolling because of its isolation from the National Park headquarters and the excessive risk that guards are exposed to in the area. The management regimes are presented in Table 6.1.

Table 6.1. Summary of management regimes between 1976 and 1997

	1976 to 1984	1984 to 1991
Southern Sector	poaching high, investment low	poaching low, investment high
Central Sector	poaching high, investment low	poaching moderate, investment high
Northern Sector	poaching high, investment low	poaching high, investment moderate
Evidence	Oral testimony from contemporary wildlife managers	ICCN patrol reports, project reports, project accounts

6.2.2 Changes in savanna herbivore populations

The aim of this chapter is to discern the effects of wildlife management from the many factors that influence the abundance of large mammals. Alternative determinants of mammal population change include habitat factors, disease, and species interactions. Understanding the causes of population change can be complicated by the fact that explanatory factors can evolve in synchrony. Furthermore, survey methodology can potentially account for a substantial amount of the variation in animal population numbers. These factors are discussed below.

Many ecological theories have promoted the notion that, in the absence of human interference, mammal populations are stable. However, with increased access to long term ecological data for a number of eastern and southern African savanna ecosystems, this notion has increasingly been brought into question (Owen-Smith 1988). Several authors emphasize dynamic disequilibrium, and not stasis, as the dominant process in savanna ecology (Dublin *et al* 1990, Sinclair 1995). These authors argue that unpredictable rainfall, and the complex interplay of randomly varying, but synergistic factors such as fire, grazing, browsing and disease accounts for most of animal (and plant) population change.

Coe *et al* (1976) have shown a significant correlation between large savanna herbivore biomass and rainfall. Similarly, Owen-Smith (1988) has shown that kudu populations in Kruger National Park, South Africa, increased by almost 250 percent in the 1970s and demonstrated that this could largely be attributed to changing rainfall. Changes in the Tsavo ecosystem in Kenya have inflamed the debate over the causes of ecological change. The so-called 'elephant problem' has focused attention on the role of a single species in influencing the structure of the animal community as a whole. It was argued that the growth of the elephant populations within the ecosystems in the late 1960s and early 1970s would profoundly influence the community ecology, and lead to catastrophic declines in other species populations. Ultimately, it was shown that the absence of rainfall was the most significant determinant of population abundance: the drought of 1970 to 1972 caused a catastrophic decline in elephant numbers within the Tsavo ecosystem (Corfield 1973). Subsequent studies in Tsavo similarly demonstrate a lack of inter-species interactions in determining species abundance, whilst emphasising the significance of unpredictable rainfall (Inamdar 1996).

The studies mentioned above relate largely to semi arid savanna environments, with low mean annual, though highly variable, rainfall. However, the Garamba ecosystem receives over 1200mm of rainfall, which rarely falls below 800mm (Hillman Smith 1989, see Figure 2.2). Although the national park shares many of the large herbivore species found in the more arid habitats described above, it is unlikely that rainfall regulates population numbers in the same way. Other factors, such as disease, have been proposed as factors driving disequilibrium ecology (Sinclair 1995). In this thesis, it is argued that conflict is another important stochastic event which has significant ecological repercussions.

Thus, the present Chapter begins with the hypothesis that levels of human off-take has been the primary determinant of change in mammal population abundance in the Garamba ecosystem between 1976 and 1995. Conservation practices regulate the offtake of wildlife by hunters. Thus, the level of investment in maintaining the laws of conservation should influence the rate of population growth for large mammal species. The present analyses test whether the interplay between human offtake and wildlife protection explains the variation in mammal abundance within the Garamba ecosystem by assessing the variations in population abundance over time and space and between species under known management regimes.

Two approaches are used. The first simply examines the variations in animal abundance over time and space relative to the management regimes shown in Table 6.1. The second explores the relationships between species, particularly between large and small mammals. Damuth (1981) proposes that a species assemblage will contain more small species than large species. Tests of the allometric laws which relate population density to body size (D:M) consistently produce a significant negative linear relationship when compared on logarithmically transformed scales (Peters 1983, Cotgreave and Stockley 1994, Silva and Downing 1995). Thus, Damuth (1981) asserts that 74% of global variations in the densities of herbivorous mammals can be explained by body mass alone. It is argued that this results from the relationship between population energy use and body mass, to produce the 'rule of energetic equivalence' (an explanation for this rule can be found in Currie and Fritz 1993, and is critiqued by Blackburn *et al* 1993). However, the debate over the validity of this explanation is not of direct relevance here. What is important is the empirical consistency of the results when the log-log regression is applied to large species assemblages (see Table 6.2).

Table 6.2. **Density / mass relationships for large assemblages of mammals.**

Source	Assemblage	*b* (slope)	*n* (species)	*p* (*B*=0)
Damuth (1987)	Mammals		467	
Robinson and Redford (1989)	Neotropical mammals	-0.61	103	0.001
Cotgreave and Stockley (1994)	Small mammals	-0.79	25	0.0001
Silva and Downing (1995)	Mammal herbivores > 100 kg	-0.44	209	0.0019
Silva and Downing (1995)	Mammal herbivores < 100 kg	-0.79	594	0.0001
Fa and Purvis (in print)	Neotropical forest mammals	-0.72	93	0.001
Fa and Purvis (in print)	African forest mammals	-0.45	72	0.001

However, management at Garamba focuses on large mammals, which may influence the abundance ratio of large and small mammals. Thus the analysis explores the consequences of this for the species assemblage within the protected area.

6.3 Research hypotheses

Two hypotheses were selected to test the relationship between the intensity of centralised wildlife management and animal abundance (see Figure 1.1).

1. Large mammal abundance varies spatially and temporally with the intensity of wildlife protection.
2. Species abundance relationships are related to the intensity of wildlife protection.

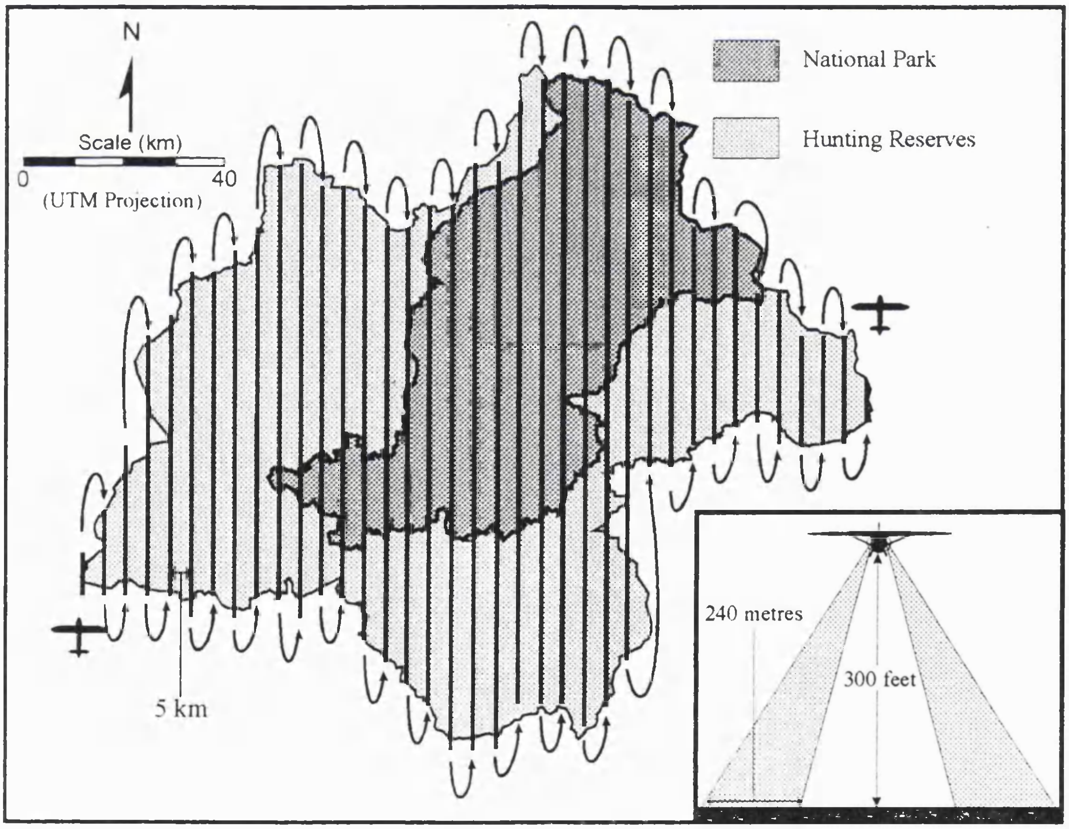
6.4 Methods: animal counts

This chapter examines long term trends in animal abundance based on regular surveys. Six systematic reconnaissance flights were undertaken over Garamba National Park at various intervals between 1976 and 1995. The author participated in the 1993 aerial count. Data on large mammal abundance and distribution were collected using the techniques described by Norton-Griffiths (1978). These are standard techniques that are in common usage in similar environments throughout eastern and southern Africa (eg. Broten and Said 1995, Inamdar 1996). The technique is summarised in Box 6.1. The flights were consistent throughout the survey period, and produced animal abundance estimates based on a nominal sampling intensity of 9.6%.

Box 6.1

Standard Reconnaissance Flight (SRF) techniques

A high winged aircraft is used which carries the pilot, a front seat observer and two rear seat observers. The aircraft flies along fixed line transect, in a north and south direction, which are interspersed at five kilometre intervals. These transects are drawn on 1:200,000 topographic charts plotted on a UTM projection. In recent years (1993 and 1995), a Pronav global positioning system has been used to facilitate precise navigation along the transect line. The rear seat observers are responsible for counting animals either side of the aircraft within fixed strip widths. Animals are only counted by rear seat observers if they are contained within the area on the ground delimited by two fibreglass rods that are attached to the wing struts. The aircraft is maintained at a fixed altitude using a radar altimeter. Thus, the area on the ground that is delimited by the rods represents a fixed strip width. Variations in strip width that are due to fluctuations in aircraft altitude are estimated before the survey by flying over fixed distance markers, and the results are used to calibrate the sampling area. Flights were undertaken by one aircraft (with a Cessna 175 or 206) in the mornings and afternoons over a period of less than 1 week.



Systematic reconnaissance flight parameters and trajectory in Garamba (1976 to 1995).

6.5 Appraisal of methods

Several studies have analysed the accuracy of systematic reconnaissance flight data (Caughley 1974, ILCA 1983, Inamdar 1996). A number of parameters may introduce bias into the aerial count data. This bias usually results in the undercounting of animals, particularly the smaller species. Survey altitude emerges as potentially the most important factor contributing to the undercounting of mammals. The aircraft's altitude represents a trade-off between the detection rate of mammals and the sampling intensity of the survey. Other important parameters which may influence accuracy include vegetation cover, season, visibility, and the size and behaviour of mammals being counted (Inamdar 1996). These are discussed below.

The detection rate of animals falls sharply with tree cover. The areas with high tree cover are predominantly in the Hunting Reserves, outside the National Park. Therefore these areas, although surveyed on several occasions, were not included in the analysis. Within the National Park gallery forest conceals certain mammals, such as primates, and therefore this study focuses on the large herbivores. All of the surveys except 1984 were undertaken during late dry season, after the fires, when vegetation cover is lowest.

Visibility may also be related to the season. In Garamba, the late dry season is the period of the Harmattan winds which carry dust from the north, together with high levels of smoke from the late dry season burns. However, the effect of low visibility caused by dust and smoke is likely to be minor at the low altitudes used for the survey. Inamdar's (1996) analysis of aerial count data in Tsavo National Park show that the seasonal effects on detection rates are non significant.

An important characteristic about the aerial surveys undertaken at Garamba between 1976 and 1995 is the consistency with which they were undertaken. With the exception of the 1976 survey, all surveys were coordinated by the same researcher, who also trained the observers. The same parameters were used during all of the counts, and these were based on the original 1976 count. Thus, aircraft altitude, strip width, transect intervals and locations and airspeed were consistent for all the surveys. Consequently, while the sources of bias mentioned above may have contributed to undercounting of animals any errors are likely to be systematic. As this study is primarily interested in change in mammal populations over time, change can be accurately detected because of the methodological consistency of the aerial counts over twenty years.

6.6 Analysis

Animal abundance data were estimated following each of the counts using parametric statistics. Jolly's method 2, also known as the ratio method, has been used to calculate standard errors on the data, from which confidence intervals were drawn (see Box 6.2, Norton-Griffiths 1978). This technique is used because each transect line is used as a data point, and therefore the analysis has to compensate for the unequal size of transects. T-tests for paired samples were used to test the significance of the differences in population abundance between surveys. Two pairs of surveys, each separated by approximately ten years, were used to represent change during periods of low investment in wildlife protection (1976 to 1986) and periods of high investment in wildlife protection (1986 to 1995).

Species abundances vary considerably across the national Park. Consequently, the variance across the transects is considerable, producing high standard errors and imprecise estimates. To reduce the variance, the National Park was divided into three strata according to the density distribution within the National Park. Strictly speaking, the correct approach is to define the strata prior to the survey, and fly each stratum independently (Norton Griffiths 1978). However, because of constraints in time and flight costs, the transects were flown as continuous transects, and the survey area was stratified *post hoc* (Hillman Smith *et al* 1995). Stratifying the survey area *post hoc* does not present analytical problems because each of the strata contain the same sampling intensity. The advantage of stratifying the data is that the confidence intervals for the overall count estimates are smaller, and population estimates exist for three separate sectors of the national park. These can be examined separately to assess the effects of different management practices.

Box 6.2

Estimating and comparing animal counts from systematic reconnaissance flights (Norton-Griffiths 1976)

Equation 1. Jolly's method 2 for estimating animal densities from systematic reconnaissance flight data: the ratio method for unequal sample points (from Inamdar 1996).

$$D = \frac{\sum y}{\sum a}$$

$$SE \quad D = \sqrt{\left(1 - \left(\sum a\right) / A\right)} \times \frac{n}{\sum a} \times \sqrt{\left(\frac{1}{n(n-1)}\right)\left(\sum y^2 + D^2 \sum a^2 - 2D \sum ay\right)}$$

$$Y = A \times D$$

$$SE \quad Y = A \times SE\ D$$

Where:

y = the number of animals in a given sample unit
a = the area of a given sample unit
A = the total area of the region being surveyed
n = the number of units sampled
D = the estimate of mean density
SE D = the standard error of the estimated mean density
Y = the estimate of total numbers in the region size A
SE Y = the standard error of the estimate of total numbers

Equation 2. Test for the significance of the difference between two sample estimates

$$t = \frac{(Y1 - Y2)}{\sqrt{VarY1 + VarY2}}$$

Y1 = population estimate at the beginning of the study period
Y2 = population estimate at the end of the study period
VarY1 = variance of the estimate at the beginning of the study period
VarY2 = variance of the estimate at the end of the study period
t = t-value (if t is greater than 1.96, estimates differ significantly at the 0.05 level)

6.7 Results

6.7.1 Population trends

Table 6.3 shows population changes during the two periods of interest. Between 1976 and 1986, when investment in wildlife protection was low, nine out of ten of the herbivore species monitored show a decrease in numbers. Six of these differences are statistically significant. The percentage change in population abundance are shown in Figure 6.2.

In contrast, between 1986 and 1995, when there was a relatively high investment in conservation, seven out of ten species increased in numbers. Three of these increases (elephants, hartebeest and warthogs) are statistically significant. Furthermore, rhinos were estimated using total counts based on individual recognition, which is a reliable technique. Thus, the increase in rhino can be considered to be real and not an artefact of sampling error.

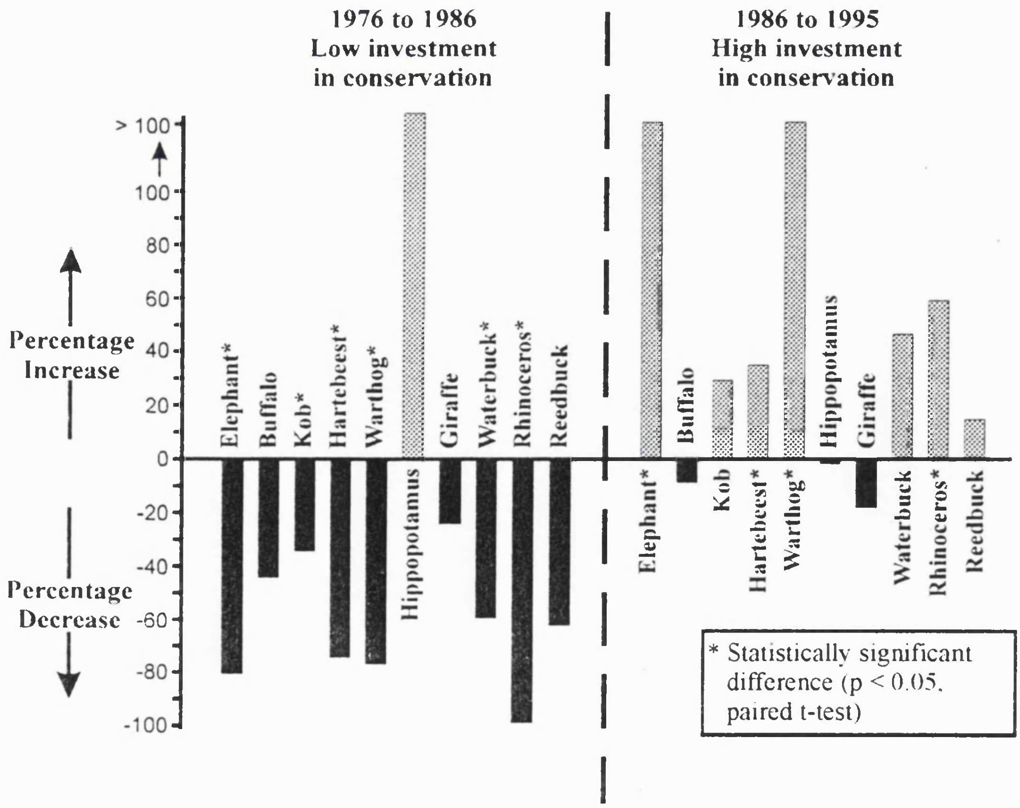


Figure 6.2. Percentage change in mammal population numbers in Garamba National Park between 1976 and 1995 (sampled aerial count data).

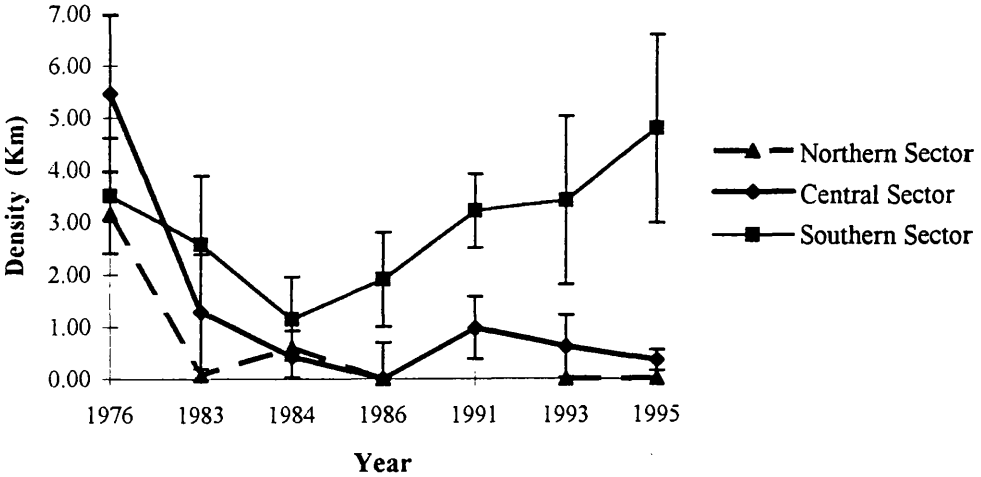
Table 6.3. Population change between 1976 and 1995, showing the significance of the differences using paired sample T-tests.

	Count			1976 to 1986		1986 to 1995	
Species	1976	1986	1995	Change	*T*, significance	Change	*T*, significance
Elephant	22,670	4,169	11,175	- 18,501	$t = 4.41$, $p < 0.01$	+ 7006	$t = 2.27$, $p < 0.05$
Buffalo	53,000	29,293	25,242	- 23,707	$t = 1.64$, p = NS	- 4051	$t = 0.50$, p = NS
Kob	7,180	4,818	6,601	- 2,362	$t = 1.80$, p = NS	+ 1783	$t = 1.09$, p = NS
Hartebeest	7,750	1,957	2,819	- 5,793	$t = 6.13$, $p < 0.01$	+ 862	$t = 2.16$, $p < 0.05$
Warthog	3,340	684	5,606	- 2,656	$t = 2.90$, $p < 0.01$	+ 4922	$t = 6.75$, $p < 0.01$
Hippopotamus	1,700	3,818	3,608	+ 2118	$t = 1.24$, p = NS	- 210	$t = 0.07$, p = NS
Giraffe	350	237	178	- 113	$t = 0.75$, p = NS	- 59	$t = 0.41$, p = NS
Waterbuck	3,680	1,409	2,100	- 2,271	$t = 4.76$, $p < 0.01$	+ 691	$t = 1.38$, p = NS
Rhino	490	19	29	- 471	$t = 3.25$, $p < 0.01$	+ 10	TOTAL COUNT
Reedbuck	640	244	271	- 396	$t = 3.54$, $p < 0.01$	+ 27	$t = 0.34$, p = NS

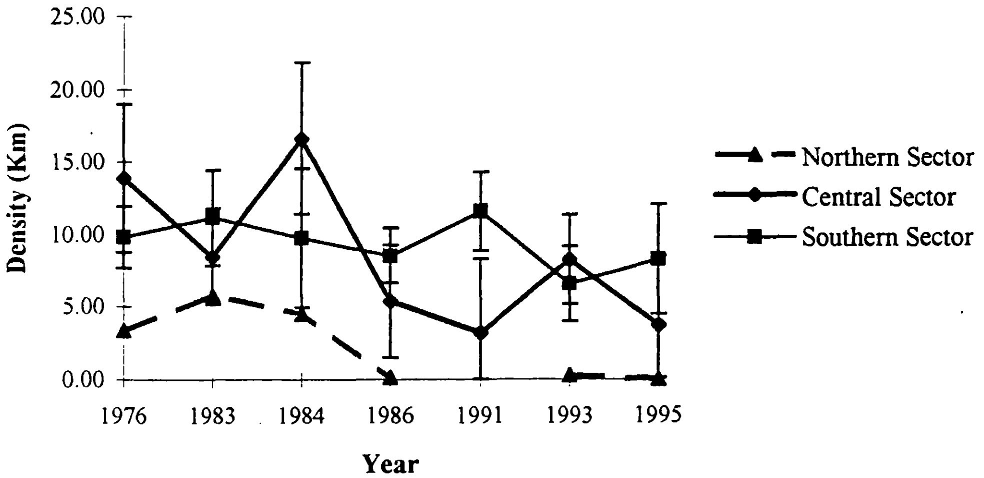
6.7.2 Spatial variations in population change

Figure 6.3 (a to e) show the variation in population estimates for six species of herbivores: elephants, buffalos, rhinos, warthogs, kob, hartebeeste. These six were selected because they correspond to most of the National Park's large mammal biomass, and they can be counted reliably because they are easily detected from the air. All of the aerial counts are shown, and the results are presented for each of the management sectors of the National Park (Northern, Central and Southern Sector). The estimates are measured in densities because each of the sectors are of different sizes.

a. Elephant densities



b. Buffalo densities



c. Rhino densities

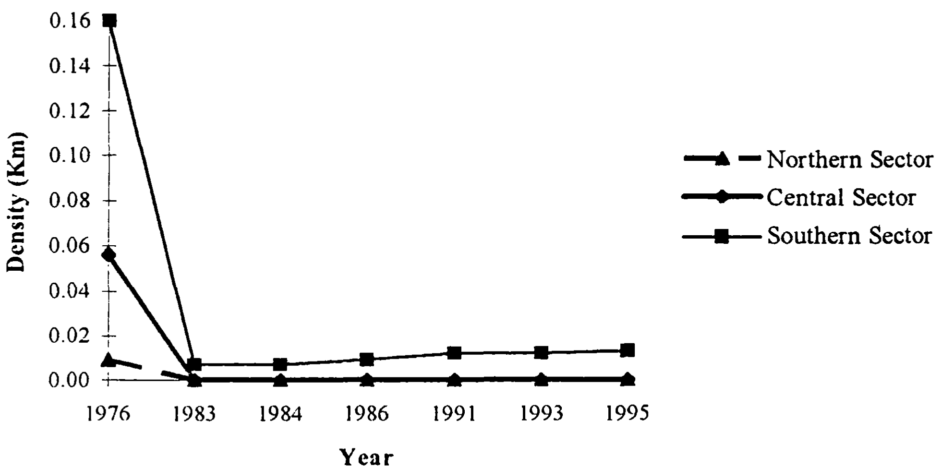
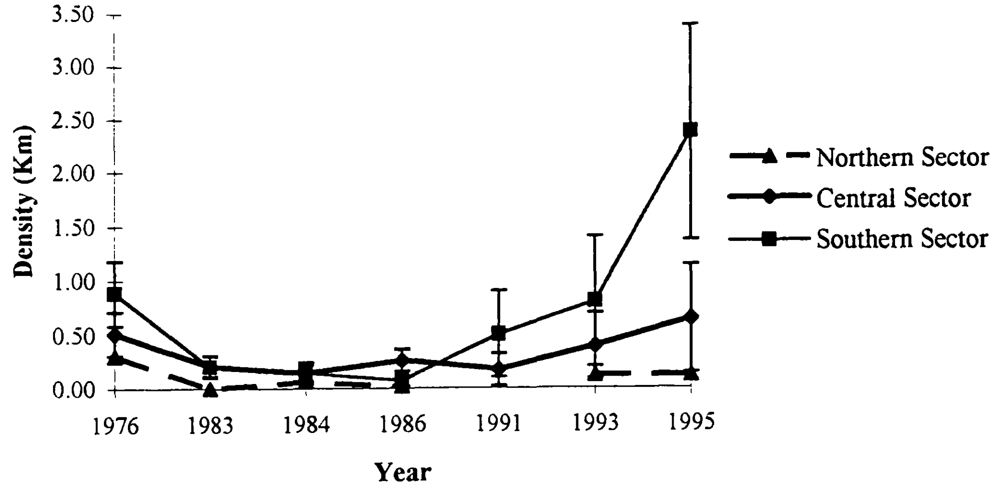
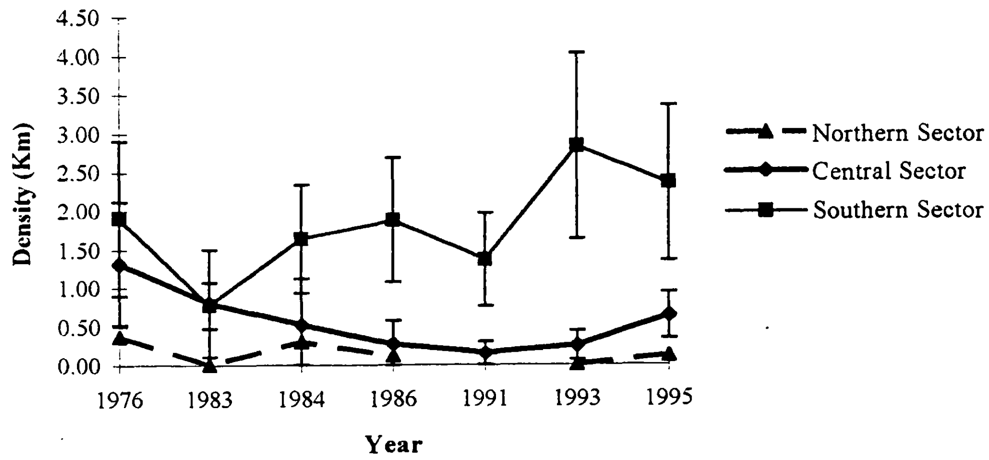


Figure 6.3a, b and c. Spatial and temporal variations in animal abundance (estimated from sampled aerial counts 1976-1995, error bars show 95% confidence intervals).

d. Warthog densities



e. Kob densities



f. Hartebeeste densities

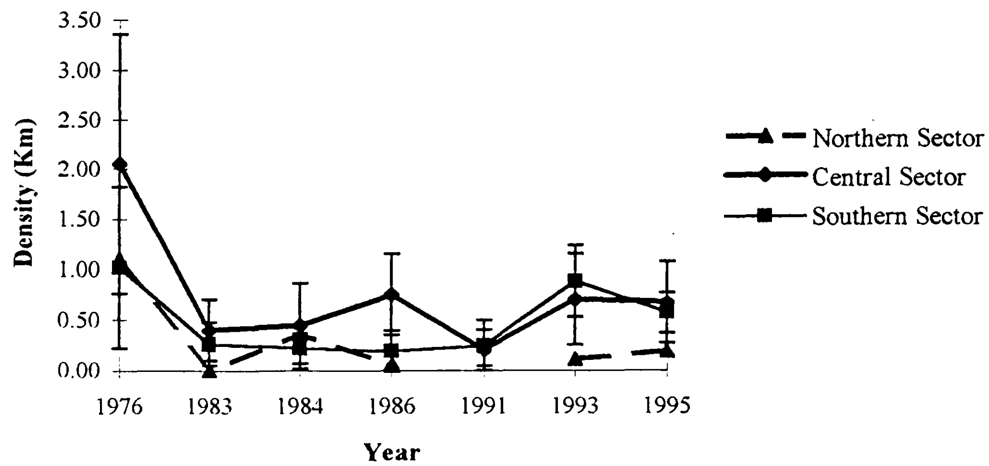


Figure 6.3d, e and f. Spatial and temporal variations in animal abundance (estimated from sampled aerial counts 1976-1995, error bars show 95% confidence intervals).

6.7.3 Changes in species relationships in relation to wildlife protection in the southern sector

Regression models were calculated to describe the relationship between large and small mammals. Regressions showing the relationship between the density and body mass of large mammals surveyed in the national park between 1976 and 1995 within the national park are shown in Table 6.4. Log transformation was used to make the results comparable to other published studies using density mass relationships (see below). The results show a statistically significant positive relationship between density and body mass in 1976 and 1995. The patterns contrast sharply with those shown in Table 6.2, which demonstrate a negative relationship between density and body mass. The significant relationships in 1976 and 1995 are plotted in Figure 6.4.

Table 6.4. Regression models showing the relationship between log (10) density and log (10) body mass for all surveyed mammals between 1976 and 1995.

Data set	n	*b* (slope)	SE (*b*)	r^2	*p* (*b*=0)
1976	9	+ 1.45	0.13	0.59	0.001
1983	7	+ 0.15	0.29	0.04	NS
1984	9	+ 0.26	0.25	0.19	NS
1986	9	+ 0.23	0.23	0.13	NS
1991	9	+ 0.31	0.24	0.17	NS
1993	9	+ 0.32	0.23	0.20	NS
1995	10	+ 1.13	0.38	0.42	0.012

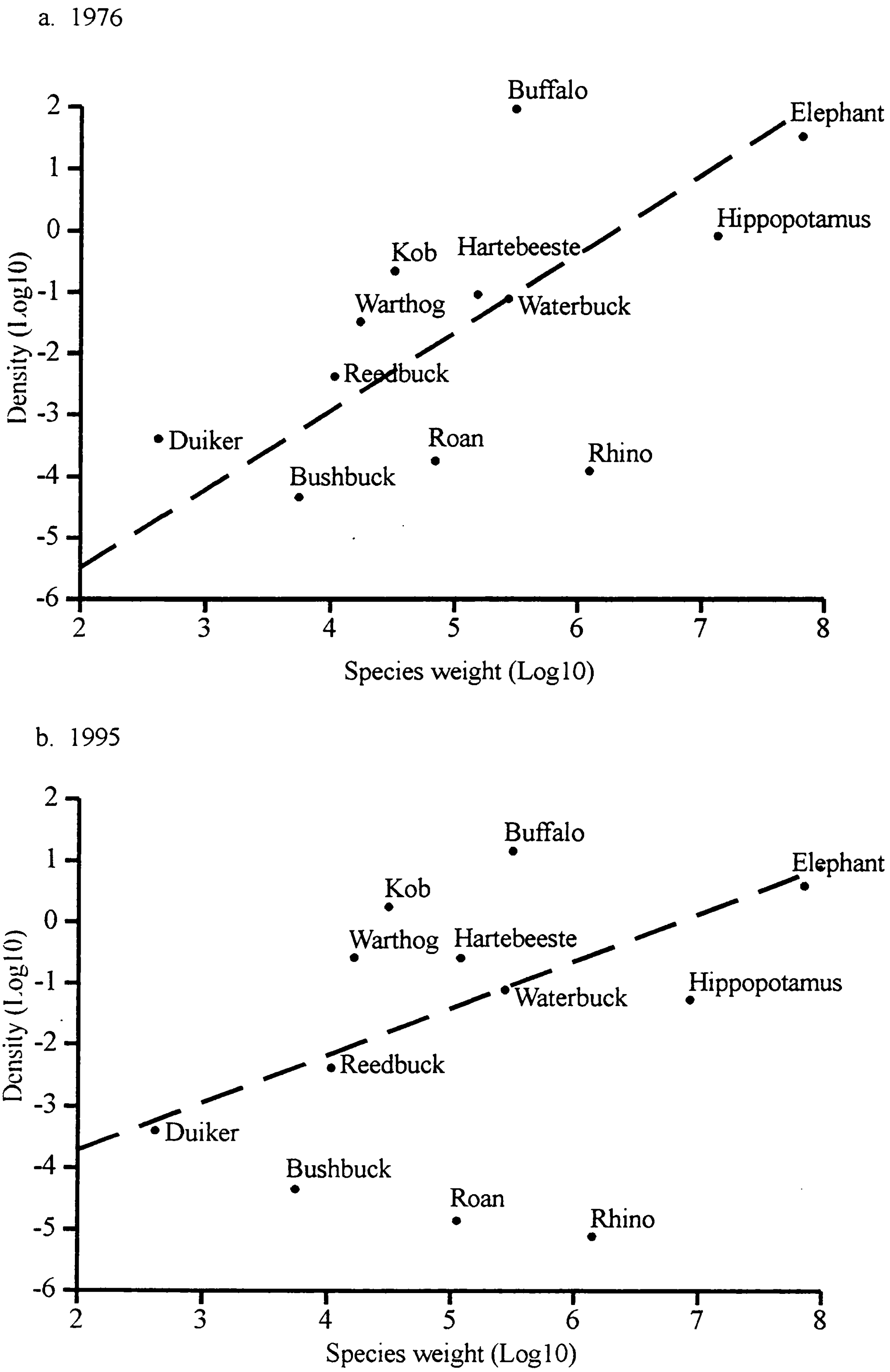


Figure 6.4. Density - Mass ratios for the mammal assemblage in the southern sector of Garamba National Park in 1976 and 1993 (estimates from systematically sampled aerial counts).

6.8 Discussion

The results of these analyses have revealed some important patterns which support the results of other chapters. It is evident from these results that a policy of wildlife protection, when effectively implemented, has an overwhelming effect on the growth of populations of very large mammals.

6.8.1 Hypothesis 1: Large mammal abundance varies spatially and temporally with the intensity of wildlife protection.

The two time periods of high and low investment in wildlife protection provide a good basis for a natural experiment to test the effects of investment in wildlife protection on the abundance of large mammals. The two periods are approximately equal in time, and the consistent methodology used for all counts contributes to the high level of confidence in the estimate of change.

Evidence for low investment in conservation between 1976 and 1986 is based on the absence of an aid project working in collaboration with the national wildlife agency. But it must be recognised that investment in conservation is a difficult variable to measure. Indeed, a study undertaken to assess the standard of living of National Park guards suggest that their purchasing power was infact higher during the period 1976 to 1986 than during the period 1986 to 1995 when the National Park authorities were receiving support from the aid project (de Merode *et al* 1994). This can largely be attributed to the economic crisis in Congo, whereby the national economy deteriorated significantly during the 1970s and 1980s (Hart and Hart 1996). The crisis affected both the guards' government salaries and the income generating activities of the guards and their families. The importance of insufficient investment as a constraint to conservation throughout Africa has been emphasised by Leader-Williams and Albon (1988).

Although the living standards of the guards may have been higher during 1976 to 1986, the wildlife protection activities undertaken within the National Park were certainly less intensive. There were no functioning vehicles during this period, and patrols were restricted to the immediate periphery of the Park headquarters at Nagero. Furthermore, reports from older guards, who served during the 1970s, state that internal poaching was widely practised by National Park staff during this period. Thus, the major difference between the two periods is in the higher frequency and efficacy of anti-poaching patrols undertaken in the National Park between 1986 and 1995.

Evidence that the population abundance of large mammal species varies according to the investment in wildlife protection is extremely strong. Almost all species show a decline during the period of low investment in wildlife protection (1976 to 1986). In contrast, most species appear to increase in abundance during the period of high investment in wildlife protection.

There are two notable exceptions to this pattern. First, the buffalo population shows a non-significant decrease in abundance throughout the study period. Secondly, although warthogs decline between 1976 and 1986 and increase between 1986 and 1995, there is evidence to suggest that factors, other than protection, may have contributed to this increase in population. The population is known to have been affected by swine fever, which is believed to have decimated the population in 1984 (Hillman-Smith pers comm). Warthogs populations have high intrinsic growth rates (Estes 1992), which may explain their fast recovery between 1986 and 1995, producing a statistically significant increase in numbers.

Observed spatial variations in animal abundance are consistent with the results of the temporal variations. The change in animal abundance patterns for each of the three management sectors correlate closely with the intensity of wildlife protection activities (Figure 6.3, a to e). For most species the overall trend is a decline in numbers between 1976 and 1986 followed by a gradual increase between 1986 and 1995, as shown in the previous analysis. However, the patterns differ significantly according to the sector being plotted: for all species, an overall decline is evident in the Northern Sector throughout the study period, whereas the increases in population abundance between 1986 and 1995 are concentrated in the Southern Sector. Buffalo populations provide an interesting contrast to this pattern. The overall trend appears to have been one of decline during both periods. However, this result is not statistically significant, and should therefore be treated cautiously. A plausible explanation for buffalo population decline in all sectors of the park may relate to their behavioural response to poaching. It is argued that, unlike other species such as elephants, buffaloes do not reduce their exposure to poachers by moving to safer areas (Hillman Smith pers. comm.). Furthermore, because buffaloes are seasonally mobile (Marks 1977), they become more exposed to the high poaching intensity areas in the north.

6.8.2 Hypothesis 2: Species abundance relationships are related to the intensity of wildlife protection

Regression models were used to test the relationship between population density and body mass in the Southern Sector of the National Park. This sector was examined because it represents an area where wildlife protection has been most intensive. The results show that throughout the study period, larger mammals tend to be more abundant than smaller mammals. This is particularly so in 1976 and 1995, when the relationship between density and body mass relationship showed statistically significant positive relationships (Table 6.4). Interestingly, these two relationships correspond to data that were collected after a long period of effective wildlife protection: at the end of the ICCN / FAO project, and after eleven years of the ICCN / WWF project.

The results of the density mass ratios presented in Table 6.2, based on continental scale data, provide a good comparative baseline which contrast sharply with the patterns identified at Garamba which have a strong positive correlation coefficient. Certainly, some bias will have been introduced into this analysis from undercounting the smaller species because they have a lower detection rate when using an aerial sampling technique (Broten and Said 1995). However, this alone does not explain the startling contrast in the direction of the relationship in the results from the literature and the Garamba data. The relationship suggests that larger mammals are more successful at Garamba, resulting in their higher relative abundance than small mammals. This unusual pattern appears to relate strongly to the fact that large mammals are the focus of wildlife protection activities.

Nevertheless, the relationship between large and small mammals remains remarkably static over the period 1976 to 1995. This period experienced high variability in the intensity of wildlife protection, and in the abundance of large mammals. This suggests that there is no causal reduction in small mammals in response to the increase in large mammals. To suggest otherwise would be to assume that herbivore populations are resource dependent and that the greater number of large mammals is depleting the food available to small mammals. The assumption of herbivore competition is implicit to much of the earlier ecological literature on savanna mammal assemblages (e.g. Lamprey 1963). Whilst predator prey density relationships can be modeled with a relative degree of confidence, herbivore interactions are more complex. The level of resource competition between savanna mammals is greatly reduced by the high variability in primary production (Sinclair and Arcese 1995). Furthermore, niche separation between large and small mammals is particularly high (Sinclair 1995), and therefore it is not possible to show a relationship between an increase in large mammals and a related decrease in small mammals based on these data alone. Nevertheless, the increase in large mammals is sufficient to create the unusual density / mass relationships that are evident at Garamba, which is attributed to wildlife protection activities being focused towards large mammals

6.9 Conclusion

This chapter aimed to assess the effects of wildlife protection with a view to explaining the patterns described in Chapter 5. Chapter 5 revealed that the spatial variation in mammal species richness and abundance in the Hunting Reserves was best explained by distance from the National Park. The National Park differs from the hunting reserves both in terms of the habitat type, and the management practices that are undertaken within it. Thus Chapter 4 could not provide conclusive evidence that high abundance was associated with wildlife protection because of the confounding effects of habitat.

The analysis of long term temporal variations in animal abundance supports the hypothesis that active wildlife protection has a positive causal relationship with animal abundance. Two comparable datasets were examined and these reveal that a period of low investment in the institution that implements wildlife protection was associated with a statistically significant decline in most mammal populations. In contrast, a period of high investment was predominantly associated with an increase in mammal populations. The spatial variations of animal abundance also showed patterns that were associated with the intensity of wildlife protection.

The community structure reflects an unusual abundance of large mammals relative to smaller mammals. This appears may be related to a management regime which focuses on the protection of large mammals. However, the relative proportions appear remarkably constant between 1976 and 1995; a period when management intensity varied considerably.

Chapter 7

Multiple Perspectives on Wildlife Resources

7.1 Summary

Chapter 4 presented the planned zonation of the hunting reserves whereby conservation practitioners demarcated areas of 'conservation priority' (with high elephant abundance) and areas of 'development priority' (with high levels of human settlement). This mirrors how conservation objectives in the Garamba ecosystem have traditionally been implemented, by limiting the settlement of resident populations and regulating wildlife utilisation through law enforcement. Chapters 5 and 6 show that these policies meet conservation objectives: areas where human presence is restricted show higher animal abundance and species richness. However, the cost of setting land aside for conservation and its implications for local development have not been evaluated at Garamba.

Understanding the costs of conservation in the hunting reserves requires an evaluation of competing demands for wildlife resources. This analysis compares resource distribution in terms of the priorities expressed by two groups with a stake in wildlife resources: local residents and conservation officers. GIS and geo-statistical techniques are used to combine data generated using participatory and quantitative survey methods so that multiple perspectives on wildlife resources can be compared systematically. The results show that 'conservation priority areas' within the game reserves are also the areas most valued by local residents for resource use. This suggests that conservation and local development objectives cannot easily be reconciled using traditional protectionist paradigms that set aside land for conservation. This conclusion provides the basis for the second part of this thesis which examines alternative approaches to wildlife management in the hunting reserves.

7.2 Introduction

Currently, most protected area policies state the dual objective of maintaining an area's biological diversity, and providing services to surrounding populations (WWF, IUCN and UNEP 1980). In essence, they seek to satisfy the needs of all stakeholders. However, the impacts of protected area policies on local livelihoods are increasingly being examined. The implementation of protected areas, by definition, restricts human access to natural resources. Yet, the value of the natural resources, such as wild foods, pasture and fuelwood that are contained within many protected areas is considerable and can be critical in supporting rural livelihoods in the developing world (Weaver 1979, Malaisse and Parent 1985, Scoones *et al* 1992). Consequently, it has been shown that, rather than enhancing human welfare, protected areas can bring about resource alienation which may cause economic hardship for adjacent human populations (Brockington and Homewood 1996, Colchester 1997, Pimbert and Gujja 1997).

The evaluation of the costs and benefits of a policy is a key element of policy appraisal (Department of the Environment 1992). Yet there are few examples of quantified assessments of the costs of protected area policies. This may be because the costs and the benefits of biodiversity conservation operate at different spatial and temporal scales. Typically, the costs are felt at the local level and within a short time frame. In contrast, the benefits of biodiversity conservation are said to accrue at a national or global level and are aimed at future generations. The discourse surrounding protected areas usually highlights their global value for humanity, for example the UNESCO's World Heritage Sites which include Garamba National Park, and not their local benefits.

Another factor which complicates the objective analysis of the costs of conservation policies are the conflicting values of multiple stakeholders. Few resources evoke such diverse emotions as wildlife. In the eyes of some, African wildlife produces positive images of beautiful but threatened mammals. In stark contrast, others experience wildlife as a threat to their livelihoods or to their security (see Tchamba 1997 for an account of the impacts of wildlife on local agricultural production in Cameroon, and

Thouless 1994 in Kenya). The negative impacts of wildlife on local economies are often compounded by prohibitions on the use of wildlife. The result is a conflicting set of attitudes towards protected areas. The diversity of views on wildlife makes conventional approaches to conservation biology, such as surveys of key mammal populations, appear naïve in the context of a complex socio-political, as well as ecological, environment.

Thus, whilst it can be argued that protected areas, as tools for biodiversity conservation, do indeed make a contribution to human welfare at the global level, the notion of 'welfare' is subject to multiple interpretations. These can only be understood from a more holistic understanding of the benefits of natural resources. Brown and Moran (1993) provide a framework for understanding the value of biodiversity (Box 7.1).

Box 7.1.

Multiple values of biodiversity (modified from Brown and Moran 1993)

1. ***Direct use value***
   This use of biodiversity can be understood in terms of *consumptive use value* which typically covers domestic or non-market use of biological resources, or *productive use value*, which covers products that are used to generate financial income.

2. ***Indirect use value***
   These values refer to the wider ecological services provided by biological resource. These values, therefore, are not consumed or sold but are significant to human welfare.

3. ***Intrinsic value***
   This value is best described as a moral position, based on the rights of non-human species to existence. The value has no direct connection to human welfare.

National park policies tend to be constructed with a view to enhancing a combination of the *indirect use value* and the *intrinsic value* of wildlife. This is because, by definition, national park legislation prohibits people from deriving *direct use value* from the resources contained within them.

The framework is helpful in understanding the motivation behind the protected area zonation at Garamba. Chapter 4 described the criteria used to define management priorities. These criteria aim to protect large mammals, such as rhinos and elephants. Thus, areas in the hunting reserves classified as *conservation priority areas* are designated for the regulation of wildlife utilisation and direct use is restricted. It is difficult to identify the local indirect use values provided by large mammals. Indeed, many agriculturalists in the region argue that large mammals are an environmental hazard contributing to high levels of crop damage (see de Merode *et al* 1994, Hillman Smith *et al* 1995, Buls, 1997). Thus, the values behind the conservation objectives at Garamba can largely be explained in terms of the *intrinsic value* that is attached to the wildlife.

The present analysis uses the concepts of *direct-use* and *intrinsic* (non-use or conservation) values of wildlife, re-classifying the landscape using local resource use criteria and recognised conservation criteria (species existence value, endemism and vulnerability). A spatial approach using GIS and geo-statistical techniques is used to apply these alternative values to standard wildlife survey data so that the results are directly comparable to the zonation map in Chapter 4 (Figure 4.3). Figure 4.3 represents the perspectives of one stakeholder, the conservation authority. The analyses presented below add the resource use perspectives of local residents, enabling a comparison of the differing land-use priorities of two stakeholders.

The introduction of local values into spatial analysis contributes to a growing debate surrounding the requirements for 'politically aware' quantitative analysis. For, example, Harris *et al* (1995) discuss the potential for "community integrated GIS", which breaks away from the extractive nature of information gathering in rural communities. The use of exclusive decision making technology, such as GIS, compounds and formalises the distinction between so called 'experts' and local stakeholders whose livelihoods are most affected (Dunn *et al* 1995, Abbot *et al* 1998). Recent attempts to develop functional links between participatory approaches and GIS are an attempt to redress the imbalance in the influence of remote decision makers and local stakeholders. The contributions of this analysis to this emerging debate are considered in the analysis.

7.3 Methods

The methodology applied conservation (intrinsic) and local resource use (direct-use) priorities to data on mammal distribution within the hunting reserves.

7.3.1 The distribution of wildlife resources

Mammal abundance data in the hunting reserves is drawn from the five kilometre line transects described in Chapter 5. In summary, 42 transects were distributed throughout the hunting reserve using a stratified random sampling scheme. Faecal counts are used as an indicator of animal abundance.

7.3.2 Adding intrinsic and direct-use value to wildlife resources

a. Intrinsic value

This was defined by the *Conservateur Principal* at Garamba National Park, Mbayma Atalia. A list was drawn of all mammal species identified during the line transect exercise (Table 7.1). These species were then weighted by the wildlife officer according to the conservation criteria used by ICCN (Table 7.1): vulnerability and endemism (Atalia *pers. comm.*). Species were given a value of 0 or 1 depending on whether or not each criterion was met. All species were given an existence value of 1.

Table 7.1. Species weighted according to their estimated intrinsic and direct-use values

Species	Intrinsic value					Direct-use value		
	Existence	Endemism		Vulnerability		Preference	Market value	Abundance
		Global	National	High	Moderate			
Rhinoceros	1	1	1	1	1	x	x	0
Bohor reedbuck	1	0	0	0	0	2	x	2
Bongo	1	0	0	1	1	4	x	1
Hartebeest	1	0	0	0	0	3	3	3
Buffalo	1	0	0	0	0	5	5	5
Bushbuck	1	0	0	0	0	3	3	3
Duiker	1	0	0	0	0	4	3	4
Giant forest hog	1	0	0	0	1	5	4	1
Giraffe	1	0	1	1	1	5	x	1
Hippopotamus	1	0	0	0	1	5	5	5
Bushpig	1	0	0	0	0	4	3	2
Kob	1	0	0	0	0	3	3	5
Warthog	1	0	0	0	0	4	4	5
Waterbuck	1	0	0	0	0	4	5	5
Elephant	1	0	0	0	1	5	5	5
Aardvark	1	0	0	0	0	2	2	2
Rabbit	1	0	1	0	0	1	1	5
Cane rat	1	0	0	0	0	1	1	5
Porcupine	1	0	0	0	0	1	1	4
Baboon	1	0	0	0	0	3	3	4
Chimpanzee	1	0	1	1	1	4	x	1
Colobus	1	0	0	0	0	3	2	4
Mona monkey	1	0	0	0	0	2	2	4
Patas monkey	1	0	0	0	0	3	2	3
Vervet monkey	1	0	0	0	0	2	2	4
Civet	1	0	0	0	0	2	x	2
Genet	1	0	0	0	0	3	x	3
Leopard	1	0	0	0	0	x	x	x
Lion	1	0	0	0	0	x	x	x
Mongoose	1	0	0	0	0	2	1	4
Serval	1	0	0	0	0	2	2	2
Hyeana	1	0	0	0	0	x	x	x

b. Direct-use value

An understanding of the importance of species to members of the communities living in the hunting reserves was achieved through the field work undertaken in Kiliwa. Informal interviews were undertaken to determine the characteristics for which species were valued. These included factors such as taste of meat and enjoyment derived from hunting the animal. Other factors that were stressed included the monetary value of the meat and the availability of the species. A sample of 128 households were interviewed as part of a long term study of household consumption (see Chapter 8). Species preferences were explored and discussed with members of the households using images of species scanned from Dorst and Dandelot (1970). The images were enlarged and printed on A4 sized sheets of paper. Members of the households were asked to rank them in order of preference. This usually involved a certain amount of debate between members of the households before a preference ranking was developed.

The monetary value of bushmeat was derived from the market data on bushmeat (see Chapter 10), and from the abundance data drawn from the survey work (both aerial counts and ground transects, see Chapters 5 and 6). Use values were scaled to a range of 1 (least valued species) to 5 (most valued species). An X denotes species that do not contribute to local livelihoods.

7.4 Analysis and Results: applying multiple perspectives to wildlife distribution data

To understand the importance of each species to each stakeholder, the intrinsic and direct use values are calculated for each of the 31 species by summing the attributes associated with each type of value. These values are then applied to data on the distribution of the species obtained from faecal observations at each of the transects. This prioritises the landscape according to each stakeholder's perspective.

The result, however, is heavily biased by certain species, such as elephants and buffalos, which have a much higher detection rate than other species. The bias is partly because of their higher densities, but also because they leave conspicuous signs of their presence. An equal weighting can be given to all species by standardising the number of faecal observations made along the transects for each of the species individually. These standardised values are calculated in number of standard deviations from the mean number of observations for the species (z-scores).

The outcome of this exercise is to produce a set of transect values for each species. The range of values was the same for all species, because standardised transect scores were used. This can be interpreted as a dataset whereby *all animals are equal*, and can subsequently be individually weighted according to intrinsic and direct-use values.

The scores displayed in Table 7.1 were summed to produce total intrinsic and direct-use values, and these were multiplied by each of the transect z-scores for each species in turn. This produced a set of species values that are weighted according to intrinsic and direct-use values. An example of the procedure is outlined in Table 7.2.

Table 7.2. Example of the procedure used for calculating intrinsic and direct-use value for a species (elephants) at a transect position.

Transect No.	No. of elephant signs	z-score (a)	Elephant conservation score (b)	Elephant utilisation score (c)	Relative conservation importance of transect position (a*b)	Relative utilisation importance of transect position (a*c)
1	103	2.1	2	15	4.2	31.5
2	10	-0.52	2	15	-1.04	-7.8
3	26	0.05	2	15	0.1	0.75
4	0	-2.14	2	15	-4.28	-32.1
5	8	-0.87	2	15	-1.74	-13.05
6	47	1.18	2	15	2.36	17.7
...	...	...	...	...	...	...
42	3	-1.51	2	15	-3.02	-22.65

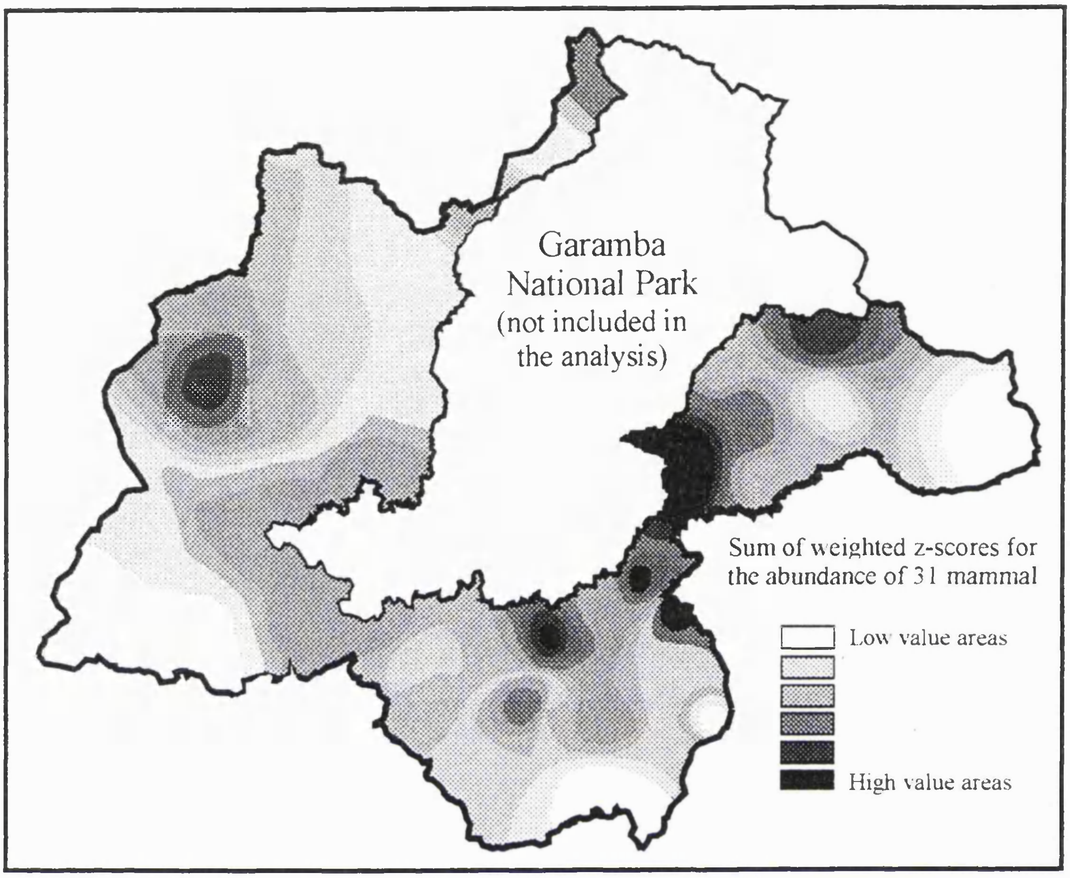
7.4.1 Mapping the distribution of resources

The spatial variation of wildlife, according to intrinsic or direct-use values, was mapped using a GIS interpolation routine. Interpolation provides a basis for generalising survey data to the whole area. The routine uses a weighted distance average to assign values to cells between the transects using the six nearest transect scores (Eastman 1995). The contribution of each of the six transect scores is:

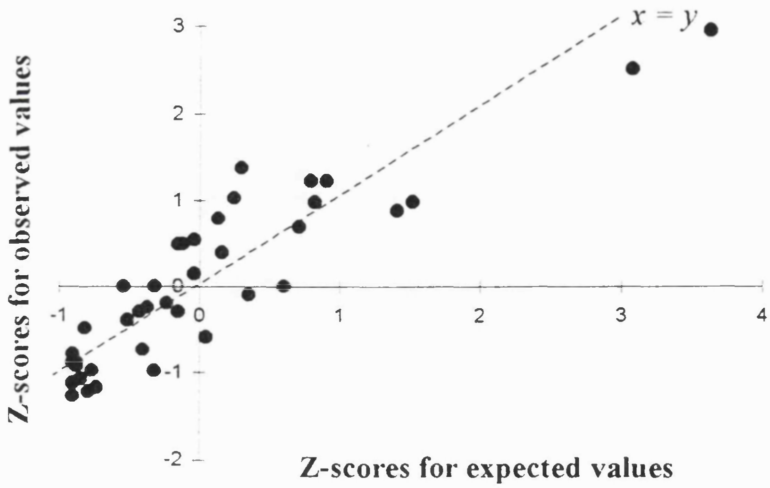
$$I = \sum_{i=1}^{n} \frac{1}{d_i^2} T$$

where I is the interpolated value to be assigned to an empty cell, d is the distance between the cell and the transect, and T is the species z-score for that transect. The distribution of wildlife resources were interpolated according to intrinsic (Figure 7.1) and direct-use values (Figure 7.2)

The confidence levels on the interpolated results were measured using simple geo-statistical tests. Observed (transect data) and expected values (interpolated data) were compared. Observed values are simply the transect values (the two right hand columns in Table 7.2). Expected values were generated from the interpolation routine as follows: a transect is removed from the dataset and the interpolation is computed. The position where the removed transect was located subsequently contains an interpolated (or expected) value. This can be compared to the actual value of the removed transect which represents the observed value. This procedure is repeated 42 times to produce observed and expected values for all transects. The observed and expected values are plotted on a semi-variogram (Isaaks and Srivastava 1989). If all interpolated values were equal to the actual values (in other words, correct), the plotted points would all fall exactly on the line $x = y$. Thus, the residuals from the line $x = y$ represent the interpolation error, and confidence intervals can be generated from these residuals (note that the standard deviation of residuals, rather than the standard error is used to define confidence intervals because the 'average error', and not the sampling error is being measured here). The confidence intervals are relatively small and are within the margins typically associated with wildlife survey data (Inamdar 1996, Hillman-Smith *et al* 1995). However, it should be noted that the results of this accuracy assessment tend to be conservative because the expected values are computed from a smaller sample as a result of removing a transect from sample dataset (41 transects are used for the accuracy assessment, instead of the actual 42 used in the original interpolation).

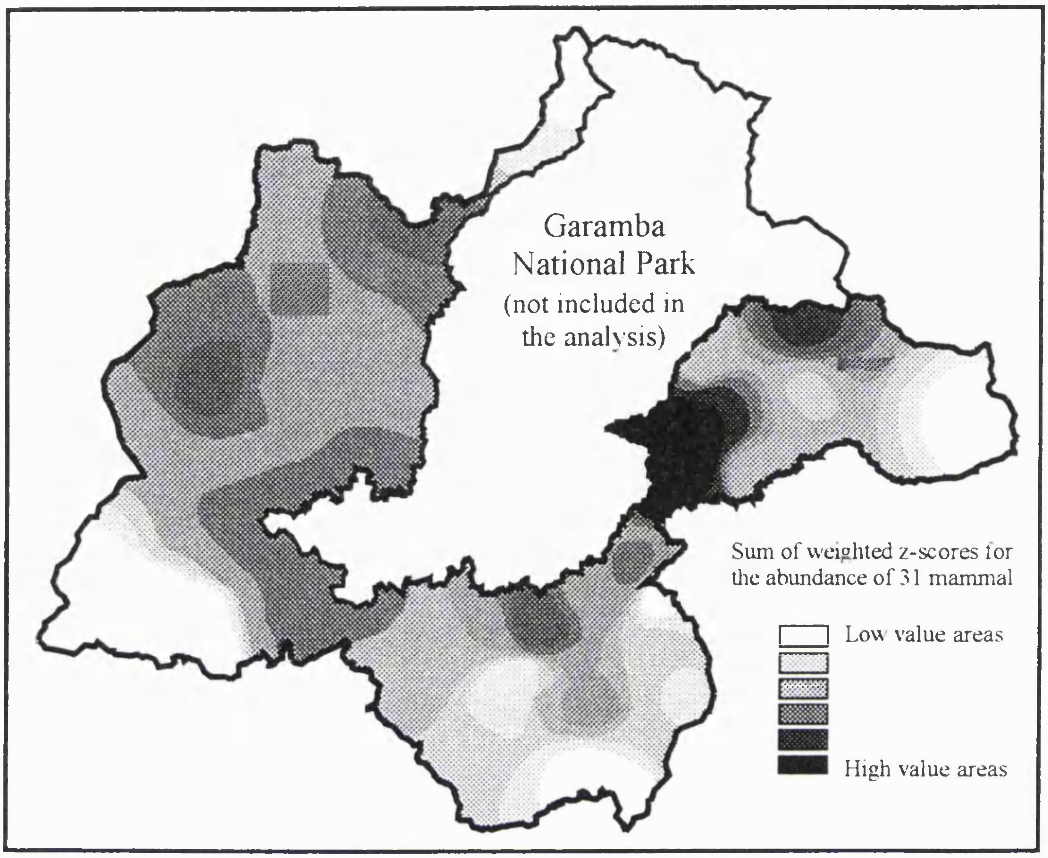


Error estimates for the interpolation:

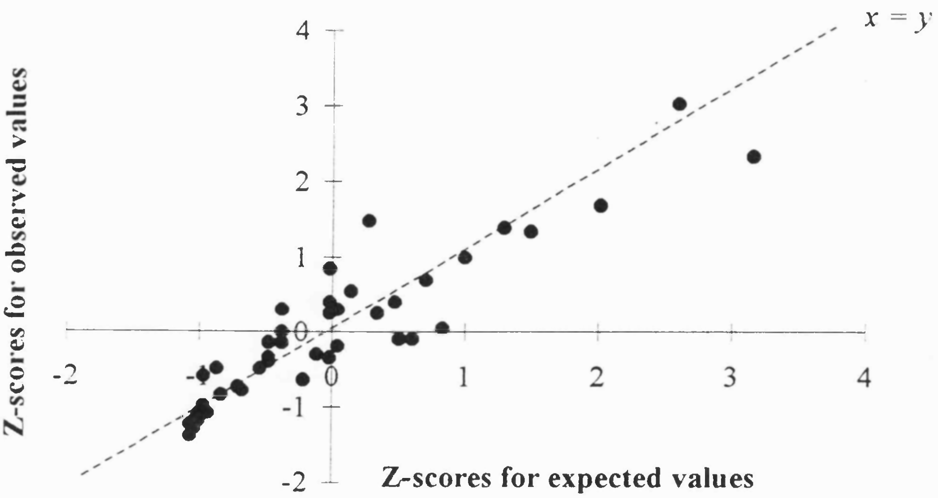


N	Standard error	95 % Confidence Intervals	95 % Confidence Intervals (%)
42	0.11	± 0.22	± 12.83 %

Figure 7.1. The inverse distance interpolation showing the distribution of mammal abundance weighted according to *intrinsic* value



Error estimates for the interpolation:

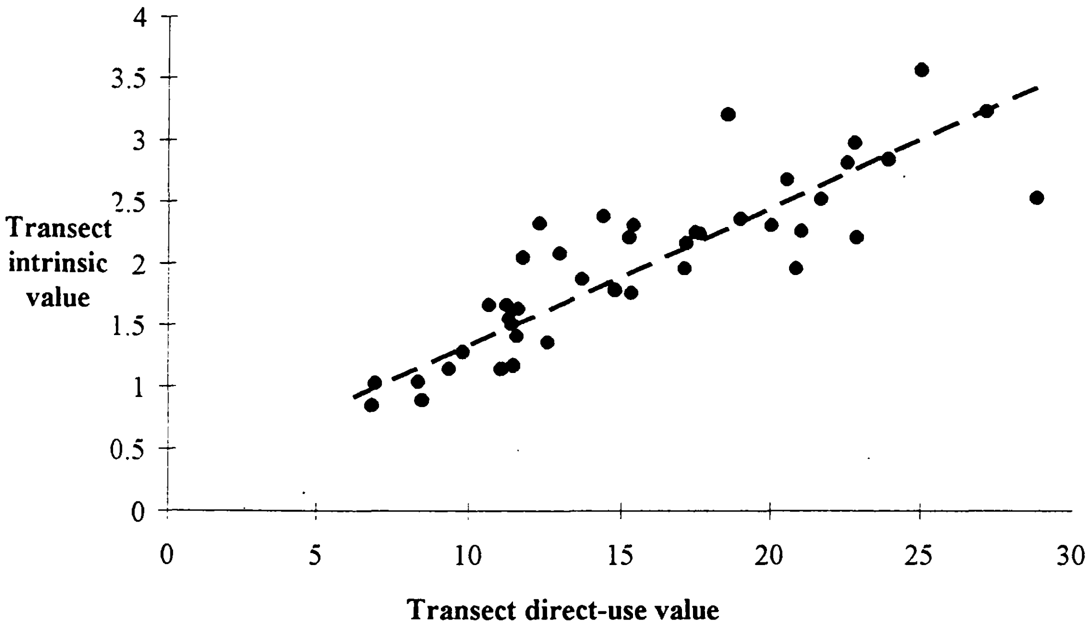


N	Standard error	95 % Confidence Intervals	95 % Confidence Intervals (%)
42	0.08	± 0.16	± 8.39 %

Figure 7.2. The inverse distance interpolation showing the distribution of mammal abundance weighted according to *direct-use* value

7.4.2 *Resource conflict analysis.*

A visual analysis of the maps presented in Figures 7.1 and 7.2 suggests that, on the whole, areas that are important to conservation are also important in terms of people's resource use requirements. This observation was tested using a simple linear regression, comparing the conservation value of transects with the use value of transects (Figure 7.3). This analysis shows that high intrinsic value is highly correlated with high direct-use value. The strong positive correlation shows that areas that are valued for wildlife protection are also highly valued for people's livelihoods. The implications of this result for protected area land-use planning are discussed in the next section.



N	r^2	*F-ratio*	*P*
42	0.74	113.96	< 0.0001

Figure 7.3. Least squares regression to show the relationship between areas of high conservation value and areas of high importance for local wildlife utilisation.

7.5 Discussion

The results of the analyses presented in this chapter may appear self evident: areas that are important for conservation are also important to local people for their wildlife utilisation requirements. However, it is useful to make this trade-off explicit, particularly in the context of the protected zonation outlined in Section 1 of Chapter 4. This zonation demarcated the hunting reserves into 'conservation priority areas' and 'development priority areas'. This zonation, developed by conservation practitioners, is intended to provide the basis for 'community conservation'. However, local residents were not consulted. Thus, the zonation exercise documented in Chapter 4 shares many of the characteristics of protected area planning in Africa: extensive areas of land are gazetted by stakeholders who do not bear the costs of the land-use policy (Pimbert and Pretty 1995).

This chapter has explored some of the apparent contradictions in attempting to merge established conservation agendas with development objectives. Two issues emerge from this study and are discussed. The first is methodological, and examines the use of information and the representation of the landscape using GIS by conservation practitioners. The second addresses the implications of conflicting land-use objectives for protected area management at Garamba.

7.5.1 Methodological issues in land-use planning

Geographic information systems have been heralded as a tool for objective decision making in land-use planning. This was the assumption behind the GIS zonation in Section 1 of Chapter 4, and is reflected in some conservation thinking, for example:

> *It is best to avoid 'mixing apples and oranges' and instead focus on getting the biological priorities right in the first step of the process. Other kinds of data can then be superimposed on the biological foundation using a Geographic Information System (GIS) and thus*

> *develop meaningful and scientifically-based conservation agendas.*
>
> (Mittermeir and Bowles 1993, cited in Pimbert and Pretty 1997)

Whilst a GIS approach may bring a certain level of analytical rigour to decision making, the uncritical use of the technology fails to provide a meaningful representation of the issues *"because of the selective participation of groups in data/information production"* (Harris *et al* 1995). As GIS increasingly becomes part of the conservation and development planning 'toolkit', there is a concern that centralised and top-down development planning will be reinforced at the expense of local knowledge and interests. The caveats of centralised planning are clearly shown by comparing the community priorities in Figure 7.2 of this chapter with the GIS planning exercise in Chapter 4 (Figures 4.2 and 4.3). The zonation map in Chapter 4 was intended facilitate 'community conservation', but used only biological criteria to prioritise the landscape categories.

GIS hardware, software, and data are expensive, require technical expertise and are often defined as 'expert' systems. These concerns formed the basis of a workshop in January 1998 in Durham, United Kingdom, which aimed to address the political context of systems analyses, such as GIS. A number of simple questions emerged: "Whose interests are considered in local policy? Who owns the information and decides what is important? What are the goals of local politicians, experts and bureaucrats?" (Abbot *et al* 1998). This discourse increasingly reflects the limitations of statements such as Mittermeir and Bowles's quoted above, for example:

> *A GIS reflects the mandate of the agency that operates it. Agencies have internal rules and value systems, as well as a stake in self-preservation. The extent to which GIS represents objectivity in terms of what data is used, or how it is classified, or how it is analysed, or the interpretations drawn from it, is clearly highly questionable. Value-neutral GIS simply do not exist.*
>
> (Harris *et al* 1995)

The use of GIS as a planning tool, and the practices that ensue, have particular significance in a context such as this, when land-use planning decisions are influenced by outside agencies, namely international environmental NGOs. As Ghimire and Pimbert (1997) point out, *"there exists no legal or political framework that would permit local populations to seek justice for social conflicts and misery caused by any international or national conservation organisations and environmentalists"*. Thus, the selective use of information, that is narrowly defined according to environmental protection criteria and which neglects social needs, can serve to meet external agendas in a way that is wholely unaccountable, yet is masked behind a shield of 'meaningful scientifically-based' techniques.

The use of GIS to represent local values goes some of the way in achieving the objectives of 'participatory GIS'. However, an important aspect of participatory decision making is ownership over the data and the analysis. In this context, local residents have been consulted, but have had little input into the types of information that were considered important to landuse planning. Thus, the data gathering techniques are extractive, and residents have no control over how the information is processed and subsequently used. This is largely because of the limitations of a research project, whose remit did not include a land-use planning and implementation process by local communities. Nevertheless, the process of consultation with local communities does provide the basis for a more "community integrated GIS" advocated by Harris *et al* (1995), which is perhaps a more achievable objective than 'participatory GIS'.

7.5.2 Conflicting landuse priorities in the hunting reserves

Acknowledging multiple perspectives on wildlife resources can have profound significance on the implementation of conservation policy. The maps shown in Figures 7.1 and 7.2 represent landuse priorities based on conservation and local social and economic priorities respectively. The similarity between the two maps shows that conservation priority areas are also most valued for their wildlife resources by local residents. The significance of the regression presented in Figure 7.3 quantifies this conflict over resources.

To date, wildlife conservation policies at Garamba have been implemented by the eviction of residents, followed by the enforcement of laws restricting access to the land, and the resources contained within in it. The approach, whereby *"it is thought necessary for the state to own land so as to direct development, and to protect it from destruction by local people"* (IIED 1994) is common throughout Africa and elsewhere. For example, Moorehead and Diakité (1991) document the eviction of over 3,000 residents from the agricultural land of the Bahr Azoum river system in Chad, in order to develop the Zakouma National Park. The forced eviction of pastoral communities in east Africa has also been extensively documented: in northern Tanzania at least 1,000 Maasai pastoralists and their livestock were evicted from the Serengeti plains in 1959 and moved to the Ngorongoro Conservation area, where their access to pasture was subsequently restricted further (Homewood and Rodgers 1991). Some early ethnographic texts, such as Turnbull's (1972) portrayal of the Ik of Northern Uganda have been used to illustrate the adverse social impacts of eviction from the area that is now Kidepo Valley National Park (Brechin *et al* 1991, Calhoun 1991). A long term study of the impacts of eviction on pastoralists around Mkomazi National Park, Tanzania indicated *"that the livelihoods followed are more vulnerable to misfortune, and generally more precarious than before* [eviction]" (Brockington 1998).

Thus, the social costs of eviction as a tool for wildlife conservation are self-evident and are increasingly seen as a cause for concern. However, Chapters 5 and 6 in this thesis provide indications of the biological outcomes of eviction: higher mammal species richness and abundance are associated with the area from which people have been evicted. This represents a dilemma whereby *"conservation and development seem to represent diametrically opposed aims, so that management will be at best a compromise and at worst a destructive conflict between the two"* (Homewood and Rodgers 1991).

One response to the dilemma has been to present protected areas as means of achieving sustainable development. It is said that one of the most important outcomes of the UNCED agreements is the universal acceptance of the concept of conservation *with* development. A development agenda is now included in almost all protected area policy documents as a matter of course. However, in practice protected area policies are founded on values which vary from site to site. Indeed, "*five years after the Earth Summit in Rio, it is not uncommon to hear Western-trained conservation biologists argue in favour of taking over large portions of the world to expand the network of protected areas*" (Ghimire and Pimbert 1997). Advocates of protectionist approaches to wildlife management are beginning to use the concepts of protected areas and sustainable development interchangeably. As a result, protected areas, in themselves, are presented as tools for development.

Contradictory statements coming from within the same organisation reflect an inability to reconcile conservation agendas with local development needs. For example, the World Wide Fund for Nature's position paper on Indigenous Peoples and Conservation (WWF 1996) states that "*WWF recognises that indigenous peoples have the rights to the lands, territories, and resources that they have traditionally owned or otherwise occupied or used*". This does not sit comfortably with the statements published by some of the same organisation's employees, for example:

> "*These forests represent largely intact and complex ecosystems, lightly touched by the hand of man. It is our responsibility to protect them for their own intrinsic value. We cannot do this by handing over our responsibilities to uninformed local communities who lack the scientific knowledge to manage these large and complex ecosystems*"
>
> (Gartlan 1997, WWF representative for Cameroon).

The analysis presented in this chapter reflects how established protected area management practices cannot easily be reconciled with goals that aim to promote the interests of local residents when eviction, or other practices that constrain human presence, are used. The assumption of the zonation presented in Chapter 4 was that 'community development' could be achieved by setting highest biodiversity value areas aside for conservation, and promoting community development elsewhere. By definition, this means restricting access in areas that are most valued for their wildlife resources, and focusing development interventions at a greater distance from the national park. Moorehead and Hammond (1992, cited in IIED 1994) discuss a similar approach to community conservation at Korup National Park, Cameroon, whereby the focus of development aid by the conservation agency was directed away from those residing in close proximity to the national park. Thus, those who lost the most from the presence of the national park, through loss of access to land and wild resources, benefited the least from the conservation agency's development intervention.

The use of development agendas to promote purely conservation goals is not new. Nzabandora (1984) describes the eviction of the residents in North Kivu, Congo earlier this century. Over 2,000 local fishing and agricultural households were moved from the Semliki Valley and Lake Edward region as part of a sleeping sickness eradication programme between 1928 and 1930. This programme was established under the District Commissioner Hackers, who was also *Conservateur Principal* (senior wildlife officer) of Albert National Park (now Virunga National Park). In 1935, Bloc XIII was established, which extended the boundaries of Albert National Park to cover the evacuated areas. The fact that the sleeping sickness epidemic was used to justify eviction meant that the former residents of the area could not claim compensation. A report in 1959 by the District Commissioner of North Kivu (Caprasse 1959, cited in Nzabandora 1984), stated that there were no cases of sleeping sickness in the area concerned between 1928 and 1930.

Whilst this is perhaps an extreme example of the abuses that are possible in the name of conservation and development, it highlights the dangers of mixing development discourse with what are essentially conservation objectives. Land-use planning as outlined in Chapter 4 has the potential to leave local residents further alienated from their resources, but without the option of compensation because the land-use policy was community development and implemented 'in their interest'.

Benefit sharing schemes have been implemented to compensate local residents (IIED 1994, Western 1994). Although these do alleviate some of the social costs of eviction, as a process of community development, they have proved less than satisfactory. For example, Bell (1987) suggests that the weakness of the Windfall community conservation programme in Zimbabwe was the failure to involve local level recipients in management decisions. The relationship with local residents as passive recipients of funds suggested that they were considered "*a nuisance that is being bribed to keep quiet*" (Bell 1987). This has not provided a sound basis for community based wildlife management.

The inadequacy of benefit-sharing schemes explains why it is increasingly recognised that effective biodiversity conservation must begin with an understanding of existing local wildlife utilisation and management practices. Section II in Chapter 4 showed that local level wildlife management practices are well established around Garamba, and involve large numbers of local groups. Furthermore, the analysis of animal distribution and abundance in Chapters 5 and 6 indicates that it is the regulation of offtake that influences animal abundance, and not necessarily the eviction of local residents: the presence of agricultural populations was not correlated with a decrease in animal species richness or abundance. Thus, the solution to the apparent incompatibility between conservation and community objectives may lie in the active management of wildlife resources by local residents. The remainder of this thesis explores the potential for local conservation management, based on current wildlife utilisation practices.

7.6 Conclusions

The use of GIS and geo-statistical techniques made it possible systematically to compare areas that were important in terms of their conservation value with areas that were important in terms of their use value. The results showed that areas that were important to conservation were consistently those areas that were important to local residents. Consequently, setting areas aside as 'conservation priority areas' would bring significant costs to the local economy. At Garamba, the assumption of 'conservation *with* development' cannot be made without a better understanding of the trade-offs between conservation and economic development.

This Chapter discussed the difficulties of meeting what are perhaps mutually exclusive conservation and development objectives. The analysis of animal distribution and abundance presented in the two preceding chapters showed that the restriction of the human use of wildlife tended to be associated with increased species richness and abundance. However, in the past this has been associated with the eviction of local residents from parts of the protected area and the enforcement of coercive measures for law enforcement. The remainder of this thesis will explore local systems of wildlife utilisation and management as an option for meeting conservation and development objectives.

Chapter 8

Wealth and Wild Foods

8.1 Summary

The previous chapter emphasised the difficulties in reconciling centralised wildlife protection with local resource use priorities, and concluded by emphasising the need to consider community level wildlife management as an alternative. Thus the present chapter develops this theme by addressing two issues.

First, it explores who are the primary beneficiaries of wild foods. Wild foods are frequently cited as important to rural food security, particularly for the more vulnerable households (Chambers and Leach 1986, Hunter *et al* 1990, McGregor 1995). Indeed, increased reliance on wild foods is sometimes used as an indicator of impending famine, during which time poorer households use wild foods as an important survival strategy (Vaughan 1987, de Waal 1988). The benefits of wild foods to the poorer and more vulnerable sectors of a community are often used as an important justification for community level wildlife management (Pimbert and Pretty 1995). However, recent work has questioned the notion that poorer households benefit more from wild foods (Wickramasinghe *et al* 1996, Chenevix-Trench 1997). An understanding of the benefits of extractive wildlife utilisation requires a clear assessment of the beneficiaries of this system of wildlife management.

Second, the study examines the relationship between wealth and people's entitlements to wild foods. This emphasises people's modes of procurement of wild foods and helps to build a better understanding of the relationship between human resource use, harvesting practices and the sustainable management of natural resources.

8.2 Introduction

Chapters 5 and 6 used ecological approaches to understand the effects of wildlife management on animal populations. Distinct patterns of variation were identified in the abundance of mammals in the Garamba protected area. Wildlife abundance appears to be significantly influenced by the application of wildlife regulations to specific parts of the protected area. Areas where the conservation laws have been actively enforced contain relatively high levels of mammal abundance. Paradoxically, areas with higher levels of human settlement do not always show correspondingly low levels of mammal abundance. This is surprising in view of the higher demand for wild meat that could be expected in these areas, and justifies a closer examination of wildlife utilisation and the processes that underlie the consumption of wild foods. Thus, this chapter examines patterns of wild food consumption by households in a village community at Kiliwa, in the Azande Hunting Reserve to the west of Garamba National Park.

Wealth is used to understand the processes that determine wild food consumption. Wealth differences provide one of the most important characteristics that differentiate people within a community (Chambers 1997). Furthermore, wealth is often strongly correlated with other community level inequalities, such as race and origin, that explain much about household well-being. Wealth is determined by access to, or control over, economic resources. Thus, defining wealth is central to understanding the dynamics of natural resource use within a community because it is the single most important determinant of producer behaviour. Wealth determines factors, such as access to the capital inputs to exploit wild resources (e.g. shotguns, nets etc.), and the resources to market their products (e.g. bicycles). The rich to poor continuum provides a basis on which to understand the incentive for exploiting wild resources: as wealth increases, so does the opportunity cost of extracting wild foods, and the incentive for richer households to exploit wild resources can decrease (Bailey and Headland 1991). However, this can be offset by new technologies for extracting and marketing wild foods. These may substantially increase the productivity of labour and increase the incentive for wealthier households to exploit wild resources (Hames and Vickers 1983). Furthermore, greater wealth can increase a household's access to wild foods at the marketplace (Robinson and Redford 1991).

Patterns of resource use that correspond to wealth status are useful in understanding the processes by which human communities impact on wildlife populations. It is important to examine these processes to understand the relationship between wildlife utilisation, conservation and economic development in the reserves. Natural resource economists (e.g.Vincent and Binkley 1991) present the use of wild resources as passing through a series of defined stages. When traditional communities are exposed to wider markets, their resource use patterns expand and then stabilise. In the context of a growing local and national economy, resource use declines, because of the growth of alternative income generating activities. Associated with this, however, is an increasing specialisation amongst small groups exploiting selected natural resources. Increasing income and a decreasing availability of those wild resources gives rise to a process of substitution of wild foods by industrial and farmed products. Finally, in a more developed industrial society, wild resources provide relatively little in terms of food resources. Their primary value is recreational and in providing environmental services.

The initial stages of the above process predict increased resource specialisation and reduced relative incomes from wild resources amongst wealthier households. A study by Godoy *et al* (1995) has tested for these changes in foraging behaviour associated with a growing cash economy in a central American rural population. Rapid appraisal methods were used to record monetary and non-monetary income together with wage levels and to evaluate foraging behaviour. Some of their conclusions contrast with the above predictions in that high income families do not develop more specialised foraging behaviour. This suggests, in these communities, wealthier households do not become specialised in the exploitation of wild resources as an income generating activity. Other studies, such as Wickramasinghe *et al* (1996) and Chenevix-Trench (1997) also suggest that the level of wild resource use does not increase with wealth. Understanding the relationship between wealth and consumption of wild foods in the context of a growing economy has important implications for the sustainability of wild resources, because of the corresponding increase in household wealth during periods of economic growth.

This chapter contributes to this debate by examining food consumption patterns associated with wealth status in a Zande subsistence agricultural community. The research seeks to address the question: do wealthier households use more wild resources? This question is important in understanding the relationship between conservation and development. Micro economic theories suggest that if development is initially driven by wild resource use, the opportunity cost of foraging and hunting will increase as, inevitably, new income generating activities develop (Vincent and Binkley 1991). This corresponds to the resource use patterns described by resource economists, and provides a self regulating mechanism for natural resource use. Conversely, if wild resource use increases with income, as a result of access to more efficient technology (Ayres *et al* 1991), or through greater access to meat purchased at the market (Asibey 1986), then the consumption of wild foods will increase in a growing economy. This shows that it is important to examine the broader concept of a household's entitlements to wild foods in order to understand the dynamics of resource use, and their implications for the sustainable use of natural resources. Household entitlement is a term that encompasses the diverse strategies used by a household to gain access to resources (Young 1992). In this study, these are classified as hunting or foraging, purchasing foods, or obtaining them as a gift from another household.

Godoy and Bawa (1993) review 24 studies of the economics of wild resources in the tropics and identify four main problems: "incompatibility of results, a tendency to examine flora (mainly) or fauna but not both, a lack of attention to sustainability, and a disproportionate attention to Latin America". This chapter attempts to address all four of these problems by studying the use of wild foods in a Zande community. First, a quantitative approach is used that ensures replicability of results, making the findings directly comparable to other quantitative studies. Second, a disaggregated approach to the collection of wild food data is made, so that wild animal and wild plants can both be examined and compared. Third, the relevance of these findings to the sustainable use of wild resources are discussed. This forms the basis of subsequent chapters which address the question of sustainability more directly. Finally, the findings from this Central African community are presents in relation to similar studies from other regions.

8.3 Research Hypotheses

These research hypotheses are chosen to examine the importance of local resource use to local development, as shown in Figure 1.1.

8.3.1 Household consumption of wild foods is determined by wealth

The study will test the hypothesis that the consumption of wild foods is particularly important to poor households.

8.3.2 A household's modes of procurement of wild foods differs according to wealth

This hypothesis examines how wild food consumption varies on the poor to rich continuum according to how wild foods are obtained. This makes it possible to discuss the conservation implications of natural resource use in the context of economic growth.

8.4 Methods

8.4.1 Sample preparation and household selection

A preliminary, informal survey of the community was undertaken. This was preceded by a meeting with the village authorities to solicit their permission to undertake the study. A formal introduction at a village gathering during the weekly market was made, whereby the objectives of the study were outlined to the community. They were asked to make a collective decision on whether to accept the study in their community. A general sense of the social and spatial organisation of the village was developed over a period of ten days with the help of two village informants (a teacher and assistant health worker). All of the footpaths extending from the road were covered. Households were visited and informal discussions were held to gain a better impression of their attitudes towards the study and the presence of a outside researcher in the community.

A pilot study was undertaken to assess the feasibility of the household survey techniques using a systematic sample of 32 households. This sample also provided the data for estimating the optimal sample size for household monitoring (Box 8.1). During this study, the household is defined in terms of a resident kinship group that carries out domestic functions (Bender 1967).

Box 8.1 Estimating an optimal sample size for household monitoring from pilot study data.

An optimal sample size was calculated using an estimate (E) of the acceptable level of accuracy in weekly expenditure based on the variance in the pilot study recall data (a sample of 32 weekly expenditure records were counted in the pilot study). Weekly expenditure is used as a correlate of economic status. The acceptable level of error for parameter estimation was determined as follows (Barnett 1991):

$$\text{Sample size:} \quad n = \left[\frac{\sigma(z\alpha/2)}{E} \right]^2$$

Where σ is the standard deviation of household income, $z_{a/2}$ is the z-score to ensure 95 percent confidence either side of the mean and E is the acceptable margin of error (20 percent of the mean weekly expenditure was used).

Table 8.1. Parameters used to estimate household survey sample size

σ	E	n
2.2	0.2	138

The final sample size was determined on the basis of the variance in the results of the pilot study (Table 8.1), and feasibility (taking into consideration the constraints on time and resources). A final reduced sample of 128 households was used. In the absence of a sampling frame, households were selected for the survey using a systematic random sampling scheme. Households were selected along the footpaths at intervals of five households, to produce a sampling intensity of about 20%.

8.4.2 Food consumption

A 24 hour recall technique was used to collect data on household dietary intake and on household budgets. Data were collected with the help of two locally recruited research assistants. Both were trained in household monitoring techniques over a three month pilot study period. Detailed descriptions were made of all foods and beverages consumed, together with the mode of procurement. All items purchased or sold by any member of the household were recorded in the same way. Quantities of foods were made in local household measures (the same measures which are used in the market).

The research schedule involved visiting each household on a daily basis for one week. This made it possible to avoid biases resulting from the daily variation in consumption associated with the day of the week (market days were associated with higher food consumption and expenditure). Questions were addressed to the member of the household who had prepared the food. When this member was not present, the researcher would return later in the day, or the following day. Recordings that could not be made within 48 hours of consumption were omitted. Food items were converted to their economic value based on market prices over the period of study.

8.4.3 Wealth status

Wealth differences can be identified by assessing the level of income. However, the definition of wealth status is not consistent across communities where the nature of economic resources, and patterns of access to them, vary considerably (Grandin 1988). Chambers (1983) stresses that wealth should not be defined as merely an economic attribute. Rather, it is the combined effect of important social, political and economic correlates, including such factors as patronage and authority as well as access to wider resources such as education and other services. Therefore, two techniques were used to collect data on wealth status and establish a broader assessment of wealth.

a. Participatory wealth ranking

This technique is used as a non-intrusive approach to estimating relative wealth (Grandin 1988). In using participatory methods, it is argued that many of the complex social definitions of wealth are more accurately assessed (Guijt 1992). The approach adopted was a modification of the standard participatory approach to wealth ranking developed by Grandin (1988) and used by PRA practitioners (e.g. Sarch 1992, Schaefer 1992). In the approach used in the present study, a greater emphasis was placed on the information provided by key informants, rather than by the households themselves. This emphasis reflects the difficulties in using participatory methods in scientific research, where excessive demands for information from members of a community cannot be justified in the context of a research project where no immediate tangible benefits can be provided to the community. Four key informants were used in this study and included a teacher, an assistant health worker and two agriculturalists.

The pilot sample of 32 households was used to obtain locally defined wealth categories. Each household was visited, and the head of household's name was marked on a card. Whilst moving between households, the group discussed the wealth characteristics of the previous household, and ranked the households in relation to the households previously visited. The justification for the ranking of each household was recorded. When the 32 households were completed, each informant was consulted individually. Each was asked to place the cards into groups of similar wealth status, and to discuss the characteristics of each group. Following this, all informants met and the groupings were discussed. Attention was drawn to the differences between the results of each informant, and this was discussed until a consensus was reached. Finally a list of attributes characterising each of the four wealth ranks was compiled (Appendix 3). This list was used to characterise the wealth rank of all subsequent households included in this study.

b. Measuring indicators of wealth.

A survey was carried out to quantify wealth related characteristics that had been highlighted in the participatory wealth ranking exercise. The characteristic that was stated as being most important in characterising wealth was agricultural production. The size of exploited agricultural land was used as an indicator of the level of agricultural production. Field sizes were measured using a survey wheel and a magnetic compass. 378 fields were measured for 110 households (the full sample of 128 households was not measured because of the untimely end to the field work, as described in Section 3.6). These field measurements were plotted on to 2 millimetre graph paper and the fields were drawn at a scale of 1:1000. The resulting co-ordinates were entered into a geographic information system (Arc/Info) and field areas were calculated.

From the participatory wealth ranking, other important indicators of wealth included household assets, disposable income and the quality of the food that was consumed. Household assets were recorded using a formal questionnaire survey of visible signs of wealth (bicycles, radios etc.), and resource use (nets and shotguns) (Oppenheim 1992).

Finally, the participatory wealth ranking indicated that household budgets were an important component of wealth. These were calculated from the 24 hour budget recall data. This included total monetary income to the household from all of its members (this was converted to US dollars based on the weekly exchange rate provided by the Catholic Mission in Dungu). However, non-monetary income is said to provide a more accurate estimate of household income than household expenditure (Deaton 1988, Godoy *et al.* 1995). Data on non-monetary income were based on the market value of goods produced or foraged by the household, supplied in exchange for labour (there are few opportunities for financial earnings from wage labour in this community), or provided as a gift by other households.

8.4.4 *Standardising households*

Households differ in a number of factors that have to be controlled for to compare their wealth status and consumption patterns. These include demographic characteristics such as age, sex and kin relations. Every 24 hour recall interview was preceded by questions aimed at establishing the household composition for the previous day. Members of the household were characterised in terms of kin relations and aged, using dates of births or an historical event calendar if dates of birth were unknown (*cf.* Biran 1997).

8.5 Appraisal of methods

8.5.1 *Food consumption*

Sources of error in 24 hour recall data can be considerable, and have been extensively documented (Fleuret 1979, Bingham 1987, Aunger 1993). Recall error and deliberate under or over-estimations are recognised as important sources of error wherever food consumption surveys are undertaken. These problems may be compounded in anthropological research in developing countries when communication between the members of a community and a researcher is difficult initially, and the objectives of the study can easily be misinterpreted.

Patterns of variance provide a useful indication of the nature of error that can be found in household monitoring data. There are a number of sources of variance. Some of these have to be analysed in detail, because they are of primary interest to this study (for example, variance that is caused by differences in household wealth), others are not of direct interest, but have to be controlled for to avoid confounding effects with the main explanatory variables. The sources of variance can be classified as follows:

a. *Intrinsic factors*

These can broadly be defined as variation in resource use variables that are caused by the characteristics of the household. It is hypothesised that the most important of these is wealth, however, other sources of variation might arise from other household characteristics such as average age or the sex ratio of the household. Assessing the variation that can be explained by household wealth is the primary purpose of this study, and it is therefore important to assess its magnitude.

b. *Extrinsic factors*

These are factors that affect all households equally, and include sources of variation such as seasonality and the effect of the day of the week. The study included all days of the week and both the late dry season (often referred to as the hungry season), when there is an increased dependence on wild foods, and the wet season, when agricultural products are relied on to a greater extent.

c. *Error*

Some of the variance in the data is likely to be caused by inaccuracies in the data. This is caused either by inaccuracies in data collection, or in sampling error. There are two primary sources of error in the data collection. Firstly, incorrect information may be provided by the subject. Initial contact with members of a household was sometimes associated with a certain amount of suspicion with regard to the perceived motives for the study. This could lead to under-reporting of dietary intake, and the avoidance of reporting certain food items. Furthermore, initial misunderstandings on the part of the subjects about the precise nature of the information required could also constitute a source of error. Informal conversations held with members of the households suggested that the types of incorrect information provided by the subjects diminished as the study progressed. An analysis of temporal variation in the sequence of data collection is likely to reflect the level of this error. Secondly, there may be mis-reporting on the part of the researcher. The response of subjects to the enquiries is considerably influenced by the researcher's behaviour. Important effects would be reflected by a difference in the results from each of the two researchers. An analysis of the variation between the researchers is likely to reflect the systematic differences in the collection of data between the two researchers.

d. Unaccounted sources of variation

This includes all the sources of variation that cannot be attributed to explanatory variables that have been quantified. Crawley (1993) recommends that statistical analysis with high levels of unaccounted variation should be treated with considerable caution. He refers to this as overdispersion, which contributes to the inadequacy of a statistical model.

The household data was collected in a format that provided information on the nature and magnitude of specific sources of variance in the household dietary intake data with reference to the market value of all food items consumed. A survey design was adopted that allowed the measurement of these sources of variation, whilst avoiding artefactual bias (caused by the over or under-representation of certain factors as a result of the structure used to collect the data, Beaton *et al* 1979). The sample of 128 households was divided into sixteen blocks of eight households. Two blocks were interviewed repeatedly each week, so that the complete sample could be monitored twice over a four month period. Thus, each subject was monitored fourteen times, seven times by each of the two researchers, seven times in each season and twice on each day of the week (Table 8.2) (Saturday's data was not collected on the Sunday because of market day, when a large proportions of household members were absent from their homes - these data were collected on the Monday).

Table 8.2. Research design undertaken to assess the sources of variance in resource use data.

		Sun	Mon	Tue	Wed	Thu	Fri	Sat
Dry	Researcher 1	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.
	Researcher 2	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15
Wet	Researcher 1	Blocks 2, 4, 6, 8, 10, 12. 14, 16.	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15
	Researcher 2	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.	Blocks 1, 3, 5, 7, 9, 11, 15	Blocks 2, 4, 6, 8, 10, 12, 14, 16.

Although this provides a very robust structure for analysing data, in practice, it was impossible to follow the pattern precisely because of the occasional absence of subjects from their homes. As a result, of the 1792 consumption days that should have been surveyed, 1334 were actually surveyed and of these 1245, met the specifications of the design in Table 8.2. The resulting sample is sufficiently large to avoid artefactual bias. This design is similar to a study by Beaton *et al* (1979) who use a similar technique to understand the sources of variance in 24 hour recall data using a sample size of 360 interviews. Their smaller sample was found to be large enough to compensate for artefactual bias.

The sources of variance in the consumption data were analysed as follows: the treatment deviance of each of the factors was divided by the total deviance of all samples. This provides an indication of the variation (the coefficient of variation, Crawley 1993) caused by each of the following sources of error: intrinsic factors (inter-household and wealth), extrinsic factors (day of the week and seasonality), error (research assistants and sequence) and unaccounted variation (residual deviance). F-ratios are used to assess the significance of the variation caused by the sources of error in the data. The results of this analysis are shown in Table 8.3.

Table 8.3. Sources of variation in the resource use data (economic value of consumed products) (n = 1245).

Sources of variation	R^2	F-ratio	P
Inter household	26.92%	3.53	< 0.05
Participatory wealth rank	2.26%	5.67	< 0.05
Day of the week	0.2%	0.63	NS
Season	0.09%	1.26	NS
Research assistants	0.03%	0.44	NS
Sequence	0.3%	2.98	NS
Residual deviance	72.45%	-	-

The results show that, although much of the variation remains unaccounted for, the variation that can be attributed to differences between the two research assistants is insignificant. Nor is there a significant change in the data as the study progressed. This is probably due to the fact that the survey was begun after the researcher had been in the community for several months, and following a pilot study, when members of the community became more familiar with, and less suspicious of the research.

Thus, the sources of error that can be described by the variance in the data are not significant.

However, these two sources of variation only provide an indication of the level or error that results from the researcher's behaviour, or that can be attributed to the early stages of the research. As discussed above, other important problems include recall error and under-reporting as result of a maintained level of suspicion on the part of the informant. Only a qualitative assessment can be made on these more general forms of survey error. Based on extensive discussions with key informants and with the members of the households themselves, it is felt that, with a few exceptions (one of whom asked to be withdrawn from the survey), members of the community were happy to be interviewed. A useful indication was that all households were prepared to discuss potentially difficult topics, such as bushmeat.

Recall error is often referred to as the main problem in 24-hour diet recall. It is certainly true that 24-hour recall data cannot provide the level of precision needed for studies on nutritional requirements that require precise weights for food items (Dangour 1996). However, this study does not require the levels of precision needed for a nutritional assessment. Rather, the study makes an assessment of the relative economic value of household consumption. For this purpose, 24-hour recall methods seem appropriate.

Extrinsic factors (seasonal and daily differences in resource use) do not appear to play an important role in explaining variations in the value of food consumed. However, intrinsic factors, the variance caused by differences between households, are sufficient to justify further analysis, although the participatory wealth ranking differences explain only a small proportion of the variation. There are two possible reasons for this: either participatory wealth ranking does not provide a good description of wealth, and therefore does not sufficiently explain the variation that is defined by true wealth status in the community, or, simply, wealth status does not explain inter-household variations in the value of food consumption. This may be the case in a community such as this, where diets are relatively homogenous and increased wealth does not necessarily imply increased expenditure on food. Although wealth does not explain much of the variation in the value of consumption as a whole, this may not be the case of particular subsets of the diet, such as wild foods. The extent to which participatory wealth ranking is an appropriate measure of wealth status in the community is discussed below. The importance of wealth in explaining consumption is the main question of this chapter and is analysed and presented in the research results.

8.5.2 Wealth status

As a multi disciplinary study, this research adopts both a formal, quantitative approach and a participatory approach, that draws on the experiences of community members, to make an assessment of relative household wealth. This section discusses the merits of each approach.

Participatory wealth ranking has sparked considerable recent interest as an appropriate tool for understanding wealth and for classifying households using criteria that are defined at the community level. Participatory wealth ranking enables community members to explore their own perceptions of wealth, thereby providing the researcher with an understanding of the rich to poor continuum that is locally relevant, and not merely based on monetary income (Mukherjee 1992). The prolonged discussions that ensued (both as part of the exercise and for several months afterwards) provided this study with valuable information about the structure of the community. It provided the qualitative context from which the quantitative survey was formulated and enabled the selection of quantitative indicators of wealth to be critically assessed.

The current enthusiasm for experience based research techniques has not been subject to extensive scientific scrutiny. This is partly because the philosophy that underlies participatory learning techniques is considered incompatible with a structured, quantitative approach to social research. There are many well documented justifications for using an approach to understanding communities that is not structured according to conventional systematic research design (see Scoones *et al*

1992, Chambers 1997). These approaches stress that validity and reliability in the results is best ensured by understanding the experiences of community members. However there are also potential problems that may bring into question the reliability of the results. The analysis that follows discusses the limitations in using participatory techniques in a scientific study. It does not discuss, or question, the considerable advantages to using participatory approaches to field work for local consultation and as part of a process of community empowerment.

There are potential problems with using participatory approaches (see for example, PLA Notes special issues on "Wealth Ranking", no. 15, and "Critical Reflections from Practice" no. 24), some of which include:

a. *Replication*

The assessment of wealth is specific to the community that has been studied. It is difficult to determine the extent to which the understanding of wealth in one community can be extended to other communities. Repeating the exercise in another community does not produce an inter-community comparison.

b. *Representation*

The exercise is carried out by a limited number of informants. There is no estimation of the degree to which the opinions of the informants are representative of those of the community as a whole. Nor is there usually any assessment of the contribution each individual informant makes to the results, potentially leading to biased findings. All too often, the individuals making up such groups are drawn from a small subset of powerful interest groups (Guijt and Shah 1998).

c. *Methodological complementarity*

This is best expressed by Chambers' term 'optimal ignorance' (1997), where emphasis is placed on accuracy rather than precision. Chambers correctly asserts that it is better to be approximately right than precisely wrong. However, the inability to compare levels of precision can make it difficult to use multi-disciplinary approaches effectively (Guijt and Cornwall 1995). Lindblade (1995) cautions against the use of participatory methods without triangulation with other methods. She supports her argument by suggesting that local realities can be shaped external interests: from her study in Uganda, she found that British colonial officers had stressed the effects of overpopulation on land degradation as part of an "*intense campaign of education and propaganda*". These pervasive views were reflected in people's accounts and reflect "*what they think we want to hear*" (Lindblade 1995). This tendency may be reflected in the suggestion by an elderly woman in Kiliwa that perhaps a return to cotton production would improve village prosperity. Whilst this may have been music to the ears of Belgian colonial extension officers, it almost certainly would not be reflected in a quantitative analysis of people's wealth during the cotton producing period in the 1920s and 1930s (Likaka 1995).

The above problems do not, by any means, represent a fatal flaw in the participatory learning approach. Indeed, good PRA practitioners are aware of them, but may only consider them to be of secondary importance. However, there is little evidence in the participatory learning literature of work that has assessed the extent of error caused by factors such as informer bias, or the use of households that do not represent the full range of diversity that exists in the community.

As a multi-disciplinary and collaborative study, participatory learning techniques were used together with quantitative survey data. Therefore, to enhance compatibility, it is important to assess the level of error in the participatory wealth ranking results using criteria similar to those used to assess formal quantitative data. Statistical techniques are most often used to determine the extent to which a sample is representative of the population from which it was selected. Participatory appraisal usually uses a sample to make a general statement about a community, but there is rarely any recognition that the results refer to the sample, and not to the whole community (e.g. Steinich 1996). When formal social surveys are undertaken, statistical tests give an estimate of the extent to which the sample is representative of the community, but certain strict assumptions have to be met. The most important of these is that each household has an equal probability of being included in the sample and thus households are randomly selected. However during a participatory survey, the members of the community decide on the households to be assessed. It cannot be assumed that these have been randomly selected.

The analyses presented in Boxes 8.2 and 8.3 estimate the degree of confidence that can be placed in the participatory results. First, the consistency between the information provided by each of the informants and the final result of the pilot sample is analysed, and second the participatory wealth ranking is compared to the quantitative survey data.

Box 8.2

Estimating the influence of individual informants on participatory wealth ranking results

Each of the four informants classified the households into ranks. From this a final classification was compiled, based on a 'consensus' between the four informants. It is useful to determine whether the final wealth ranking classification is based on a true consensus, or whether one informant is influencing the results more than the others. The number of each informant's wealth rank values that correspond to those in the final wealth rank are displayed in Figure 8.1. This suggests that the third informant has influenced the final result to a greater extent than the other three. This is confirmed by the binomial test in Table 8.4 which shows that informant 3 has a significantly higher proportion of results corresponding to those in the final wealth rank than the other three informants. This particular informant was more assertive than the others, and certainly expressed himself more during the discussions. Assertiveness does not necessarily represent accuracy, and this can be interpreted as a potential source of bias in the results.

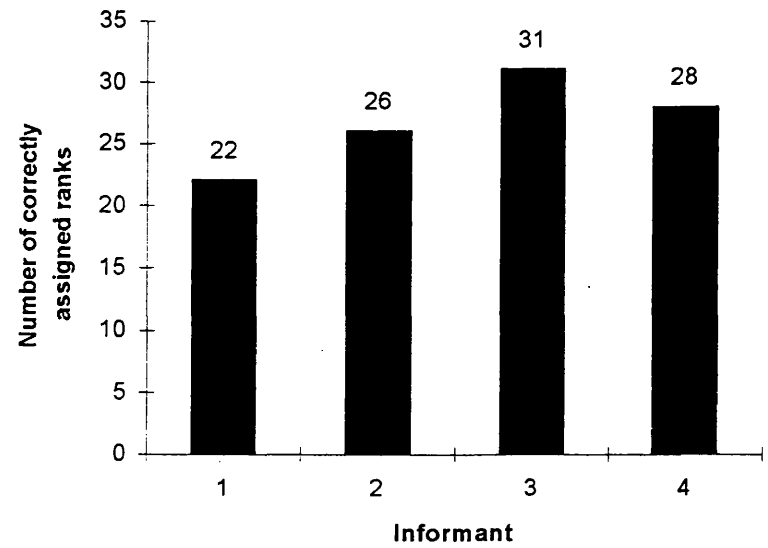


Figure 8.1. Proportion of each informant's household wealth rank values that correspond to those in the final wealth rank

Table 8.4. One-way anova, using binomial errors, to show the difference between informer 3 and the other informers.

N	X^2	*Change in DF*	*P*
128	7.11	1	< 0.01

Box 8.2 (Continued)

The number of incorrectly classified households for each wealth ranks is also an indication of error in the participatory wealth ranking exercise. The proportion of households that were inconsistent with the final classification was calculated for each wealth rank and is shown in Table 8.5.

Table 8.5. Number of rankings made by informants that were inconsistent with the final household wealth ranking (n = 4(32)).

Wealth Rank*	Inconsistent rankings	N
1	1	28
2	6	32
3	14	44
4	0	24

*** 1 is poorest, 4 wealthiest.**

These results show that there is greater inconsistency in the two middle wealth ranks. A generalised linear model fitted to this proportion data using binomial errors shows that the middle ranking proportion of the community is more likely to be mis-classified (Table 8.6). These findings are similar to Grandin's (1988) findings, suggesting that informants agree more on their definitions of the poorer and wealthier households, but find it difficult to differentiate middle ranking households.

Table 8.6. One way anova, using binomial errors, to show the difference in the proportion of inconsistent rankings between ranks 1 and 4 and ranks 2 and 3.

N	X^2	*DF*	*P*
128	7.11	1	< 0.001

Box 8.3

Comparing participatory data with systematic survey results

a. Statistical tests can be used to test the level of agreement between the participatory wealth ranking and the factors that were stated as being the primary indicators of wealth. Spearman's rank correlations were used to quantify the level of association between the wealth ranks and each of the wealth related variables (Table 8.7).

Table 8.7. Spearman's rank correlations to assess the level of association between participatory wealth rank against indicators of wealth (standardised using adult male equivalents (AME) and dependency ratios(DR))

a. Household expenditure against wealth rank (n = 121)

	Standardised (AME)	Standardised (DR)
Coefficient	0.5894	0.5744
Significance	< 0.001	< 0.001

b. Non-monetary expenditure against wealth rank (n = 121)

	Standardised (AME)	Standardised (DR)
Coefficient	0.1020	0.1146
Significance	0.252	0.198

c. Field size against wealth rank (n = 110)

	Standardised (AME)	Standardised (DR)
Coefficient	0.3542	0.3855
Significance	< 0.001	< 0.001

These tests indicate that the value of consumed foods (non-monetary income) does not correlate well with the participatory wealth rank data. The other two indicators of wealth, household expenditure and field size, are highly correlated with the participatory wealth ranking data.

b. Community members who undertake a participatory wealth ranking exercise take into account a large number of wealth related factors, and assess them collectively to produce an overall assessment of relative household wealth. It could be argued, therefore, that it is not appropriate to compare this overall assessment to the individual quantified wealth indicators. Therefore a technique has to be used that compares the wealth ranking data to the combined effect of all the wealth indices. Cluster analysis can be used to derive homogenous groups of households from all of the wealth indices. This simple technique produces clusters of households based on their standardised proximity (values are converted to z-scores) when they are plotted on multi-dimensional axes. When the groups are ranked, they represent the combined effect of the wealth indices, and as such, can be compared directly to the participatory wealth ranking data. The error matrix in Table 8.6 shows the extent to which the wealth ranking and the cluster analysis based on quantified wealth indices are correlated.

Box 8.3 (continued)

Table 8.8. Error matrix and Spearman's rank correlation comparing participatory wealth ranking and cluster analysis on four wealth indices, based on results from 110 households.

		Wealth Rank*				
		1	2	3	4	Total
Ranked clusters	1	15	14	0	0	29
	2	18	11	10	5	44
	3	8	12	7	4	31
	4	3	0	2	1	6
	Total	44	37	19	10	

*** 1 is poorest, 4 wealthiest.**

Coefficient	0.2599
Significance	0.007

The correlation between the wealth rank data and the ranked clusters is highly significant ($p<0.01$). This suggests that the two measures are, to some extent, interchangeable.

Participatory techniques provide a more efficient means of producing data on relative wealth in a community than formal quantitative techniques. Whereas the participatory wealth ranking could be completed in a period of about one week, the household surveys that produce the wealth indices required over five months of fieldwork. Yet, as the results from both approaches appear to correspond (see Box 8.3), the participatory techniques provide a much more efficient means of obtaining the same results. However, this argument in favour of participatory techniques should be qualified because the participatory wealth ranking criteria were produced after the researcher had stayed for several months in the community. It is unlikely that the same level of accuracy could be achieved on the basis of one week's visit by an external researcher (see McGee 1997).

Furthermore, participatory wealth ranking data alone did not explain very much of the variation in food consumption (only 2.26%, Table 8.3). It is possible that certain aspects of wealth, such as field size or income, explain variations in food consumption more effectively when analysed in isolation. Yet, the concept of wealth, as defined by community members, encompasses many factors, only some of which may be relevant in explaining resource use. Participatory wealth ranking data do not provide the means to disaggregate wealth into these various components so that they can be examined in isolation.

Participatory wealth ranking has been shown to have limitations in the context of a study on resource use by a community. It is difficult to address the question of bias in participatory data unless very careful note is taken of how the data were collected (which households were selected, and how) and analysed (who produced the results, and to what extent were they based on stated criteria). This study has examined these sources of bias, but in doing so, may have detracted from the truly participatory nature of a community assessment.

This appraisal of methods has shown that both quantitative survey data and participatory techniques have important limitations in a study such as this. However, using participatory techniques in conjunction with formalised quantitative surveys has the combined effect of focusing the research on wealth related issues that are locally relevant, whilst collecting data that make it possible to use a rigorous and quantitative approach to understanding resource use.

8.6 Results

This section analyses the relationships between wealth and natural resource use by exploring patterns of association between the measured household consumption of wild foods and the measures of wealth described above. The market value of foods is used as an estimate of their importance. This provides an effective measure of value that is consistent for all food types.

Two approaches are used. The first examines the total consumption of wild foods by households. The second examines the consumption of wild foods as a proportion of total household food consumption. The distinction is made because absolute values are a reflection of a household's consumption of wild foods, whilst proportions provide a better reflection of the importance of wild foods to the household.

Together, these two approaches provide the basis for testing the hypotheses outlined above.

Wild foods are classified as bushmeat, wild plants and fish. Consideration is also given to the way that wild foods are obtained. This recognises that a household's access to wild foods, through foraging or hunting, may differ substantially from its ability to access wild products at the market. Furthermore, inter-household relationships, expressed through the donation of wild food products as gifts, are an important consideration in understanding access to wild resources. Thus, the procurement of wild foods is classified into three modes: foraging, purchasing and received as a gift.

8.6.1 The effects of wealth on the quantities of wild foods consumed

Figure 8.2 shows the differences in the value of consumed wild foods for each wealth rank. The differences between wealth ranks are analysed in GLIM4, using a one-way anova model (see Box 3.1). Straightforward linear analysis of variance models could not be used on these data because they might lead to negative values in predicting the expenditure on wild foods. Furthermore, the response data are highly skewed towards the lower values because of the high frequency of zero values. As a result, the error variance is not constant, and some of the assumptions of the generalised linear model cannot be met (equal variance and normal distribution errors). These problems are solved by using Poisson errors and a log link function: using a log link function ensures that the predicted values are always positive, and the Poisson error structure ensures constant error variance by making the variance equal to the mean (Crawley 1993).

Figure 8.2 suggests the following patterns: the value of consumed bushmeat appears to peak in the middle ranks, whilst the value of wild plants decreases and the value of fish increases with increasing wealth rank. However, the analysis of variance in Table 8.7a. suggests that it is only bushmeat that has a significant difference according to wealth rank. This was found only after a Box-Cox transformation was applied to the model to find a better fit than was achieved using the log transformation (producing an exponent of -0.21) (Crawley 1993). The t-tests suggest that the significant difference lies between wealth rank 1 and 2, suggesting that the poorest households consume less bushmeat than the middle ranking and wealthy households. There is no significant difference between the middle ranking and wealthiest households in terms of bushmeat consumption.

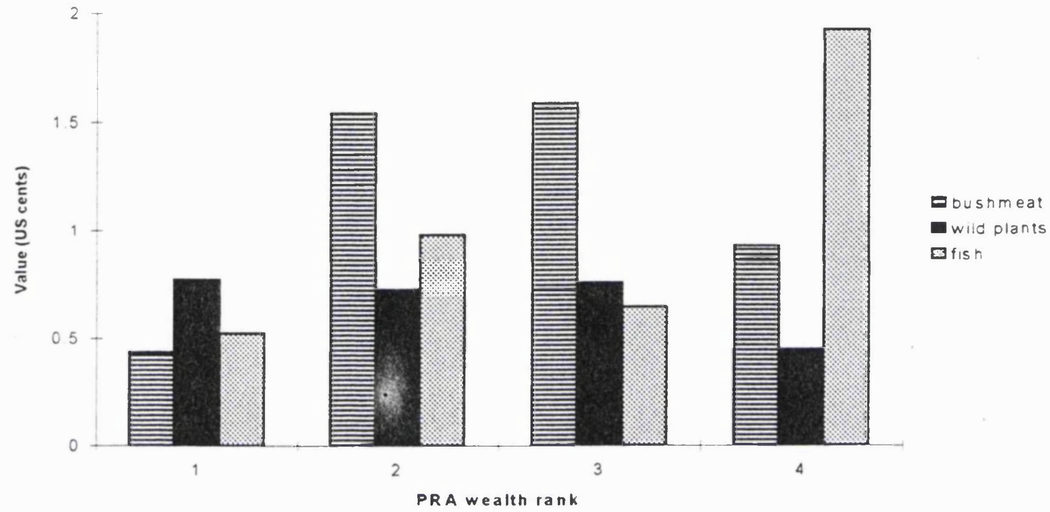


Figure 8.2. Value of wild food consumed by households according to wealth rank (n=121) (average daily intake, standardised to adult male equivalents). Wealth ranks: 1 is poorest, 4 wealthiest.

The multiple regressions on the wealth indices derived from the quantitative survey (Table 8.10) show that non-monetary expenditure provided the best predictor of the value of consumption of both bushmeat and wild plants. The value of wild foods was subtracted from the non-monetary expenditure variable so that the response variable was not contained in the explanatory variable producing spurious significant results. The value of the household consumption in fish was best explained by the presence of foraging tools in the household. This variable included the presence of fishing nets. No other wealth indices, or interactions between them, could improve these models.

Table 8.9. Results of the generalised linear modelling analysis, using Poisson errors, showing:
(a) anova models and intercept values for households of different wealth rank
(b) t-tests to compare wealth ranks

a.

Wild foods	Link function	Linear Predictor	% variation explained	X^2	Change in DF	P
Bushmeat	e = -0.21	$y^{e-0.21} = 0.435 + 1.1\, x_i^{e-0.21} + 1.148\, x_{ii}^{e-0.21} + 0.49\, x_{iii}^{e-0.21}$	5.60	4.27*	3	< 0.05
Wild plants	$\log_e$	$\log_e y = 0.77 + 0.05 \log_e x_{ii} + 0.01 \log_e x_{iii} + 0.32 \log_e x_{iv}$	1.4	0.87	3	NS
Fish	$\log_e$	$\log_e y = 0.52 + 0.46 \log_e x_{ii} + 0.12 \log_e x_{iii} + 0.1.4 \log_e x_{iv}$	5.2	3.99*	3	NS

y_i = wealth rank 2, y_{ii} = wealth rank 3, y_{iii} = wealth rank 4.
* scaled to compensate for overdispersion using X^2/DF (F-ratios are used to verify significance).

b.

Bushmeat

Wealth rank	1	2	3
2	t=2.23 df=73 p<0.05		
3	t=1.85 df=62 p=NS	t=0.06 df=83 p=NS	
4	t=1.2 df=34 p=NS	t=0.47 df=55 p=NS	t=0.44 df=44 p=NS

Wild plants

Wealth rank	1	2	3
2	t=0.19 df=73 p=NS		
3	t=0.39 df=62 p=NS	t=0.18 df=83 p=NS	
4	t=1.52 df=34 p=NS	t=0.94 df=55 p=NS	t=1.35 df=44 p=NS

Fish

Wealth rank	1	2	3
2	t=1.11 df=73 p=NS		
3	t=0.02 df=62 p=NS	t=0.83 df=83 p=NS	
4	t=1.18 df=34 p<NS	t=1.31 df=55 p=NS	t=2.08 df=44 p<0.05

Wealth ranks: 1 is poorest, 4 wealthiest.

Table 8.10. Results of the generalised linear modelling analysis, using Poisson errors, showing the effects of wealth indices on the value of wild food consumption between households

Wild foods	Link function	Linear Predictor	% variation explained	X^2	Change in DF	P
Bushmeat	$\log_e$	$\log_e y = -0.99 + 0.08 \log_e x_i$	43.06	38.26	1	<0.05
Wild plants	$\log_e$	$\log_e y = -0.69 + 0.026 \log_e x_i$	10.05	8.04	1	<0.05
Fish	$\log_e$	$\log_e y = 0.32 + 1.01 \log_e x_{ii}$	4.97	4.13	1	<0.05

x_i = standardised food consumption (controlled for wild foods). x_{ii} = Presence of foraging tools

8.6.2 The effects of wealth on the proportions of wild foods consumed by households

The analysis above was repeated using the proportions of wild food in the diet as the response variable. Proportions are always strictly bounded between zero and one (in other words, the proportion of wild foods in the diet cannot be less than 0% or more than 100%). Proportion data are also unusual, in that the variance is not constant: the variance is greatest when the proportion is 50% (p = 0.5), and decreases as the proportion increases and decreases. Therefore, the models were applied using a logit link function and binomial errors. The logit transformation constrains the predicted values to the logistic curve, thereby ensuring that the values cannot be less than zero or more than one. The variance of the binomial distribution is a function of the mean, and peaks at p = 0.5, making it appropriate for the analysis of proportional data (Crawley 1983).

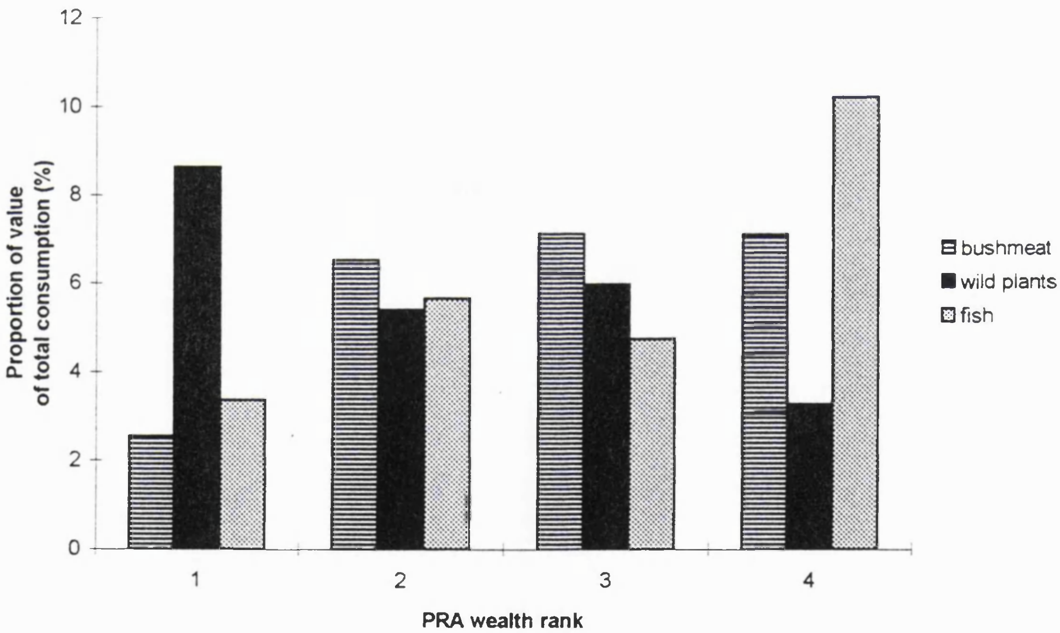


Figure 8.3. The value of wild foods as a proportion of the value of total household food consumption (average daily intake, standardised to adult male equivalents, n=121)

Figure 8.3 shows how the proportion of the value of wild foods consumed by households in relation to the value of total food consumption varies with wealth rank. The proportional value of bushmeat and fish increase with wealth rank whilst wild plants appear to decrease. Analysis of variance suggests that there is a significant difference between wealth rank in the proportion of the value of bushmeat and fish consumed (Table 8.11a). The difference was not significant for wild plants. But there was a significant difference for the value of consumed wild plants between wealth rank 1 and 4 when t-tests were used (Table 8.11b). The multiple use of t-tests should be treated with some caution, as they can result in the null hypothesis being falsely rejected (Hurlbert 1984).

Table 8.11. Results of the generalised linear modelling analysis, using binomial errors, showing:
(a) anova models and intercept values for households of different wealth rank
(b) t-tests to compare wealth ranks

a.

Wild foods	Link function	Linear Predictor	% variation explained	X^2	Change in DF	P
Bushmeat	e = -0.24	$y^{e-0.24} = -3.16 + 1.101x_{ii}^{e-0.24} + 1.01x_{iii}^{e-0.24} + 0.046x_{iv}^{e-0.24}$	4.73	2.31*	3	<0.05
Wild plants	logit	$\log_e y = 0.086 + 0.032x_{ii}^{e-0.24} + 0.01 \log_e x_{iii} + 0.32 \log_e x_{iv}$	3.42	2.53	3	NS
Fish	logit	$\log_e y = 0.52 + 0.46 \log_e x_{ii} + 0.12 \log_e x_{iii} + 0.1.4 \log_e x_{iv}$	6.47	2.86*	3	<0.05

* scaled to compensate for overdispersion using X^2/DF (F-ratios are used to verify significance)

b.

Bushmeat

Wealth rank	1	2	3
2	t=1.9 df=73 p=0.05		
3	t=2.16 df=62 p<0.05	t=0.23 df=83 p=NS	
4	t=1.6 df=34 p=NS	t=0.29 df=55 p=NS	t=0.17 df=44 p=NS

Wild plants

Wealth rank	1	2	3
2	t=1.06 df=73 P=NS		
3	t=1.55 df=62 p=NS	t=0.5 df=83 p=NS	
4	t=2.11 df=34 p<0.05	t=1.34 df=55 p=NS	t=1.24 df=44 p=NS

Fish

Wealth rank	1	2	3
2	t=1.0 df=73 p=NS		
3	t=0.65 df=62 p=NS	t=0.39 df=83 p=NS	
4	t=2.05 df=34 p<0.05	t=1.31 df=55 p=NS	t=1.56 df=44 p<0.05

Wealth ranks: 1 is poorest, 4 wealthiest.

Of all the wealth indices, only non-monetary income showed a significant relationship with the proportion of the value of bushmeat to the value of total household consumption (Table 8.12). None of the wealth indices had a significant effect on the proportions of the value of wild plants and fish consumed.

Table 8.12. Results of the generalised linear modelling analysis, using binomial errors, showing the effects of wealth indices on the proportion of wild food consumed relative to overall consumption (households are standardised to adult male equivalents and daily averages are used).

Wild foods	Link function	Linear Predictor	% variation explained	X^2	Change in DF	P
Bushmeat	$\log_e$	$\log_e y = -2.248 + 0.01 \log_e x_i$	59.72	4.29	1	<0.05

x_i = standardised food consumption (controlled for bushmeat)

8.6.3 The analysis of wealth and procurement

Wild food consumption data were classified according to how they were obtained by the households: by foraging, as a gift or purchased. Figures 8.4 and 8.5 show the value of the wild foods consumed and their proportional value relative to the total value of consumption. The models in Tables 8.13 and 8.14 show the statistical significance of these patterns.

These models show a much stronger relationship between the value of bushmeat consumed and wealth, than the earlier models which did not take account of the method used to obtain the meat. There is a significant increase in both the value of bushmeat that was obtained through hunting, and that which was purchased, according to wealth rank (although, only the highest wealth rank shows a significant increase in the value of the bushmeat that was obtained through hunting, see Tables 8.13 and 8.14). There is a significant difference between wealth ranks for the value of bushmeat that was obtained as a gift, but this does not correspond to increasing wealth (see Figures 8.4a). Similar patterns can be seen in the proportional data (Figure 8.5a), although the wealthiest group have a lower proportion of purchased bushmeat than the group in wealth rank 3.

The consumption of fish shows a similar pattern to bushmeat. The value of fish that was foraged or purchased increases with the wealth rank of the household. This is true for both the value of the fish consumed, and for the analysis of the proportion of fish to the value of household consumption as a whole.

Figures 8.4b and 8.5b suggest that poorer households use wild plants to a greater extent than the richer households, irrespective of how the plants were obtained. However, none of the findings for wild plants were significant. This is consistent with results shown in Figures 8.2 and 8.3.

Table 8.13. One way anovas to show the effects of wealth on resource use according to how the food was obtained (n=121).

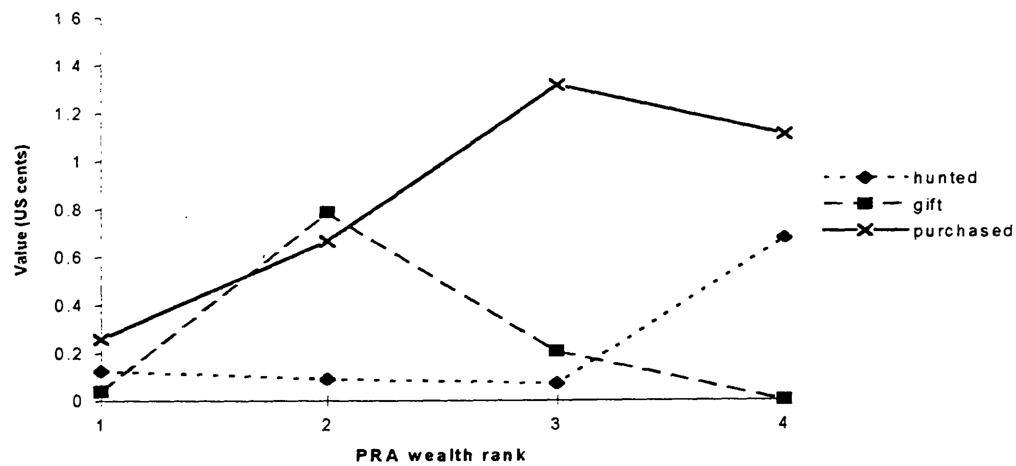
Wild foods	Method obtained	% variance explained	X^2	Change in DF	P
Bushmeat	**Foraged**	14.65	12.15	3	<0.05
	Gift	29.91	13.79	3	<0.05
	Purchased	8.03	4.93*	3	<0.05
Wild plants	**Foraged**	2.72	2.16	3	NS
	Gift	8.44	3.85	3	NS
	Purchased	2.2	0.64	3	NS
Fish	**Foraged**	5.48	4.51*	3	<0.05
	Gift	- No convergence -			
	Purchased	11.28	4.51	3	NS

* scaled to compensate for overdispersion using X^2/DF (F-ratios are used to verify significance)

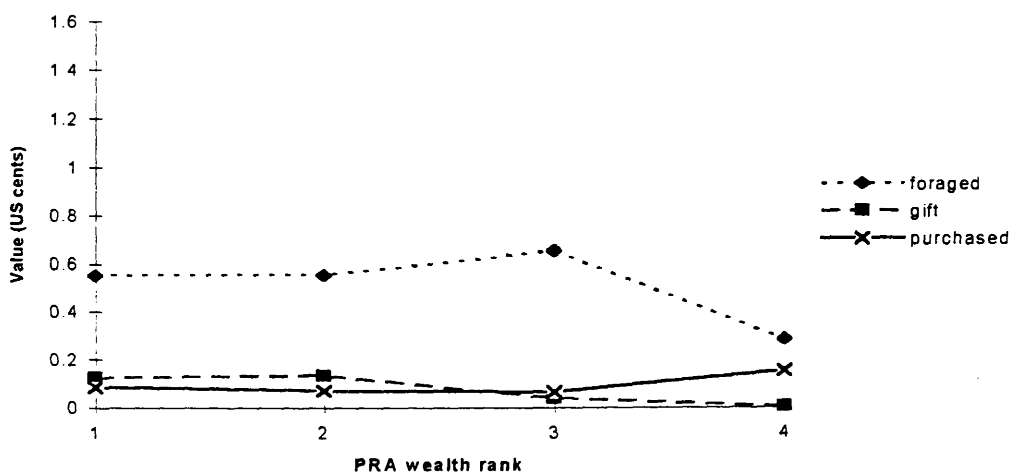
Table 8.14. One way anovas to show the effects of wealth on the proportion of wild foods in the diet according to how the food was obtained (n=121).

Wild foods	Method obtained	% variance explained	X^2	Change in DF	P
Bushmeat	**Foraged**	17.17	14.37	3	<0.05
	Gift	22.87	9.15*	3	<0.05
	Purchased	9.56	5.61*	3	<0.05
Wild plants	**Foraged**	3.36	2.7	3	NS
	Gift	9.42	4.14	3	NS
	Purchased	3.34	1.18	3	NS
Fish	**Foraged**	5.65	1.07*	3	NS
	Gift	- No convergence -			
	Purchased	10.18	5.8*	3	<0.05

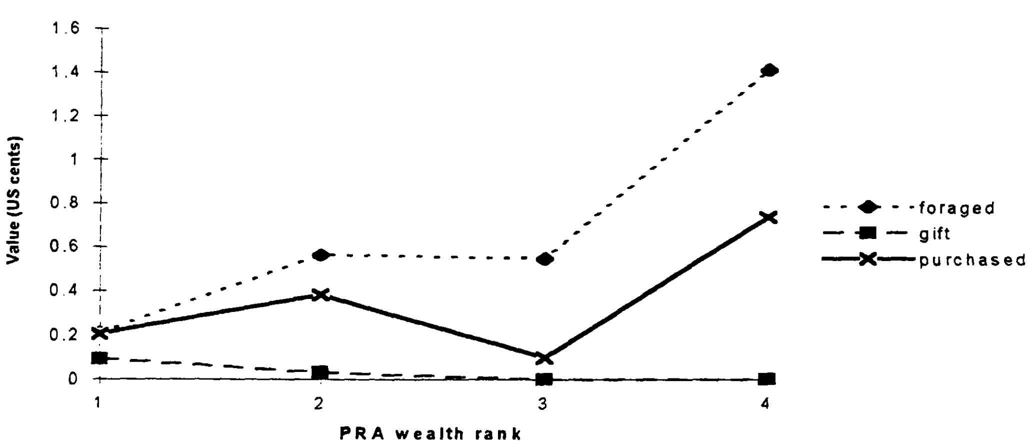
* scaled to compensate for overdispersion using X^2/DF (F-ratios are used to verify significance)



a. Bushmeat

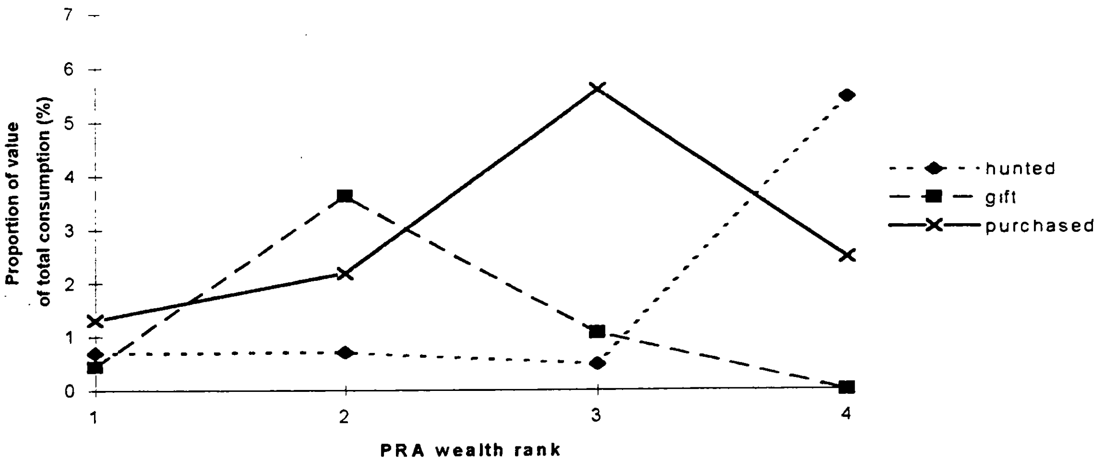


b. Wild plants

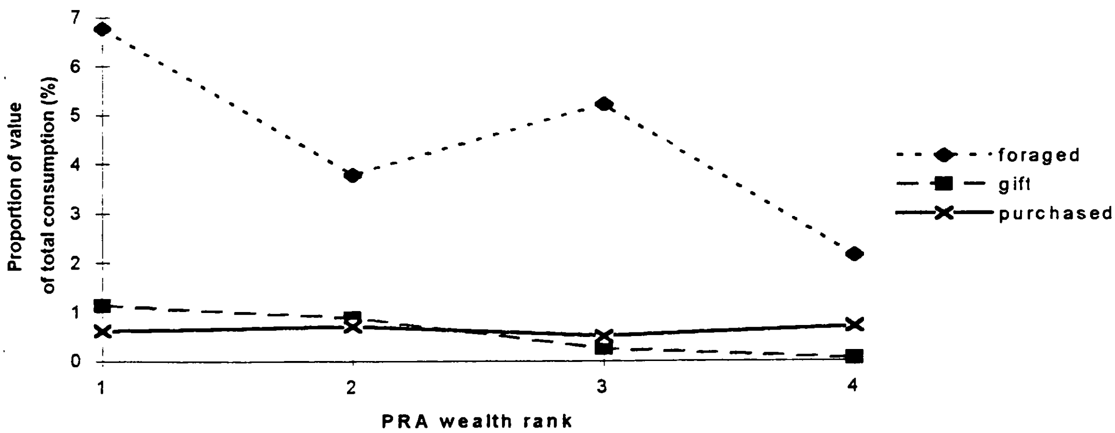


c. Fish

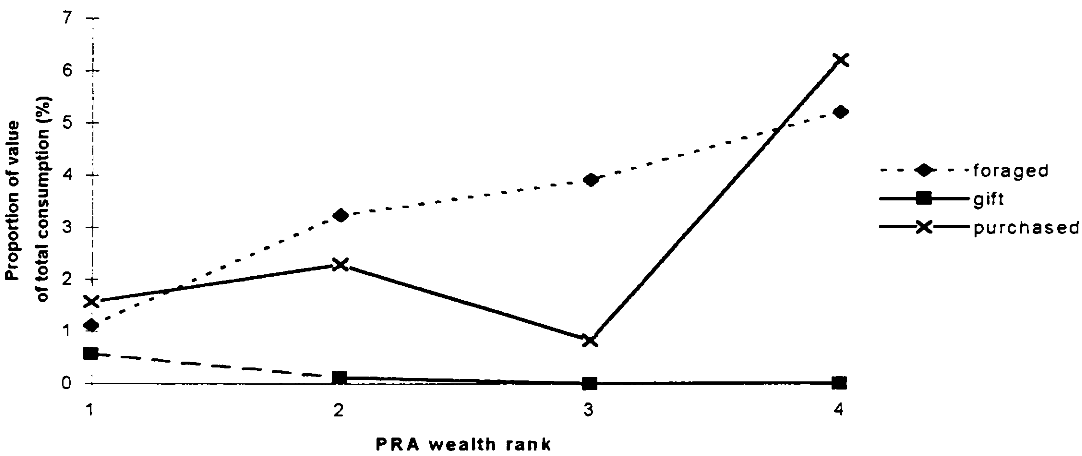
Figure 8.4. The value of wild foods consumed by households, according to the method obtained (average daily consumption, standardised to adult male equivalents, n=121). Wealth ranks: 1 is poorest, 4 wealthiest.



a. Bushmeat



b. Wild plants



c. Fish

Figure 8.5. Proportion of the value of wild foods to the total value of household food consumption (average daily values, standardised to adult male equivalents). Wealth ranks: 1 is poorest, 4 wealthiest.

8.7 Discussion

This section examines the findings of these analyses. First, the effect of wealth on the contribution of wild foods to household consumption is assessed. The three types of wild foods, bushmeat, plants and fish, are discussed in terms of the absolute value of their contribution to household consumption and in terms of the proportion of the value of wild foods to the total value of consumed food. The results are discussed in relation to findings for similar studies in other regions. Second, the effect of wealth on patterns of wild food procurement is examined. Finally, the relevance of wealth and household entitlements are discussed with respect to the issue of sustainable resource use.

8.7.1 Hypothesis 1: household consumption of wild foods is determined by wealth

Generally, the hypothesis that wild resources are more important to poor households is not borne out by these analyses. Indeed, the analyses of bushmeat and fish show the exact opposite. Bushmeat consumption, in particular, showed a statistically significant increase with wealth, both in terms of the total value of bushmeat consumed, and in terms of proportion of the value of bushmeat to the value of all food items consumed. However, the richest wealth rank (wealth rank 4 in Figure 8.2) appears to have consumed less bushmeat than the two intermediate wealth ranks (wealth ranks 2 and 3). This is may be explained by the fact that the sample size of wealth rank 4 is relatively small, and therefore the estimate for the value of consumed bushmeat has a larger sampling error, which makes the differences between wealth rank 4 and other wealth ranks more difficult to assess. This is shown by the fact that the t - values for the differences between the mean of the value of bushmeat consumption for wealth rank 4 and for wealth rank 2 and 3 are relatively low (Table 8.11b.).

Fish consumption showed similar patterns to bushmeat consumption when the proportion of the value of fish to the value of total consumption was examined: the increase in the proportion of fish consumption with wealth rank is statistically significant (Table 8.11a). The differences are largely due to the wealthiest rank (4), which consumed a much greater proportion of fish, on average, than all other wealth ranks. This is shown in Figure 8.3 and is confirmed in Table 8.9b (the mean proportion of household fish consumption for wealth rank 4 is significantly different from that for wealth ranks 1 ($t= 2.05$, $p<0.05$) and 3 ($t=1.56$, $p<0.05$)).

This partly a product of the fact that fisherman represent relatively wealthy professionals. The village of Kiliwa is an important centre for the production and trading of fish, and the fisherman comprise a fairly small group of men. They are formally affiliated to a 'guild' of fisherman who pay a quarterly tax to both the civil administration in the town of Dungu, and to the wildlife authorities. This tax is considered to be beyond the means of most villagers, who are therefore precluded from fishing. Fishing is thus a specialised activity that is undertaken by relatively wealthy members of the community as a commercial enterprise. Seven commercial fisherman were included in the sample of households used in this study. All of these were in wealth rank 4, thus giving this wealth rank a higher mean proportion of the value of fish consumed in the household.

The proportion of wild plants in the diet appears to decrease with wealth, although the differences between wealth ranks were not statistically significant (Table 8.9a and 8.11a). However, the difference between wealth ranks 1 and 4 in the proportions of the value of wild plants consumed relative to the value of all foods consumed was statistically significant when a t-test was used (Table 8.11b). Thus, wild plant utilisation appears to show a different pattern of resource use from either bushmeat or fish. The difference is probably because wild plants are lower value items than bushmeat and fish. Wild plants are more easily accessed by less wealthy households because their extraction is not contingent on the use of high capital tools, such as shotguns or nets.

Monetary values may be less useful for assessing the importance of wild foods for a household than nutritional values. This is particularly important when comparing the patterns of consumption of wild plants, to that of fish and bushmeat. Fish and bushmeat are high financial value food items, and therefore their market values probably inflate their importance in terms of contribution to the diet. It is possible that the nutritional value of wild plants is greater than that of bushmeat and fish, although the economic analysis does not reflect this importance.

Economic value of wild foods was used because it could be interpreted more easily by both the informants and the researcher collecting the data. It is based on the rationale that 24-hour recall data cannot be used to measure the nutritional value of consumption precisely.

Thus, these findings appear to contradict the conventional wisdom that wild foods are most important to the poorest households in a community (e.g. Scoones *et al* 1992). Several recent studies of wealth and resource use, using extensive quantitative data, produce similar results to the findings of this study. In a study of the use of forest resources amongst pastoralists in Northern Kenya, Chenevix-Trench (1997) found that wealth did not significantly affect the level of reliance on wild resources, although these findings were affected by the provision of relief aid in the area. Similarly, a study by Wickramasinghe *et al* (1996) in Sri Lanka, used regression models to examine the factors which explain the value of household consumption of wild foods and other forest resources and found the relationship between household wealth and resource use to be non-significant.

A number of studies have explored the significance of household size in explaining resource use patterns (e.g. Abbot 1996, Biran 1996, Wickramasinghe *et al* 1996). However, contrary to this study's findings, these authors show that household size shows a significant relationship with the amount of wild products used. In the case of Wickramasinghe's study, households were not standardised according to household size, so their results largely reflect total household values, which are a function of household size. Thus, large households will tend to have a higher gross consumption by virtue of having more members that consume. Therefore, their conclusion that larger households derive a greater income from wild products because of their increased access to labour is questionable because their results do not represent per capita gains.

The present study found that family size had no effect on increased consumption of wild foods for the member of a household. This is probably because family size is positively correlated with the dependency ratio (Pearson's correlation coefficient 0.287, $n = 121$, $p < 0.01$), which implies that larger families tended to have more unproductive mouths to feed. Other studies have found that family size does infact provide a good explanation for household consumption. This is the case for a study of fuelwood consumption amongst a fishing community in Malawi (Abbot 1996) and for water consumption amongst pastoralists in Tanzania (Biran 1997). However, in these communities, per capita consumption decreases with family size. This is explained by an economy of scale: larger families benefit from the more efficient use of specific commodities, such as fuelwood and water, which reduces their *per capita* consumption. This does not apply to food products.

8.7.2 *Hypothesis 2: A household's modes of procurement of wild foods differs according to wealth*

The methods used to obtain wild foods were examined in detail in order to understand how rural households can access wild resources. It is increasingly recognised that rural households differ considerably in their entitlements to wild resources, whatever the abundance of wild foods in their environment (de Waal 1989). This study has highlighted these differences by examining household access to wild foods through foraging, as gifts or by purchasing the products.

a. Wild foods obtained through foraging

The consumption of foraged bushmeat and fish increases with wealth rank, both in terms of the value of the wild food consumed, and in terms of the proportions of value of the resource to the total value of all food consumed. The difference in the value of fish consumed between wealth ranks is largely explained by the fact that the wealthiest rank (4) consumes significantly more than the other three. This corresponds to the earlier explanation: fishing is essentially a commercial activity dominated by a minority of specialised fisherman who derive relatively large incomes from fishing. This result contrasts with Godoy *et al*'s (1995) findings in Central America which show that increased wealth is not associated with greater levels of specialisation in the procurement of the wild resources.

The value of consumed meat that was procured through hunting shows a similar pattern, which is probably explained by the fact that much of the bushmeat is hunted using shotguns. The value of a locally constructed shotgun is in excess of US $150, which is beyond the means of most households. Those that could afford the capital cost of a shotgun together with the expense of the ammunition were mainly in wealth rank 4.

All households obtained most of their wild plants through foraging (f-ratio=46.35, n=121, p<0.01, and a 'Tukey's least significant difference test' showed the difference between the value of foraged wild plants and wild plants that were purchased and obtained as a gift to be most significant). Poor households appeared to forage the most wild plants, both in terms of the absolute value of plants and the proportional value of consumption, although this was not statistically significant. The foraging of wild plants would appear attractive to poorer households because their acquisition does not require any specialised equipment. Furthermore, the majority of wild plants that appeared in the diet were seasonally available products, such as mushrooms. These were abundant in the early wet season, when household provisions were low, particularly amongst the poorer households. This pattern has also been noted by Toulmin (1986) in Central Mali, who describes the differences in wild food foraging between poor and rich households. During the dry season, poorer households procure more wild foods to ensure that their food supplies are sufficient until the next harvest, whilst richer households, that are more likely to have larger food stores, focus their labour activity on the acquisition of non-food wild products, such as building materials. Thus, wild plants seem particularly important as 'hungry season' resources for the poorer households who have less access to stored agricultural products (Chambers *et al* 1981, de Garine and Koppert 1988).

b. Wild foods obtained as gifts

On average, more bushmeat was obtained as a gift than was obtained by hunting. There are two possible explanations for this. First, successful hunts result in the acquisition of large amounts of bushmeat (most hunted mammals weigh more than five kilogrammes). It is difficult for a household to store large quantities of meat, and it may choose to distribute it to other households. When a relatively large animal, such as a warthog or baboon was caught, most of the animal would be distributed to other households (see Chapter 9). Furthermore, hunts are usually composed of several individuals, only some of whom have shotguns. The others assist with the tracking, and killing of an animal if it has been wounded, and with carrying the carcass back to the village. These unequipped members of the hunt are usually provided with a portion of the hunt as a gift. It is probably for this reason that the middle ranks have larger amounts of bushmeat acquired as a gift.

The second reason for the importance of bushmeat acquired through gifts has been explained by hunters in the course of the field work. Excessive good fortune is perceived to be at the expense of the community as a whole, and may even bring misfortune to particular families. A string of successful hunts is one form of excessive good fortune, and suspicion and animosity from other members of the community is most effectively curbed by distributing portions of meat. Selling the surplus at the market is likely to instil high levels of suspicion because the market place is a public arena, and the hunter is seen to capitalise further on his excessive good fortune (see Evans Pritchard 1972). Giving bushmeat is another case of the use of gifts, widely acknowledged as cohesive gestures in communities (e.g. Mauss 1952, Guyer 1994).

Fishing, on the other hand does not instil the same suspicions amongst members of the community. Fishing is perceived as a profession, and therefore a successful fisherman is considered hard working or intelligent rather than lucky. Fishing is more of a commercial activity in the village, and fish is therefore rarely provided as a gift between households. When a fisher obtains large quantities of fish, they can readily be disposed of at the market. Likewise, wild plants are rarely given as gifts. Their relatively low value, together with their relative abundance in the environment, make them accessible to all households.

c. *Wild foods that are purchased*

The purchasing of meat at the market is the most important means by which households are able to obtain bushmeat. This is because the immediate area around the village, where local villagers hunt, has a low abundance of large mammals. Large mammals provide the bulk of commercialised meat, and they appear to be obtained away from the village by commercial hunters.

Both bushmeat and fish are relatively high cost food items, and this is reflected in the data by an increase in both the quantity and the proportion of purchased bushmeat and fish in relation to increasing wealth rank. Wild plants, on the other hand, are rarely purchased, largely because of their high abundance in the environment in and around the village.

8.7.3 ***Wealth, wild foods and sustainable natural resource utilisation***

This study of wild food use in a community in the hunting reserves does not allow for any reliable statements to be made about the sustainability of wildlife utilisation. Indeed, an accurate impact assessment of wild resource use requires accurate quantitative data on the abundance of the resources as well as the levels of resource offtake. Ideally, these should be examined over a sufficiently long period of time to be able to detect a causal link between human offtake and significant reductions in animal or plant abundance (Cunningham 1990).

This study has not been sufficiently extensive to provide the data to answer questions about sustainability. Indeed, there appear to be no examples in the literature of long term datasets that can show a causal link between animal population trends and human resource use (Godoy and Bawa 1993). Given the lack of feasibility of such studies, a multi-disciplinary approach that examines resource use from various perspectives at one point in time, covering population structure and distribution as well as consumption and supply, can successfully improve our understanding of the impacts of resource use through a process of triangulation of evidence (eg. Abbot 1996, Chenevix-Trench 1997, Sullivan 1998). This study has given important insights into the current patterns of resource use. Increased wealth is significantly associated with increased demand for high value wild foods. As shown in Figure 8.4a, the wealthier households purchased most of their meat. Their demand appears to be met by an increase in the marketing of wild foods. Although richer households also hunt more, this does not appear to fully meet their demand and they purchase from the market to bridge the shortfall between the demand and household catch.

This raises important questions, both from a legal perspective (the *Code Penal* only permits subsistence hunting in the reserves) and from the perspective of the impact of hunting on animal populations: is subsistence hunting in the periphery of the village viable, or is demand met primarily by hunting larger mammals from areas where they are currently more abundant? The rest of this thesis will address these questions by examining the costs and benefits of subsistence and commercial hunting, and the incentives for marketing bushmeat from different locations in the reserves.

8.8 Conclusions

When wild foods are aggregated, and when the market value is used as an indication of the level of consumption, the results suggest that the use of wild foods does not benefit the poorer households to a greater extent than the wealthier households. However, these results are heavily influenced by the effects of bushmeat and fish, that are high value products, and whose use correlates with wealth. By contrast, wild plants do appear to be used to a greater extent by poorer households, both in terms of their absolute value, and the proportion of their value in relation to the value of all consumed food items.

A better understanding of the effects of wealth on resource use is gained by examining a household's entitlements to wild foods. This study has shown that the patterns of procurement of wild foods differ substantially according to wealth. Wealthier households are more likely to forage and purchase high value wild foods (bushmeat and fish). Fishing is dominated by a small minority of households belonging to the wealthiest sector of the community. Bushmeat is predominantly purchased at the market, suggesting that the commercial sale of bushmeat is more important than the subsistence hunting of bushmeat at Kiliwa. These results indicate that increased wealth is associated with a greater demand for high value wild foods. This demand is met primarily by specialised hunters and fisherman who distribute their products through markets. This will be examined further in Chapters 9 and 10, which assess the costs and benefits of hunting, and of marketing bushmeat.

Chapter 9

Wildlife Harvesting and Conservation

9.1 Summary

Data on faunal harvests at two locations in the Hunting Reserves are presented to explore the incentives to hunt and the ecological implications of hunting amongst the Zande communities around Garamba National Park. Hunting practices were observed and recorded in Zande communities at two locations, Kiliwa and Mamba. Kiliwa is a site of relatively low animal abundance and Mamba, which is close to the National Park Boundary, is a site of high animal abundance (see Figure 2.4). The data were analysed to test the hypothesis that hunters manage their resources as conservationists. The alternative hypothesis is that hunters make decisions to maximise their short term economic benefits. The results reveal that the benefits from hunting activities are diverse and cannot be explained solely in terms of economic incentives. An understanding of wildlife utilisation that takes account of the legal constraints and the social incentives to hunt provide a better explanation for Zande hunting patterns. Nevertheless, there is no evidence to show that hunters make decisions based on conservation objectives. The implications of these findings for community based conservation are discussed.

9.2 Introduction

Hunting as a form of wildlife management has received considerable attention in the conservation literature because it is seen as a viable alternative to the more coercive strategies implicit in 'protectionist' wildlife management (Barbier *et al* 1990). The rationale for this argument is that communities have an incentive to manage resources sustainably when they generate local profits. This 'use it or lose it' principle now underpins several conservation policies, particularly in Southern Africa (Child 1990, Murphree 1990, 1996, Pearce 1996).

The contribution of wild game to the economy is often underestimated because it is concealed within the informal sector, and often provides local as opposed to national level financial benefits (Asibey 1974, Butynski and von Richter 1974, Ghimire 1991). The net profits from wild mammal populations often exceed those of domestic herds (de Vos 1977). Thus, the incentives to exploit wild animal populations are considerable. Nevertheless, it is not an implicit consequence that hunters will deliberately conserve their resources because the resources are highly profitable. Indeed, the economically rational decision for individual hunters might be to maximise their rate of returns from hunting (Milner-Gulland and Leader-Williams 1992) as restraint on the part of an individual is likely to profit other hunters who do not show restraint when exploiting finite resources (Smith 1983). This chapter examines the motivations behind wildlife harvesting patterns with a view to providing a better understanding of hunting strategies and their implications for conservation.

9.2.1 Wildlife management and conservation by hunters

This thesis examines the patterns and consequences of wildlife management. Two definitions of wildlife management have been proposed (see Chapter 1). The first was described as a centralised, state managed system whose implementation focuses on the protection of animal populations by a recognised wildlife authority. The authority's mandate is well defined, and its activities were documented in Chapter 4. The second system of wildlife management was defined as consumption-based and is driven by the nutritional, economic and other needs of the human populations in the region. Consumption-based wildlife management is loosely defined because it encompasses the many aspects of the relationship between human and wildlife populations. The rationale for the integration of broad-based 'community' approaches into wildlife management has been extensively documented and advocated (IIED 1993, Pimbert and Pretty 1994, see also Chapter 8 for an analysis of a community's use of wildlife resources). Nevertheless, there are relatively few studies that have explicitly tested the assumptions that the consumptive use of animal populations can be described as a form of wildlife management.

The use of the term 'wildlife management' is sufficiently broad to encompass a range of wildlife utilisation practices. For instance, the economically rational decision to deplete a resource in order to convert it to a more profitable commodity (money) can be interpreted as an effective form of wildlife management. Indeed, it has been postulated that this is the most appropriate form of wildlife management for certain large mammal populations if a criterion of economic efficiency is used (Caughley 1993). In contrast, conservation management involves the maintenance of wild populations to ensure that their numbers are not depleted in the long term.

This chapter tests whether the wildlife management practices of resident communities can be linked to long term conservation objectives on the part of the individuals who exploit the wildlife populations. This means that communities must exploit the resource sustainably. This condition is met when human populations do not hunt their prey to extinction. A biological definition of sustainability relates to the population dynamics, whereby "a stable or fluctuating equilibrium is obtained when a predator population is limited in its ability to drive its prey population to extinction" (Taylor 1984, in Alvard 1995). Thus, a broad definition of conservation would include the maintenance of a stable or fluctuating "equilibrium" in species populations over prolonged periods of time. Although somewhat vague, this concept of conservation does provide a basis for understanding the conservation component of local wildlife management practices.

A number of authors have asserted that indigenous communities are dependent on natural resources for their subsistence and therefore have a vested interest in managing the resource sustainably, thus maintaining an equilibrium in the animal populations (Feit 1973, Bunyard 1989). Indeed, the popular belief that indigenous communities have established a "balance with Nature" is a strongly held view, supported more by a concern for the loss of traditional culture than by empirical evidence for sustainable resource use (Robinson and Redford 1991).

Certainly, hunting communities can be shown to have a non-significant impact on natural resources if they do not contribute to a systematic decline in the abundance of the resource. This was shown to be the case in the Hunting Reserves around Garamba National Park, because the presence of agricultural populations could not be associated with a decline in the abundance of most mammals (see Chapter 5). However, Alvard (1993, 1995) warns against the assertion that this can be used as evidence for 'community conservation'. He maintains that an understanding of the decisions of individuals is more important to the definition of conservation management by hunters than is the sustainability of their hunting. This is because evidence for sustained yields from hunting does not necessarily support the hypothesis that hunters are managing the resource. It may simply be an artefact of density dependant and other relationships between the hunter and the prey. Thus, Alvard describes sustainable hunting in the absence of any pro-active conservation as 'epiphenomenal'.

Alvard's definition of conservation involves an understanding of the hunter's motivations: "conservation can be thought of as enduring a cost in the present so that some benefits will be realised in the future" (Alvard 1993). This is a useful definition of conservation for two reason. First, conservation management can be operationally defined by assessing the evidence for restraint in people's hunting practices. Second, sustainable yields are an artefact of the current socio-economic and demographic context. In view of the rapid change affecting rural communities, future sustainability can only be predicted through an understanding of people's motivations.

On the basis of these definitions, Alvard tests the decisions of Piro hunters in Amazonia in terms of their choices of restraint or rate maximization during hunting expeditions. In his study, optimal foraging models are used to determine whether hunters' decisions are based on rate maximising objectives. The alternative hypothesis is that their decisions are not optimal, and therefore the hunters are showing restraint in the volumes of meat that they are obtaining. He tests the choices made by hunters based on hunting locations and prey types. He predicts that conservationists would avoid depleted hunting sites, and certain critical prey types, such as females and young individuals and species with low intrinsic rates of reproduction even if these represent costly decisions (Robinson and Redford 1991). Alvard consistently shows that hunters are making optimal (rate maximising) choices, rather than sustainable yield choices, when patch choice and inter and intraspecific prey choice are examined (Alvard 1993, 1995, Alvard *et al* 1997).

9.2.2 Reasons for hunting

How a hunter chooses to hunt involves a wide range of economic, social and cultural incentives and constraints. These are outlined in Table 9.1, and will be explored further in this section.

Table 9.1. Factors influencing hunting decisions

Incentives		Constraints	
Economic:	financial and nutritional benefits of meat. complementary to agriculture during the 'hungry season'	Economic:	Availability of capital Access to markets Time and energy trade-offs with agriculture
Social:	Prestige Entertainment Strengthening social ties	Ecological:	Animal abundance Animal size Animal availability (predator avoidance behaviour)
Cultural:	Spiritual value Maintaining traditions Clanic indentity	Legal:	Restrictions on hunting areas Restrictions on species Restrictions on hunting tools

9.2.3 Definitions of hunting

Hunting techniques can be defined in terms of the physical properties of hunting tools as well as the strategies used by hunters to exploit wildlife. However, there are also wider cultural, legal and ecological characteristics which define Zande hunting. Various characteristics have been employed to categorise hunting in other studies of hunting societies (see, for example Hart and Hart 1979, for the Mbuti of the Ituri Forest in eastern Congo, or Berry and Petty 1992, for an agricultural community in Malawi). A broad description of hunting around Garamba National Park is summarised below, according to technical as well as the legal, ecological and economic context of the area.

a. Technical definitions of hunting

Much of the hunting technology is artisanally constructed and is therefore varied in design and function. Nevertheless three broad classes of tools are typically used by the Azande in the region: nets, snares and firearms.

1. Nets are used as part of a group hunting exercise. Net hunting usually involves groups of four to twelve hunters, carrying nets and spears. Nets measure between fifteen and forty metres in length and are just over a metre in height. They are constructed locally using bark from a variety of species of trees. Nets are valuable because of the high time investment that is required to construct them. There are some specialised net makers in the village, although most men have a good knowledge of net construction and maintenance. Most households have nets, and these can easily be indentified hanging from the food stores. Trained dogs play a key role in the hunt. The owner of the dogs is the most prestigious member of the hunt. The dogs have wooden bells attached to their necks to increase the noise during the tracking of game. The bells are filled with leaves when not in use. Bailey and Aunger 1989, Hart and Hart 1986 and Bahuchet and Pujol 1975 all provide descriptions from the region of hunting techniques using nets.
2. Snares and traps vary from small nylon snares used to capture wild fowl and rodents to large pits that are dug to capture animals as large as the giant forest hog. Some snares are relatively expensive, such as the large wire snares, made of

steel cable, that are used for capturing medium sized animals, whilst others are locally constructed from wild resources.

3. Firearms used fall into two categories. Firstly, there are locally constructed shotguns, known as *fabrications*. Most are built in the town of Isiro, about three hundred kilometres away. The amunition is either purchased as pre-fabricated cartridges, or made locally with used cartridges, lead from disused vehicle batteries and gun powder that is usually bought from the military. The locally constructed cartridges are cheaper, but have a much higher rate of misfiring. During this research, 43 percent of the locally made cartridges misfired, compared to none of the purchased cartridges. Secondly, automatic rifles have become widely available, and cheap to purchase, following the prolonged civil war in southern Sudan. These primarily include Chinese built AK47s and American built G3s. Ammunition is cheaper than for shotguns, but there are heavy penalties if a hunter is found in possession of an automatic weapon.

b. Hunting techniques

Bahuchet (1971) provides a useful classification for hunting techniques based on the relationship between the hunter and the prey. The hunter's objective is either to come into direct contact with the prey and kill the animal directly, or to maintain a distance with the animal and capture it before killing it:

Direct hunting

These activities rely on a technology that brings the hunter in direct contact with the prey. They imply a calculated approach on the animal, followed by the kill. Several hunting strategies are included in this category:

1. Provoking the animal to flee: This is typified by net hunting, whereby the dogs are used to frighten the animal, directing them into the concealed nets of the hunters. Nets are laid out relatively close to the point of departure, and most of the hunts take place within the village itself. The hunt is organised several days before the arranged date. On the day of the hunt, hunters are summoned using a gong to the house of the man responsible for coordinating the hunt. Hunters are

usually related or have close ties of friendship, and each hunter has an assigned role.

2. Provoking the animal to approach the hunter: this form of hunting is only used by the more experienced hunters using firearms. It seems to be particularly effective for hunting primates. One hunter in Kiliwa was able to attract certain species of monkeys to within a few metres by mimicking their calls.
3. Provoking as little reaction from the animal as possible: this technique is adopted when hunting mammals using firarms. Shotgun hunting is usually undertaken individually because hunters are more concealed. In the case of hunts using automatic weapons, large groups of men may take part because the hunt can last several days and large amounts of meat may need to be carried. However, the hunt itself is usually carried out by an individual. The hunt usually takes place at considerable distances from the village. The most organised of these hunts are the poaching expeditions in the park, which are well equipped and usually very productive.

Indirect hunting

These techniques can be summarised by the use of traps and snares. The principle is to maintain as great a distance as possible between the hunter and the animal. Traps and snares are usually owned and placed by individuals, although the task of monitoring can be allocated to other members of the owner's household. Prescribed rules exist for the distribution of the catch if someone other than the owner finds an animal in a snare or trap. The person is allowed to kill the animal, but is not allowed to touch the animal after having killed it. The person then has to find the owner, and the owner is obliged to provide them with one front limb. Snare and traps are often placed relatively close to the owners fields so that they serve the dual purpose of protecting the fields from crop raiding animals, as well as providing meat.

c. *Legal definitions of hunting*

The legal status of hunting in the reserves is defined in the *Code Civil Zairois 1982* (owing to the change of government, this has recently been revised, but is not available at the time of writing). The law classifies the use of wild animal resources into hunting or poaching. Hunting is permitted in the hunting reserves in Congo within certain constraints, based on the species used and the methods used to kill the animal. Giraffes, rhinoceros, elephants, bongos, apes and buffalos are protected species, and cannot be hunted. A number of other large mammal species are partially protected, and can be seasonally hunted, with a permit from the wildlife authorities. Hunting for commercial gain is prohibited, as is the use of firearms.

However, the laws as published in the civil code often have little bearing on how the law is administered in the region. For instance, shotguns can be used openly if a hunting permit is purchased. Furthermore, the agency that is responsible for maintaining the laws of conservation, ICCN, has only a limited presence in the Hunting Reserves. Thus, most hunting activities that take place in the Reserves are unconstrained by the law, whether the activities are technically legal or not. Perhaps the only important influence that the laws of conservation have on hunting behaviour is the restrictions that they place on hunting in the National Park, where law enforcement is largely financed by international conservation organisations. Thus, in practice, the effect of the laws on hunting are largely determined by the resources that are available to enforce their regulation.

Milner-Gulland and Leader-Williams (1993) define 'illegality' in the context of hunting and poaching as an action that is "*irregular and immoral*". However, local interpretations of what constitutes 'legal' or 'illegal' hunting certainly do not appear to be inspired from the civil code, nor for that matter, from any conservation objectives. Indeed, local terminology such as *Nyama ya l'état* (the state's meat) reflects a belief that certain species are set aside, not for conservation objectives, but for a privileged élite, symbolised by, and concealed behind, the authority of the state. The differences that exist between local practice and statutory law result partly from the inconsistencies that arise from the conflict between two distinct systems of thought: whereas Zande hunting practices have evolved to fulfil nutritional, economic, and cultural needs, the origins of the laws that criminalise the use of natural resources have diverse origins, some of which can be traced back to Feudal Europe (Grove 1990). Certainly, the wildlife laws in many African states were largely passed under alien colonial administrations (Brockington and Homewood 1996, Marks 1984, Bell 1987, Mackenzie 1987). As such, they have little bearing on the local context other than the fact that they represent a means of controlling resources that have not been subsumed by private ownership (Lynch and Alcorn 1994).

d. Cultural definitions of hunting

This research focuses on the functional characteristics of hunting, drawing on quantitative analytical techniques. Thus, hunting is studied as a system of food production (Caughley and Gunn 1996), and hunting techniques are studied in terms of the technology used and the outcome (the volume and type of meat obtained). Nevertheless, hunting is also a social process and the cultural definitions of hunting must be considered simultaneously. With reference to 'techniques' in general, Mauss (1935) describes them as "*actions which are both* effective *and* traditional ...". Thus, contemporary hunting behaviour among the Azande is based on a combination of traditional and imported ideas interacting in a complex social environment. Thus, hunting techniques are more than simply the optimal means of obtaining meat within ecological and economic constraints.

An accurate description of hunting techniques among the Azande must take into account religious and 'magical' phenomena (Evans-Pritchard 1972). Certainly the cultural expression of magic (rituals) appears to have physical consequences that were perhaps overlooked during the planning of this study. This is best explained by using a curious example from my field work in the Zande community at Kiliwa: I undertook hunter follows over a period of seven months (the methods are described below). During the first month, the outcome from the hunts in which I participated was felt to be unusually poor by many of the hunters, and several hunters suggested that my presence was contributing to this. After consistently bad results, a termite oracle was consulted by a hunter. The oracle concluded that I had been bewitched. I was approached and instructed to discuss the matter with the 'culprit' who was a hunter that I knew well. I spoke to this hunter, stressing that I was merely curious. He rejected the accusation, and I did not pursue the issue any further. About a year later, on analysing the hunting data, I was intrigued to find a significantly higher hunting success rate in the month after this incident than in the month before: the average hunt yield 0.12 kg of meat before the incident and 1.34 kg after (one-tailed, independent samples t-test, $t = 6.95$, $p < 0.01$, $n = 36$).

Whilst this may be dismissed as a type 1 error, scientific rigour would dictate that other explanations should be sought. For example, the size of an individual's bushmeat harvest is socially constrained, because an unusually successful hunter is likely to incite jealousy from other members of the community. In Zande communities, as in many other cultures, accusations of witchcraft are often the expression of jealousy (Evans-Pritchard 1972). Accusations of witchcraft enable an individual to target the animosity of a whole community against a successful hunter by drawing on the community's fear of the supernatural. This provides a powerful incentive for restraint in the volumes of meat that are harvested from the wild. Consequently, the effects of magic and witchcraft on the volume of an individual's bushmeat harvest may be as important as the availability of wildlife, the technology or the skills of the hunter.

Thus, the cultural properties of hunting behaviour can be pictured as traditional hunting systems superimposed to varying degrees by modern techniques and approaches. The use of firearms, for instance, may appear to represent a significant departure from traditional hunting techniques. Nevertheless, hunters using firearms have retained a number of traditional traits, such as the rules determining the distribution of the catch, and certain clanic taboos on the species that can be hunted (Evans Pritchard 1972). Certainly, the magical dimensions to hunting behaviour are not exclusively Zande, nor are they exclusively a tool for restraint. For instance, magic is used in Southern Africa to the extent that certain sport hunting companies use magic as a means of securing a kill for their clients (K. Wilson, *pers comm.*).

In summary, hunting takes place in a wide cultural, economic and ecological context which has to be studied as a whole if hunting techniques are to be appreciated. This study tests the importance of the economic and ecological dimensions of hunting. This can help to understand the importance of other factors that influence how people hunt. These are addressed in the discussion. For the purposes of this study a simple classification of hunting techniques which encompasses many of the facets of hunting is given in Figure 9.1:

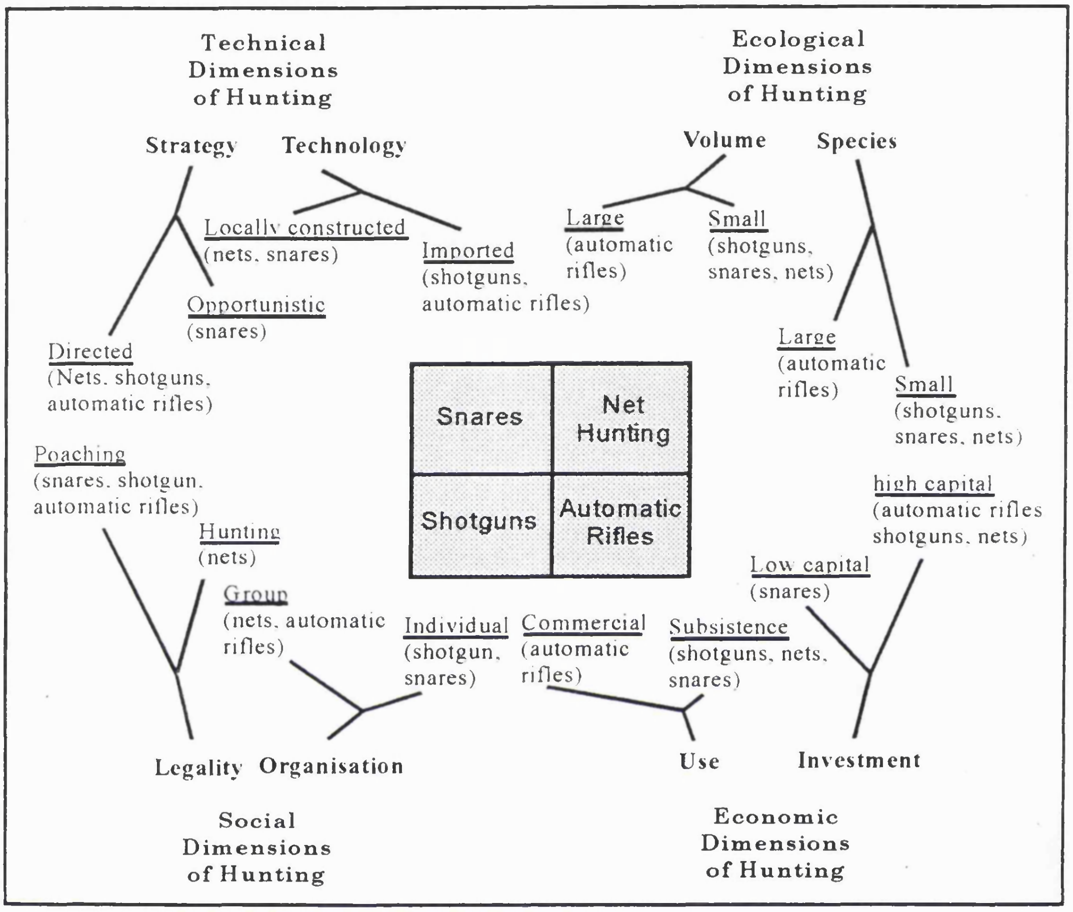


Figure 9.1. The characteristics of hunting

9.3 Research questions

The data were analysed to explore and test hypotheses that helped to understand hunters' decisions whilst hunting. The principal factors that explain the variations in hunting success are explored. The research hypothesis is: hunters show restraint by limiting their harvests (see Figure 1.1)

9.4 Methods

The methods used to collect data on hunting were designed according to the specific hunting practices observed at Kiliwa and Mamba. A pilot study was undertaken over a five month period, during which time the nature of hunting was discussed. Hunts were undertaken with local hunters with a view to building a qualitative understanding of the range of hunting patterns and techniques. Hunter surveys were undertaken with individuals and groups of hunters. Similar techniques have been used extensively in South America (Smith 1983, Alvard 1993, 1994) and in Africa (Marks 1994). Focal subject sampling provided a basic framework within which data on the hunt was collected so that:

1. all occurrences of specified actions of an individual, or specified group of individuals, are recorded during each sample period;
2. a record is made of the length of each sample period.

(from Altmann 1974).

To ensure a minimum of bias in the hunter survey data, hunters were selected from the sample of households described in Chapter 8. This offered a number of additional advantages. Firstly, hunters were gradually identified as the study of household consumption progressed, and the use of the meat could be monitored after the hunt. Secondly, an estimate for the number of hunters in the population could be calculated (Table 9.2). The men in each of the households that took part in the consumption surveys were questioned about their hunting practices. After two months of household surveys, a relatively complete list of hunters undertaking various types of hunting was compiled. Permission to join the hunt was solicited from the hunters. Care was taken to participate in an equal number of hunts with each of the hunters in order to avoid a bias towards the results of any particular hunter.

9.4.1 Shotguns

The hunter was consulted several days before the hunt and a date and time for the hunt was agreed. The group (the hunters and researcher) would form at the hunters' home about half an hour before the hunt was due to start. The hunt was divided into a series of stages:

a. The journey to the start of the hunt

The start of the hunt was marked by the hunter preparing the shotgun and removing the cartridges from a sack. Data were collected on the time taken to reach the hunting site, and the mode of transport (walking or cycling).

b. The hunt

This corresponded to the period when the hunter was actively seeking animals to shoot. Data were collected on a broad range of variables including

a. search time and stalking time;
b. the amount of time spent in each habitat;
c. species characteristics: the species encountered and whether they were stalked, number of individual animals in the group;
d. the outcome: the number of shots, animals that were killed, wounded or missed, the weight of the animal killed and the use of the meat after the hunt.

c. The return journey

Time taken to return to the hunter's home was recorded. The hunter usually stated when the hunt was complete, although this could be difficult to determine because a number of animals were encountered and subsequently shot on the return journey.

A sketch map was drawn during the hunt to record the positions of the above data. These data were then transcribed to a more accurate map based on Landsat TM satellite data.

9.4.2 Automatic Rifles

Whereas shotgun hunts could be monitored directly, it was not possible to participate in the hunts using automatic weapons because of the legal implications: the unauthorised possession of automatic weapons in Congo is an offence in terms of both the conservation laws and the criminal law. For this, and for security reasons, the researcher was unable to participate in the hunt. Thus, research data were collected by interviewing the hunter. The hunters were visited prior to the hunt, and the researcher waited at his household until his return. On the hunters return, an interview was undertaken to obtain data on the hunt, described above. The meat obtained from the hunt was weighed directly, and a description of the animal was made by direct observation.

9.4.3 Net hunting

Information on a forthcoming net hunt could usually be obtained several days before it was due to occur because it involves a considerable amount of planning. The organiser of the hunt was approached and if his permission was granted, he was interviewed to obtain information on the other participants. The roles played by each of the hunters and equipment of each member of the hunt was recorded, together with their relationship to the organiser and to each of the other members of the hunt. The hunt was followed and same data were collected as for shotguns.

9.4.4 Snares

Snare hunting was difficult to monitor directly because of the protracted nature of the hunt: when a snare is laid, it may remain in place for up to five months. Furthermore, the members of the household check the snares opportunistically and at irregular intervals. As a result, the animals that were caught were nearly always consumed before the researcher could record data directly. Thus, data had to be based on hunters recalling the events of the hunt.

Before the snares were monitored, the researcher spent time discussing the objectives of the study and the kinds of data that were required with members of the household. If the household agreed to participate in the research, each snare was visited and the time taken to reach and check all the snares was recorded. Subsequently, the household was visited twice a week and the owner of the snares (usually the head of the household) was interviewed on the success of the snares since the last visit. Data on the characteristics and use of the animals caught are recorded.

9.5 Results

Analyses of the hunting data are divided into three sections. The first section is essentially descriptive, but provides a quantitative framework to understand the four hunting techniques practised at Kiliwa and at Mamba. The second section is a simple cost benefit analysis of hunting decisions. It analyses the variation in overall hunting outcomes based on the decisions that hunters make including the technique used, the time invested in hunting, the capital and recurrent costs of hunting, and the location where a hunter choses to hunt. The third section examines the choices that are made by hunters concerning the number of animals that they choose to pursue. This analysis tests the factors which determine whether a hunter will choose to continue to pursue game or to end the hunt after having killed an animal.

9.5.1 The characteristics of hunting

Table 9.2 shows the number of hunters that were surveyed at Kiliwa and Mamba. Those surveyed at Kiliwa were drawn from the systematic sample described in Chapter 8. This makes it possible to estimate the proportion of hunters that engage in the various forms of hunting in the community at Kiliwa (Figure 9.2.a.), together with the statistical precision that can be placed on these results. Hunters in Mamba had selected opportunistically because there was no sampling frame. Therefore the results from Mamba cannot be used to estimate the proportion of hunters in the population.

Table 9.2. Number of hunters and hunts undertaken at the two study sites for the various hunting techniques (including the estimates for the percentage of hunters to the total population, standard errors (α) and 95% confidence intervals in Kiliwa, n = 128).

Site	Shotgun hunts	Automatic rifle hunts	Net hunts	Snares
Kiliwa	Hunters = 9 Surveyed hunts = 53 (7.44%. α = 0.024. ± 0.048%)	Hunters = 1 Surveyed hunts = 10 (0.83%, α = 0.008, ± 0.016%	Hunters = 54 Surveyed hunts = 8 (44.6%, α = 0.45, ± 0.9%)	Hunters = 38 Survey weeks = 172 (31.4%, α = 0.42. ± 0.84%)
Mamba	Hunters = 6 Surveyed hunts = 34	Hunters = 3 Surveyed hunts = 9	Hunters = 16 Surveyed hunts = 5	Hunters = 14 Survey weeks = 64

The use of space by hunters is shown in Figure 9.2b. and Figure 9.3. These data show the position of animals, killed using the various hunting techniques, relative to the village. Only Kiliwa was mapped because the researcher was not sufficiently familiar with the landscape around Mamba to be able to locate the position of kills. Nevertheless, the approximate distance from the point of departure could be estimated at both Kiliwa and Mamba. The results clearly show the important differences that exist in the distance that hunters are prepared to travel, according to the hunting technique that they are using.

Figures 9.2d. and 9.2e. show the outcome of the hunts. These results show the very clear advantage that hunters have when they use automatic rifles, both in terms of the volumes of meat and the reliability of this form of hunting. These differences were shown to be statistically significant in all cases (Table 9.3). Figure 9.4d. shows that the animals obtained through the use of automatic rifles are considerably larger than those obtained with nets and snares. Furthermore, the rate of success is highest for those hunts using automatic rifles.

Most of the meat that was obtained through the use of firearms was sold either at the market place or directly from the household to local traders (Figure 9.2c). Meat obtained from nets and snares was largely consumed by the family of the hunter, although an important proportion was also provided as a gift to other households.

9.5.2 Costs and benefits of hunting decisions

This analysis examines the financial incentives of hunting based on the costs and the benefits of various options that are available to hunters. The financial benefits of hunting were calculated by converting the volumes of meat obtained from the hunter surveys to market values using the market survey data described in Chapter 10. A number of decision variables were examined. Including the hunting technique, the hunting site, and the time invested in hunting.

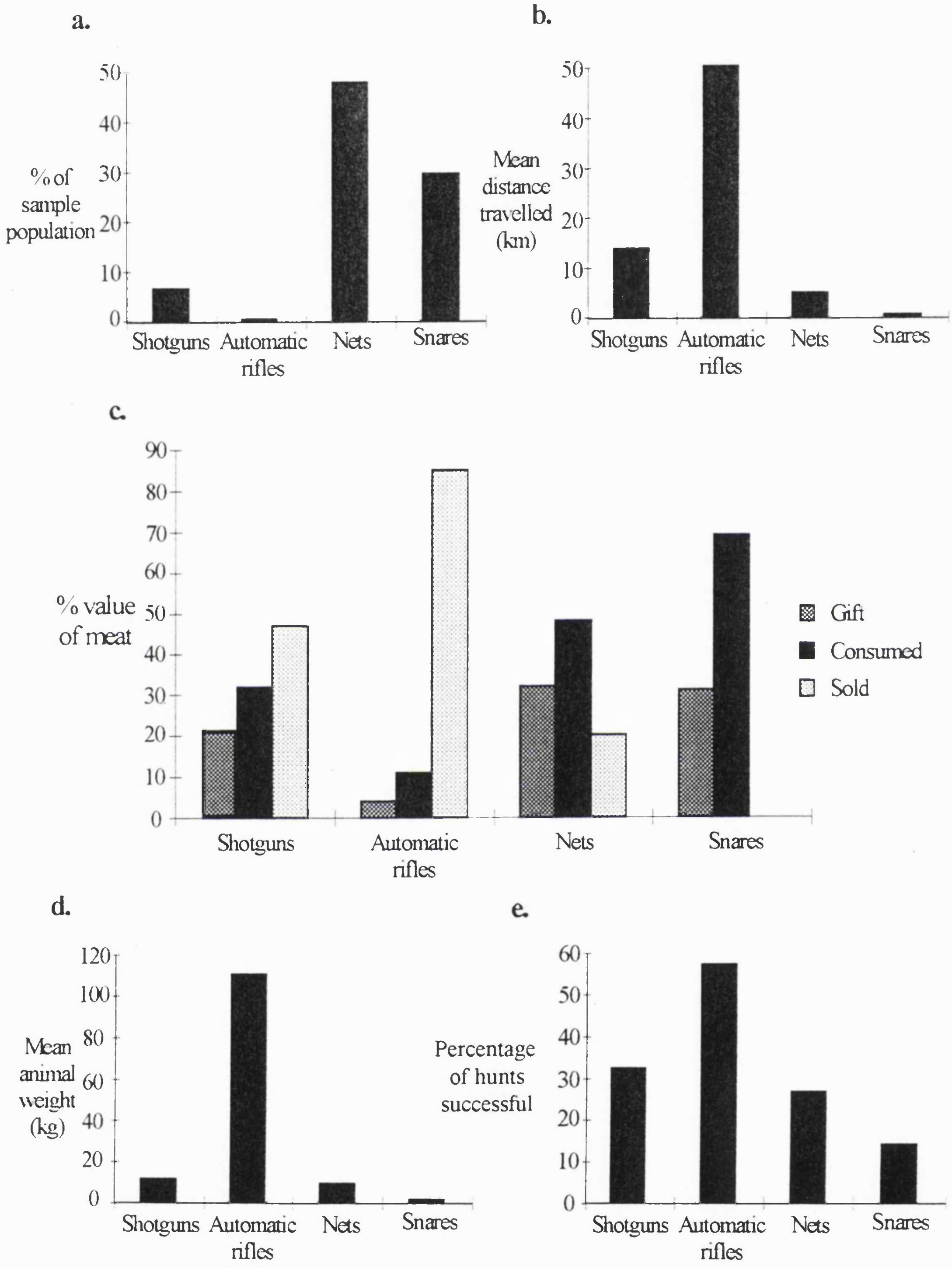


Figure 9.2. Characteristics of the four surveyed hunting techniques in Kiliwa and Mamba.

a. Proportion of sample population of households (n=121)

b. Distance travelled from the village during the hunt (n=335)

c. Use of the hunted meat (n=74)

d. Mean weight of animals killed (n=74)

e. Percentage of hunts resulting in a kill (n=335)

Table 9.3. **Kruskal Wallis tests to show the significance of the differences between the major hunting techniques practiced at Kiliwa and Mamba.**

Variable	Mean*				N	X^2	P
	A	B	C	D			
Percentage of the population	7.8	0.78	47.1	29.3	121	6.21	< 0.01
Distance travelled (Km)	14.2	49.3	6.2	0.8	335	4.27	< 0.01
Proportion sold	48.1	87.2	19.9	0	74	22.1	< 0.01
Animal weight	13.2	114.1	11.4	1.8	74	18.2	< 0.01
Success rate	0.08	0.21	0.01	0.03	335	5.3	< 0.01

*A = *Shotguns*, B = *Automatic Rifles*, C = *Nets*, D = *Snares*

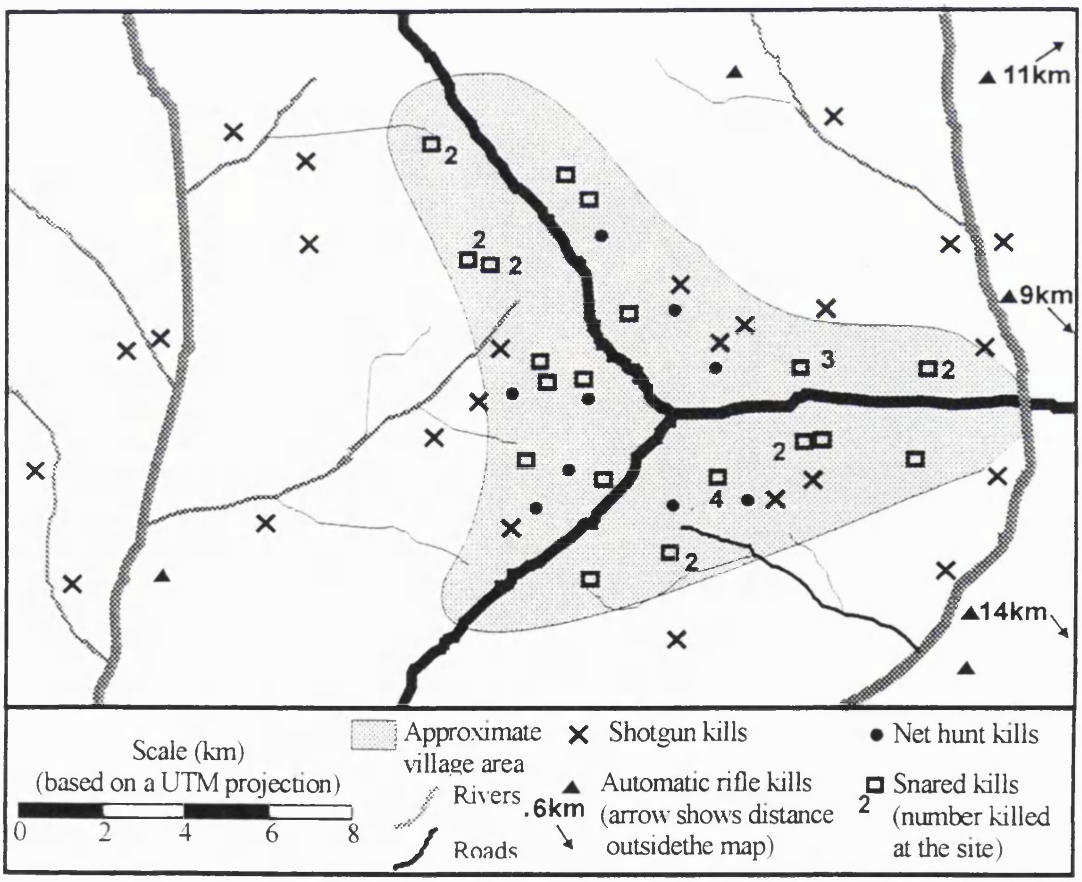


Figure 9.3. The approximate locations of kills made around Kiliwa village during the hunter surveys

Two additional explanatory variables were associated with the choice of hunting techniques: capital and recurrent costs of hunting equipment. The capital cost of hunting equipment was calculated based on the average price of the equipment (all the hunters were questioned on the price of their equipment). The recurrent costs, such as bullets, cartridges or snares (based on the rate of loss that could be expected from snare hunting) of hunting were obtained from market prices. Rates for the loss of snares were estimated from the weekly survey data. Hunting using nets had low recurrent costs because the materials used to construct and maintain the nets were gathered locally from the natural vegetation.

The proportions of each hunting technique had to be equal in each of the two samples in order to have unbiased results for the subsequent analyses. To achieve this, a number of hunt results were removed from the analysis using random number tables (Table 9.4). The final variable, time spent hunting, was based on the data recorded during the hunter surveys.

Table 9.4. Number of hunter surveys undertaken at the two study sites for the various hunting techniques (the number removed from the analyses to make the proportions of techniques equal in each site are shown in brackets).

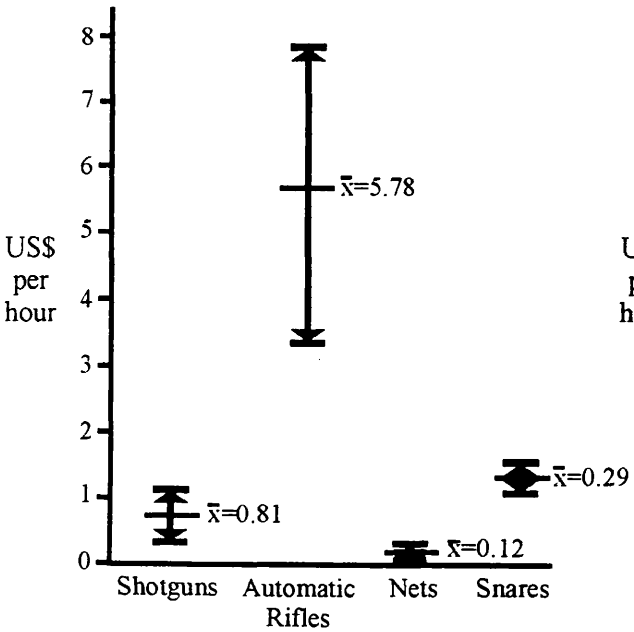
Site	Snares*	Net hunts	Shotgun hunts	Automatic rifle hunts
Kiliwa	172 (-70)	8	53	10
Mamba	64	5	34 (-1)	9 (-3)

*survey weeks

Generalised linear modelling analysis shows the factors that significantly explain the variation in the profits from a hunt (Table 9.5). Poisson errors were used because of the high proportion of zeros in the outcome from the hunts (the distribution of errors is skewed towards the lower values), and because the predictor variable could not be less than zero (Crawley 1993). The results show that the difference between the four hunting techniques explain most of the variation in revenue generated from the hunt. It is interesting to note that the difference between the revenues from hunting at the site of high animal abundance was not significantly different from the revenues at the site of low animal abundance. This is shown more clearly in Figure 9.4 which shows the mean and standard errors of the revenues from hunting according to the hunting technique used and according the site. Thus, if hunters want to increase their yields, their choice should be to use alternative hunting techniques, rather than opt for higher density sites.

Table 9.5. Generalised linear model using Poisson errors showing factors explaining the variation in financial returns from hunting (US $ per hour)

Explanatory variables	Link function	Linear Predictor	% variation explained	X^2	Change in DF	P
1. Technique: Shotguns (Constant) Automatic rifle (x_i) Nets (x_{ii}) Snares (x_{iii}) 2. recurrent cost (x_{iv}) 3. Interaction of capital cost and time (x_v)	$\log_e$	$\log_e y = -25.34 + 17.15 \log_e x_i + 16.85 \log_e x_{ii} + 23.65 \log_e x_{iii} - 0.17 \log_e x_{iv} + 0.17 \log_e x_v$	47.06	48.43	6	< 0.001



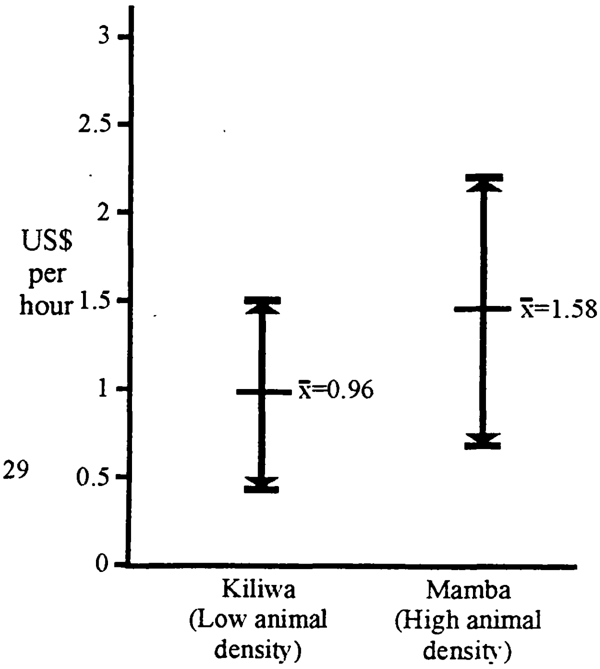


Figure 9.4. Revenue from hunting according to the techniques used and the abundance of wildlife (US$ per hour, showing mean values and 95% confidence intervals).

9.5.3. Analysis of hunters' choices

This analysis assesses the outcome of hunters' choices after killing an animal. This is achieved by examining what happens after the first kill has been made. If the animal was killed at or near the end of a hunt, this is taken to be an indication that the hunter chose not to pursue game further. Conversely, if the animal was killed in the early stages of the hunt, this indicates that the hunter chose to continue hunting after making a kill. The x axis in Figures 9.5 and 9.6 show the proportion of the duration of the hunt. Thus, a kill plotted as 0.1 indicates that the kill was made in the initial stages of the hunt and, therefore, the hunter decided to continue hunting after making a kill. Conversely, a kill made at 0.9 indicates that the hunter has refrained from further hunting after making a kill.

Figures 9.5 and 9.6 relate the hunters decision to pursue game after making a kill according to the size of the animals killed and to the distance from the village. The results are also classified according to the method used to kill the animal (snares are not included in the analysis because they involve different choices). The patterns reveal that the decision to pursue more game is highly correlated with both the size of the animal and the distance from the village where the animal was killed (Table 9.6). Thus hunters ceased to persue more animals after killing large animals, at greater distances from the village.

The generalised linear model in Table 9.7 examines all the variables simultaneously as part of an analysis of covariance. This analysis revealed that there is cross correlation between the animal weight and the distance from the village where the animal was killed. It also shows that most of the variation in the decision on whether to pursue more prey is explained by the techniques used. In other words, hunters that used automatic rifles were less likely to pursue more prey after they had killed an animal. The interaction of hunting technique and animal size is also statistically significant. This shows that hunters will be influenced by the size of their catch in their decision on whether to pursue the hunt further, irrespective of which hunting technique is used.

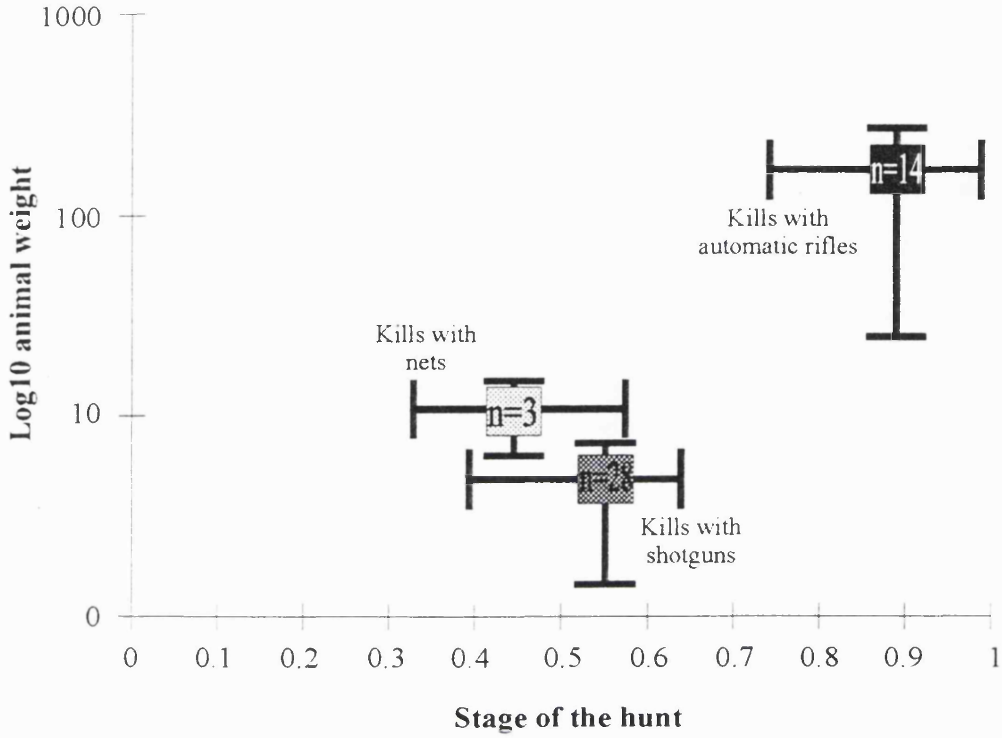


Figure 9.5. Stage of the hunt at which a kill was made relative to animal weight (error bars each show one standard deviation from the mean)

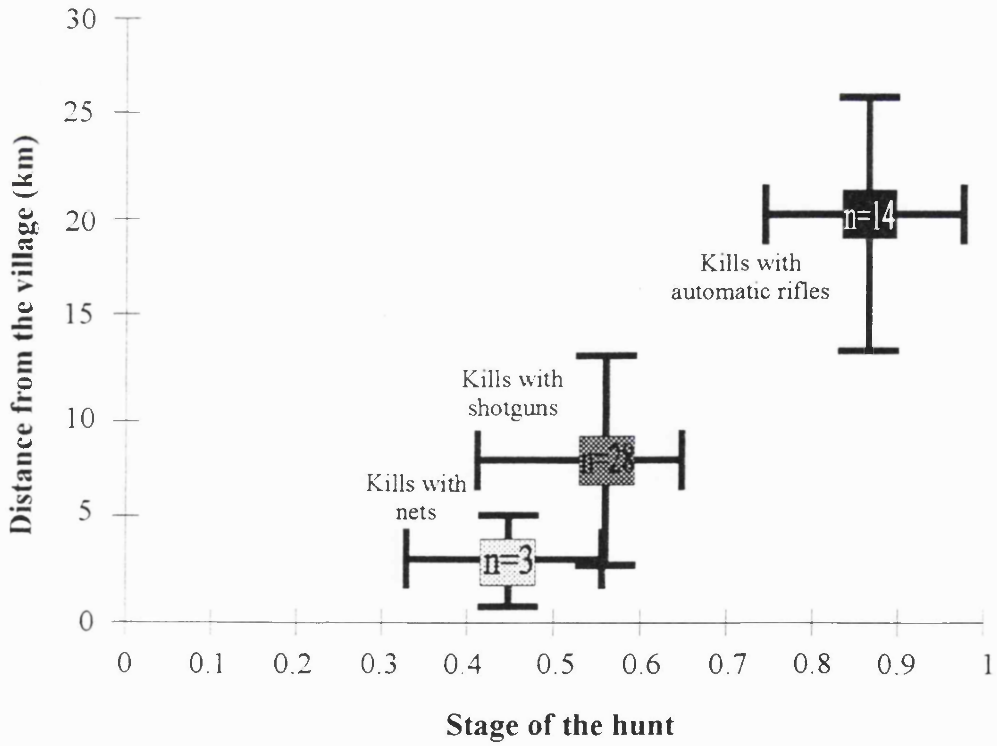


Figure 9.6. Stage of the hunt at which a kill was made relative to distance from the village (error bars each show one standard deviation from the mean).

Table 9.6. Spearman's rank correlations showing the relationship between and size and distance from the village and the stage of the hunt.

	r	P
Animal weight	0.46	< 0.001
Distance of the kill from the village	0.39	< 0.01

Table 9.7. Genaralised linear model showing factors explaining the variation in financial returns from hunting (US $ per hour)

Explanatory variables	Link function	Linear Predictor	% variation explained	F	Change in DF	P
1. Technique: Shotguns (Constant) Automatic rifle (x_i) Nets (x_{ii}) 2. interaction of animal weight and hunting technique (x_{iii})	e = -0.32	$y^{e-0.32} = 0.435 + 0.45\, x_i^{e-0.32} - 0.11\, x_{ii}^{e-0.32} + 0.05\, x_{iii}^{e-0.32}$	38.52	25.06	3	< 0.001

9.6 Discussion

This section discusses the patterns of hunting behaviour, the factors contributing to people's hunting decisions and their implications for 'consumption based' wildlife management described in Chapter one of this thesis (see Figure 1.1).

9.6.1 Hunting patterns

The results show that the patterns and outcomes of hunting are highly variable. But, this can largely be explained by the choice of hunting technique. Of the five characteristics of hunting examined (proportion of village population, distance travelled by hunters, use of the meat, animal weight and percentage of hunts resulting in a kill, see Table 9.3 and Figure 9.2), all showed significant differences according the hunting technique used. Hunters using automatic rifles, in particular, showed markedly different resource use patterns to all other hunters. They represent a minority of the population, hunt at greater distances from the village, are much more successful in the frequency and volume of meat they obtain and tend to sell most of their catch.

These differences can partly be explained by the technology. Automatic rifles are more reliable than shotguns, and allow the hunter to kill much larger animals than any other hunting tool. The effect of technology on the outcome of a hunt has been well documented in Amazonia by Yost and Kelley (1983). They quantify the benefits of using shotguns, blowguns and spears and show the significant increase in productivity that can be acheived by using firearms. Their results emphasise the significance of the technology used in explaining variation in hunting productivity. However, the Amazonian study was based on data from two different communities. One community used firearms and the other blowguns and spears. Therefore their study cannot be used to understand the hunting choices that are made by hunters in each of the two communities, because their options are not the same.

9.6.2 Hunting decisions

The analysis of the costs and benefits of hunting reveal an interesting apparent contradiction: the significantly higher benefits from hunting with automatic rifles are not counterbalanced by correspondingly high economic costs. Indeed, both the recurrent and capital costs of hunting with shotguns are higher than those of hunting with automatic rifles (the cost both of a shotgun and of shotgun cartridges are significantly higher than an automatic rifle and bullets). These differences are interesting because they contrast with the results that would be predicted using optimal foraging models (see Alvard 1993, 1995, Smith 1983, Stephens and Krebs 1978), which predict that hunting decisions are the outcome of rate maximising criteria. These criteria should encourage hunters to use the optimal hunting technique to gain the highest profits. This would predict that hunters would automatic rifles on large mammals at considerable distances from the village. These data show that only a small minority of hunters at Kiliwa decide to hunt using the rate maximising techniques. This provides strong evidence to suggest that hunters base their decisions on wider, possibly non-economic, incentives and constraints (see Table 9.1).

Discussions held with hunters during the hunter surveys revealed that many hunters felt that the risk of being caught with an automatic weapon outweighed the benefits of obtaining the much higher yields. A number of studies have examined the relationship between people's hunting behaviour and law enforcement. Milner-Gulland and Leader-Williams's (1992) analysis of the effect of law enforcement on hunting patterns examines the trade-offs between the severity of the penalty and the chance of being caught. They conclude that the probability of being caught has a more significant effect on people's hunting decisions than the severity of the punishment. People were dissuaded from hunting illegally if the probability of being caught was high, but not necessarily if the penalty was high.

Thus, a regime of high penalties for illegal hunting associated with a low probability of being caught by National Park guards is unlikely to deter hunters from hunting illegally. At Kiliwa, National Park guards are rarely present and generally have a limited impact on people's hunting activities. Nevertheless, people still claim to avoid illegal hunting (ie. with automatic weapons), and the data show that only a small proportion of the populations are recorded as hunting with automatic weapons (Table 9.3). The constraints on people hunting with automatic weapons are therefore more complex than simply the effect of the wildlife authorities' law enforcement activities. The real constraints on hunting with automatic weapons appear to relate more to the risk of possessing an automatic weapon than to using it for hunting. This is for two reasons. Firstly, the Groupement Ungua, which contains both Kiliwa and Mamba is administered by a traditional chief who has been active in taking automatic weapons out of circulation. Enquiries into the chief's activities revealed documentary evidence (*remise d'armes*) for 61 automatic rifles handed over to military and civil authorities since 1991 (Sangbalenze 1995).

The second disincentive for using automatic weapons relates to the heavy military presence in the region. Whilst certain soldiers at the time of study were known to take an active part in hunting using their automatic weapons, they also seemed intent on preventing civilians from possessing their own automatic rifles. Indeed, all of the hunters who were observed using automatic rifles had borrowed them from soldiers, and were subsequently indebted to them. A significant proportion of the animals killed had to be given to the owner of the rifle. Thus, borrowing a rifle from a soldier provides a means of significantly reducing the risk of being caught in possession of an illegal weapon because the hunter is not in permanent possession of the rifle. Furthermore, he is likely to benefit from the protection of the soldier who owns the rifle.

Another factor which explains the use of 'less profitable' forms of hunting is the social function of some forms of hunting, especially net hunting. Net hunts are typically undertaken on Saturday or Sunday mornings. They provide a focus for groups of men that have strong family or friendship ties to participate in an activity that could be described more appropriately as sport than an economic activity. Furthermore, much of the meat that is caught is often used of social occasions such as the *retour de deuil* (these are commemorative celebrations carried out forty days after the death of a relative and then repeated one year later). There were relatively few instances of individuals selling meat that had been obtained through a net hunt. Meat from net hunting was the product of a collective activity, whereas the selling of meat at the market usually only benefits the individual. Whereas the killing of game individually generates greater profits, hunting collectively brings prestige based on the cultural values of reciprocity and mutual support. The effects of these values on hunting behaviour have been extensively documented in the social anthropological literature. For instance, Lee (1979) describes the social trade-offs that are implicit to the hunting decisions of the !Kung San on the border of Botswana and Nambia. Whereas the killing of game and the distribution of meat brings prestige and status to the individual, cultural values based on reciprocity, modesty and egalitarianism act against individuals profiting from large harvests.

Snare hunting also appeared to be a less profitable form of hunting. However, hunting with snares differs substantially from the other forms of hunting. Hunting with nets or firearms correspond to Bahuchet's (1971) *direct* form of hunting, and requires all of the hunter's time and attention during the hunt. Snaring, on the other hand, is an *indirect* form of hunting and can be combined with other economic and social activities, such as agriculture, going to the market or visiting friends. The incentives to hunt were based on the weight of meat obtained per hour, and the time required to check snares was calculated by visiting each of the snares with the owner. In reality, the owner checks the snares opportunistically, and often the time used in checking the snares coincides with agricultural work and the owner is not diverted from other activities. Therefore, time is not usually a constraint for snare hunting. Nevertheless, the cost of the snares makes this form of hunting less profitable than many other forms. Furthermore, snares can easily be lost or stolen.

In discussing snares with household members, it was evident that they are valued for a variety of reasons. They are considered to be a low cost means of obtaining meat relying on a technique which involves all the members of the family, and not just the male head of the household (hunting with nets and firearms is an exclusively male activity). This means that members of the household, other than household men, are prepared to invest their time and money in snare hunting. Small nylon snares are preferred to the larger metallic snares which are more expensive. Furthermore, metallic snares have to be placed at greater distances from the household where larger mammals are more abundant. As a result, a greater number of metallic snares are lost or stolen when compared with nylon snares. Furthermore, nylon snares that are placed in close proximity to the fields where they are believed to protect the fields from animal crop raiding and require little additional travel.

9.6.3 Self regulation by hunters

The conservation implications of these results are better understood by re-examining the results of Chapter 5. These results showed that, on the whole, species diversity or abundance did not appear to be influenced by proximity to agricultural population settlements. However, large herbivores were significantly more abundant near to the national park, where they are protected. This pattern is consistent with the results of the hunting data presented in this chapter. The returns from hunting techniques which target smaller mammals (using nets, snares and shotguns) produced significantly smaller yields than automatic rifles. Furthermore, they targeted smaller species which typically have higher intrinsic rates of reproduction, and are therefore less prone to population depletion from wildlife harvesting (Caughley and Gunn 1995, Robinson and Redford 1991). Shotgun, net and snare hunters hunt close to, or within, the village because they claim that their chances of making a kill are no greater further away. This suggests that the areas around the village are not heavily depleted.

In contrast, harvesting patterns associated with the use of automatic weapons show signs of producing unsustainable yields: large herbivores which tend to have a low intrinsic rates of reproduction are targeted. The results of the analysis of the financial benefits of hunting (Table 9.5) revealed that there was no significant difference in the profitability of hunting large herbivores in a relatively high abundance area (Mamba) versus a low abundance area (Kiliwa). This implies that wildlife harvesting that is driven by financial incentives is not dependant on the density of the large herbivore populations. In other words, it is nearly always profitable to hunt large mammals, even when they are at very low levels of abundance. This is because the profits from killing single large mammals always outweigh the costs of a hunting expedition, even if the expedition lasts several days. Thus, animal density dependant regulation is unlikely to occur when hunters use automatic rifles. This provides an explanation for the spatial patterns of mammal community structures around the hunting reserves (see Figure 5.4). Those mammals that appeared to be significantly influenced by distance from the National Park were the large herbivores. These animals are targeted by hunters using automatic weapons who are prepared to travel considerable distances to hunt them. Thus, large herbivore abundance is greatest where they are actively protected in the National Park. by contrast, the optimal locations for hunting smaller mammals are nearer to the villages, because hunting does not seem to provoke systematic depletions.

The evidence for deliberate restraint on the part of the hunters was tested by looking at their decisions on whether to end or continue the hunt after killing an animal. The data revealed that hunters were more likely to end a hunt after a large animal had been killed (Figure 9.4). If a small animal was killed, hunters were likely to continue the hunt. This is likely to correspond to an optimal economic decision, as opposed to a deliberate conservation decision. The threshold, representing the critical animal weight when hunters decided to terminate the hunt, was based on the hunter's limited ability to carry the meat back to the village. Ending the hunt due to weight limitations has been described as an optimal foraging constraint by Stiner (1991). Obtaining more meat than could be returned to the village in one trip was sometimes futile. For example, it was reported that much of the meat from a hippopotamus killed in the reserves was stolen because hunters were unable to transport all of the meat back to the village in one trip. The meat was unguarded for a period of six hours which was sufficient time for other people to steal the meat.

When distance from the village is examined as a factor explaining the decision to end the hunt, the same pattern emerges. Hunters are more likely to end the hunt when they are at a greater distance from the village (Figure 9.6). The opposite pattern would be expected if hunters were making conservation based decisions: hunters should show restraint in the more depleted sites near the village. However, this conclusion is probably over simplified. When the results shown in Figure 9.5 are examined according to the hunting technique used it is evident that the decision to end the hunt is best explained by the hunting method used: animal size and distance from the village are both dependant variables of hunting techniques. Hunters using shotguns, nets or snares tend to hunt near to the village and are constrained to smaller animals because of the limitations of the technology. They tend to continue hunting after having made a kill because the constraint of having to carry a small carcass does not prevent them from hunting further.

The pattern of kills with distance from the village shown in Figure 9.6 seemed to be more or less random, suggesting that shotgun hunters have an approximately equal chance of making a kill at any distance from the village. Most shotgun hunters began searching for animals almost immediately after leaving their home, and continued searching with increasing distance from the village. After making a kill, they generally continued hunting in the hope of killing another animal. With a few exceptions, these hunters rarely stalked an animal for more than 15 minutes. In contrast, hunters with automatic weapons didn't begin to search until they were at considerable distances from the village. Usually they set off on bicycle, and began the hunt at least ten kilometres from the village. They tended to commit themselves to one animal, and would stalk it for several hours, or even days. This strategy can be seen as a process contributing to the depletion of a prey population: hunters are prepared to invest considerable amounts of time into killing large mammals throughout the reserves even when large mammals are relatively scarce.

These analyses help to assess the relevance of Alvard's definitions of conservation to the hunting communities around Garamba National Park. Hunters using shotguns or nets do not appear to cause population depletion. This conclusion is based on the results of this chapter as well as those of Chapter 5. Firstly, hunters hunt in close proximity to the village suggesting that there is sufficient animal abundance to make hunting worthwhile. Secondly, the animal abundance data, derived from the line transect data in Chapter 5, did not show a significant reduction with increasing proximity to populated areas. Nevertheless, there is no evidence to show that these hunters are deliberately conserving their wildlife resources. Hunting patterns follow optimal decision rules and there is no evidence of restraint on the part of a hunter after they have made a kill. As such, the sustainable outcome of hunting with nets or shotguns appears to be an example of 'epiphenomenal conservation'.

Restraint on the use of snares could not be used to test Alvard's hypothesis because there is no decision process after an animal has been killed. Nevertheless, hunting with snares is usually carried out close to the hunters' homes. Qualitative data from discussions with hunters suggest that hunters do not deliberately limit their harvest if their yields exceed a certain level. Hunters using automatic weapons do appear to show restraint because they tend to stop hunting after they have killed an animal. But this is explained by their limited ability to carry large volumes of meat back to the village rather than any conservation related decision. Thus, they also carry out optimal, rate maximising, resource use.

Thus, under the current demographic and socio-economic conditions, the hunting techniques based on the use of shotguns, nets or snares, are unlikely to have a significant impact on animal populations. However, under different density relationships between hunters and prey (ie. when offtake increases as a result of an increase in the number of hunters in the reserves) this form of hunting could become unsustainable. Amongst the hunters studied there is no evidence for self regulating behaviour based on resource abundance. Under current hunting regimes, it does not appear that hunters will reduce their yields if their offtake is unsustainable. In the case of hunters using automatic rifles, it is clear that they continue to hunt at rate maximising levels irrespective of the abundance of large mammals. The extremely low rhinoceros densities at Garamba (Hillman Smith 1989) are a consequence of hunters continuing to hunt irrespective of the abundance of their prey.

9.6.4 Conservation implications

These findings contribute to our understanding of the potential for community based conservation in the Garamba ecosystem. Hunting is important in adding value to wildlife resources at the local level, and this is believed to be a condition for the long term success of a conservation programme (Eltringham 1984, Marks 1988).

However, hunters do not appear to practise conservation in the way that they hunt. Whilst it may be in the interest of the community as a whole to conserve the resource base for the future, individual hunters make optimal foraging decisions, which may result in the depletion of mammal populations. This has been shown to be the case for those hunters who use automatic rifles and target large mammals. They continue to exploit low abundance areas, such as around Kiliwa, because the technology makes it possible for them to generate high profits at very low animal densities. Nevertheless, these conclusions assume that hunters would not change their behaviour as resources become scarcer. This has been shown with the collapse in the number of rhinos at Garamba between 1960 and 1984. Only hunters using automatic rifles have been shown to hunt unsustainably. Other hunters may show restraint if the wildlife abundance were to drop significantly, but this cannot be verified from the data in this study.

The conclusion that the hunters studied do not show conservation related behaviour in the way that they hunt cannot be used as evidence to suggest that human resource use and conservation are incompatible activities. Whereas wildlife utilisation has been used as a basis for several conservation programmes (see Child 1990, Lewis *et al* 1990, Murombedzi 1991), it is unlikely, in its present form, to contribute to the conservation of mammal populations at Garamba because hunters do not show any evidence of restraint when animal populations become depleted. Nevertheless, these results suggest that certain forms of 'epiphenomenal conservation' also have the potential to give community members the incentive to conserve their wildlife. Epiphenomenal conservation, in this case is an activity that benefits conservation, but is not motivated by an explicit desire to manage the resource sustainably. Several examples of this exist, such as activities of the traditional chiefs who seize illegally held automatic rifles. The motivation to seize automatic rifles is largely explained by the chief's incentives to create a climate of stability in his area. This is because stability enhances economic development. Activities aimed at promoting stability in the region also create important constraints on the unsustainable exploitation of very large mammals in the hunting reserves. The potential of these activities for the improved conservation management of the Garamba ecosystem is described in

Appendix 4. These activities may provide a more realistic basis for community based conservation around Garamba than unregulated utilisation, and, unlike established protectionist practices, have the potential to contribute directly to local development.

9.7 Conclusions

This study has shown that the major variations in hunting are explained by the choice of hunting techniques used, either shotguns, automatic weapons, nets or snares. Hunters that used automatic rifles differed from all other forms of hunting. They hunted at greater distances from the village, killed larger prey, obtained significantly higher bushmeat yields and subsequently made much higher profits from hunting.

The analysis of the costs and benefits of hunting revealed that if hunting decisions were exclusively based on financial incentives, all hunters would choose to use automatic rifles: automatic weapons are relatively inexpensive and make very large mammals available to the hunter. Thus, the profits from hunting with automatic rifles were considerable, even at relatively low levels of large mammal population abundance. Yet the number of hunters claiming to use automatic rifles represent less than one percent of the study population. This is explained by the legal constraints on hunting with automatic rifles, and the high risks if caught, together with the non-financial incentives to hunt using other techniques. These include the social and cultural benefits that a hunter gets from group hunting.

Hunters did not show any evidence of restraint in the number of kills made. In the case of hunters using shotguns, nets or snares, populations of the species that were targeted did not appear to be depleted in the sites where they were being hunted, and therefore there is no obvious reason why hunters should show restraint. This was described as 'epiphenomenal conservation'. Hunters using automatic rifles tended to end the hunt after making a kill. however, this is better explained by the constraint of having to carry the meat back to the village rather than by any deliberate decision to refrain from hunting.

The results from this chapter complement the study of landscape scale variations in mammal abundance described in Chapter 5, particularly by the finding that the variations in animal density and abundance do not appear to be influenced by the presence of agricultural populations. These data show that shotgun, net and snare hunting result in a relatively low offtake, and targeted small mammals that were typically more resilient to population depletion from hunting than the large mammals targetted by automatic weapons. Thus, these species remained relatively abundant throughout the reserves. The large mammals, that were targeted by hunters using automatic weapons are less resilient to high levels of offtake from hunting. Furthermore, hunters were prepared to cover much greater distances to catch these large mammals. As a result, they appear depleted throughout the protected area except where they are actively protected, in the national park.

Chapter 10

Wildlife Regulations in War and Peace

10.1 Summary

This chapter explores the relationship between the enforcement of wildlife regulations and the commercialisation of bushmeat during periods of relative stability and during periods of conflict. Market surveys were undertaken in village and urban markets and patterns of trade in bushmeat are presented. A number of significant differences emerge from these analyses. An estimated 6.4% of bushmeat sold in the village markets and 58.9% sold in the urban markets consists of large protected mammals originating from the national park.

Indicators of success in wildlife protection are assessed using patrol data collected by the national park's research and monitoring programme from April 1996 to February 1997. An analysis of the variations in effective wildlife protection showed that the most important factor determining level of wildlife protection was political conflict, partly because of its effect on donor support to the centralised conservation. Effective wildlife protection dropped sharply during the conflict months of late 1996 and early 1997.

Whilst the village markets are not significantly affected by changes in wildlife protection, the urban markets showed a marked increase in the sale of bushmeat during periods of conflict. Furthermore, the bushmeat *filières* described in Chapter 4 changed significantly during the conflict months because urban traders avoided Kiliwa as a commercial centre and obtained their meat directly from the hunters at source.

10.2 Background

Trade in bushmeat has been presented as the primary threat to wild mammal populations in Central Africa (Mittermeier 1987, Feer 1993, Fa *et al* 1998). Robinson and Redford's (1991) simple model for measuring sustainability from harvesting rates provided the basis for a number of studies examining the relationship between the marketing of bushmeat and animal populations. For example, Juste *et al* (1994) undertook long term monitoring of markets in Equatorial Guinea and analysed the effects of wildlife harvesting on local mammal populations. A similar study was undertaken in the Arabuko-Sokoke Forest in Kenya by Fitzgibbon *et al* (1995). The objectives of these studies were to assess the sustainability of wildlife harvesting, and to identify those species that were subject to over-harvesting. Fa *et al* (1995) use the Equatorial Guinean market data to recommend greater regulation through "*the maintenance of already decreed protected areas ... where control of hunting is vital for conserving the endemic fauna*".

Regulating off-take is an obvious solution for reducing the amount of meat in the markets. However, there have been relatively few studies that examine the relationship between the flow of bushmeat in the markets and differing intensities of wildlife protection. This section explores the relationship between the flow of bushmeat through the Azande hunting reserve and the intensity of wildlife protection in the national park.

Chapter 4 provided an outline of the bushmeat chain through Kiliwa, highlighting that trade in bushmeat operates at two levels. A village trade relies on resident hunters providing the markets with meat which is largely sold to households within the village. A second, parallel trade operates through the village. These activities involve much larger volumes of meat, comprising large protected mammals. This meat is mostly sold in the five urban markets in Dungu. The objective of this chapter is to examine the relationship between the marketing of meat and the implementation of wildlife regulations in the protected area. Market value of bushmeat is used as an indicator of the volumes of bushmeat passing through the hunting reserves. The market in Kiliwa and the markets in Dungu are examined separately to provide a comparison of urban and village trade. These patterns are then related to the levels of wildlife protection in the park.

10.2.1 Factors influencing the efficacy of wildlife protection

Exclusion and law enforcement remains the dominant management strategy in protected areas throughout Africa (IUCN 1993). Yet there have been relatively few systematic studies to assess the efficacy of law enforcement in protected areas or the factors that may contribute to, or threaten, its success in securing a sustainable resource base. The factors which influence the efficacy of law enforcement need to be understood to establish its viability as a wildlife conservation strategy. This section will focus on the impact of two factors on effective law enforcement. First, external financial investment in wildlife protection, establishing the extent to which wildlife protection regimes are viable in the absence of external sources of funding. The second factor that will be examined is the effect of military conflict as a constraint to effective law enforcement.

Leader Williams and Albon (1989) have published data to show the levels of financial investment required to 'guarantee the integrity' of protected areas. They propose a ball-park figure of US$ 200 per km^2, yet law enforcement budgets in most African protected areas are less than five percent of this estimate (Dublin *et al* 1995). They conclude that underinvestment in wildlife protection is a major constraint for conservation in Africa. This constraint applies to the efficacy of wildlife protection at Garamba (see Box 10.1).

Regional assessments, such as Hart and Hart (1997), emphasise the consequences of conflict as the major challenges to wildlife conservation. They cite the lack of reliable financial support for protected area management as a consequence of conflict.

Box 10.1

Extracts illustrating the effects of investment and conflict on wildlife protection in Garamba National Park

Extract from a management report to donors (WWF and IUCN), by the Garamba Rehabilitation Project's Chief Technical Advisor in June 1984.

"Money for rations has been provided by FAO project ZAI/80/002 administered by Dr. P. Rodgers in Kinshasa. Guards will not undertake patrols without rations and during my time there the only patrols conducted from Nagero by IZCN staff were three simultaneous patrols of four days in search of rhinos... Salaries are extremely poor, ranging from the equivalent of US$ 4 for a labourer and US $ 10 for a senior guard."

(Mackie 1984)

Extract from a management report to donors (WWF and IUCN), by the Garamba National Park Project's Chief Technical Advisors in July 1997.

"There has been a civil war during this financial year of the project... Over 90% of the vehicles and equipment needed for park operations and anti-poaching have gone and for a period the guards have been disarmed. This led to anti-poaching patrols from March to June being 14% of those during the same period in 1996. As a result poaching has increased enormously and moved further south into the northern edge of the rhino area, along the Garamba river. Poaching has mainly been for elephants, buffalos and hippos. One rhino has been poached, probably more, but 18 individuals were seen in June, indicating at least 24 present then."

(Smith and Smith 1997)

Jachmann and Billiouw (1997) analyse law enforcement data in the Luangwa Valley, Zambia, to understand the factors that influence the success of wildlife protection. They show that investment in conservation explains the variations of success in wildlife protection.

The present analysis makes use of the extensive patrol data that has been collected by the Garamba Research and Monitoring Programme (Hillman-Smith 1997) since 1993. Whereas Jachman and Billiouw's study used poached elephant carcasses as their indicator of conservation success, this study uses the recovery of automatic weapons. This is for three reasons. First, the biological indicators of conservation success were analysed more explicitly in the previous section (for instance, elephants are known to have increased substantially in recent years). Second, elephant carcass counts are less intensively monitored than the outcome of patrols, and therefore provide a less reliable measure of conservation efficacy. Lastly, the number of automatic weapons recovered can be expressed as a rate relative to the number of patrols, and to the number of encounters between park guards and poachers. This produces rates which are less likely to have a confounding effect than the number of elephant carcasses. In other words, elephant carcasses, as an indicator of conservation efficacy, can be confounded by other factors, such as an increase in the demand for meat. Nevertheless, there are inaccuracies associated with patrol data which will be discussed below.

10.3 Methods

10.3.1 Patterns of bushmeat use in local markets

a. Market surveys

Five markets in Dungu and two markets in Kiliwa were surveyed during the period April 1996 to February 1997. Standard techniques were used to monitor the flow of all products through the market (Martin 1995). The number of stalls in the market was enumerated every two hours, and the proportion that was selling meat documented. All stall owners selling meat were interviewed and the quantity of meat available for sale was weighed. Stall keepers were questioned about the geographical origin of the meat. The meat from the Azande hunting reserve came predominantly from four locations: Limai and Kiliwa, where meat was bought by urban traders from intermediate traders (as described in Chapter 4), and Mamba and Wilibadi, where meat was bought directly from the hunters.

Meat was usually processed before being taken to the market. This involved cutting it into smaller pieces and possibly smoking the meat, to preserve it and to reduce the weight during transport. As a result, it was not always possible to recognise the mammal species from the processed meat. However, the form and texture of the meat meant that the larger, protected species were easily identifiable, and therefore it was possible to use the category of protected / unprotected to describe the meat.

The Dungu market surveys were based on a sample of the total number of market days. Two of the five markets in Dungu were open every day of the week, one market was open three days a week and two were open one day a week. This produced a total of 19 market days per week in Dungu. Each week, six of the nineteen possible markets were randomly selected to produce a sample of 282 market days, and a sampling intensity of 31.6% of all the markets days in Dungu. Thus, the value of the products passing through the Dungu markets could be evaluated using standard statistics by extrapolating from the sample mean values.

Each of the two markets in Kiliwa were open for only one day a week, Sunday and Wednesday. This made it feasible to survey every market during the study period. 92 market days were surveyed in Kiliwa, which represents a total count for the Kiliwa markets.

b. Traders' supplies

A second technique was used which provided an accurate measurement of the quantity of bushmeat leaving the Azande hunting reserve. Traders were interviewed on the road between Kiliwa and Dungu. The contents of the load of every eighth trader passing along the road was documented and weighed. The survey was maintained for seven days a month. The survey started at 6.30 am and ended at 8 pm each day. A total of 931 trader records were made between April 1996 and February 1997.

Traders were initially suspicious about the motives behind this research. However, careful explanations and discussions created a more relaxed relationship with the traders after about one month. Therefore, the first month's data (March 1996) were omitted from the analysis.

10.3.2 Efficacy of wildlife protection

Patrol data have been collected at Garamba for several decades. Since 1989, data have been systematically collected as part of the law enforcement monitoring exercise (Hillman-Smith 1997). Patrols are carried out by teams typically ranging from 10 to 20 armed guards (more recently patrols of over 30 guards have been used in response to the increased size and fire power of organised poaching groups). Data on the distribution and intensity of illegal activities have been collected as follows:

a. *Manpower utilisation records*

These are kept by the central store keeper, who also produces monthly summaries of data including the number of days patrolled by each guard, the total number of man days and patrol days undertaken each month[1], together with the number of encounters with poachers, and the number of weapons recovered subsequent to those encounters.

b. *Patrol summary sheets*

Monthly patrol summary sheets have been maintained since July 1996, providing more detailed descriptions of the nature and outcome of patrols.

c. *Direct reporting*

This is undertaken on a daily basis by patrols in the field, and the information is recorded by the radio operator at the National Park headquarters.

d. *Summary of patrols*

A new summary of patrols sheet was completed for 1997. This was a temporary measure taken during the war in 1996 to 1997 because of the absence of a store keeper. This provided a summary of the more detailed information normally collected during the debriefing of patrol leaders.

The accuracy of patrol data is difficult to assess. Guards are provided with performance related pay, and consequently, contact with poachers is probably

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[1] Man days and patrol days are not proportional because the patrol sizes have varied over the years.

exaggerated. However, payment is related to the number of days spent on patrol, together with direct indications of success, such as arrests and the seizing of arms, which make it difficult for guards to exaggerate the number of encounters with poachers.

To evaluate the accuracy of patrol reporting, the author joined a two week patrol in the north east of the National Park in June 1994. On the third day, the patrol was attacked, and subsequently pursued for about three kilometres by poachers of Sudanese origin. This incident was registered in the patrol report as a success, with the park guards causing the poachers to flee back to Sudan. This was known not to be the case. Guards experience considerable levels of stress from the high risks associated with patrolling the National Park. Consequently, the details contained in the patrol reports are not necessarily accurate. Thus, this analysis relies on tangible evidence for the reported success of a patrol, namely the recovery of automatic rifles from poachers, which is thought to provide a more accurate measure of success.

Monthly summaries of patrol days and man days are used as an index of conservation efficacy by using the 'catch - effort' ratios developed by Bell (1984). Patrolling effort (man days spent in the park and patrol days) are related to the number of contacts with poachers and the number of arms seized from poachers. Summaries based on patrol data collected between January 1992 and July 1997 are used, although a small proportion of months were ommitted because of inadequate reporting. Conservation efficacy is tested by comparing monthly summaries during periods of relative stability and during periods of conflict. The first five months of 1992 and the months between December 1996 and July 1997 were classed as conflict months.

10.4 Results

The results below first describe the analyses used to explore the patterns of variation in the outcome of patrols and the volumes and characteristics of bushmeat in the Azande hunting reserve. The assumption of normality of distribution and errors could not be maintained on either the patrol data or the market data. Therefore, non parametric data are used in the analysis. However, the only deficiency in the distribution of patrol data was a high index of skewness (0.214) on the number of weapons recovered in the park. Therefore, generalised linear models were used to explore the factors that explain the efficacy of patrols (number of rifles recovered per contact with poachers).

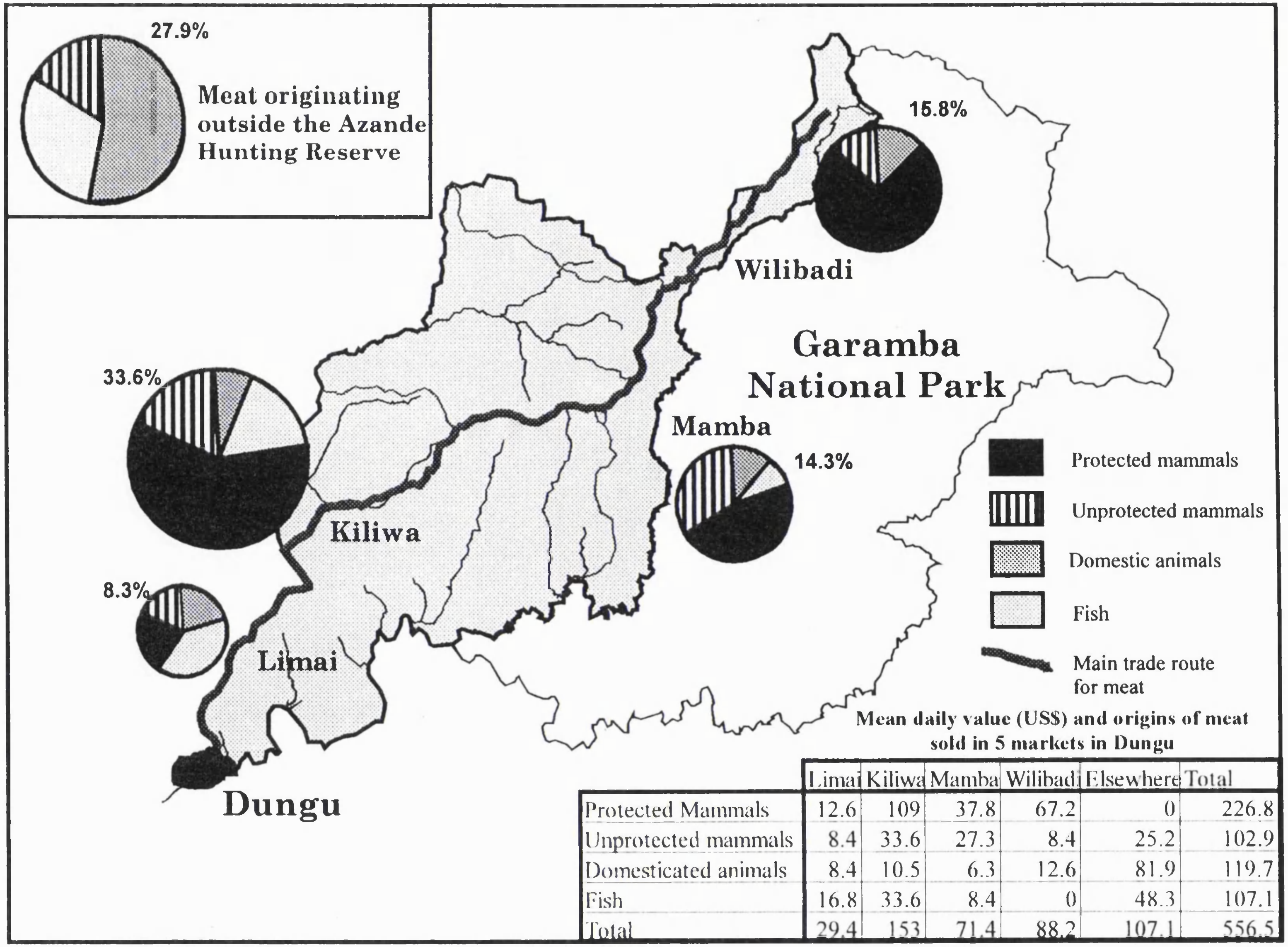
10.4.1 Patterns of bushmeat commercialisation

Table 10.1 shows the average daily value of bushmeat products passing through the markets in Kiliwa and Dungu. The value of all market products are also shown to indicate the scale of commercial activities in the respective markets, and the relative importance of bushmeat. The estimate of the value of all market products are derived from the survey of a sample of stalls.

Table 10.1. Mean daily values of products sold at the Kiliwa village market and the Dungu urban markets, with 95% confidence intervals (April 1996 to February 1997).

	Protected mammals	Unprotected mammals	All market products
Kiliwa	US$ 8.4 (total count)	US$ 34.2 (total count)	US$ 391.2 (±83.1)
Dungu	US$ 343.7 (± 79.6)	US$ 110.1 (±18.1)	US$ 10,301

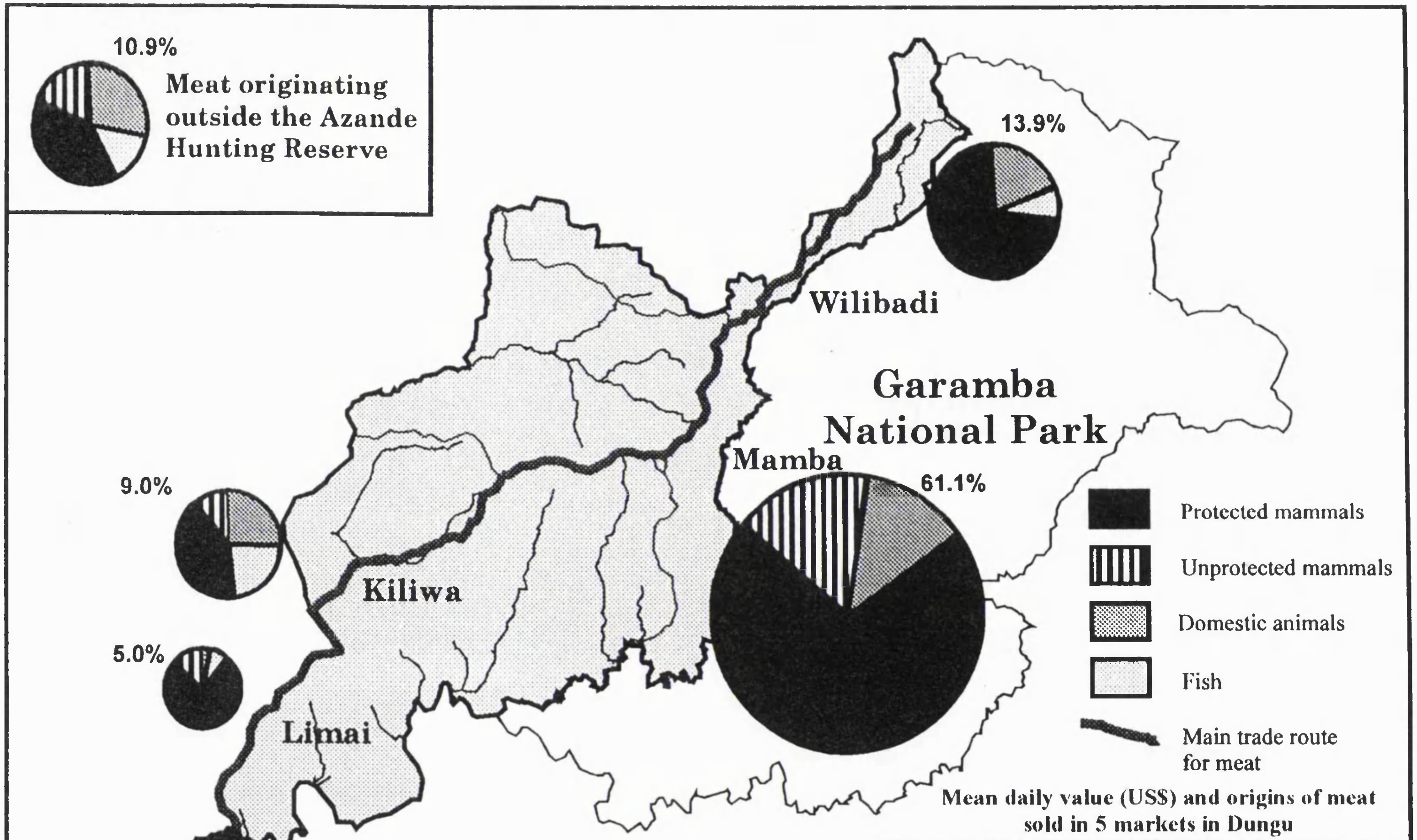
The value of meat from domestic animals and fish was also recorded in each of the markets in the same way as bushmeat. This revealed that bushmeat derived from protected species constituted 58.9% of all the meat sold in the Dungu markets and 6.4% of all meat sold in the Kiliwa markets. The origins of the meat sold in Dungu are shown in Figures 10.1 and 10.2. Figure 10.1 plots the sources and types of meat from different sectors of the hunting reserves during the politically stable period between April and November 1996, and Figure 10.2 during the period of conflict from December 1996 to February 1997. Figures 10.3 and 10.4 show the results of the trader surveys on the road between Kiliwa and Dungu. The volumes of bushmeat from protected and unprotected mammals are displayed in each of the two graphs.



Mean daily value (US$) and origins of meat sold in 5 markets in Dungu

	Limai	Kiliwa	Mamba	Wilibadi	Elsewhere	Total
Protected Mammals	12.6	109	37.8	67.2	0	226.8
Unprotected mammals	8.4	33.6	27.3	8.4	25.2	102.9
Domesticated animals	8.4	10.5	6.3	12.6	81.9	119.7
Fish	16.8	33.6	8.4	0	48.3	107.1
Total	29.4	153	71.4	88.2	107.1	556.5

Figure 10.1. Sources and proportions of meat sold at the Dungu Market during times of relative stability (April to November 1996). Pie chart size is proportional to the importance of the village in supplying meat to the Dungu markets (percentage contribution of each village to the Dungu markets is given next to each chart).



Mean daily value (US$) and origins of meat sold in 5 markets in Dungu

	Limai	Kiliwa	Mamba	Wilibadi	Elsewhere	Total
Protected Mammals	38.1	33.2	442.9	98.1	43.1	655.4
Unprotected mammals	9.4	12.2	91.6	0	18.8	132
Domesticated animals	0.7	23.4	74.1	31.7	32.6	162.5
Fish	2.1	21.1	0	8.4	14.1	45.7
Total	50.3	89.9	608.6	138.2	108.6	995.6

Figure 10.2. Sources and proportions of meat sold at the Dungu Market during times of political conflict (December 1996 to February 1997). Pie chart size is proportional to the importance of the village in supplying meat to the Dungu markets (percentage contribution of each village to the Dungu markets is given next to each chart).

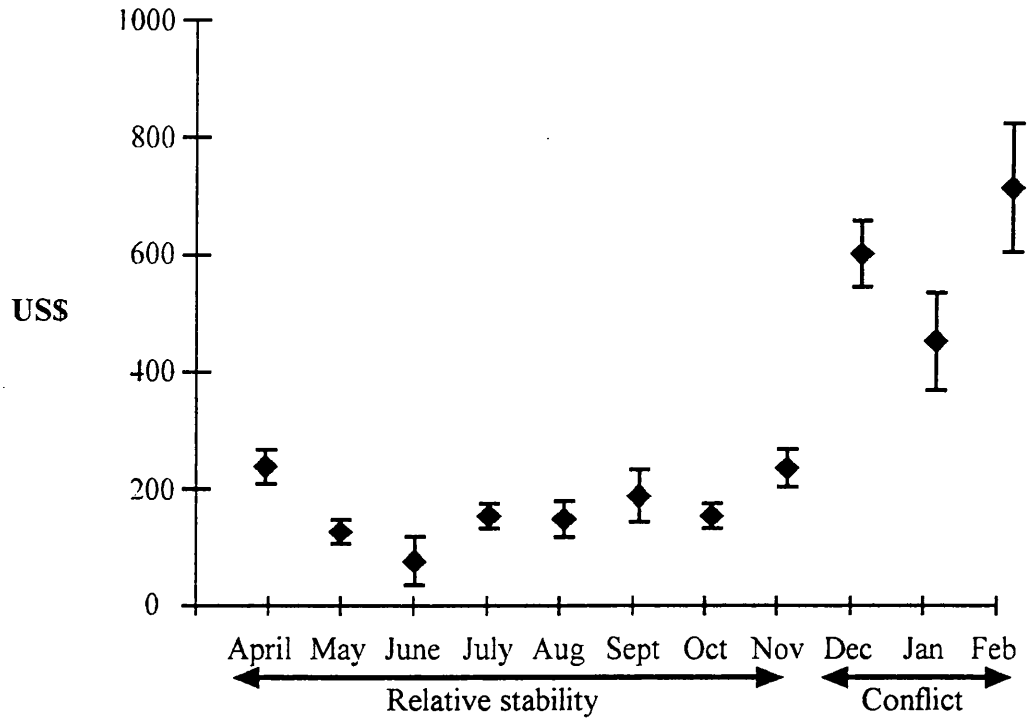


Figure 10.3. The estimated daily value of bushmeat from protected species passing through Kiliwa between April 1996 to February 1997.

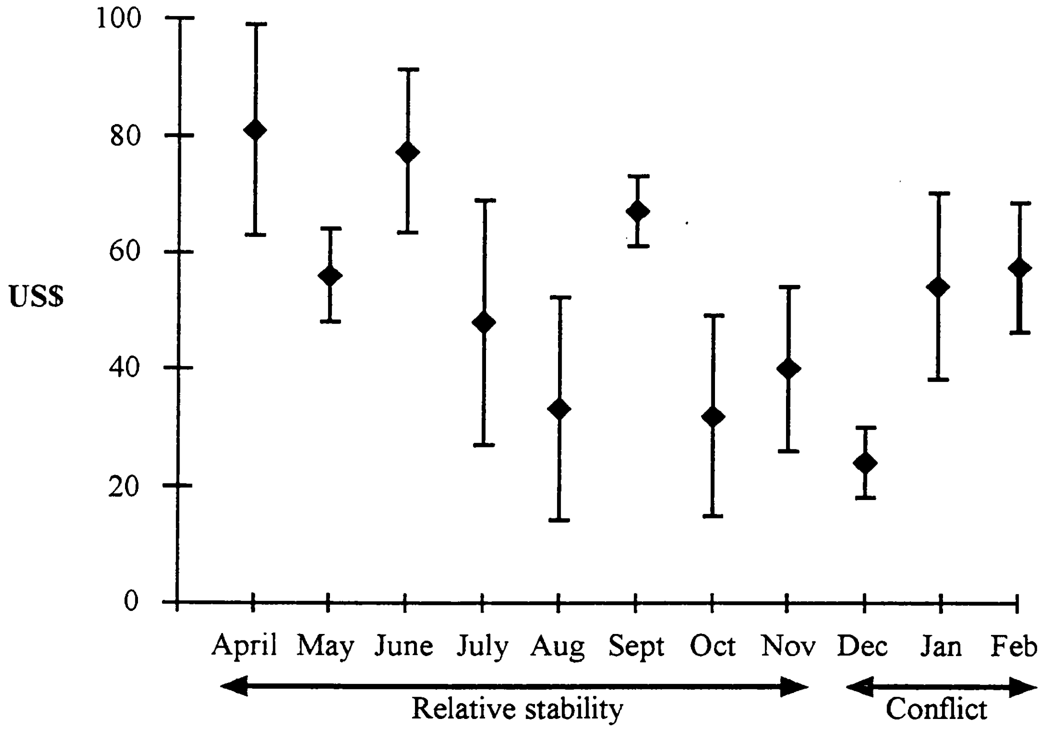


Figure 10.4. The estimated daily value of bushmeat from unprotected species passing through Kiliwa between April 1996 to February 1997.

10.4.2 Indicators of success in wildlife protection

Three explanatory variables were used. Two continuous variables, *patrol days* and *man days*, were used as an index of investment in conservation. Two variables were used because they were expected to have a different effect on poaching intensity. In other words, there may have been few large patrols or many small patrols for the same number of man days. The final explanatory variable was *periods of conflict*. This is a binary variable (denoting the presence or absence of conflict), and therefore a Mann Witney U-test is used to test the significance of its effect on the efficacy of wildlife protection.

The response variables were as follows: *contacts (with poachers) per patrol day* was used as an index of the level of poaching in the Park. The variable is similar to the use of elephant carcasses as an indicator by Jachman and Billiouw (1997). *Rifles seized per contact* was used because it represents the efficacy of patrols in responding to poaching.

The results of the non-parametric tests (Table 10.2) show that investment in conservation, in terms of man days, had no effect on the indicators of efficacy in wildlife protection. By contrast, the number of patrol days had a significant negative correlation with the encounter rates between poachers and guards. This suggests that there is a causal relationship between patrolling intensity and the number of poachers in the park. However, man days (the other indicator of conservation investment) did not have a significant effect on either the encounter rate between patrols and poachers, or the recovery rate of automatic rifles.

Table 10.2. Non-parametric tests for assessing the significance of patrolling effort and conflict on the efficacy of wildlife protection.

	Contacts per patrol day	Rifles seized per contact
Man days*	$r = 0.076$ $n = 55$ $p = \text{NS}$	$r = -0.05$ $n = 55$ $p = \text{NS}$
Patrol days*	$r = 0.326$ $n = 55$ $p < 0.05$	$r = 0.328$ $n = 55$ $p < 0.05$
Periods of Conflict†	$z = 0.593$ $p = \text{NS}$	(-) $z = 2.02$ $p < 0.05$

* Spearman's rank corelation
† Mann Witney U-tests
(-) Values are significantly lower in periods of conflict

The GLIM analysis of covariance (Table 10.3) provided similar results: *patrol days* and *periods of conflict* were significantly correlated with the recovery of automatic rifles (weapons seized per contact). *Man days* was not significant. This further developed the relationship between conservation effort, conflict and the recovery of automatic rifles by examining the interactions between explanatory variables (Crawley 1993). There is a significant interaction between *patrol days* and *periods of conflict*. This interaction shows that, whilst a high number of patrol days resulted in a relatively high number of rifles recovered during non conflict months, this was not the case during conflict months. A higher number of patrol days per month did not result in a higher rate of rifle recovery. This confirms that conflict has an overwhelming effect on the ability of patrols to disarm poachers.

Table 10.3. GLIM analysis of covariance using Poisson errors to show the relationship explanatory variables (patrol days and periods of conflict), and their interactions, with the number of rifles recovered from poachers (rifles seized per contact).

Link Function	Linear Predictor	% variation explained	*n*	*F*	Change in DF	*P*
Poisson	$\log_e y = 0.79$ $- \log_e 0.043x_i$ $+ \log_e 0.12x_{ii}$ $+ \log_e 0.0013x_{iii}$	17.32	49	10.42	3	< 0.01

x_i = Patrol days
x_{ii} = Difference in the constant between periods of stability and conflict
x_{iii} = Interaction term between x_i and x_{ii}.

10.4.3 The relationship between wildlife protection and the commercialisation of wildlife

The following analyses explicitly test the relationship between wildlife protection and the volumes of bushmeat passing through urban and village markets (Table 10.4). The results show clearly that the volume of meat in urban markets is negatively correlated with the number of automatic weapons seized in the national park. By contrast, there is no relationship between the wildlife protection activities in the park and the volumes of bushmeat passing through the markets of Kiliwa. These patterns are shown graphically in Figures 10.5 and 10.6.

Table 10.4. Results of Spearman's rank correlations to test the relationship between wildlife protection and quantities of bushmeat in the markets in Kiliwa and Dungu (April 1996 to February 1997).

	Amount of meat in Dungu Markets	Amount of meat in Kiliwa Markets
Weapons seized in the park	$r = -0.607$ $n = 11$ $p = 0.05$	$r = 0.037$ $n = 11$ $p = 0.915$

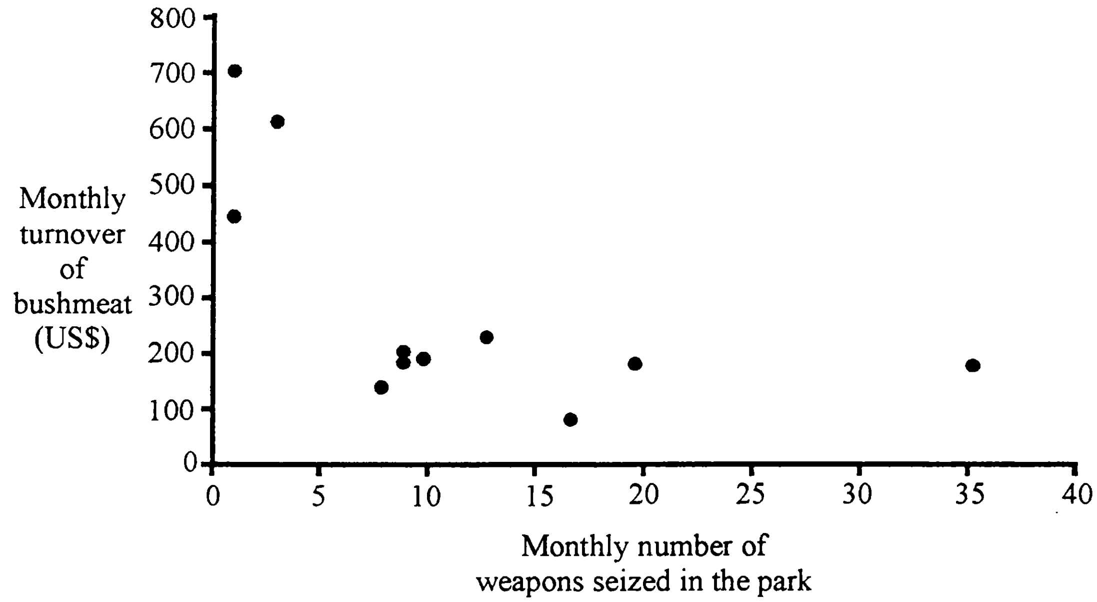


Figure 10.5. Scatter plot showing the relationship between wildlife protection and quantities of bushmeat in the markets in Dungu (April 1996 to February 1997).

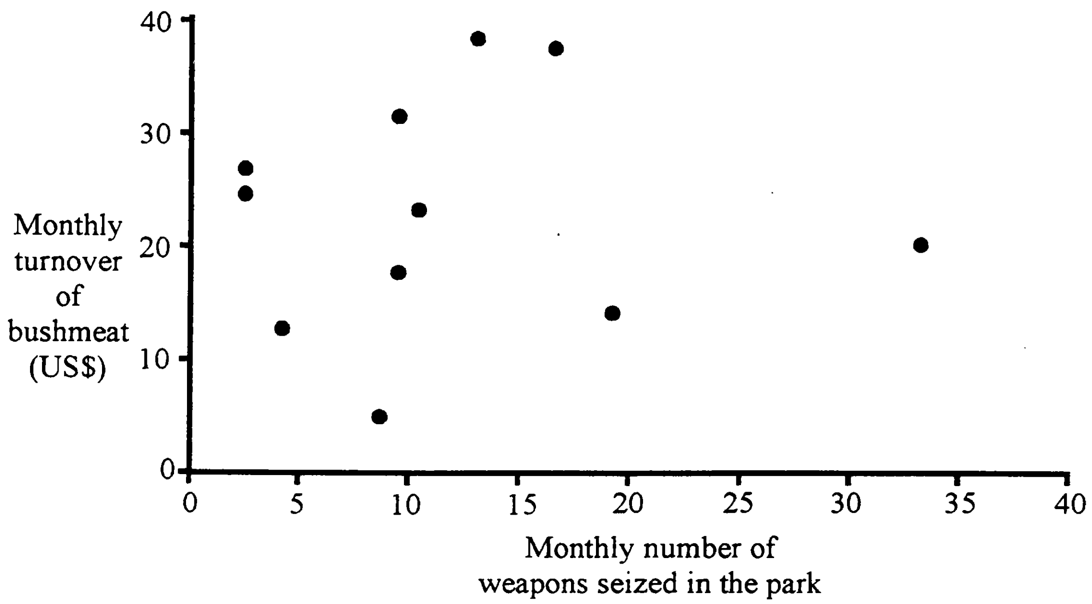


Figure 10.6. Scatter plot showing the relationship between wildlife protection and quantities of bushmeat in the markets in Kiliwa (April 1996 to February 1997).

10.5 Discussion

10.5.1 Markets as indicators of wildlife utilisation

Juste *et al* (1995) suggest that most hunted ungulates and primates end up in the markets, but that some species, such as rodents or other small mammals, are more likely to be consumed by the hunter's family without the meat reaching the market. The fact that village hunters eat meat directly after hunting introduces some bias into the results because a measure of the meat in the village markets underestimates the amount consumed by village residents. The results of Chapter 9, which examines people's harvesting patterns, showed that, excluding meat obtained from snares over 25% of bushmeat obtained by village hunters is subsequently sold at the local market. Thus, the meat represented in village markets is likely to represent less than a quarter of the total amount of meat consumed in the village. By contrast, the meat recorded in the urban markets represents most of the meat consumed by urban dwellers.

10.5.2 Patrol data as indicators of efficacy in wildlife protection

Greater accuracy in predicting the efficacy of wildlife protection could have been achieved if precise data on poaching intensity in the park were available. For example, a more accurate measure of patrol efficacy is provided by Abbot and Mace (in press) for women wood collectors in Lake Malawi National Park. This study provided an additional level of accuracy in the measurement of patrol efficacy because the researcher was able to monitor both the anti-poaching, by using patrol reports, and simultaneously monitor the illegal use of park resources, by accompanying local women into the park on their fuelwood gathering forays. They were able to show that the detection rate of women is low, just 12% of incursions by women into the park are intercepted by guards. They also show that the detection rates would have to increase to 58% to prevent wood collection in the park.

Following poaching groups at Garamba was not a practical research option, given the risks of bushmeat hunting in the park. Thus, the results are limited to the interpretation of poaching intensity by using the 'catch - effort' ratios recommended by Bell (1984). Nevertheless, the variations in patrolling effort and encounters with poachers was sufficient to detect the primary factors explaining the efficacy of wildlife protection at Garamba during the study period. These are largely explained by the effects of the periods intense conflict which started in December 1996.

Much of the variation in the indicators of conservation efficacy can also be explained by both investment in conservation. A high number of patrols in the park was associated with a relative decrease in the frequency of encounters with poachers. In addition, when encounters did take place, the rate of recovery of automatic rifles was higher than when there were fewer patrols.

10.5.3 The effects of conflict on centralised wildlife protection

The analysis of both the market and patrol data revealed that the three conflict months between December 1996 and February 1997 had an overwhelming effect on patterns of bushmeat trade and wildlife protection in the national park. The ecological consequences of the Rwandan civil war for the Parc National des Volcans were described by Plumbtre *et al* (1997) and show a similar marked increase in the use of bushmeat. The experience in Garamba has highlighted that the ecological consequences of war are based on a multitude of factors occuring in succession: at one level, conflict is associated with immeasurable levels of human suffering during which time conservation concerns cannot be prioritised. Wildlife authorities were not immune to the predicament, which was compounded by the curtailment of existing structures of external support during the conflict. Although project field staff maintained regular supplies to ICCN staff throughout the war, this was of little help in maintaining activities, particularly when the national park headquarters Nagero became a focal point of the conflict between foreign mercenaries and the advancing troops of the AFDL (Smith *pers comm*). The sharp decrease in patrol days during this period is self evident.

Hart and Hart (1997) analyse the effects of conflict on conservation initiatives in north eastern Congo and emphasise the inadequacy of the existing financial support structures throughout the region. They explain how the financial basis to conservation management in Congo is dependant on international aid. International aid is primarily channeled through non-governmental organisations and ICCN, who implement conservation interventions within Congo's protected areas. Aid is provided within an economic development framework, which is influenced by the country's wider political context. Consequently, the financial input to protected area management is curtailed during periods of conflict.

At another level, the war created a number of commercial opportunities which are not available during times of stability. This is reflected in the sharp increase in the volumes of meat passing throught the markets in Dungu, and along the road between Kiliwa and Dungu (Figures 10.3 and 10.4). This meat consists predominantly of protected species.

When the changes in mammal population abundance, outlined in Chapter 6, are re-examined in relation to the analyses of anti-poaching performance indicators, a pattern emerges. The period 1976 to 1986 was associated with an overall decline in animal population abundance within the National Park. This was a period of relative political stability in the region. The period 1986 to 1995 was associated with an increase in mammal population abundance, yet this was a period of conflict: the Second Civil War of Southern Sudan began in 1983 and has been fought with varying degrees of intensity to the present day. The period 1996 to 1997 was a period of generalised conflict, both in Sudan and Congo. Whilst there is no comparative ecological data to show mammal population change during this period, the results above show that the efficacy of wildlife protection declined significantly. Furthermore, a rapid aerial survey undertaken in June 1997 indicated that poaching in the Park had increased substantially, and spread to the southern sector of the National Park during the conflict months of 1996 and 1997 (Smith and Smith 1997).

On the basis of the above observations, however, it could be argued that conflict alone does not provide an explanation for the decline of large mammal abundance. Indeed the period of conflict in Southern Sudan was associated with relative increase in large mammal abundance. Thus, the immediate symptoms of war, such as the widespread availability of automatic weapons and the increased demand for bushmeat, do not explain fully the collapse of effective wildlife protection regimes. The reduction in international support received by the institution responsible for maintaining effective wildlife protection (ICCN) seems to be of greater importance. Smith and Smith (1997) describe a decrease of over 90% of anti-poaching resources to the Garamba Project. This resulted largely from the confiscation and looting of equipment, but is also explained by the difficulties experienced by external donor agencies in maintaining support for anti-poaching as a result of the conflict.

The immediate consequence of the decline in the resources available for conservation was a decrease in the number patrols in the park: the number of man days spent in the park by national park guards was significantly less during the conflict months than during the more stable periods ($z = 3.285$, $p < 0.001$, Mann Witney U-test). These results show that, whilst wildlife protection appears to have the intended ecological consequences (the maintenance or increase of animal abundance), the efficacy of wildlife protection is strongly influenced by the ability of external aid agencies to provide support to the local implementing institution.

10.5.4 Informal wildlife regulations during conflict

The patterns of trade in the urban markets during periods of stability and conflict reflect the efficacy of the structures that regulate the offtake of wildlife. The reduction in the capacity of the centralised wildlife authorities to regulate poaching has been discussed using patrol data in section 10.5.3. The market data in the town of Dungu also reflect the changes that have affected the informal regulators operating in the Azande Hunting Reserve. Before the conflict, a small number of traders provided Dungu with bushmeat, and obtained the meat from Kiliwa. These were the urban women traders described in Chapter 4. However, during the conflict larger numbers of traders bought meat to sell in Dungu. These traders did not obtain their meat from middle men in Kiliwa as shown in Figure 10.1, but instead bought it directly from the hunters in areas such as Mamba and Wilibadi (Figure 10.2), where they could secure higher profits. This new pattern of trade is probably best explained by the departure of the military from the region, who had formerly restricted access to bushmeat to their own clients. This highlights the significance of informal power relations in the hunting reserve in lowering the offtake from the national park. Alternative community based regulatory mechanisms that take account of the impact of local power relations in limiting offtake of wildlife are presented in Appendix 4. These concepts are based on greater collaboration between centralised and local authorities to regulate the flow of bushmeat through the hunting reserves using appropriate incentive mechanisms.

10.5.5 Village and urban markets

The pattern that emerges from these data is that village markets tend to sell small unprotected mammals and the urban markets sell large mammals (see Table 10.1). The volumes of meat passing through the urban markets appear to vary significantly with the level of effective wildlife protection in the park. This is reflected in Table 10.4 and Figure 10.5. Wildlife management at Garamba focuses on the protection of large mammals which would suggest that the meat passing through the urban markets is significantly regulated by wildlife protection in the Park.

However, the Figures 10.1 and 10.2, which show the locations from where bushmeat is obtained by urban traders, offer a level detail which suggests that regulation in the park alone is insufficient to explain the volumes and patterns of bushmeat entering the Dungu markets. These maps indicate that during the periods of conflict, the elaborate bushmeat *filières* described in Chapter 4 are no longer practised. During periods of relative stability urban traders buy most of their meat at the villages of Limai and Kiliwa. This is because the trade networks between the villages of Mamba and Wilibadi, near to the park where bushmeat was harvested, and Kiliwa and Limai, were largely controlled by the military who have a garrison near Wilibadi. During the conflict months FAZ personnel fled the region ahead of the advancing troops of the AFDL. This was probably an important reason for the change in patterns of bushmeat use in Dungu. Whereas before the conflict, the bushmeat trade was under the control of the military and a handful of urban women, after the departure of the military, all traders were able to exploit bushmeat by going straight to the producers in Mamba and Wilibadi. Thus, to suggest that the extraction of bushmeat from the park is solely determined by the levels of wildlife protection in the park would be to over-simplify the situation. It is likely that the power relations and control mechanisms that existed prior to the conflict limited the flow of bushmeat to the urban markets. The collapse of the *filières* is likely to confound the strong correlation between wildlife protection and the volumes of meat in the markets in Dungu.

10.6 Conclusions

This chapter revealed a number of important patterns which help to understand the relationship between the bushmeat trade and wildlife regulations, both centralised and informal. The results showed that there are two bushmeat trade networks. One operates at the village level, and the other serves the urban markets at the periphery of the reserves. The two systems of trade respond differently to the intensity of wildlife protection and to the effects of war in the region. Whereas the village trade in bushmeat remained largely unchanged during this period, patterns of bushmeat use in the urban markets changed significantly. There was a greater use of large protected species which were obtained from hunters closer to the national park. This development appears to be the result of two factors. First, the efficacy of wildlife protection dropped significantly during the period of conflict. This was shown in the analysis of variation in patrolling efficacy. Second, the *filières*, or bushmeat trade networks described in Chapter 4, no longer existed after the departure of the military forces alligned with the ousted regime. The military no longer controlled the bushmeat trade, and a greater number of traders were able to purchase and sell meat.

Chapter 11

Concluding Discussion

This thesis has explored various dimensions of wildlife management policy and practice in and around Garamba National Park. The outcome of current management practices were analysed in relation to their impacts on the conservation status of large mammals and on their contribution to local development. Thus, the thesis has analysed the social, economic and biological outcomes of conservation management. This chapter summarises these findings and outlines their potential contribution to improved conservation management at Garamba in the future.

11.1 Main findings

11.1.1 Centralised and devolved management

The thesis began by exploring the various forms of wildlife management at Garamba National Park and in the surrounding hunting reserves. Broadly these were defined as centralised and devolved systems of management. Describing centralised management is straightforward: policy documents are produced by the management body of the national park, and a zoning and planning exercise was undertaken to deepen the understanding of centralised wildlife management.

Devolved and informal systems of wildlife management are more complex. This is because the local systems of wildlife management are tied into wider power networks and long established patterns of wild meat use that have come into existence through the rapid development of the informal economy in Congo. Bushmeat is an important component of the informal economy. To trace the flow of bushmeat along the informal commodity chains, between its harvesting and subsequent sale at village and urban markets, the study used access mapping of bushmeat *filières*, or trade networks (Ribot 1998). These revealed that wildlife utilisation around Garamba is highly structured, and is organised through the competing demands for access to a profitable trade. Local regulations limit the offtake of bushmeat. Regulators include the traditional, civil and military authorities who compete for fiscal revenues from the informal economy. An example of this is the restriction of the movement of soldiers, who trade in bushmeat, through the village of Kiliwa. This is administered by the traditional authorities because a military presence in the village discourages others from trading (the chief raises market taxes from non-military traders for his own administration).

Another example is that the military themselves discourage hunting and trade in bushmeat by anyone other than their clients, to who are either a small selection of urban women traders, or local hunters who are provided with automatic weapons by the military. Chapter 10 showed that departure of the FAZ during the conflict months was associated with higher volumes of meat passing throught the hunting reserve (see Figure 10.3), and with traders dealing directly with hunters rather than through the military's clients (the urban women traders, see Figure 10.1 and 10.2).

11.1.2 The contribution of centralised wildlife management to conservation and development

The analyses of animal abundance provide compelling evidence that centralised wildlife management at Garamba has contributed significantly to the objective of increasing the number of large mammals in the ecosystem. While high variability in animal abundance would be expected in savanna ecosystems if current thinking on non-equilibrium population dynamics is accepted (Dublin 1991, Behnke *et al* 1993, this variability is highly consistent with the intensity of protectionist regimes. This pattern was shown on both spatial (Chapter 5) and temporal (Chapter 6) axes of variation, which strengthens the hypothesis that, generally, most variation in abundance is explained by the wildlife protection regimes and not by random events.

Local development agendas have not yet been integrated into centralised wildlife management practice at Garamba. Instead, centralised wildlife management is based largely on a 'reduction of threats' approach to wildlife management (Margolius and Salafsky 1998). Thus, conservation activities have focused on the eviction of resident populations and the restriction of wildlife utilisation by the enforcement of wildlife regulations. These policies and practices were outlined in Section 1 of Chapter 4. The zonation exercise described the management regimes that were planned for different areas of the park and hunting reserves. This analysis showed that an approach based on protectionist paradigms was also envisaged for the future management of the hunting reserves. This approach involved setting areas in the hunting reserves aside for conservation. Chapter 7 analysed the extent to which these protection approaches conflicted with local resource use priorities. The analyses showed that an approach which focused on the setting aside of areas for conservation, and could be described as an incipient form of eviction, was incompatible with the local development objectives that have, in theory, become central to global protected area policy (WWF, IUCN, UNEP 1980, IUCN 1994).

The difficulties of reconciling protectionist conservation and local developement objectives highlight the need to examine further the ecological justifications for protectionist conservation practices. This thesis has argued that the 'human threat' to biological diversity is an assumption that that is not always tested using empirical evidence (Brockington and Homewood 1996). The results presented in this thesis provide an insight into the ecological validity of the two perceived threats that underpin current conservation practices: human presence and unregulated offtake.

a. Human presence

At first sight, the outcome of eviction from Garamba National Park appears to be the significant increase in large mammal populations. This notion is supported by the significantly higher animal population abundance in the national park, where human populations were evicted in 1938, compared to the hunting reserves where human populations are present. However, the detail that emerged from the analysis of animal abundance over time and space suggests that eviction, in itself, does not provide a satisfactory explanation for higher animal abundance: the distribution and abundance of wildlife in the hunting reserves was not significantly affected by human presence. Furthermore, the northern sector the national park, where populations *had* been evicted, showed evidence of a substantial *decrease* in animal abundance between 1976 and 1995. This northern sector of the park experiences relatively little patrolling effort because it was effectively abandoned due to instability and conflict due to its position on the border with Sudan. This indicates that effective regulations, and not eviction *per se*, are likely to be the primary determinant of conservation success.

b. Unregulated offtake

The enforcement of wildlife regulations appears to provide a better explanation for high mammal abundance than the absence of local residents. The spatial and temporal dynamics of mammal populations in the park can be explained by the intensity of law enforcement. The proximity to the national park explained most of the overall variation in animal abundance in the hunting reserves, with high abundance being negatively corelated with increasing distance from the park. Within the national park, the effective enforcement of wildlife regulations is also associated with high animal abundance: the populations of most mammals increased during the period when wildlife protection was being funded by an external donor. Furthermore, this increase in animal abundance is largely concentrated in the southern sector of the national park, which is the focus of wildlife protection activities because of the presence of the rhino population.

However, it should be noted that data from the hunting reserves show that current law enforcement influences species differently. The analysis in Chapter 5, of the different guilds of species, characterised according to their physiological and life-history traits as well as the modes of wildlife exploitation, reveals that the distribution of larger mammals is influenced by the regulation of wildlife utilisation. Larger mammals are significantly more abundant near to the national park where they are protected. However, the abundance of smaller mammals did not appear to be significantly influenced by distance from the national park.

The result of the ecological analyses concur with those of the market data analyses presented in Chapter 10: when regulations were less intensive as a result of political conflict in the region, the trade in large mammals, destined for the urban markets, increased substantially. In contrast, trade associated with village markets, which tended to focus on smaller mammals, was not significantly influenced by the absence of law enforcement during the conflict months.

Thus, two levels of wildlife utilisation, with different regulators, markets, technologies and ecological impacts, are apparent at Garamba. One level is the exploitation of large mammals which has a high impact on the their distribution. The networks associated with this trade are largely dominated by the military and the SPLA, together with the civil administration in Dungu. The meat is largely destined for urban markets in Dungu and Isiro.

At another level, village markets trade in smaller mammals whose distribution and abundance does not appear to be significantly influenced by resource use by local residents. In Kiliwa, the trade is largely controlled by the traditional authorities, who both promote commercial activities in the village by creating a climate of stability, and who exploit them by generating fiscal revenues imposed on those who use the market. This level of resource use is not influenced by the presence or absence of external wildlife regulations: this is shown in Chapter 10, which shows that the flow of bushmeat through local markets is not influenced by the efficacy of the centralised wildlife management. Thus, during the conflict months between December 1996 and February 1997, when the intensity of centralised wildlife protection was very low, village trade in bushmeat did not increase. The potentional for village level wildlife management in meeting conservation objectives is discussed below.

11.1.3 Local alternatives to centralised wildlife management

The difficulties in reconciling centralised conservation with local development agendas at Garamba justifies a closer examination of the potential for local, consumption-based, wildlife management. The justification for this change of emphasis is supported by the finding that effective wildlife regulation, and not eviction, provides the best explanation for successful conservation of large mammal species. It is therefore of interest to explore the possibilities for community based regulation. This study examined the evidence for existing wildlife utilisation regulations among those who harvested the resources (hunters), and amongst those who most influenced the trade in bushmeat (the local regulators described in Chapter 4).

a. Hunters as conservationists

As a first step in analysing the potential for local conservation, hunting behaviour was analysed (Chapter 9). During the hunts surveyed as part of this study, there was no evidence to show that hunters displayed characteristics in their harvesting patterns that could be attributed to deliberate conservation of the resource base. While diverse forms of hunting practices could be identified, none showed anything other than the rate maximising objectives that Alvard (1995) attributes to optimal foraging strategies. Hunters decisions were largely determined by economic criteria, except when the risk was high. Thus, hunters were prepared to forfeit the very high profits obtained from the use of automatic weapons because of the high penalties, both from the wildlife and the military authorities. Also, there was no evidence that hunters deliberately limited their yields in order to conserve the resources. Hunters make rate maximising decisions that would be predicted by optimal foraging models: hunters usually continued to hunt after they had made a kill. Those who ceased to hunt after a kill usually did so because they were unable to carry more meat back to the village, and not necessarily to avoid over-harvesting.

The absence of restraint in the harvesting patterns of local hunters may be explained by the lack of local ownership of wildlife resources: the system of resource tenure around Garamba, which is a combination of *de jure* state ownership and *de facto* free access, is unlikely to provide the incentives for local users to exploit the resources sustainably. Changing the system of tenure, possibly through the establishment of exclusive rights to exploit wildlife, may provide an incentive mechanism encouraging local hunters to exploit wildlife sustainably. The revenues generated from license fees have the potential to broaden the benefits of wildlife harvesting to the community as a whole. A precedent to this approach exists with the fishing guilds around Kiliwa, who sometimes provide benefits to the community within the group (fisherman purchased the beds for the village clinic in Kiliwa), and through the payment of license fees to civil and wildlife authorities. The extent to which this benefits the community has not been established although the potential for this is discussed below. This approach is necessarily tied to the region's legislative and administrative structures, and their efficacy in regulating resource users.

b. Local regulators as conservationists

The absence of meaningful sustainable offtake mechanisms from existing harvesting patterns implies that external organised regulation of bushmeat offtakes would be required to promote the sustainable management of wildlife. Currently this regulation is centralised. The ecological impacts of this are shown by the exceptionally high abundance of large mammals where and when effective wildlife regulations are in place (see Chapters 5 and 6). The analysis of the *filières*, or trade networks showed that offtake from the park was also socially regulated. The bushmeat trade provided opportunities that were seized by various levels of authority in the hunting reserve, including traditional, civil and military authorities. Although none of these regulatory mechanisms could be linked to planned conservation of wildlife resources, local and informal regulations were shown to have both ecological and local development implications. For example, the sale of bushmeat is regulated by both the traditional authorities and by the military and civil authorities. Traditional authorities are largely concerned with village markets which focus on the sale of small mammals by village hunters. At this level, the village trade in relatively small mammals appears to have a limited impact on animal ecology. The spatial analyses of animal abundance presented in Chapter 5 show that the abundance of small mammals was not significantly affected by proximity to rural populations.

A critical challenge in developing local approaches to wildlife management is to establish incentive and regulatory mechanisms that function appropriately within the existing power relations in the region. Using traditional and local systems of authority to achieve non-local objectives is not new around Garamba, and past experiences highlight the potential dangers of this approach. Chapter 2 described how local systems of authority were used in the first half of the twentieth century to promote cotton production. Coercive measures were adopted by colonial and commercial interests to ensure that traditional authorities enforced cotton production on subjugated local populations. Besides the hardships that were imposed on rural communities, these approaches proved to be neither profitable nor sustainable in the long term (Isaacman and Roberts 1995). Field work observations indicated that traditional authorities, particularly at the *groupement* level, are dependent on local consent. This is exemplified by the suspension of two chiefs in the area through popular opposition to their authority. These incidents indicate that local consent is not only a desirable objective, in terms of a policy that seeks to meet local development needs, but is also a condition for sustainable conservation management in the hunting reserves.

A framework for the development of such initiatives is outlined in Appendix 4. This approach combines local incentive mechanisms for sustainable management of wildlife resources with existing regulatory authorities. The incentive mechanisms are financial, and are based on the lucrative bushmeat and fish trade. The approach outlined above would require a significant departure from established approaches to conservation at Garamba, although such approaches are not without precedent in other regions of Africa (see for example Metcalfe 1995).

c. *Who benefits?*

The present study explored the benefits of resource use for two reasons. Given the current emphasis on integrating conservation and development objectives (WWF, IUCN and UNEP 1980), benefits have to be understood to determine the extent to which wildlife resources contribute to local development. Second, the success of devolved wildlife management in meeting conservation objectives is directly linked to the level of support that local administrators receive from local residents in the hunting reserves. Thus, the success of local authorities appears to rely on local consent. This emphasises the importance of local administrations being associated with local benefits.

This thesis showed that, whilst the benefits from wildlife utilisation are considerable, they reinforce existing power, wealth and gender differentials (Chapters 4 and 8). Bushmeat is expensive to hunt and to purchase, and is therefore less accessible to poorer households than lower value resources, such as wild plants (Chapter 8). However, some redistribution of meat does occur through the giving of gifts. Whilst women are prominent in the bushmeat trade, the extent of their benefits is unclear. Fiscal decentralisation provides a mechanism to enhance equity in the allocation of conservation benefits, as well as financing a local administration (see Appendix 4).

11.3 Wider contributions to conservation policy and research

The target audience for this thesis has primarily been decision makers concerned with conservation and development in north eastern Congo. However, many of the themes addressed during this study are common to other regions of Africa and elsewhere, and the work can be drawn on to contribute to those debates.

The first is methodological. The research was able to link a social science approach to long term ecological data collected over two decades by the Garamba National Park Project. This study contributes to a growing understanding that conservation issues require the integration of social and natural science approaches. Furthermore, GIS helps to present the complexity of multiple perspectives regarding wildlife resources within a comparative framework. This provides a basis for balancing competing demands for wildlife resources, but only where all the stakeholders perspectives are represented (Chapter 7).

This form of analysis contributes to a growing understanding that 'scientific data' are not value-free. Sullivan (1998) describes the environmental and land policies in Namibia as being largely founded on "crisis narratives". This decision making process is not uncommon throughout Africa (see for example, Fairhead and Leach 1996, for an example in West Africa, and Homewood *et al* 1997, in East Africa). It is partly symptomatic of the distance that exists between policy makers and local realities, and partly due to the imbalance in power relations between different stakeholders. This work has attempted to close this gap by presenting local level ecological and social data and make possible more informed management based on indepth analyses of processes and linkages.

Current thinking, that savanna ecology is determined by disturbance, is largely founded on 'natural' processes such as rainfall, disease and fire. These pervasive views have sometimes failed to consider human induced disturbance as an overwhelming cause for ecological change. This thesis has quantified the effects of war on animal ecology, thereby reinforcing the need to consider the resilience of local institutions in periods of conflict to ensure effective conservation management. Centralised wildlife authorities have been effective during times of relative stability, but are largely dependent on external support which decreases during periods of conflict. Because informal administrations are locally financed, they are better able to adapt to rapidly changing contexts. Thus, their enhanced role in meeting conservation and development objectives should be considered a priority.

The issue of devolved or centralised management may ultimately be resolved by attrition more than deliberate decision making: as wildlife declines and the capacity of a centralised conservation authority is eroded by the isolation of Garamba, by the legacy of war in Congo and the continuing conflict in Sudan, government and donor support is likely to diminish. In this context decentralised management may provide a viable approach. Indeed, this thesis has shown the potential complementarity of the two systems of wildlife management. Centralised regulation of wildlife offtake has increased the value of wildlife resources. This in turn has contributed to the financial basis of an informal administration which both regulates offtake and has the potential to make effective linkages between conservation and local development. The political will for centralised authorities to collaborate with local administrations could achieve this more integrated and potentially more sustainable and resilient system of wildlife management.

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Appendix 1

Inventory of Mammals in Garamba National Park and Surrounding Hunting Reserves

The following list of species is based on Hillman-Smith (1989), with minor modifications. Hillman-Smith also refers to Verschuren (1987). English names were largely drawn from Kingdon (1974, 1993)

Proboscidea

Loxodonta africana	Elephant

Ungulata

Syncerus caffer brachyceros	Buffalo
Ceratotherium simum cottoni	N.White Rhino
Giraffa camelopardalis congoensis	Giraffe
Hippopotamus amphibius	Hippo
Alcelaphus buselaphus lelweli	Lelwel's Hartebeeste
Kobus kob thomasi	Uganda Kob
Kobus defassa harnieri	Defassa Waterbuck
Redunca redunca dianae	Bohor Reedbuck
Hippotragus equinus bakeri	Roan
Tragelaphus scriptus dianae	Bushbuck
Tragelaphus spekil	Sitatunga
Taurotragus derbianus	Derby's Eland
Ourebia ourebi	Oribi
Cephalophus grimmia roosevelti	Grey Duiker
Cephalophus silvicultor	Yellow backed Duiker
Cephalophus rufi latus	Red flanked Duiker
Phacochoerus aethiopicus	Warthog
Potamochoerus porcus ubangensis	Red River Hog
Hylochoerus meinertzhageni ituriensis	Giant Forest Hog

Carnivora

Crocuta crocuta	Spotted Hyena

Panthera leo	Lion
Panthera pardus	Leopard
Canis aureus	Common Jackal
Viverra civetta	Civet
Felis serval	Serval
Fellis lybica rubida	African Wild Cat
Felis aurata	Golden Cat
Genetta tigrina aequatorialis	Large-spotted Genet
Herpestes sanguineus mustela	Slender Mongoose
Herpestes paludinosus	Marsh Mongoose
Herpestes ichneumon	Egyptian Mongoose
Munyos mungo gotneh	Banded Mongoose
Dologale dybowskyii	Pousargue's (Dwarf) Mongoose
Lutra maculicollis	Spotted necked Otter
Aonyx capensis	Cape Clawless Otter

Primates

Colobus polykomos uellensis	Black & White Colobus
Colobus badius powelli	Red Colobus
Cercopithecus aethiops	Vervet Monkey
Cercopithecus neglectus	De Brazza's Monkey
Cercopithecus ascanius schmidti	Black-cheeked White-nosed Monkey
Erythrocebus patas pyrrhonotus	Patas Monkey
Cerocebus galeritus agilis	Crested Mangabey
Galago demidovi anomurus	Dwarf Galago
Papio anubis	Baboon
Pan troglodytes schweinfurthi	Chimpanzee

Insectivora

Elephantulus rufescens dundasi	Spectacled elephant shrew
Erinaceus albiventris	Four toed hedgehog
Potamogale velox	Giant otter shrew
Sylvisorex megalura gemmeus	Long tailed forest shrew
Crocidura littoralis	White toothed shrew
Crocidura boydi	White toothed shrew
Crocidura suajhelae	White toothed shrew
Crocidura turba nilotica	White toothed shrew
Crocidura flavescens sururae	White toothed shrew
Crocidura luna garambae	White toothed shrew
Crocidura roosevelti	White toothed shrew
Crocidura hildegardae	White toothed shrew
Crocidura jacksoni	White toothed shrew

Crocidura bicolor planiceps	White toothed shrew
Crocidura bicolor tephrogaster	White toothed shrew
Crocidura pasha	White toothed shrew
Crocidura nanilla	White toothed shrew

Chiroptera

Epomops franqueti	Singing fruit bat
Epomophorus anurus	African epauletted bat
Micropteropus pusillus	Insect bat
Myonycteris torquata wroughtoni	Little collared fruit bat
Taphozous mauritianus	Tomb bat
Taphozous sudani	Tomb bat
Taphozous nudiventris	Naked rump tomb bat
Nycteris arge	Slit faced bat
Nycteris nana	Slit faced bat
Nycteris hispida	Slit faced bat
Nycteris grandis	Slit faced bat
Nycteris thebaica	Slit faced bat
Nycteris arge luteola	Slit faced bat
Lavia frons	Yellow winged bat
Rhinolophus fumigatus	Horseshoe bat
Rhinolophus landeri	Horseshoe bat
Rhinolophus alcyone	Horseshoe bat
Hipposideros Cyclops	Cyclops bat
Hipposideros abae	Aba leaf-nosed bat
Hipposideros caffer	African leaf-nosed bat
Hipposideros caffer nanus	African leaf-nosed bat
Hipposideros beatus	Leaf-nosed bat
Tadarida ansorgel	Wrinkle-lipped bat
Tadarida pumilia	Wrinkle-lipped bat
Tadarida limbata	Wrinkle-lipped bat
Tadarida majcr	Wrinkle-lipped bat
Tadarida condylura	Wrinkle-lipped bat
Tadarida faradjius	Wrinkle-lipped bat
Tadarida midas	Wrinkle-lipped bat
Tadarida trevori	Wrinkle-lipped bat
Otomops martiensseni	Giant mastiff bat
Eptesicus minutus	Serotine
Eptesicus garambae	Serotine
Eptesicus rendalli	Serotine
Pipistrellus nanus	Pipistrelle
Pipistrellus culex (?)	Pipistrelle
Nycticeius schlieffeni	Schlieffen's twilight bat
Scotophilus dingani	House bat

Pholidota

Manis gigantea	Giant pangolin
Manis tricuspis	Tree pangolin

Hyracoidea

Procavia johnstoni lopesi	Hyrax

Tubelidentata

Orycteropus afer faradjius	Aardvark

Rodentia and Lagomorpha

Xerus erythropus lacustris	Striped Ground Squirrel
Helioscurus rufobranchium	Sun squirrel
Helioscurus gambianus lateris	Gambian sun squirrel
Paraxerus boehmi emeni	Ground squirrel?
Protexerus stangeri centricola	African giant squirrel
Graphiurus murinus lorraineus	African doormouse
Dendromus mesomelus	Climbing mouse
Dendromus mysticalis	Climbing mouse
Steatomys pratensis opimus	Fat mouse
Tatera valida dichura	Tatera gerbil
Taterillus congicus	Taterillus gerbil
Otomys tropicalis faradjius	Groove-toothed rat
Aethomys bindei helleri	Bush rat
Arvicanthis niloticus jebelae	Arvicanthis rat
Cricetomys gambianus langi	Giant pouched rat
Dasymys incomtus bentleyae	Shaggy swamp rat
Lemniscomys striatus	Zebra mouse
Lemniscomys macculus akka	Zebra mouse
Lophuromys sikapusi ansorgel	Brush-furred mice
Oastomys coucha ugandae	Mouse (indigenous species)
Mus minutoides enclavae	Mouse (indigenous species)
Mus sorella acholi	Mouse (indigenous species)
Mus triton	Mouse (indigenous species)
Mylomys dybowski alberti	Mill rat
Oenomys hypoxanthus hypoxanthus	Rusty nosed rat
Praomys jacksoni jacksoni	African soft furred rat
Thamnomys surdaster callithrix	Broad-footed thicket rat
Uranomys ruddi ugandae	Uranomys mouse
Cryptomys lechei	Blesmol
Thryonomys gregorianus harrisoni	Savanna cane-rat

Hystrix cristata	Porcupine
Poelagus majorita ma~orita	Uganda grass-hare

Appendix 2

Habitat Classification for the Park and Hunting Reserves

Main Habitat categories

Code	Class
FR	Gallery forest
BR	Riverine woodland
BS	Source woodland
R	Riverine swamp and grass complex
N	Ndiwilli
P	Papyrus
HV	Valley grassland
ZB	Tall deciduous woodland
ZB1	Dense
ZB2	Moderate
ZB3	Sparse
SA	Tree/Bush savanna
SAR	Riverine
SA1	Dense
SA2	Moderate
SA3	Sparse
H	Tall grass savanna
T	Short Termitaria grassland
HP	Tops of Inter riverine ridges
HC	Edges of Inter riverine ridges
CR	Rocky hills and plateaux

Appendix 3

Wealth ranks

Poorest	1	Often old or disabled. Fields were generally too small to provide enough food for the household. These households were generally dependant on other households for food. Some had lost all their possessions because a spouse had recently died and, according to Zande custom, the spouse's family had taken possession of all their belongings. If these individuals were young, they tended to be in this category for a limited period, until they could redevelop their fields and eventually purchase more commodities.
	2	Fields were large enough to supply the family with food, but did not sell very much at the market (only sold enough agricultural products to buy salt and occasionally soap). Often young families that had just left their parents households, but who had not yet developed large fields were contained in this category.
	3	Had large fields. Rarely owned a bicycle, and never owned a radio. Didn't possess fishing nets. Sometimes owned a shotgun, but rarely hunted because of the cost of gunpowder and lead. Some cash income, often through selling bushmeat from snares. Had additional income generating activities such as mending bicycles or maintaining a forge.
Richest	4	Had very large fields. Owned bicycles, radios and other commodities. Owned a shotgun, and several hunting nets and dogs. Sometimes owned fishing nets. Went to the market in Dungu to sell agricultural products. Owned many chickens, and often owned goats. Sometimes lent money and equipment to poorer households.

Appendix 4

Extracts from the framework document:

Supporting Community Institutions to Promote Conservation and Development around Garamba National Park

Proposed by

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a4.1 Summary

The concepts outlined in this document are founded on the shared experience of individuals who have a long term commitment to the objectives of conserving Garamba's wildlife resources and improving the welfare of the communities surrounding the National Park. The activities described below will make a substantial and tangible contribution to both of these objectives. They are based on the following understanding:

1. Under the current circumstances, many of the ecosystem's most valuable resources are vulnerable to unsustainable exploitation.
2. A conservation priority at Garamba is the successful and recognised ability of wildlife managers to integrate the area's natural resources into the process of local development.
3. Successful conservation with development can only occur through the creation of innovative and appropriate incentive mechanisms for local people to conserve wildlife resources. The following document summarises how this can be achieved through:
    - community controlled wildlife protection (Section 1),
    - fiscal devolution (Section 2) and,
    - private sector partnerships (Section 3).

The activities outlined in this document use a 'minimalist' approach based on the following principles:

1. Costs are kept to a minimum by relying as much as possible on local institutions, expertise, labour and other resources.
2. It is planned that activities are financially viable beyond the five year programme period
3. Programme planning is based on the current political climate. Lessons are drawn from the experience of recent conflicts in the region. The programme focuses on institutions and activities that were not undermined by the conflict, and capital equipment, such as vehicles, is kept to a minimum

The present document proposes a process project, using principles of adaptive management. Thus, the document will form the basis for a more comprehensive proposal developed through other interested parties (l'Institut Congolais pour la Conservation de la Nature, community representations, potential donors etc.). Detailed project proposals for each activity are developed by the Programme Coordinator and Advisory Board in year 1 of the programme. This framework document explains the institution building and the institutional relationships required to initiate locally appropriate projects which respond to current needs in the current context of this region of the Democratic Republic of the Congo.

a4.2 Section 1. Traditional authorities and wildlife protection

RATIONALE:

- Many of the threats to the wildlife of Garamba national Park emanate from the Hunting Reserves surrounding the Park:

a. in recent years, the focus of poaching activities in the national park has moved southwards, thereby increasing the vulnerability of the rhino population and other large mammals, concentrated in the south. Poachers of Sudanese origin come from the north and are increasingly using the hunting reserves to gain access to the southern sector of the Park in order to reduce their exposure to patrols. Some members of the local communities are complicit, providing refuge, storage for weapons and porters for the poaching expeditions.

b. soldiers present in the Hunting Reserves are often unsupervised and can be undisciplined. Some of these soldiers take part in poaching on regular basis as a means of supplementing their salaries.

c. as a result of recent events, automatic weapons are widely available in the Hunting Reserves. A minority of individuals amongst the local communities hold automatic weapons and regularly take part in poaching

- Although armed patrols can be effective within the National Park, they are ineffective and inappropriate in populated areas:

  a. patrolling the hunting reserves is logistically difficult and expensive

  b. inadequately supervised armed guards amongst the communities can substantially increase the existing tensions between the communities and the National Park

  c. inadequately supervised armed guards are susceptible to getting involved in poaching

EXISTING SOLUTIONS

Many of the threats to conservation outlined above relate to the climate of instability in the area. The symptoms of political instability, which include the widespread availability of automatic weapons and the free movement of armed groups, are as much a problem for state officials concerned about the welfare and development of the local community as they are for wildlife managers. This provides the basis for a much stronger collaboration between the wildlife authorities and effective civil authorities.

Traditional chiefs, or *chef de groupement,* have a long history of local administration which dates back to the last century. They have been assimilated into the state hierarchy because of their effectiveness and self-sufficiency in managing a local administration. Traditional authorities are well placed to address human related threats to conservation because of their intimate knowledge and contact with the resident population, together with their legally recognised mandate to enforce the law in their constituencies.

To this end, traditional chiefs currently use a small unarmed force of '*gendarmes*' to maintain the law in their administrative areas. The *Gendarmes* are local residents who share kinship and social ties with the rest of the community. They differ fundamentally from other law enforcement agents in the Congo, in that their strength is derived not from their weapons, but from the personality of the chief who's authority is based on local traditions and the respect that he is afforded from the community as a whole. Thus, the efficacy the system relies largely on the personal motivation of the chief.

There are currently 9 chiefs in the Domaines de Chasse around Garamba National Park. Whilst chiefs' capacity to manage conservation and development initiatives is varied, there is evidence to suggest that a number of chiefs are extremely motivated, and would benefit from the support of the wildlife authorities. For instance, research undertaken by the Garamba Project staff in the *Groupement Kilîwa* has revealed the efficacy of the traditional leadership in maintaining a climate of stability. This experience also highlights the mutual benefits that could be gained from a closer collaboration between the wildlife and traditional authorities. Of all the systems of authority in the region, traditional systems are the most accountable to the local population. Exceptionally, some chiefs are less responsible and operate through patronnage and coercion, however there have been a number of incidents of chiefs being deposed through popular pressure. A number of successful chiefs have the consent of the population in the groupement, which provides a basis for effective collaboration for both conservation and development in the region:

- The chiefs have access to detailed information on Sudanese movements resulting from their close relationship and the high level of trust that has been established with the community. Incursions by the Sudanese are reported well in advance and can be referred to Park authorities.

- Soldiers passing through the village report to the chiefs. They are provided with accommodation at the chiefs' residence and he maintains control over their movements. Lack of discipline is repeatedly reported to higher authorities until action is taken.

- The above approaches have resulted in the voluntary handing over of automatic weapons to the traditional authorities. For example, documentary evidence exists to show that the traditional authority of Kiliwa recovered 61 automatic rifles between 1989 and 1995. These were delivered to the military, civil and park authorities. This is achieved with the help of unarmed *Gendarmes*.

ACTIVITIES

The programme will use a 'pilot project' approach. Initially, efforts will focus on strengthening the remarkable success of the traditional authorities of the groupement

Kiliwa. This experience will be used as a basis for collaborating with other traditional authorities, using the chief from Kiliwa as a key facilitator in the process.

The Programme Coordinator will build the capacity of traditional chiefs to maintain the laws of conservation by:

- develop consent for conservation activities through improved communication and accountability to village commitees. Presentations at village markets also provide a mechanism for communicating the link between conservation and community benefits outlined in sections 2 and 3 below. Participatory monitoring and evaluation will be initiated as the project develops.

- developing a system of rewards (primes) for chiefs and gendarmes for their performance in recovering automatic weapons and providing useful information to the wildlife authorities

- act as liaison officer between the traditional authorities and the park authorities, reporting regularly to the Conservateur Principal.

- develop a database drawing on the knowledge of the traditional chiefs and other key informants on the situation in the reserves pertaining to the threats to wildlife conservation

- Should the traditional authorities' means of managing particular illegal activities be inadequate to tackle a particular problem, the programme coordinator will advise the Park authorities on appropriate supportive action.

- replicate the successes by identifying and encouraging other traditional chiefs that are capable and willing to undertake the same conservation activities.

IMPACTS AND THEIR MEASUREMENT

These activities will significantly reduce the number of automatic weapons that are illegally held around the national park. The approach will reduce the overall cost of managing the protected area, and improve relations between wildlife authorities and local populations. In conjunction with the activities outlined in sections 2 and 3, this programme will produce a system of wildlife management that is sustainable in the long term. The decreased availability of automatic weapons will increase stability which is associated with the development of markets and other community driven welfare initiatives, such as the maintenance of local schools and dispensaries.

The benefits can be measured in the short term through the *remise d'armes*. These are certificates which document the transfer of weapons from traditional chiefs to higher authorities. In the medium term, the benefits will be shown in a reduction in the incidence of contacts between poachers and guards in the park. These are monitored through patrol reports.

- The Programme Coordinator will develop criteria for selecting welfare initiatives and ensure that they reach appropriate groups, such as the poor and women. The Programme Coordinator will facilitate the implementation of these projects by consulting with representative groups from the community.

- The Programme Coordinator will research, and if successful, design and implement the following issues:

a. the use of taxation to monitor offtake from the protected area.
b. the use of taxation to regulate offtake from the protected area.

a4.4 Partnerships in Conservation and Local Enterprise

RATIONALE:

- Certain development activities, such as trade in bushmeat and gold mining, present a direct threat to conservation

- Development in certain areas, such as at the boundary of the National Park, is likely to have a higher negative impact on Park resources than development at the periphery of the Hunting Reserves

- Economic development in the hunting reserves is an inevitable process. Therefore, wildlife managers must take an active part in economic development, and must position themselves to influence the nature and geographical focus of the process. This will mitigate the growth of 'high impact' economic activities.

- A long term threat may arise if conservation is increasingly perceived by the local communities as a hindrance to the development process

EXISTING SOLUTIONS:

- The informal economy in Congo provides the 'backbone' to local administration. The continued growth of the informal economy can strengthen the capacity of local administrators to ensure sustainable resource use.

- Experience at Kiliwa, far from the Park boundary, is evidence of the positive effects that conservation compatible economic development can have: the village, on the periphery of the reserves, is an economic growth pole, and consequently, has been associated with a movement of populations from the immediate periphery of the national park (Bagbele and Mamba) to Kiliwa.

- Certain economic activities, such as animal husbandry, have been successfully undertaken in the reserves, and may reduce the demand for bushmeat. For example, at Kiliwa, the chief has developed a 'goat lending scheme', whereby poorer families are lent a pair of goats from the chief's herd. The offspring from this pair are shared between the household, who are responsible for looking after the pair, and the chief who owns them. Both parties benefit: the poor household is able to develop their own herd, and the chief loses fewer goats to predators because of the more intensive protection offered by the poor household.

ACTIVITIES:

The programme will use a 'micro-enterprise' approach to development that has been tested with considerable success throughout the developing world (UNDP 1996). The initiative is based on the 'solidarity group model', in which five to fifteen individuals pursue their own micro-enterprise using a small loan ($50 to $200) and provide joint guarantees for each person's loan. The credit groups are self-selecting. Access to credit through the programme is subject to each member of the group being current with their repayments. The rewards are high for good performance and the penalties are immediate for poor performance.

The approach offers the following advantages:

- it uses locally available skills
- the framework is easily understood by members of the communities
- it promotes an entrepreneurial culture, based on community level initiatives, and not on well intentioned 'hand-outs' from above which have been the downfall of many development interventions
- it charges market interest rates on loans, which will make the programme cover its costs, reach more people and be financially viable in the long term
- it can reach a truly substantial number of poor households, especially women who often have a better record for credit worthiness
- it is labour intensive and creates significant employment
- they can serve as a basis for community participation, and a focus for environmental awareness

The programme will begin with the Microstart framework developed by UNDP, and adapt it to the local context. The approach uses a minimum of staff (most of the development administration is provided by the entrepreneurs themselves) requiring little capital equipment.

Trial credit groups have recently been set up by the Bakita Foundation according to the framework summerised above. Larger scale activities will draw on this experience and replicate successes.

a4.5 Planning, Monitoring and Evaluation

- Planning will be undertaken by the Programme Coordinator, with the help of the Advisory Board (see section 6). The Programme Coordinator will ensure that a representative selection of community members are consulted. The Programme Coordinator will sensitive to the problems of unduly raising expectations.

- The Programme Coordinator will develop a set of economic, social and conservation indicators that accurately measure the success of the programme.

- The Programme Coordinator will research the impacts of economic development on conservation in north eastern Congo.

- The Programme Coordinator, in collaboration with the Board of Advisors, will write up the evaluation results to the standards expected for recognised scientific journals