ECOLOGY, CONSERVATION AND MANAGEMENT OF THE BLACK LECHWE *(Kobus leche smithemani)* IN THE BANGWEULU BASIN, ZAMBIA

by

Bernard Mwila Kamweneshe

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN WILDLIFE MANAGEMENT

Centre for Wildlife Management
Faculty of Biological and Agricultural Sciences

Supervisors: Professor W. van Hoven and Professor G. Bredenkamp

UNIVERSITY OF PRETORIA
March 2000

ABSTRACT

The black lechwe (*Kobus leche smithemani)* is an antelope that belongs to the family *reduncinae*. Its current population is confined to the Bangweulu Basin in the northern Zambia. This research was undertaken to assess its current population status, the sex and age ratios, carrying capacity of the flood-plain where it occurs and its maximum sustainable yield. The study also estimated its potential sustainable off-take and looked into the links that exists between wildlife and socio-economics in order to demonstrate the views of local people on current wildlife management and utilisation. Historical records suggest that these antelopes were more widely spread and more numerous earlier last century. Until the 1930s the population may have numbered over 250 000. Records indicate major population decline during the first half of last century and therefore called for a quick management action. The population decline was thought to be caused by over-hunting and habitat change caused by an increase in water levels in the swamps. Aerial surveys during the 1950s suggested less than 20 000 and by 1970 only 16 000 lechwe were counted from the air. From 1988-1996, ground surveys were undertaken with a four-wheel drive vehicle, on motor bike and on foot. A series of aerial censuses was also conducted during October, at the height of the dry season when the lechwe are relatively evenly distributed in the swamps, thus facilitating the use of stratified random sampling method. A fixed wing cessina 182 was used throughout the surveys. The study revealed that black lechwe is a highly prolific and resilient species. Its population has great potential to increase if given adequate protection and proper managed. Mating takes place on shallow flood-plains between November and April, but peaks in March. Receptive females leave their herds to join small breeding ground comprising few dominant males, which may be likened to *leks* formed by some other antelopes. The population of lechwe is currently maintained around 30,000. The sex ratio of the species is equal to unity and the age ratio was estimated at 3 : 1. The entire Bangweulu wetlands can sustain a population of at least 160 000 lechwe. A sustainable off-take of 6 000 individuals per annum was recommended. Black lechwe being an endemic species to the Bangweulu Basin is important for the economy of the country and the rural population. The study has revealed that local people are keen to participate in conserving it together with other species and the habitat as long as they are clear about benefits that they will gain from their effort.

Key words: lechwe, poaching, population, conservation, Zambia.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADMADE	Administrative Management Design for Game Management Areas
CAMPFIRE	Communal Area Management Plan for Indigenous Resources
CDU	Community Development Unit
DGL	District Game License
GMAs	Game Management Areas
ITCZ	Inter-tropical Convergence Zone
IUCN	The World Conservation Union (The World Conservation Union).
MSY	Maximum Sustainable Yield
NCS	National Conservation Strategy
NP	National Parks
NPWS	National Parks and Wildlife Services
OSY	Optimum Sustainable Yield
PR	Public Relation
VSP	Village Scout Programme
WRCF	Wildlife Conservation Revolving Fund
WCS	World Conservation Strategy
WWF	World Wide Fund for Nature
ZK	Zambian Kwacha

"Harmony between the local people and wildlife would be restored, by involving the people directly in wildlife management and by removing unnecessary restriction on their way of life"

W.J. Lusigi (1984, pp.143)

CHAPTER 1
WILDLIFE MANAGEMENT IN ZAMBIA

1.1 A historical review

Biological resources should be managed to ensure long term sustainable utilisation of species and ecosystems (Allen, 1980; Eidsvic, 1980; IUCN; 1980). Effective management ensures not only the survival of biological resources such as wildlife and natural habitats, but also their increase while they are being systematically utilised and thus providing the foundation for sustainable development (McNeely, 1988).

Wildlife management in Africa as a whole has more or less inherited the policies practised during the colonial era. Colonisers perceived that wildlife could only thrive under protection in national parks, reserves and sanctuaries (Lusigi, 1981; Marks, 1984). This conservation line of action emphasised the aesthetic and scientific values at the expense of local people's needs and values.

The first European traders in Zambia who came towards the end of the last century started the ivory trade which at the same time marked the beginning of the alienation of local man from wildlife (Langworthy, 1972). These traders were very eager to gain control over the lucrative trade in ivory. One of the initial policies against Africans was to curtail the possession of firearms and gunpowder (Gann, 1954 in Marks, 1984). These restrictions were made in order to discontinue the decline in wildlife species which in their opinion was being caused by the excess hunting by the local inhabitants, ignoring the rinder pest epizootic which greatly reduced populations of several ungulates in many areas (Pullan, 1983).

The first two game reserves, Mweru marsh in the north of Zambia for elephants (*Loxodonta africana*) and Luangwa in the east for Giraffes (*Giraffa camelopardalis*) were established in the early 1900s. Consequently, a game decree was declared in 1925 under which certain wildlife species were protected. Game hunting was only allowed under permit and licence, thus the traditional hunting which was one of the largest protein providers to the local African was declared illegal.

In the early 1930s, a Game Department whose major activity was centred on elephant control with regard to crop damage was established. The game reserve network was expanded around 1940s and it was recommended that people living in these areas be removed to pave way for "smooth" management of the same areas (Pitman, 1934).

Kafue National Park was the first national park to be established in Zambia in 1950. It was realised that other than being a source of protein, wildlife could realise economic benefits through visitor hunting and game viewing (Darling, 1960). Both these concepts were alien to the affected indigenous people.

After independence in 1964, the government of Zambia inherited the colonial wildlife legislation. Priorities of the Game Department were to encourage management programmes within game reserves and to encourage research into vegetation and wildlife populations (Astle *et al.,* 1968; Dodds & Patton, 1968). The prime objective was to establish economic importance of wildlife through tourism and cropping of "excess" wild animals (Stier, 1973). An effort was made to provide more tourists facilities and game cropping schemes and the ultimate result of this move was the forced withdrawal of local people from their traditional lands. This further entailed that their cultural, social and economic contacts with wildlife was curtailed. Although other types of research were being encouraged, the sociological aspect was essentially omitted. The Game Department was later changed to National Parks and Wildlife Service (NPWS) in 1972.

The World Conservation Strategy (WCS) launched in 1980 (IUCN, 1980) has demonstrated that conservation of living resources is essential for the achievement of sustainable development. Based on the WCS, a detailed plan for the rational use of the Zambian resources was set up in the National Conservation Strategy (NCS) (IUCN/GRZ, 1985). Since then a new era has emerged in wildlife management which places importance of conservation on human survival rather than preservation of species, (although the argument is hinged only on proper management). Attention is being drawn to the value of development on small scale and at local level, utilising traditional knowledge and skills. Since early 1980s, wildlife management and utilisation place emphasis on local communities participating in decision making, conservation and management of their own natural resources.

1.2 Wildlife management and utilisation areas

Zambia has an extensive network of wildlife protected areas. These areas cover about 240 951 km^2 or approximately 32 percent of the total surface area of the country. The two main categories of such areas are as follows:

1.2.1 National Parks

There are 19 National Parks in Zambia, covering almost 60 234 km^2 or close to eight percent of the area of the nation. These have been established to protect their natural landscape, vegetation and all forms of wildlife. Due to their protected assemblage of species and groups of habitats, national parks were and are still considered as "living laboratories" for educational and research activities. They also posses potential as wilderness for back country recreation (usually on foot and/or use of special vehicles) because of the symbiotic, cultural and ecological values of terrain, which are relatively unaltered by human activities.

Wildlife utilisation in national parks is based on protectionist policies and left for non-consumptive tourism only. This entails that apart from tourism infrastructures, no other forms of land-use are allowed in these areas.

1.2.2 Game Management Areas (GMAs)

GMAs are opened to restricted and closely controlled hunting. The considered maximum safe annual off-take of trophy animals is determined by periodic counts and other investigations and quotas are fixed accordingly. Sportsmen wishing to hunt in these areas are issued with special permits and licence for which they pay appropriate fees in respect of those animals, which they wish to hunt. Fees vary according to the trophy value of the animal concerned as shown in Table 1.

Table 1. Commercial values of selected common mammals hunted in Bangweulu Basin (Wetlands Project records (1996).

Species	Zambian residents	Non-Zambian residents	Trophies
Lechwe	ZK 100 000 (US $ 500)	ZK 200 000 (US $1000)	ZK 1 300 000 (US $ 6 500)
Reedbuck	ZK 32 000 (US $ 160)	ZK 175 000 (US $875)	ZK 200 000 (US $ 1 000)
Sitatunga	ZK 25 000 (US $ 125)	ZK 195 000 (US $975)	ZK 500 000 (US $ 2 500)
Tsessebe	ZK 50 000 (US $ 250)	ZK 160 000 (US $ 800)	ZK 604 000 (US $ 3 020)

*(Trophy fees are based on the October 1996 foreign exchange rate, which on average was 1 US$ equivalent to ZK 200).

GMAs in most cases act as buffer zones to national parks as shown in Figure 1 and are largely zoned for sustainable wildlife utilisation by hunting through permits and licences. Other forms of land use such as human settlement and agriculture on subsistence level are permitted.

There are currently 36 GMAs covering approximately 180 713 km^2 or 24 percent of the total area of Zambia. In the remaining open areas, any existing wildlife still falls under the same protection, though it is not strictly adhered to. NPWS has jurisdiction over wildlife matters in virtually all national parks, GMA and open areas. Most decisions concerning wildlife policies, practices, protection and enforcement are centralised at the headquarters in Chilanga (Lusaka). The country has, however, been divided into 12 administrative zones called commands, which administer daily activities in national parks, and GMAs, which fall within their respective jurisdictions. The system hence becomes partially decentralised. The zoning does not necessarily conform to provincial boundaries or any navigational points but were determined by the distribution of wildlife estates.

1.3 Socio-economic and cultural considerations

Wildlife management in Zambia was for a long time mainly concentrated on the biological aspects of animals and their habitats' well-being. The human dimension, though equally essential, was neglected in most wildlife issues. Management practices reflected the western cultural interest and did not express the social scope which makes the "resource" a possibility in a specific African cultural context (Marks, 1984).

According to Spoer (1956), in Lusigi (1981), the concept of "natural resource" indeed was regarded differently in unique cultures. Cultural, political and socio-economic problems arose from the issue of "National Park" as it was conceived alien and unacceptable to some local people. Land was delineated for national parks with little or no regard for impacts of these changes on the livelihood of the affected people. These actions were devoid of pre-assessment of cultural values and needs of local people and their interaction with wildlife. The exclusion of socio-cultural considerations in management decisions contributed considerably in the fostering of local negative attitude towards wildlife and conservation activities. The influence of socio-cultural factors on conservation of wildlife is stronger than assumed (Lusigi, 1981). It is clear that the survival of wildlife will in due course depend more or less on the ability to make significant social contributions than on its aesthetic and biological values (Manning, 1977).

Zambians living in areas adjacent to national parks generally viewed national parks as a law enforcement agency with little or no interest in their socio-economic problems (Kaweche *et al.*,

1987). In fact, some rural residents in GMAs looked upon NPWS personnel as their most brutal and uncertain among the national bureaucracy with which they had to encounter (Marks, 1989). Consequently, this led to lack of trust and co-operation between local residents and NPWS personnel. Such antagonism by people living around national parks has also been observed elsewhere in Africa (Kurji, 1976; cited by Eltringham, 1984; Lusigi, 1981; Westem, 1982; Nzima, 1984) and in Asia (Mishra, 1982; Lehmkuhl *et al.*, 1988).

While national parks were considered major economic assets, little or no money generated through tourism directly benefited the local people. These are the people who felt their land had been appropriated to create national parks (Lusigi, 1981) and were actually bearing the real cost of conserving wildlife (Eltringham, 1984; Marks, 1984; Bell, 1987; McNeely, 1988).

Animals do not obey artificial boundaries and hence they wander and in many cases damage crops of residents living in and around GMAs and national parks. Moreover, national parks are developed with the major objectives of attracting foreign tourists who can afford the gate fees and exorbitant costs of accommodation and other services. These charges are normally beyond the reach of most local people. In addition, appreciation and recreation are low priorities for most of the rural populations who are simply struggling with means to earn their basic needs. Results of all the above factors have substantially led to the solidification of local negative attitudes and resentment to national parks and other conservation areas.

Protection of wildlife not only depends on the income generated by tourism and the strict conservation laws, but conservation effort must win a degree of acceptance from local people if it is to be successful (Lusigi, 1981; Marks, 1984; Kaweche & Lewis, 1985; MacKinnon *et al.*, 1986; McNeely, 1988). The lack of socio-economic and local cultural considerations linked with their denial of access to wildlife has manifested itself in many ways such as:

- **Illegal hunting**

  Wildlife policies have provided little or no incentives for research into the needs and perception of local people. There has been no motivation for them to participate in wildlife management programmes. Foreign conservation values or at least methods of achieving values have been imposed on resident societies. The wildlife legislation only allows hunting by licence, but these have been very difficult for local hunters to obtain due to either the bureaucracy involved or lack of money. Under such conditions, many local hunters have turned out as "illegal hunters" utilising wildlife for personal and commercial benefits.

- **Over exploitation**

  Poaching has already led to over exploitation of economically valuable species such as elephants and black rhinoceros (*Diceros bicornis)*. The strict policies set up a stage with the local people as scapegoats in a scenario controlled by outside traders in ivory, rhinoceros horns, skins and dry meat. This conspiracy of use of wildlife resources on unsustainable rates has lead to the depletion of wildlife stocks and local extinction of some of the economically important species.

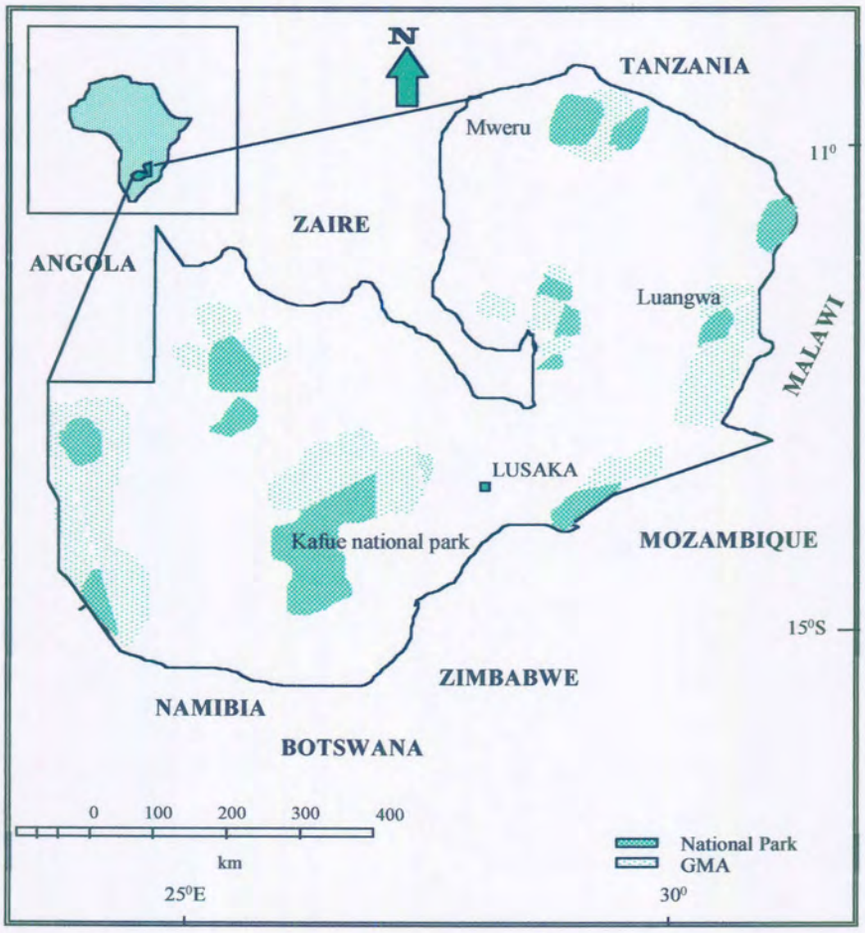


Figure 1: Map of Zambia showing locations of national parks and game management areas.

1.4 New trends in wildlife management in Africa

Recent developments in Africa have attempted to reverse the negative attitudes of local people against wildlife legislation.

It is realised that an evaluation of cultural, political, socio-economic and ecological factors must be balanced against local expectations in both short and long term management considerations (Lusigi, 1981). Conventional ideas on wildlife and parks in particular are under question (Allen, 1980; Eidsvik, 1980; IUCN, 1980; Mackinnon *et al.*, 1986; McNeely, 1988).

In Kenya's Amboseli National Park, conservation of migratory wildlife has been enlisted to local people (Western, 1982, 1984). In Zimbabwe, Communal Area Management Plan for Indigenous Resources (CAMPFIRE) was initiated in Sebungwe region and other communal lands with the objective of achieving management of natural resources (Wildlife, forests, water and grazing land) by local communities (Martin, 1984a, 1987).

In Zambia, NPWS has established a system involving local people in management and utilisation of wildlife and sharing revenue generated from it (Mwenya *et al.*, 1988). The system is called Administrative Management Design for Game Management Areas (ADMADE). The system is already operational in more than 17 of the 36 GMAs.

The WWF and Zambia Wetlands Project, which operates under the frame work of ADMADE was initiated in 1987. This covers four GMAs within the Bangweulu Basin, namely Kalasa-Mukoso, Bangweulu, the proposed Chikuni GMA and part of Kafinda (Figure 5). These areas form part of the Bangweulu Wetlands, which are important for wild fauna and flora, some of which are endemic to the area and for this reason called for special conservational attention. The broad objective of the Wetlands Project is to work in partnership with local communities in the conservation and management of renewable natural resources with an ultimate goal of giving the latter capacity to conserve and manage their own resources.

Many of the conservation problems involving man-nature relationship may be solved by affirming the positive aspects that could be used as basis for motivating changes within the social and cultural frame work. Martin (1984a) indicated that a restoration of rights to many rural communities would in fact make a reasonable job of resource management and that such an approach would turn the tide of conservation endeavour in Africa.

1.5. The environment and wildlife protected areas of the Bangweulu Basin

Bangweulu Basin lies in the northern part of Zambia. It has a rich wildlife heritage with an approximate area of 30 000 km^2. Within the broad study area, there are two national parks and four GMAs. The GMAs are Bangweulu, Kafinda and Kalasa-Mukoso and the proposed Chikuni GMA which is completely enclosed by the Bangweulu GMA and this extends for approximately 2 500 km^2. Chikuni GMA is the cardinal area for different forms of wildlife utilisation of the entire Bangweulu and this at the same time coincides with the distribution range of the black lechwe (*Kobus leche smithemani*). The two National Parks are the Lavushi-Manda and Isangano though both are heavily depleted of important wildlife species (Figure 5.)

1.6 Justification and objectives of the present study

The initiation of the World Wide Fund for Nature (WWF) and Zambia Wetlands Project in the Bangweulu and the Kafue flats attracted a number of wildlife related research activities. These included quantification of wildlife numbers and their harvesting potentials, classification of vegetation types and other related studies, ornithological and soil mapping (Chileshe & Kamweneshe, 1987). Wildlife related studies covering the major part of the Bangweulu Basin (under the Zambia Wetlands project) also included socio-economic surveys. Although various types of wildlife utilisation are taking place, there was no in-depth study of wildlife management and utilisation with reference to local people and their socio-economic benefits prior to the inception of the project. It was proposed to appraise the current status of major wildlife populations in the Bangweulu with the intention of estimating potential sustainable off-take for different wildlife species in the area. Some of the links between wildlife and socio-economics are studied so as to demonstrate the views of the local people on current wildlife management and utilisation activities. The study also states some ideas on how wildlife management policies can be directed to enhance incorporation of local people in legal sustainable utilisation of wildlife with particular reference to the black lechwe.

Specific objectives of this study are:

- to provide a methodology and a baseline for the future monitoring of the black lechwe population;
- to assess the current black lechwe population status and structure;
- to estimate the relative recruitment and survival rates among sex and age classes of lechwe;
- to assess the correlation between sex and age ratios and seasonal distribution;

- to determine the distribution of lechwe in relation to resource availability by different sexes;
- to determine the sex and age ratios as indicators of population trends;
- to study the species' social behaviour;
- to ascertain if the species is a seasonal breeder (observe the rutting and calving periods);
- to estimate the carrying capacity of the flood-plain for lechwe and the maximum sustainable yield;
- to evaluate attitude and perception of local people towards current wildlife management;
- recommend strategies for both long and short term management of wildlife populations with reference to black lechwe through integrated multidisciplinary effort involving local knowledge and skills.

1.7 Literature review

1.7.1 Wildlife populations

The term "wildlife" has a variety of meanings. For the purpose of this study, it refers only to untamed animals particularly large and medium sized mammals. As used here, "game" is considered synonymous with "wildlife". This definition does not embrace plants unless otherwise stated. Another term, which needs to be defined at this point, is resource as it is often misinterpreted. Resource in simple terms means material that is available for use. For the purpose of this report, resource will be centred on biological resources, also commonly known as renewable resources as opposed to non-renewable ones, which include minerals. Because renewable resources are characterised by the capacity to grow, they are also potentially vulnerable to destruction or death, and wildlife is such a resource.

The term conservation has also been used in different versions. For the purpose of this work, the definition advanced by the WCS has been adopted. This states that "Conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the aspirations of future generations".

Most of the work on wildlife populations in the Bangweulu Basin has mainly been confined to the proposed Chikuni GMA. The studies carried out have been to estimate elephant, black lechwe and tsessebe (*Damaliscus lunatus)* populations (Kamweneshe *et al.,* 1987,1988 Unpublished). A declining trend in populations was reported in these species but there is apparently an increase in numbers of tsessebe and lechwe whereas elephants continue to decline. Over the last decade, much attention has been given to the causes of declines particularly as a result of illegal hunting for meat, skins and horns (the last two being of less importance). It should be stated here that

subsistence hunting is mainly for meat though in some instances skins are used in making chairs and drums.

1.7.2 Public attitudes and perceptions of wildlife

Review of public attitude towards wildlife conservation in the third world was made by Harcourt *et al.* (1986). Many people support wildlife protection for different reasons and there is correlation between different influences and attitudes to wildlife conservation.

Local people living adjacent to Nepal's Royal Chitwan National Park complained about prohibitions on grazing, fodder cutting and firewood collection, and crop damage by wildlife (Lehmkuhl *et al.*, 1988). However, some people around the park favoured the national park for its role in wildlife conservation and in generating employment opportunities.

In Malawi, people complained that the Government was taking away the most productive fishing areas, and the only source of fuel wood and thatching grass when Lake Malawi National Park was established in 1980 (Nzima, 1984). In assessing the future of wildlife and its natural habitats in Botswana, Mordi (1989) carried out a nation-wide survey to establish how the public perceived cattle *vis-à-vis* wildlife. The proportion of people in favour of cattle grazing was more than those who supported wildlife conservation.

1.7.3 The traditional management system

Management of local resources in most areas in Zambia, including wildlife, was vested in collective or village level institutions under the guidance of elders (Marks, 1984). Depending on these resources, rural people developed their own means of managing a sustainable yield of benefits (Beyer, 1980; McNeely, 1988). The use of wildlife was hence fully integrated into the local socio-cultural structures. Traditionally, the people wanted protection for themselves and their crops from wildlife. Avoidance and control of wildlife were some of the management goals which local people developed in the encounter for survival among wildlife. The variety of management techniques traditionally developed were successful by any conventional standards (Beyer, 1980).

1.7.4 Socio-cultural attributes of wildlife resources

Resources are products of social processes that define them initially as potentially useful things and then provide means which convert them for social purposes (Marks, 1984). Culture has an important role in affecting people's perception and use of resources (Lusigi, 1981; Marks, 1984;

Martin, 1984b; McNeely & Pitt, 1985). In this sense, wild animals are not just which determine the value of a particular animal for a group of people. To a great extent, the outlook towards wildlife in African societies has been a commodity rather than resource oriented (Lusigi, 1981).

There has always been something of a love-hate relationship between man and nature (McNeely & Pitt, 1985). On one hand, wildlife has supported the livelihood of the people and has given spiritual satisfaction on the other hand. It has been accountable for dangers and threatening the survival of human communities living within and around wildlife habitats. Man has adapted to this situation, involving social systems, technology and customs that allowed him to live in a form of balance with nature. Living in harmony with the environment has been an integral part of the African culture (Lusigi, 1981). This type of interaction with the environment and wildlife in particular has permitted both man and wildlife to co-exist and survive in natural habitats on the African continent. However, some critics point out that there is a discrepancy in the WCS about the cultural dimension in conservation issues and the value of different ways of life and philosophies, and indeed, about populations (McNeely & Pitt, 1985).

1.7.5 The role of local subsistence hunting

Marks (1976) carried out an in-depth study of subsistence hunting among the Bisa Community in Luangwa Valley, Zambia. In the past, they hunted mainly for food and for traditional tribal ceremonies and rituals. Hunting of large animals was of social and religious significance. For instance, elephants were venerated and respected. Hunting followed strict tribal customs, and were conducted only for specific ritual purposes (Versi, 1989). However, the situation is changing owing to largely external economic factors.

Similarly, Campbell (1980) and Murray (1980) have detailed subsistence hunting in Botswana. Both stated that hunting is still a major activity in some parts of the country. Animals are killed with spears and bows with pointed arrows. Only in few cases are muzzle-loading guns used. Hunting also reflects local values and norms. Campbell (1980) reported that hunting is not only looked upon as a right, but also as part of African culture. In traditional Africa, it was taboo to kill more than was essentially needed (Lusigi, 1981). Normative restraints and supporting reciprocal social structures sustained local wildlife harvesting.

Though traditional methods (bows and arrows, spears and traps including pitfalls) were very effective, hunting was limited to local needs only. Hence, numbers culled were not sufficient to cause major decrease in wildlife populations (Eltringham, 1984; Marks, 1984). Muzzle loading

guns became available to local people over a large part of Africa from Europe in the late 1800s when gunpowder was introduced and following this, some animal populations began to decline.

In a more recent sociological study of local hunters in Lupande GMA, Marks (1989) concluded that skills and knowledge of local subsistence hunters would have an important role to play in effective management plans.

1.8 The current wildlife management system

1.8.1 Implications of bureaucratic management

Recent evaluation has revealed that in Africa, wildlife resources are under threat mainly because the custody for managing them was transferred from the people who lived close to them to government officials stationed in distant capital cities (MacKinnon *et al.*, 1986; McNeely & Pitt, 1985; McNeely, 1988). Consequences of strict conservation activities in East Africa have been documented (Davis *et al.*, 1973 cited by Marks, 1984).

1.8.2 Wildlife management by local people

In recent years, attention has been given to the role that local communities should play in the management of their natural resources. (Chabwela, 1987; Kaweche & Lewis, 1985; Larsen & Lungu, 1985; Martin, 1984a; Western, 1982, 1984; Child, 1984). This view is based on the assumption that local people managed their resources adequately before their communities were subjected to mainly the current external economic factors and, therefore, there is still room that they can make it again once given a chance.

In Amboseli National park, as the result of incorporating local people in the overall management of the park, there has been an increase in wildlife numbers in the ecosystem (Western, 1982). Successful incorporation of local people in decision making and in planing processes have also been demonstrated in Sapo National Park in Liberia and in Simo and Bale Mountains National Parks in Ethiopia (Bell, 1987).

There was great awareness of ownership and management responsibilities of natural resources by local people on communal lands before the CAMPFIRE programme was initiated (Martin, 1987). Bangweulu Basin is no exception as there has been tremendous awareness on the values of wildlife in recent years. This has been supported to some extent by the decrease of the number of poaching cases and the cases reported to the law enforcing officers by some local residents themselves.

1.9 Wildlife utilisation and socio-economics

1.9.1 Wildlife as food source

Before legislation against hunting of game by local people, game meat had been a large source of protein among Africans. Bush meat constituted about 25 percent of the protein intake for about one third of the people in Ibadan, Nigeria (Olawoye & Ajayi, 1975).

Similar records have been documented elsewhere (Adeola & Decker, 1987; Asibey, 1974; Ajayi, 1971; Jeffrey, 1977; Martin, 1983). Observation made among the local people in the Bangweulu for eight years clearly indicates that, next to fish, game meat provides the highest protein source to most local people especially those living in and around the swamps.

1.9.2 Wildlife and revenue for local development

Most developing countries in Africa are faced with a grave situation in which the natural resources must meet the escalating demands of an expanding human population with rising material aspirations in the rural economy. On the other hand, there is need for sustainable management of indigenous natural resources to support balanced development of these human populations. Consistent with conservation goals, protected areas should provide support for the local development (Manning, 1977; Kaweche & Lewis, 1985). Wildlife has great potential for development once properly managed, but the resource has in most cases been undervalued. Wildlife utilisation, particularly through eco-tourism, safari hunting and culling has been proved to contribute to socio-economic developments in the following ways;

- generation of foreign exchange through tourism related industries;
- revenue to the public through safari hunting licenses and taxes from tourism institutions;
- employment generation for rural residents in wildlife enterprises such as tour guiding, tourist lodges and meat and skin processing;
- provision of cheaper game meat to the local people.

The idea of integration of wildlife conservation areas into local rural economies is currently gaining wide acceptance over Africa. To promote conservation of wildlife in communal lands in Zimbabwe, revenue from hunting is paid to the local communities. Through this arrangement, about US$ 4.5 million was spent on development projects in remote parts of the communal lands over seven years in the 1980s (Child, 1988)

In Zambia, all the money accrued from different types of wildlife utilisation was externalised to the central treasury. Most of this was spent on developing other areas and used on other activities, leaving the local communities from where the money was generated with nothing to count on. With the introduction of the Wildlife Conservation Revolving Fund (WCRF) and the Wetlands Project under the ADMADE programme in 1987, revenues from safari hunting, culling programmes and area concession fees began to accrue to the local communities.

This approach was embarked on to increase benefits for the local people who in turn would provide incentives for proper management of the wildlife estates. This was followed by establishment of Community Development Units (CDUs) based on existing traditional system of chiefdoms. These are represented by local authorities, which are linked to the central government and other government departments through local district councils. The principal objective behind the Wetlands Project was to give the right of managing natural resources back to the communities living in Bangweulu and Kafue flats wetlands as pilot areas.

1.9.3 Illegal hunting/ poaching

The term "poaching" has been used widely in literature pertaining to wildlife management and conservation. The term is being used for illegal hunting under the following categories;
Hunting or trapping and killing of wild animals by people who either;

- possess no license to hunt those animals;
- kill more than the prescribed number of any species for which they are licensed;
- hunt in a national park or other designated area where hunting is not permitted.

Further, subsistence hunting could be distinguished from poaching, though the dividing line becomes blurred. In some cases this can be determined by the prevailing economic circumstances. Local subsistence hunters in the Bangweulu and elsewhere in the country have been transformed in attitude towards wildlife by recent hush economic developments. Subsistence hunting continues as in the past but nearly every hunter this time will rent his skill for monetary gain, which was not the case in the past. Poaching followed by un-prescribed bush fires therefore remains the major problem faced by the government in both national parks and GMAs. This development also threatens all other interests in wildlife resources, which includes conflicts with tourism.

CHAPTER 2

THE LECHWE IN ZAMBIA

2.1 Introduction

The multitude of the mammalian fauna is separated into various orders, families, subfamilies and genera according to their relative relationship to one another, based on anatomical, morphological and behavioural characteristics (Ansell, 1968).

The black lechwe is a member of the family *Reduncinae* that includes the waterbuck (*Kobus ellipsiprymnus*), reedbuck (*Redunca arundinum)* and the kob (*Kobus kob thomasi*) of Uganda. Three sub-species of lechwe are recognised in Zambia (Allen, 1963; Ansell, 1968; Robinette & Child, 1964; de Vos & Dowset, 1966; Child & Von Richter, 1969).

2.2 Red lechwe (*Kobus leche leche*)

This is found on the upper drainage of the Kafue and Zambezi rivers. It is also common in the Okavango delta in Botswana and currently in very limited numbers on the Chobe-Linyanti river system (Howard & Chabwela, 1987; Grimsdell & Bell, 1972) (Figure 2).

2.3 Kafue lechwe (*Kobus leche kafuensis*)

This sub-specie is endemic to the Kafue flats in the south west of Zambia.

2.4 Black lechwe *(Kobus leche smithemani)*

The black lechwe under this study is restricted to the Bangweulu Basin. A few were reported at the southern tip of Zaire, which could be an extension of the same population in the Bangweulu (Figure 2).

The fourth race (*Kobus leche robertsi)* which occurred on the Luongo River in north-western Zambia, is known to be extinct. The black lechwe is physically the most distinct of the lechwe sub-species. Ansell (1968) has given its detailed description. The black lechwe is not entirely as black as its name suggests. In the adult male, however, the black patch on the shoulder spreads up the sides of the throat and along the bottom of the flank, eventually covering the shoulder and rump and in few cases may converge on top of the spine.

The belly and the throat remain white and so do the insides of both the legs and ears, (Figures 3 & 4). The extent of the black colouring is generally related to the age of an individual and this is normally attained at the age of about four years. A much higher proportion of the well-marked males is seen during the rut when they concentrate on the flood-plain. In this respect, season appears to have some effect on the depth of the colour in males.

The immature male and female black lechwe closely resemble the Kafue lechwe. Males are larger than females and it is the former that carries horns. The black lechwe being the most important species to the Bangweulu Swamps and the country and realising the threats that haunt it, the Zambian Government decided to list it as one of the protected animals under the law.

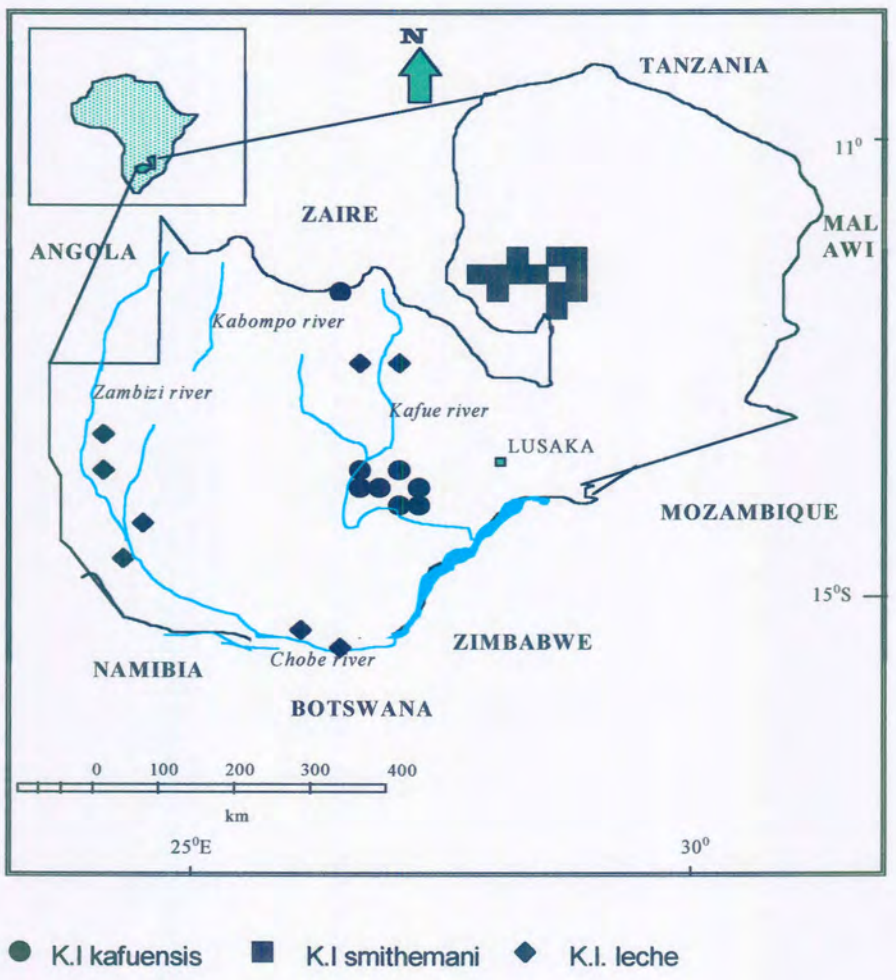


Figure 2: Distribution of lechwe sub-species in Zambia, Namibia and Botswana.

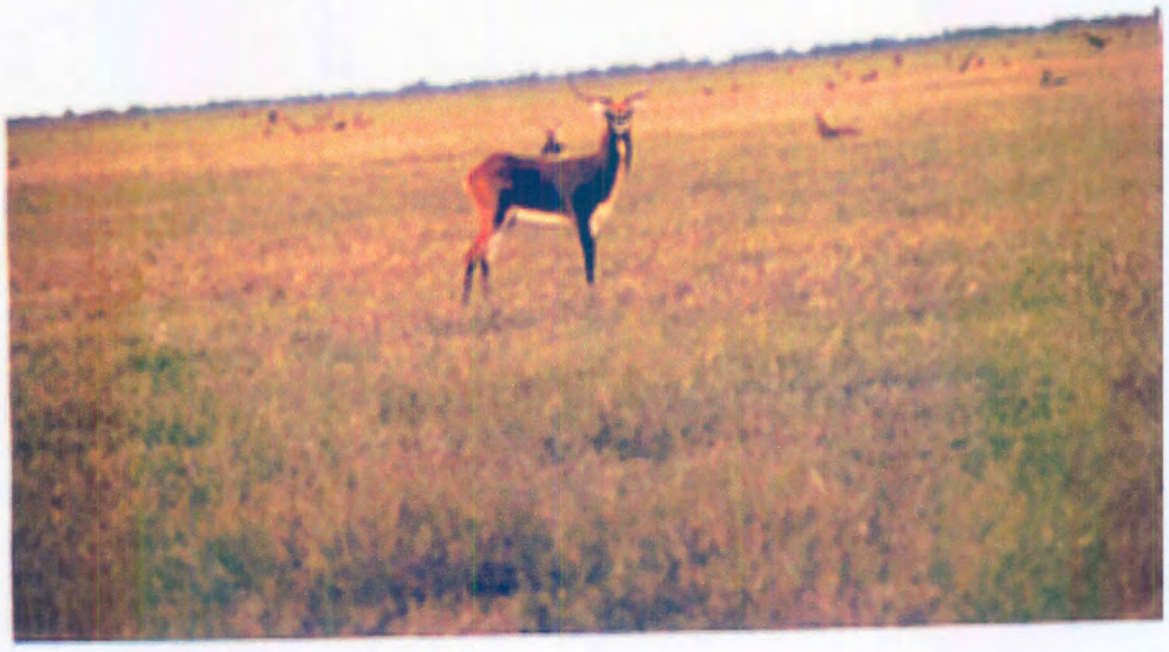


Figure 3: Male lechwe on the Chimbwi flood-plain (note the spread of the horns.

Figure 4: Black lechwe male on the Chimbwi flood-plain (Note the deep black coloration of its coat).

2.5 The history of black lechwe population

The black lechwe has its main population centre in the southern flood-plain of the Bangweulu Swamps. Historical records indicate that the antelope was more widely spread and numerous early this century. Until the 1930s the population may have numbered over 200 000 (Hughes, 1933; Pitman, 1934). By the 1940s it had declined to less than 50 000 (Brelsford, 1944). According to Grimsdell & Bell (1975), 16 500 individuals were counted from the air. The population decline was attributed to over hunting through a traditional method *(Kusowa)* whereby animals were mass driven into nets and speared. Habitat change through increase in water level in the permanent swamps was also thought to have greatly contributed to the decrease of the population as it could have affected the species' breeding characteristics (Grimsdell & Bell, 1975).

Lechwe characteristically occur in dense concentrations and therefore attempts to count them in these herd almost always result in considerable miscounts. Similarly, an observer on the ground is most likely unable to see all, or even a proportion of the herds actually present. This is also true for all those individuals and groups that are present in inaccessible areas. This could lead to serious errors. Brelsford (1944) did recognise this limitation and therefore decided to arbitrary increase his counts by doubling his observed figure of 30 000 to get a maximum of 60 000 individuals for the entire Bangweulu Basin. Very large herds of lechwe observed in early days could have tempted observers into snap guesses of herd sizes and extrapolation of total numbers that could have erred wildly. A good example is by a catholic missionary quoted by Pitman (1934) at Chilubi islands (within the interior of the swamps) who recorded that black lechwe numbered well over one million. Due to above reasons, figures of lechwe given by past observers tend to be rather doubtful as compared to the recent aerial counts, which cover a much larger area.

An intensive study of the black lechwe ecology during 1970-1973 coincided with the minor population recovery and by October 1973, the estimated population size was 25 254 ± 4 184 (Grimsdell & Bell, 1975). This increase was thought by Grimsdell & Bell (1975) to be a result of a decrease in hunting pressure and they suggested that the population might continue to increase as it was clearly under carrying capacity of the area. A further aerial survey in October 1983 confirmed that the population growth had continued and estimated a total lechwe population of 41 401± 7 626, an increase of 64% in the decade since the last census (Howard *et al.*, 1984).

CHAPTER 3

THE STUDY AREA

3.1 Location and extent

The Bangweulu Basin is located in northern Zambia between 29° 30' E and 30° 40' E longitudes and between 10° 45' E and 12° 40' S latitudes. The basin is roughly circular with an area of approximately 30 000 km^2. The wetland system (approximately 11 900 km^2) is the largest and most diversified in Zambia. Seasonally flooded plains cover about 6 800 km^2 and the permanent swamps measure at least 5 000 km^2 (Chabwela, 1987) This however varies with the amount of precipitation in a given year.

There are three GMAs within the study area which together measure approximately 8 000 km^2, (Bangweulu 3 600 km^2, Chikuni 2 500 km^2 and Kalasa-Mukoso being the smallest, 1 900 km^2) (Figure 5). The broad study area was confined to the black lechwe range, which comprise the three GMAs, while the core study area was limited to the Chimbwi flood-plain (100 km^2) including other adjacent areas within the Chikuni GMA (Figure 6). This area was appropriately selected due to its high wet season lechwe concentration, mosaic of vegetation types and relatively easier accessibility.

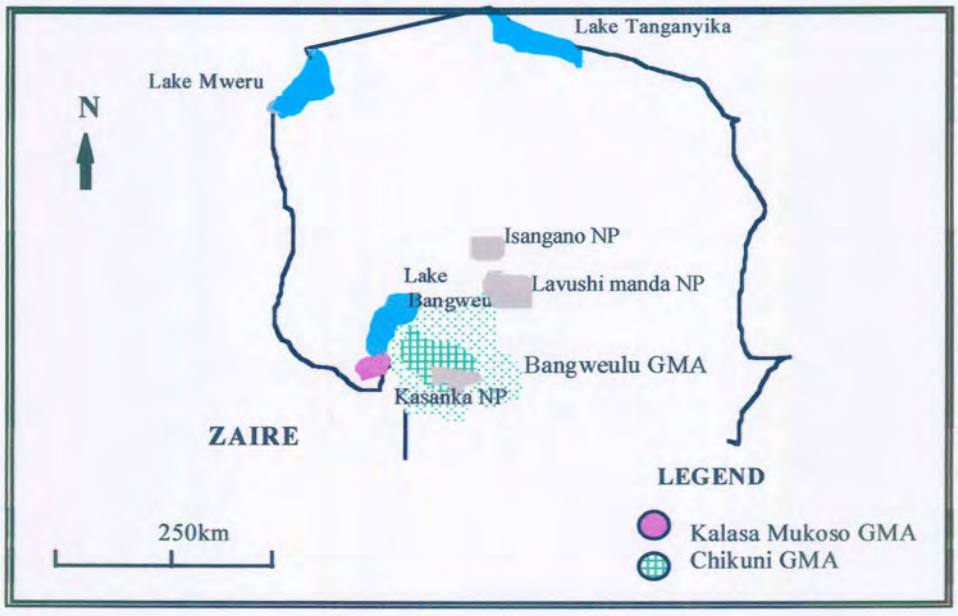


Figure 5: Location of the three game management areas and three national parks in the Bangweulu Basin.

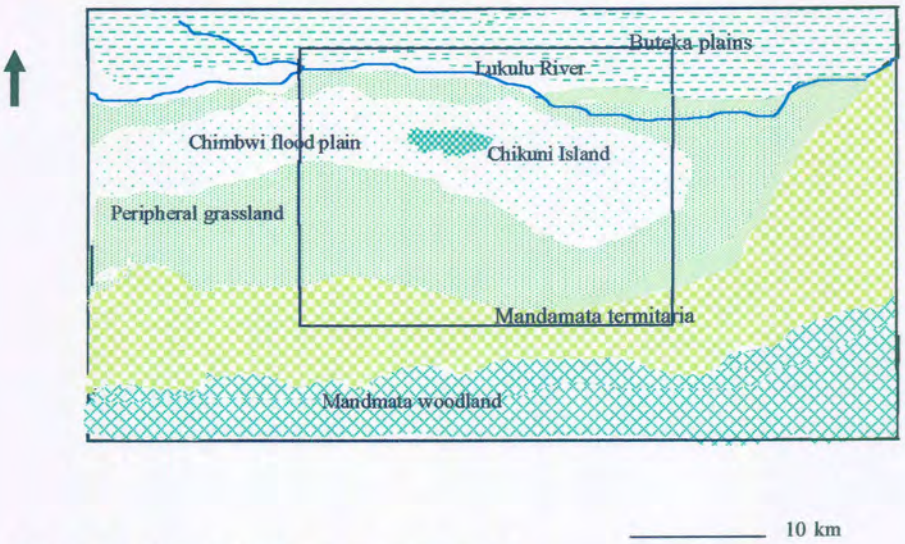


Figure 6: The Chimbwi flood-plain core study area.

Geographically, the Bangweulu wetland system can be sub-divided into four major landscapes;

- rivers, lakes and lagoons;
- seasonally flooded plains;
- permanent swamps;
- dry upland: mainland and islands on the lakes and swamps. (The altitude is about 160 m above sea level with very little variation).

3.2 Biophysical resources

3.2.1 Structure and geology

The Bangweulu lies in a shallow depression, which is referred to as the basin in the centre of an ancient cratonic platform on the general plateau. This cratonic unit, known as the Bangweulu Craton was initially formed during the Precambrian (1 800-2 200 million years ago) and has experienced little structural disturbances for the last several hundred million years (Chileshe & Kamweneshe, 1987; Grimsdell & Bell, 1975).

The cratonic platform is surrounded on three sides by rift valleys and associated areas of relatively recent geological activity. Pressures from this activity have subsequently affected the surface structure of the craton to give rise to its present form.

Lake Bangweulu itself has been formed by local subsidence in the end-tertiary (20 million years ago). Observations suggest that the down warping which caused the formation of Lake Bangweulu itself may have continued until very recently, causing a slight tilting of the basin towards the north-

west and in turn, causing the lake and river systems to migrate in that direction (Debenham, 1952) (Figure 7).

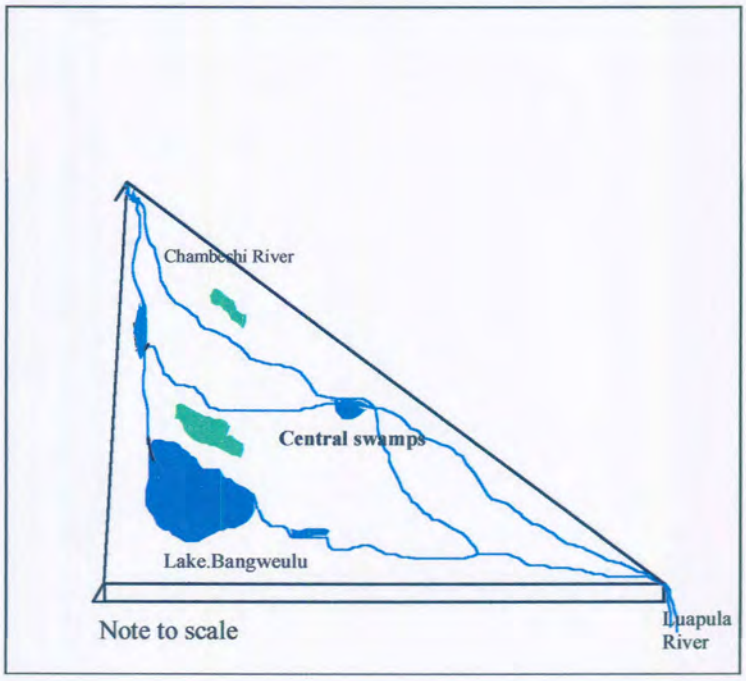


Figure 7: Hydrological model of the Bangweulu swamps.

3.2.2 Topography and soils

The cratonic unit is mainly made up of quartzite, mudstone and acid metavolcanics with intrusions of granitoides in a few places (Wetlands Project records, 1996; Grimsdell & Bell, 1975).

Despite the generally coarse texture of these parent materials, the soils now covering the Bangweulu craton are mostly fine textured, ranging from sandy clay loam to clay, with sandy clay and clay prevailing in the swampy areas. The coarse nature of the parent material is, however, still reflected in a coarse to medium textured topsoil, which at least in Zambia, is typical for soils developed over coarse-grained parent materials.

The coarse fraction that has over the millennia been removed from the weathered rock has been concentrating in the structural depressions on the craton. This is mostly observed on the Chambeshi flood-plain, where extensive deposits of sands can be found at the present day.

The minor and more recent depressions like dambos and smaller flood-plains are mostly filled with relatively recent eroded material from the surrounding upland and, therefore, contain much heavier soils which are often fairly rich in silt (Chileshe & Kamweneshe, 1987).

As a result of the great age and the acidity of much of the parent material, the soils of the craton are exceedingly infertile. However, the soils of the Bangweulu wetlands are relatively fertile compared to those of the surrounding plateau as a result of alluvial accumulation, but by normal agricultural standards are still classified as deficient in many respects (Grimsdell & Bell, 1975).

3.2.3 Climate and hydrology

Zambia's climate has two main distinct seasons; the wet season from November to April and the dry season from May to October. The seasonality in rainfall is controlled by the annual movements of a low-pressure system known as the Inter-tropical Convergence Zone (ITCZ) which, when gradually moving over southern Africa, generates convection type of rainfall.

The Bangweulu Basin is situated in the high rainfall belt of northern Zambia and seasons can be further defined as follows;

- A cool dry season from May to August;
- A warm/hot dry season from August to October;
- A warm rainy season from November to April.

Mean annual rainfall varies between 1 000 mm and 1 500 mm, with a gradient of increasing rainfall towards Lake Bangweulu (Gould, 1989). With the level topography and altitude, the climate over the entire system is fairly homogeneous. It is believed that large inland waters or swamp vegetation may have some influence on the microclimate and could increase rainfall locally (Gould, 1989).

The dominant feature in the Bangweulu system is the seasonal flooding regime which permeate every aspect of the ecology and economics of the area. Though the rainy season effectively starts in November, the plains get inundated in January and the highest water level is reached in March as the inflow from the catchment exceeds the capacity of the main river channels. After the rains, the water gradually recedes, reaching the lowest level in October/November, subsequently leaving only the central basin permanently under water. The occurrence of high and low floods is regular through successive years, but the extent of the flood water and the speed with which it rises and recedes vary from year to year.

The Bangweulu system is fed by 17 principal rivers of which the Chambeshi is the most important and the total catchment area covers a large proportion (~190 000 km^2) of the North Zambian plateau. The system is drained through only one outlet, the Luapula River which flows via Lake Mweru and the Lualaba River into Zaire, making up headwaters of the Zaire River (Figure 7). This eventually pours its waters into the Atlantic Ocean on the western side of the African continent. Of the total inflow into the Bangweulu system, only approximately 10% leaves by this outlet and the remaining 90% is lost largely to evapo-transpiration. The water level at the centre of the basin varies seasonally, causing the flood-line to advance outwards and recede by as much as 30km at the periphery in some localities.

Rainfall records show that the annual flooding pattern at any point in the basin is closely related to rainfall at the specific point or its immediate catchment area. At the same time, the swamp has a strong water storage effect, causing flood levels to be related to previous year's amount of rainfall and the inflow of water from the upper catchment area.

3.2.4 Temperature

Situated as it is within the tropics, Bangweulu has mean air temperatures being in the range of 15^{o}C to 30^{o}C. June and July record the lowest temperature which may fall as low as 1^{o}C. Nights are usually chilly and days are warm to hot mainly due to non availability of thick and long vegetation in many places. Temperatures as high as 42^{o}C have been recorded in months of September and October (Mpika airport meteorological station).

3.2.5 Precipitation

Rain begins at the end of November and continues until the end of April (Figure 8). In the swampy areas, rainfall averages slightly more than 1 000 mm in a normal rainy year. Rainfall and run off from rivers and local tributaries emanating from the main land account for the initial flooding and the water logging of most areas on the periphery during January and February. As a result of the low gradient, the water flows across these areas at very slow velocity.

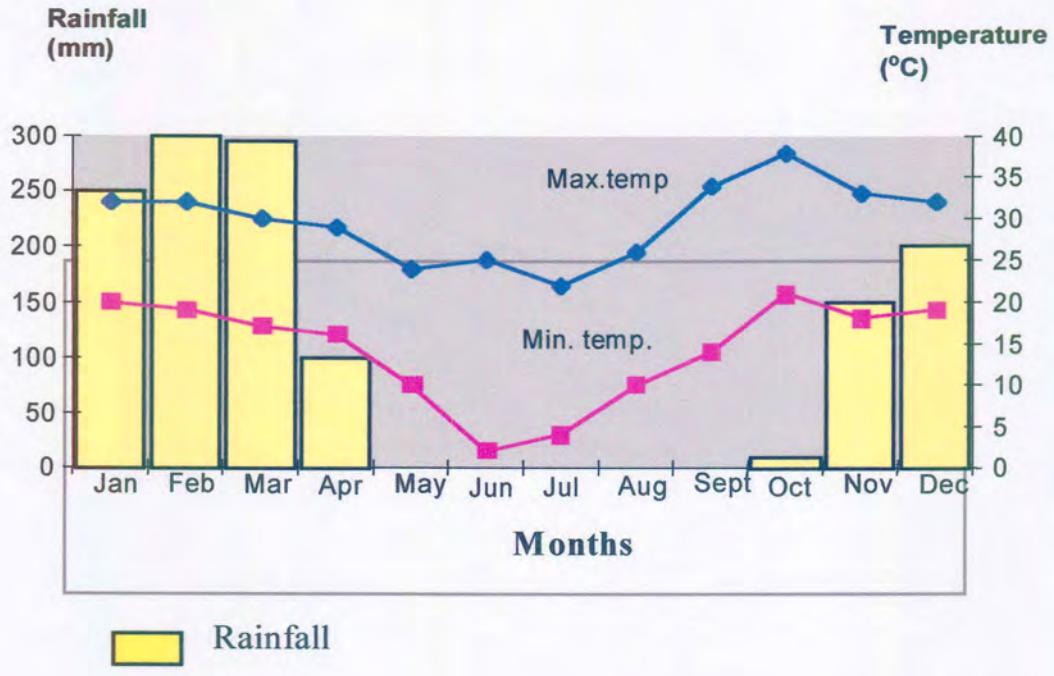


Figure 8: Average monthly temperature and rainfall in Bangweulu Basin, 1992-1996 (Source: Mpika airport meteorological station).

3.2.6 Wind and sun shine

Wind and sunshine are factors that are not widely measured in Zambia. Despite their great ecological importance, little data are available. The winds generally tend to blow from the east, August and September being the windiest of the dry months. Whirlwinds are particularly conspicuous in the areas, which are void of trees during dry months. These may be considered important in the distribution of seeds, spores and nutrients over vast areas. While the foregoing environmental factors are of importance to the life and functioning of many organisms in any ecosystem, their effects are not so obvious and well studied as those of the water, soil and fire which are considered very important in the ecological processes.

3.2.7 Vegetation

The vegetation of the study area is a mosaic of different vegetation types. The extent and location generally being determined by two major factors; soils and water regime. The vegetation falls into clearly defined zones in relation to the depth and duration of flooding (Table 2). This is particularly so in the flood-plains and swamps but it is also the case when describing the whole system in broad terms. The flood-plain, with very little local relief and lying at the lowest elevation is subject to seasonal inundation for several months each year.

Due to differences in water regime and soils and to some extent human activities, the surrounding woodland cannot be regarded as an extended area of uniform vegetation. On the basis of human disturbance, a distinction is made between closed, open and scrub forests and on edaphic grounds a separate description is made of swamp forest and of riparian forest along lakeshores and riverbanks. Likewise the drainage dambos and the termitaria which are scattered throughout the basin are described to give a clearer picture of the vegetation mosaic (Figure 9).

The Bangweulu Basin may be considered to consist of five main distinct vegetation zones;

- the upper mainland woodland;
- the fringing open woodlands;
- the termitaria and fringing grasslands;
- seasonal flood-plain;
- the water meadow / permanent swamp.

This study however puts emphasis on the termitaria, fringing grassland, seasonal flood-plain and water meadow grasslands which are largely occupied by lechwe.

3.2.7.1 Upper mainland woodland

The main woodland occurs mostly at an altitude greater than 1 000 m (a.s.l). Under such conditions, drainage is better and tree growth is not suppressed. In general, the trees are well spaced to allow growth of grasses to give rise to the savanna grasslands in some places. Dominant trees comprise mainly the miombo (*Brachystegia* spp.) and grasses include *Hyparrhenia* spp. and *Andropogon eucomis.*

3.2.7.2 Fringing open woodlands

The open woodlands consist mainly of woody species which include *Pterocarpus angolensis, Parinari* spp. and *Combretum* spp.

3.2.7.3 Termitaria and fringing grasslands

The termitaria zone is mostly found between the open woodland and the seasonal flood-plain. This is dominated by different types of termite mounds. Termitaria is a generic term for all the different habitats in which termite mounds created by *Macrotermes* and *Odontotermes* spp. are prevalent.

Termites ingest humus silt or clay to extract humus from it and use their droppings to build mounds, usually dark in colour and of hard texture.

Forest, woodland thicket, scrub and grassland can be found on termitaria. The termitaria grassland has characteristic features of the flooding areas and are found scattered throughout the Bangweulu Basin, occurring on islands and mainly peripheries of the flood-plains. Termitaria grasslands are not found on pure sandy areas (less than 10% clay + silt). There seems to be a correlation between the texture of the soil and the frequency, size and texture of the mounds; being larger, higher, harder and more numerous with the increase in clay content of the soil. For the reason that many termite species are unable to establish a mound under condition of annual flooding, most of the termitaria in the swamp may have been formed when the area was drier than it is now (Grimsdell & Bell, 1975). The soils of the termitaria are grey clays with sandy patches around larger mounds and drainage lines. Water logging in these areas during the wet season prevents tree growth in most places except upon the termite mounds. Vegetation is made up of grasses and herbs associated with occasional flooding. Large trees, shrubs and woody climbers like the fine fern commonly grow on and around the mounds giving rise to another name for this area, "bushgroup" grassland (Figure 10). Dominant tree species found on the termitaria often include *Cassia singuena, Combretum* spp., *Erythrina abyssinica, Parinari* spp., *Phoenix reclinata, Rauvofia caffra, Syzygium cordatum, S. guinense, Uapaca* spp., *Vernonia* spp. and *Vortex domiana.*

Interspersed in some areas are depressions which contain seasonal pools where some of the aquatic plants can be found. Different animal species habitant to the termitaria congregates at these pools for water at certain times of the day.

3.2.7.4 Seasonally flooded plains and water meadows

The Zaire and Zambezi catchment areas posses river valleys which have reached base level erosion on the perimeter of swamps and include extensive areas of edaphic valley grassland. Seasonally flooded plains comprise semi-floating swards of grasses and sedges which collapse when the water recedes and eventually forming a thick "mattress" which completely covers the moist, black alluvial clay soils (Fanshawe, 1971). Most of the component species of grasses flower at the end of the rainy season, but vegetative growth from node shoots, emerging through the withered vegetation, continues during the cool dry months, and many species also flower when the warmer weather sets in at the end of the dry season.

Owing to the flat terrain (Figure 11), the depth of the water during the flooding period is even over extensive areas and hence gives an impression that there is virtually no water flow in any particular direction. The vegetation swards are always dense and flowering period of the grasses

and sedges vary. In most cases, about all grasses that are palatable and utilised by lechwe on the flood-plains are hardly given time to flower and hence mostly regenerate by vegetative means.

The stems of the associated plants are so mixed together that the sampling of various individual plants is almost impossible. Depth and or duration of flooding factors dictate the extent of vegetation distribution. Permanent flood-plain vegetation is characterised by *Phragmites australis, Cyperus papyrus* and *Typha capensis.*

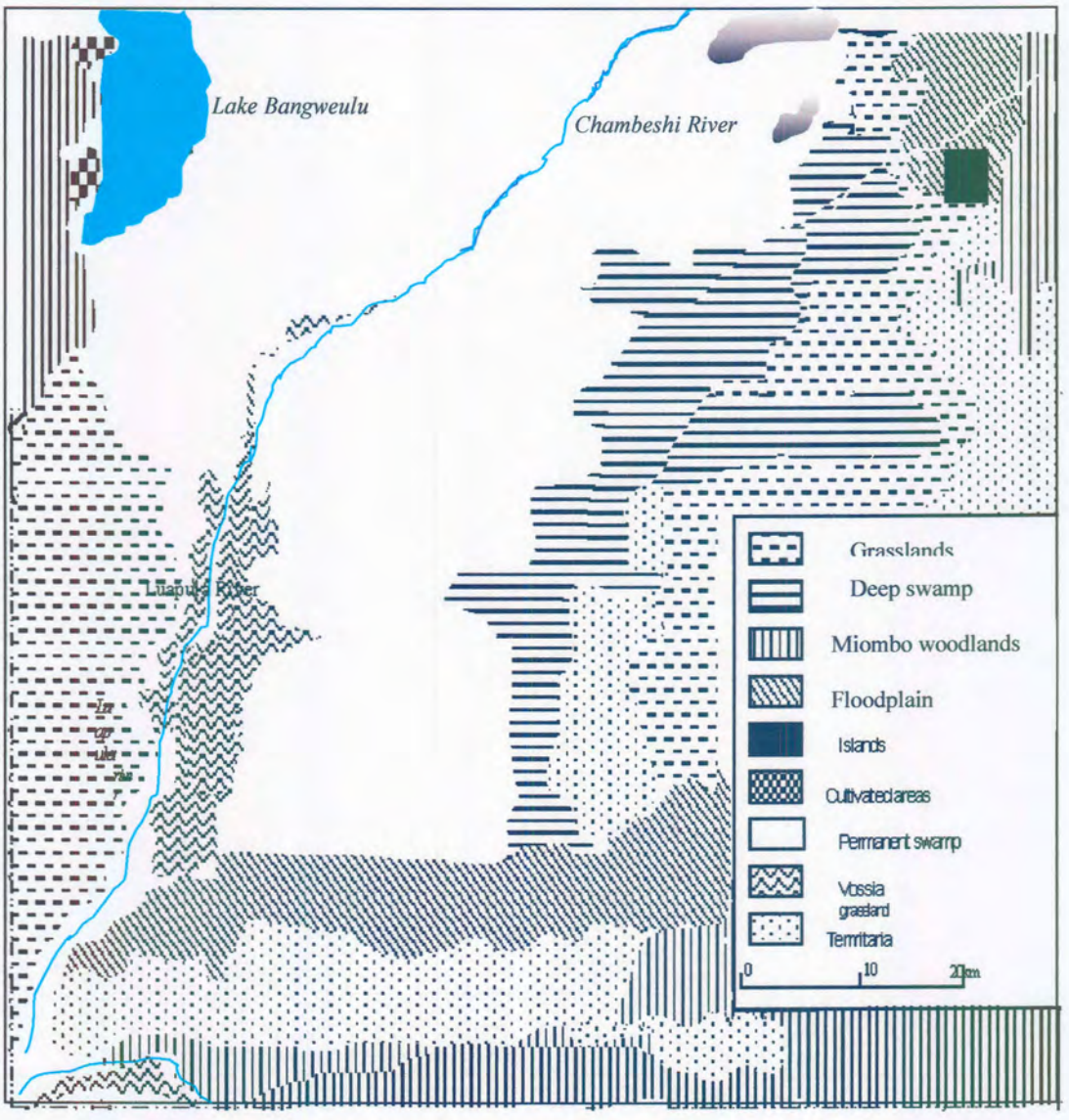


Figure 9. Simplified vegetation map of the Bangweulu Basin.

Figure 10: Termitaria grassland on Mandamata.

Figure 11: Part of the Chimbwi flood-plain at the onset of the rainy season.

Table 2. Dominant species in seven vegetation communities distinguished in this study.

Area	Community	Major species
Lakes, Lagoons	Open water	*Nymphae caerulea* *Ottelia* spp. *Pistia stratiotes* *Potamogeton richardii*
River fringes	*Vossia* flood-plain	*Vossia cuspidata*
Permanent swamp	*Cyperus papyrus/ Typha/Phragmites*	*Aeschnomene fluitens* *Cyperus digitata* *Cyperus papyrus* *Echinocloa stagnina* *Ipomea* spp. *Leersia hexandra* *Oryza barthii* *Phragmites australis* *Thallia welswitschii* *Typha capensis*
Deep water floodplain (Water meadow)	*Oryza/Vossia*	*Cyperus digitata* *Vossia cuspidata*
Shallow floodplain	*Echinocloa/ Leersia*	*Acroceras macrum* *Echinocloa stagnina* *Eragrostis aethiopica* *Leersia denudata*
Peripheral grasslands	*Loudetia*	*Cassia mimosfolia* *Eragrostis* spp. *Loudetia simplex* *Loudetia. superba* *Panicum repens*
Termitaria	Termitaria	*Eragrostis aethipica* *Hyparrhenia digitata* *Loudetia simplex* *Panicum repens* *Setaria anceps* *Sporobolus* spp *Themeda triandra*

3.2.8 Wildlife of the Bangweulu Basin

The Bangweulu Basin supports diverse populations of fauna despite the high human population densities on the surrounding areas and the islands. The area provides an important habitat for a number of mammal species (Table 3). Besides mammals, the area also provides for a rich variety of birds and fish. Of particular importance to the area is the black lechwe, which was once widespread in Northern and Luapula provinces but now restricted to the Kalasa-Mukoso flats, the eastern, central and southern flood-plains.

The shoebill stork *(Balaeniceps rex)* is a rare and endangered bird found only here, in Zambia. The wetlands also provide an important refuge for wattled cranes *(Bugeranus carunculatus)* which are listed as threatened elsewhere.

It is the seasonal flood-plain and its environs that carry the major wildlife populations, the swamps being relatively poor in species diversity due to high flooding in combination with the homogeneity of swamp vegetation which is relatively less palatable.

Over the past few decades most of the larger mammals have been heavily exploited by man, causing the populations to be well below the carrying capacity of the area (Grimsdell & Bell, 1975). There is evidence that some species that were present in the 60s are now locally extinct. This development can partially be attributed to the easier accessibility brought about by the new Mukuku road which passes through the Kalasa-Mukoso and has put the wildlife under increased pressure in the form of uncontrolled, illegal hunting by mainly hunters coming from urban areas.

No thorough research has ever been conducted to determine the abundance and distribution of smaller mammals. However, estimation of some bird species, which include shoebill storks, wattled cranes and saddlebill storks *(Ephippiorhyncus senegalensis)*, has been attempted by various researchers.

The number of elephants has been kept low due to high incidences of poaching for their tusks. It is believed that lions were dissipated in the 1960s for their trophies. The Bangweulu lions were specialised in hunting in marshy areas and the males had developed a dark mane, which was highly sought after as trophies.

Table 3. Estimates of population sizes and dates when last counted and dates of locally extinction of large mammals in the Chikuni GMA.

Species	Population estimate	Year counted or last seen	Reference
Black lechwe	33,000	1996	Kamweneshe & Mupemo, 1996
Bufallo	150	1994	Kamweneshe *et al;* 1994
Bushbuck	>2,000	1994	pers. observ
Bushpig	Common	1995	pers. obs.
Cattle	Locally extinct	1960s	pers. comm.
Duiker	>1,000	1994	Kamweneshe *et al;* 1994
Eland	Locally extinct	?	pers. comm.
Elephant	110	1994	pers. obs.
Hartebeest	Seen	1990	pers. obs.
Hippopotamus	>2,000	1990	Kamweneshe *et al;* 1994
Hyena	<100	1996	pers. obs.
Side stripped jackal	Common	1996	pers. obs.
Leopard	Seen	1995	pers. obs.
Lion	Extinct	1985	pers. obs.
Oribi	>4,000	1994	pers. obs.
Puku	Seen	1994	pers.obs.
Reedbuck	>5,000	1994	pers. obs.
Rhinoceros	Locally extinct		pers. comm.
Roan	<50	1994	pers. obs.
Sable	<20	1992	pers. obs..
Sitatunga	>10,000	1992	Kamweneshe & Kamweneshe, 1996
Tsessebe	>12,000	1994	Kamweneshe *et al.*, 1994
Warthog	Common	1995	pers. obs.
Waterbuck	Common	1993	pers. comm.
Wild dog	Seen	1990	pers. obs.
*Zebra	Locally extinct	1960s	pers. comm.

*Seven individual Zebras were re-introduced in Chikuni GMA in 1996

3.3 Demography of the Bangweulu Basin

3.3.1 The tribes

The human population of the Bangweulu area is made up of different tribes: The Unga and the Batwa occupy the central swamps, the N'gumbo are found on the north-western and western shores of lake Bangweulu, the Mukulu to the north and north west, the Ushi to the south west and the Kabende to the south and the Bisa to the south east and east.

3.3.2 Population migration, density and growth

There has been a long established pattern of migration from Luapula province in which much of the Bangweulu falls, to urban areas, mostly the Copperbelt Province. The migration started at the turn of the century in response to the economic opportunities offered by wage labour in the industrial mining areas of Zaire and Zambia's own Copperbelt. Due to the emigration pattern, the population of the whole province registered some decline of 5% according to the 1969 census.

Around 1980s, there was a general decline in the regional migration trend mainly due to the recession in the mining and associated industrial sector on the copperbelt. This stopped the emigration and at the same time initiated an imigration of the retired or redundant mining sector workers. Apart from the regional migration patterns, the Bangweulu area is also affected by local seasonal migration dictated by the area's resources in particular fish, at different times of the year. According to the most recent official information (Central statistics office figure collected in 1992), the total permanent population around the swamps could range between 15 000 and 20 000.

3.4 Land tenure

Most of the land in rural Zambia is under customary law and therefore, it is not sold, bartered or rented out. It is often passed on from parents to children or next of kin. Any interested person, provided no other person has prior claim to it, can obtain user rights over unutilised land in the area. However, under normal circumstance the traditional chief has to be consulted before development of any form is undertaken. The chief is responsible for allocating land and solving land disputes whenever necessary.

3. 5 Land use and socio-economic activities

The Bangweulu swamps are widely populated mostly on the islands and on the edge of the swamps. Fisheries and wildlife mainly sustain the economy of the area. Fringing woodland vegetation and hydrophytes are also extensively used for fuel, fibre and other domestic uses. Fishing is mainly a cash sector activity, meaning that the major proportion (50-75%) of the catch is sold. This accounts for both commercial and subsistence types of fishing. Little is known about the status of the fish stock but it is reasonably certain that the fishery in Bangweulu has decreased over time due to over fishing and use of non-sustainable fishing methods which include poisons.

The decrease in catches in the lakes has most probably caused an increase in the number of mainland fishermen going into the swamps. This has further imposed competition for the resources with the permanent inhabitants of the swamps who depend very heavily on the fishery. The increasing pressure on the resources is also directly caused by the growth of the permanent population of the swamp.

There are basically two types of settlements; temporal seasonal fishing villages or camps which are located on small islands inside or on the edge of the swamps and the permanent villages which are normally located a few kilometres from the edge of the swamp. Most permanent villages are strategically located so that it becomes easier for the inhabitants to have access to both swamps and upland resources. The positioning of the villages also makes them safe from getting inundated during flooding periods. Most of the fishing camps are established on anthills and the level of flooding and the density and movement of fish determine their location. Artificial islands are also common. These are constructed by stuffing tufts of grass into the water supported by poles on the sides until some form of mound is achieved. The wet season in most cases eases up transportation for the majority, as they are able to use their dugout canoes.

From an aqua-culturist's point of view, some swampy areas may be considered to be relatively unproductive due to stagnant and obnoxious water condition, the later being caused by decomposing organic matter. The productivity of the lakes are relatively low due to low levels of nutrients and salts that constitute limitations in the plankton production at the base of the food chain. The main fishing grounds are found in the lagoons and channels where the waters are the most nutrient rich and well aerated (Debenham, 1952)

A wide range of factors determine the pattern of settlement, the most important being the availability of natural resources, physical limitations and rainfall (Kalapula, 1987). The farming system on the mainland is mostly semi-permanent (shifting cultivation). This can be classified as a low input/output agricultural system. Traditionally land is allowed to lie fallow after being worn out and in this case fertilisers are rarely used when reclaimed. In certain areas, it appears as though the number of fallow years are decreasing now because of the increase in human population and the extent of uncultivated land is becoming limited. Fishing is the predominant economic activity and agricultural practices are clearly subordinate to this activity. Thus amongst the fishermen in the swamps and on the peripheries, there is a general lack of interest in agriculture which is reflected in the very low crop diversity in the area with cassava (*Manioc* spp.) being the predominant staple crop. Cassava has certain properties that make it especially favourable for local people. Though it

initially requires high labour input, it needs relatively little attention apart from protecting it from wild animals. It has been observed that relatively good crop is harvested even on poor soils once given enough time to reach maturity.

Some local people basically live on fishing and trading in the commodity for mealie-meal and other requirements. During bad or non-fishing season, some fishermen turn to killing game in exchange for their requirements. Very few people living in the swamps place a strong emphasis on agriculture and therefore food security is very poor. Common food crops grown in the area are groundnuts *(Arachis hypogea*), local maize (*Zea mays),* sweet potatoes (*Ipomea batatas)*, banana (*Musa* spp.*)* and pumpkins (*Cucurbita pepo*). These crops are grown for subsistence and very little or nothing is commercialised. Expansion of commercialisation may be attributed partly to scarcity of credit, storage, marketing facilities and extension services. Animal husbandry is almost absent although people in various places on the main land are beginning to keep goats rather than disease prone cattle. Chickens are the most common livestock, which can be found in nearly every household.

3.6 Social amenities and activities

The study area is extremely low in essential social facilities such as schools, health and purchasing centres. Banking and postal services are non-existent. People have to walk long distances to Chiundaponde rural health centre, which in some instances entail covering at least 50 km. The ratio of health facilities to the population is very low. Schools are few and poorly staffed to cater for the increasing population though education has continued to receive apathy by many fishing communities.

Beer from industrial breweries is not available and therefore the local brew is a favoured leisure activity virtually in all areas. The local brew is made on private basis and may be used by the brewers as payment for work (*Ukutumya)*, but most often it is sold at open house beer parties.

Different kinds of local brew is found, made from water, sugar and yeast in addition to either millet and tea leaves. The beer is taken within two days to three days from the start of fermentation process. The longer the fermentation takes, the stronger it becomes. However, it has been observed that the demand is extremely high and therefore the beer is taken before it reaches the level it can be considered to be mature enough.

3.7 Access and Communication

Accessibility is one of the main constraints faced in the exploitation of the tourism potential including other developmental activities in the Bangweulu. The roads leading to the area like many others in the country are generally bad.

The area is remote and the main line of communication is by dirt road from the great north road through Chiundaponde. Although the road may be termed all weather, it becomes extremely bad during the wet season. Two seasonal airstrips are operational at Chikuni and Chiundaponde. Footpaths used by local people are common. Public road transport for the local people is erratic and poor. The major transport during the rainy season in the swamps is by dugout canoe. Many private bus operators shun carrying out their operation for fear of breaking their buses.

CHAPTER 4

BLACK LECHWE POPULATION PARAMETERS

4.1 Introduction

In order to manage a population of wildlife, the manager needs to understand the population that he intends to deal with. Each individual of a given population has various properties, such as sex and age. In addition, they may also have different morphological and social characteristics. All these together lead to the entire population having characteristics such as age and sex structure, density and the rates of birth and death, immigration and emigration patterns. The last four attributes are sometimes described as the basic parameters of a population as a change in any of these causes a change in population size in a particular area or given range.

4.2 Methods

General data on the lechwe and the habitat were collected from December 1987 to 1996. In dry season and low floods, observations were mostly undertaken from a four wheel drive vehicle, on a motor bike or on foot. Aerial surveys also complemented in various ways. During the entire study, my wife and three research assistants greatly assisted with data collection. Students from the University of Cambridge also provided invaluable assistance for a period of three months.

4.2.1 Ground surveys

The total ground surveys covered approximately 160 km^2. Specific ground surveys were conducted throughout the year (1994 and part of 1995) at fortnight intervals within the core study area (Chimbwi flood-plain) including Buteka and Mandamata across the Lukulu river, (Figure 6). Lack of topographic features on the flood-plain necessitated navigation along grid lines by compass and vehicle speedometer. Lechwe are reasonably approachable by vehicle but tends to become timid if approached on foot. This seems to be the opposite in the case of Kafue lechwe. Driving slowly through the group in order to facilitate easier counting of smaller groups split large groups of lechwe. Climbing on the roof of the vehicle to gain better visibility was frequently done for animals at a distance. A spot telescope mounted with a zoom lens and a pair of binoculars (8X50) were used in this case. During ground surveys, the following information was recorded;

- general social behaviour;
- herd structure;
- sex and age;
- food habits;
- distribution pattern;
- physical body condition;
- deaths and;
- births.

A truly random sampling was not feasible in certain instances and therefore groups of lechwe were sampled on chance encounter in the field. For this reason, this approach might have induced some sampling bias.

4.2.1.1 Determination of animal body condition

Body condition of the lechwe was assessed to ascertain whether the condition fluctuates with changes in flood cycles and as crude measure of its status in different habitats. Judgement of body condition was based on the general appearance of the hind quarters and lumber region and classified in four categories; good, medium, poor and extremely poor.

4.2.1.2 Body measurements

In 1991, 200 and in 1993, 230 black lechwe were culled under special licence. In both instances, the animals were weighed and body measurements taken. Some blood was lost from lechwe shot but the error in weight was taken to be insignificant. Measurements, which included body length, shoulder and hip heights, were taken immediately after kill. Animals were then skinned and butchered followed by weighing of dressed carcass and visceral organs. Horns were measured to determine the basal circumference, distance between tips, length and the number of rings.

4.2.1.3 Sex and age classification

External genitals, the presence of horns in males and the colour of the coat facilitated the classification of sex in lechwe.

For sub-populations which could not easily be reached by vehicle or on foot, low aerial photographs were taken from a fixed wing aircraft. This was done at the time of high floods when animals were concentrated in narrow bands along the high flood-line. The total number of lechwe

sampled was classified into five categories; adult females, adult males, sub-adults males and females and calves. Calves included all the lechwe under the age of 12 months inclusive. Knowledge of birth period peaks was useful for discriminating between age classes. Body growth and horn development in males also played a role in estimating the age. The age of animals in the herds from which samples were taken were estimated and the sex ratio calculated separately for each herd. The overall sex ratio was obtained by addition of the results from different herds in different counting zones.

4.2.1.4 Food habits

Observations on feeding were made on an *ad libitum* basis between August 1993 and March 1994. When animals were observed feeding, date, time and type of food were recorded. Identification of grass species that were selected and those that were rejected at a feeding site was achieved by observing selected groups of lechwe for 10-20 minute intervals. A metre square frame was then placed on a random selected feeding site. Within the quadrats, the following observations were made;

- grass and sedge species present;
- number of tufts fed on for each plant species;
- the number of tufts rejected for each plant species;

Fresh faeces from selected groups were also collected to supplement the information on the food preference. In order to gain the view of the plant parts that were preferably consumed, rumen contents of the lechwe were collected from different vegetation communities. The contents of each collection were mixed, spread out on a flat surface and divided into ten equal parts. Five random samples were obtained from these sections, bulked, mixed and this time, separated into four parts. From each of these sub-samples, further samples were taken, bulked (50 g wet weight) and stored in 10% formalin. The sub samples were then separated into four plant parts:-

- inflorescence;
- leaves;
- sheaths;
- stems.

The species composition of grass in the rumen was determined from the epidermal characters of fragments present. This gave an indication of the proportions of the plant species ingested. Better results were obtained from rumen contents collected from shot animals than from the droppings, because most of the grasses were partially digested. A reference collection was made of the most

common grass species available in the area. The plant species eaten were subsequently totalled and expressed as percentage of the total observations. The percentage frequencies represent the relative importance of the respective plant species as food to the lechwe. Food habits were analysed for both wet and dry seasons, running for three months each.

4.3 Results and discussion

4.3.1 Black lechwe social behaviour

Natural selection is a process in which the fittest animals survive. We expect aggressive, competitive animals to obtain food and cover and to secure mates and thus survive, reproduce and extend their genotypes to subsequent generations. Whereas competitive behaviour is adaptive, co-operative behaviour also enhances survival and is adaptive (Bailey, 1978). Animals in social groups enhance their chance for finding habitat resources, for detecting danger and for escaping from predators or successful defence or confusion of predators. Behaviour can successfully be interpreted as success in achieving energy balance, either in the short or long term. Migration at great energy cost may result in net savings. The cost of staying in one particular area may far exceed that of moving (Smith, 1989). Territorial display or defence of areas represents an inexpensive energy cost for a population, far less than the direct assault, wounding or killing of the invaders. For example, sex ratio, age ratio, reproductive stage and lactation all interact to determine whether energy from photosynthesis will be sufficient for a given population of a particular weight distribution (Bradbury & Andersson, 1987). Sociality facilitates the learning of adaptive skills such as feeding and the traditional home ranges and migration routes.

It is rather difficult to conclude to what extent the social behaviour observations are identical throughout the year or in years with pronounced fluctuation in the amount of rainfall. Although all types of wildlife behaviour are of interest to the wildlife manager, a few are of more direct managerial value than others. The major questions of behaviour that are fundamental to the management of lechwe in this case, are as follows:-

- time and pattern of migration;
- time of breeding;
- herd formation, particularly in relation to various environmental factors;
- avoidance of predators and;
- territorial and habitat occupancy.

4.3.2 Social organisation

Although it was not the purpose of this research project to study the behaviour of the black lechwe, many observations reflected here were observed over time since 1987.

The observant visitor to the lechwe range in the Bangweulu can easily distinguish three different aspects of social organisation which is revealed by closely looking at group structure-sizes, age and sex composition and social interactions between individuals. Of particular interest in this study were **aggression, courtship** and **territorial** behaviour because these can act as indicators of social organisation underlying reproduction.

The social organisation encountered in lechwe is not absolutely rigid. It can be modified by local features of the habitat which include population density, constant harassment by predators, in this case which is largely man, seasonal changes and the rise in water level.
The following are the major group categories:

- bachelor herd;
- female herd;
- nursery herd and;
- mixed herd;

4.3.3 Herd structures

Lechwe is a highly gregarious species and characteristically occur in large herds. The herd structure is often "loose". This signifies that there is no permanent herd cohesion as experienced in elephant and buffalo (*Cyncerus caffer)*. Herd sizes vary seasonally and on a smaller scale at the time of the day.

During dry months, lechwe tend to concentrate on the more open areas during the day and most of them retreat to the more vegetated waterline comprising the water meadow grassland in the evening and stay there throughout the night. At the turn of the wet season, large groups form on the open flood-plains at the peak of the floods when the flooding water limits the area available. The formation of mixed larger groups comprising adult males and females normally occurs at this time. The composition of herds may further vary on a daily basis according to the following grouping categories:-

- single adult male (solitary) which are mostly observed on the termitaria. In most cases these are either sick or old;
- mixed bachelor group (combination of adults and sub-adult males) (Figure 15);
- bachelor group (adult males only). This type of grouping is most often observed on the termitaria grasslands fringing the open flood-plain (Figure 12);
- single female with a calf. This is commonly seen near big herds and on the flood-plain close to the water line and water meadow;
- female herds which do not normally exceed 10 individuals are often seen deeper in the central swamps during parturition period (Figure 13);
- female herd with one or a few adult males can be found throughout the range and at any time of the year;
- mixed herds with males and females of various ages are noticeable during the rutting period;
- calf group (nursery), comprising mainly calves with possibly few older animals are formed not very far from mixed groups with suckling females.

4.3.3.1 Bachelor herd

Bachelor herds are exclusively males of various age classes. The male yearlings, which have been driven out of the female herds, join the bachelor groups. A further segment of this group can be of males who either cannot partake in the rut or are too old to compete in the rutting process. Sometimes a bachelor group may temporarily join a female herd, but this is usually observed only after the rut. During this time, there is virtually no chasing of females or fighting among males as commonly observed during the active rutting period.

Bachelor herds tend to stay away from more open flood-plain and at times some may be found cohabiting the termitaria grasslands and fringing open woodlands with tsessebe herds. The most interesting observation made in bachelor groups is that there is absolutely no aggression among individuals. This can make one to believe that females are the source of seeming intra-specific conflicts, which at times even result in deaths. During this period there is also little vocalisation which is frequently heard during the rutting period. In general, the behaviour pattern of adult males within the bachelor group differs markedly from those in the mixed herds at the peak of breeding time.

The answer as to what biological purpose the separation of the sexes serve lies in the fact that males who cannot yet participate in the rut are protected from competition and harassment. Young males also cannot yet withstand the rigorous attacks from male bulls defending a piece of mating

ground. An individual will only try to take part in the rut when it has attained a fit status. It is interesting to note the male bulls' tolerance towards young males even though they could be found closer to the "defended" area. It could be assumed that the bull does not feel threatened.

Figure 12. Bachelor herd on the periphery of the termitaria after being pushed away by dominant territorial males from the floodplain in December.

Figure 13 Small female herd of black lechwe on the Chimbwi floodplain at the beginning of the rainy season.

4.3.3.2 Female herd

Separate female herds are rarely formed but are normally found during the parturition period. Pregnant females dissociate from the rest of the groups to start the journey to the central swamps where they calf. These groups are generally small and do not exceed 10 individuals (Plate 6), but are accompanied by newly borns on their way back to the flood plains.

4.3.3.3 Nursery herd

This type of herd consists mainly of newly borns, which may be joined by yearlings. In some instances there can be a few lactating mothers in the vicinity, (Figure 14). Few male calves of the previous season is observed in such a herd. The majority of the young males, about 12 months to 20 months old, are expelled from the female herd. Once they move out, they tend to join the bachelor groups. It is also common to see small groups comprising only yearlings in areas closer to the waterline and away from either adult males or females.

Figure 14. Nursery herd of lechwe comprising lactating mothers and their young on Chimbwi floodplain upon arrival from the parturition areas in the central swamps.

During dry months, females are mostly found near wetter areas (meadow grasslands). This entails that they have access to better pastures comprising mostly *E. stagnina* and *A. macrum,* which in turn benefit the calves and ultimately the increased survival of the species.

4.3.3.4 Mixed herd

There is more mixing of males and females when females return from the dry season range in November.

There are basically three points of particular interest worth noting:-

- sex ratio on the flood-plains is mostly skewed to males between August and October. This coincides with the time when expecting females separate themselves from the rest of the groups and retreat to secluded areas in the central swamps to drop the young;
- there is relatively low number of calves observed during the same period. Calves born during the same period quickly attain juvenile class before the following season and;
- in agreement with the total count data, the number of calves peaked between November and January, (Figure 21).

The variation in sex ratio may be connected to the reproductive activity of the lechwe. They tend to be falcutative territorial. Addition males get excluded from the area during the reproductive activity and therefore give a biased picture of the real situation (Thirgood *et al.*, 1992).

It is rather difficult in many instances to distinguish female yearlings from adult females on the basis of body size or other criteria as they quickly attain features of the adult. Some yearlings and adult females were thus not always separated. Mixed herd normally comprises all age classes (Figures 15 & 16). At the time of flood recession, there are various waterfowl including egrets that accumulate on the flood plain and share the habitat with the lechwe (Figures 17 & 18). There seems to be no beneficial gain from the association between the birds and the animals. However, it cannot be ruled out that some bird species may feed on the droppings from the lechwe. Others may also feed on insects and beetles that lay eggs and hatch in the dung.

Figure 15 Mixed group of black lechwe with very few dominant males- beginning of *lek* formation on the Chimbwi floodplain in November.

Figure 16. The same mixed group of lechwe above, getting bigger by the day as more females and dominant males join.

Figure 17. Lechwe sharing the habitat with egrets before the floods on the Chimbwi floodplain in December.

Figure 18. Lechwe Mixed with egrets and Sacred ibis on the drying floodplain at the end of April.

4.3.4 Territorialism

In hierarchies, animals assume ranks in dominance-subordinate systems. Dominant animals tend to be older and larger individuals. These are eventually replaced by once subordinate animals which defer to dominant animals which retain dominance with threats and displays (Bailey, 1978). The most subordinate animals in a group attain the least or poorest of habitat resources. This is reflected by the poor body condition in animals habiting the termitaria grasslands after being pushed off the flood-plain with much better food resources. The defending of a piece of ground by a dominant male in other species can sometimes either be intra-specific or inter-specific

Territorialism is found in a great number of African antelope species inhabiting open grasslands. This behaviour helps to disperse a population and thus achieves a certain degree of protection of the entire habitat, normally for the benefit of the individual or individuals. The dispersion breaks up large-scale aggregation and reduces the danger of over grazing and trampling (Smith, 1989).

Many African antelopes tend to be territorial when they breed and some feature of l*ekking* have been observed in the Kafue lechwe and other members of the genus *Kobus* which include the kob (Deutsch, 1992; Deutsch & Weeks, 1992; Nefdt, 1992). The Kafue lechwe exhibit territorial behaviour on *leks* during their main rutting season (Nefdt, 1992). Females enter a *lek* to mate and choose a male for the purpose. The social status of males on a *lek* is unequal and it is usual to observe most or all females on a *lek* with a few males on a prime territory. Only a small percentage of adult males do most of the mating.

Territory formation in black lechwe is not as striking as observed in the East-African kob and the *leks* formed in Kafue lechwe seem to last much longer than that of the black lechwe (Spinage, 1969; Nefdt, verbal communication). No defence has ever been observed to be put up by black lechwe against other species sharing the same habitat. Reference is made to tsessebe, reedbuck and orebi (*Ourebia ourebi*) which are mostly found on termitaria.

Territorialism may also be considered as a pre-requisite for reproduction. The male is unable to mate even if he is sexually mature unless he is in possession of a piece of good habitat. Territorialism in lechwe, though not distinct, is only noticeable during the rutting season. Males defend loose temporary territories, which is similar to *leks* seen in Kafue lechwe. Fights between

males, which in several cases turn out fatal, are common. Males at this time also become vocal by producing frequent grunts. Certain noises produced may be of threat display.

4.3.5 Aggression

Males fight among themselves so that the dominant few can monopolise and mate with many females. If an adult male enters the clusters of females mixed with a few dominant males which is presumed to be a *lek*, it is often chased by one of the dominant males without any physical contact (Figure 19). The chase sometimes may cover several metres and lasts several minutes. Once the pursuing male is satisfied, it returns to the *lek*. Some observations revealed that, by the time the pursuing male returned the group has almost disintegrated with females moving in different directions. Males lying down were never attacked even if they were in close vicinity to the females. Young males, especially yearling were rarely chased by the adult males even if found standing amongst females. Aggression between adult males in the absence of females was never observed and there was very little aggression in mixed herds after the active rut at the beginning of April.

4.3.6 Leadership

Males in a group seem to have roles which could be described as those of a leader and protector. It is commonly seen that when one male member of the group spots an intruder or predator it turns to produce agitation, tail twitching, cessation of eating, aimless walking, raising the head and gives an alarm call to the rest of the group. It runs off and is immediately followed by the rest of the group. At the time of retreating some adult males stand guard gazing at the rest of the herd running in one particular direction. It is always the males that trail behind the group and it is mostly when the intruder gets very close.

The situation is different when it is a female that starts the procession. In this case, members of the group could run in different directions in a non-defined pattern. Leadership as an individual characteristic can be difficult to detect in most gregarious animals, unless all members of a group were to be individually recognised either by tagging or use of natural marks.

4.3.7 Weapons and fighting techniques

The black lechwe, like other antelopes, posses horns for intra-specific fighting between male rivals. The horns in lechwe may be considered to be employed in social conflicts rather than defensive weapons against predators (Figures19 & 20). If horns were primarily an anti-predator weapon, it would be difficult to understand why females should be disadvantaged in this respect. This observation can be supported by the fact that social competition is restricted only to males.

4.3.8 Daily activities

The day to day changes in weather conditions influence the activity patterns of the individual animals. Feeding formed a major part of the lechwe's daily activity making up (80%) of the total time of the daytime activities during the wet season. This holds for non-breeding individuals. There is an increase in feeding activity during the late afternoon and especially between 17:00 and 18:00hrs during all the seasons and this can be an indication of high feeding activity the hours following sunset. A period of intensive grazing continues in the morning. The time spent feeding slows down during mid morning with an increase in percentage of time spent resting during midday (Table 4)

Most of the animals lie down to rest during the middle of the day when the temperature is high. When the range is under water, the animals are constantly standing. A few may be seen resting on small elevated islands and anthills which at this time provide the only resting areas within the flood-plain and water meadows.

Despite the presence of few islands of shrubs, lechwe have not been observed to rest in the shade. They only run to hide on anthills with overgrown vegetation of *Vernonia* spp. and *Phoenix reclinata* when it is under much pressure from pursuers. Lechwe, especially females and juveniles are mostly observed within the vicinity of the water meadow and at night there is a tendency for the herds to move even closer than during the day time. However, this is not true for the large bachelor herds that form on areas that include the Mandamata and Lulimala termitaria. Although, they may visit some pools of water within the termitaria, they spend most of their time in the dry areas.

When it is raining, lechwe usually adopt a fairly specific "rain posture" in which the back is arched, the head and neck are stretched out and the animal stands quietly, facing downward. It has been commonly observed that soaked male lechwe tend to be more aggressive to predators, specifically humans, once persistently confronted.

Table 4. Daily activities observed in black lechwe on the Chimbwi flood-plain.

Time (hours)	Activity (%)					
	Feeding	Stand. &resting	Lying down	moving	Social behaviour	others
6-8	65	2	1	20	2	10
8-10	55	10	3	12	4	16
10-12	45	12	21	10	4	8
12-14	15	15	42	8	10	10
14-16	12	5	23	10	30	20
16-18	40	1	12	12	20	15
18-	55	2	1	30	10	2

Figure 19 Male lechwe (with the head down) chasing another male to protect its territory on the Chimbwi floodplain during the rutting season.

Figure 20. Two male lechwe locked up in a fight over what seemed to be a piece of mating ground on Chimbwi floodplain during the rutting period.

4.3.9 Sex and age profile

Populations of wild animals in nature have developed a social structure which results in the optimum production of progeny (Bothman, 1996). One aspect of this structure is sex ratio in accordance with the type of reproductive system and the type of reproductive bond between the two sexes. When a game ranch manager is confronted with poor production of progeny he blames it on predators while the problem can well be an imbalance in the ratio of adult males to females in the population (Bothma, 1996). It is therefore necessary to maintain a healthy age structure in any population as especially the reproductive capacity of the same animal varies in proportion to age. Age and size are important in species that posses social organisation because they help to specify an individual's social position. If the percentage of the young is too low, the population will age progressively and this will ultimately lead to a low productivity (Smith, 1989).

The rate, at which individuals are replaced in the population depends on the population's sex and age ratio, including the physical condition of the animals. The condition of the animal, in turn, depends among other things upon the population density and the condition of the habitat (Bothma, 1996).

There are two distinct aspects to the matter of sex and age ratios; the ratio among adults and the ratio among fawns at birth. The ratio of adult males to adult females in one herd is greatly influenced by the hunting laws in Zambia, which calls for the hunting of only males. In a situation where hunters are allowed to take either sex, assuming that other factors are not influencing the ratio, they can be reasonably well balanced, although, there is no concrete evidence to support this belief. In the situation where only males are shot and assuming that the sex ratio at birth is 1:1, this could contribute to the future sex-ratio imbalance.

The sex ratio of a population will clearly affect the potential reproductive rate and could subsequently affect the social interaction. This may also determine the potential harvestable animals. In general, the importance of sex ratio varies with the breeding of a population (Smith, 1986).

After surveys from the air and ground trials to determine sex in lechwe, it was perceived that the most reliable representative surveys are between December and February when large mixed

groups are formed and confined to certain areas. Ground surveys were found to be more suitable for the reason that the animals were easily approachable. This afforded time to classify the animal with more accuracy as compared to the aerial methods, which renders difficulties in getting all the animals in view and would only need the use of a camera when groups are large. The sexes are not homogeneously distributed throughout the population; instead they characteristically show clumped distribution which makes sexing easier.

Mean counts of 3 494, 4 062, 5 548 and 4 258 for Buteka, Chimbwi, Lulimala and Manda Mata respectively were done from the ground. The results based on a total sample of 17 362 are shown in Table 5. Animals less than one year (juveniles) were not classified according to sex. The classifications indicate a sex ratio of 322 males to 400 females or one male to 1.2 females. A χ^2 test shows that this difference is highly significant (χ^2 =28.38 with one degree of freedom; P<0.001). The results from this study does not deviate from the previous study by Grimsdell & Bell (1975). Sex ratio on the Buteka and Lulimala was skewed towards females. The population on Chimbwi plain registered a 1:1 ratio and that on Mandamata was close to unity.

The determination of sex ratio presents difficulties by the uneven distribution of sexes at different times of the day and year due to habitat preferences including other factors. There is evidence that sex ratio may be biased in favour of the females at or soon after birth (Robinette & Child, 1964).

Table 5. Population structure of black lechwe in the Chimbwi core study area.

Area	No. of animals	Males	Females	Juveniles	Sex and Age ratio		
					Male	Female	Juvenile
Chimbwi	3 494	1 324	1 320	850	100	100	64
Mandamata	4 062	1 866	1 922	274	97	100	14
Buteka	5 548	1 728	3 445	375	50	100	11
Lulimala	4 258	1 749	2 074	635	84	100	31
Totals	**17 362**	**6 667**	**8 936**	**1 759**	**331**	**400**	**120**

4.3.10 Reproductive behaviour

In most ungulates, it is convenient to group several categories of behaviour as related to reproduction because they are associated with reproductive condition and occur during the rutting.

Although the main rutting season for black lechwe starts in December and peaks in March, it is probable that the process continues throughout the year at a lesser degree although no lambs have been observed throughout the year (Figure 21). Calving which coincides with the beginning of the rainy season is important as it provides the best forage conditions for both the high energetic demands for lactating mothers and the calves.

4.3.10.1 Mating

One dominant male can mate with several females. The social ties established between females and males are short lived and tendencies to herd or congregate is tremendously reduced after the oestrous cycle in females.

Sexual maturity is attained in females at approximately one year. Grimsdell & Bell (1975) found that yearling females were able to conceive. The young males mature at a much later time. The young males are frequently frustrated in their mating attempts by older and stronger competitors and more often forced out of the breeding grounds. Doubtless, this condition is less evident when the sex ratio is greatly unbalanced. How often a female conceives in its lifetime is not well documented but there is strong belief that it is able to conceive as soon as it weans its young.

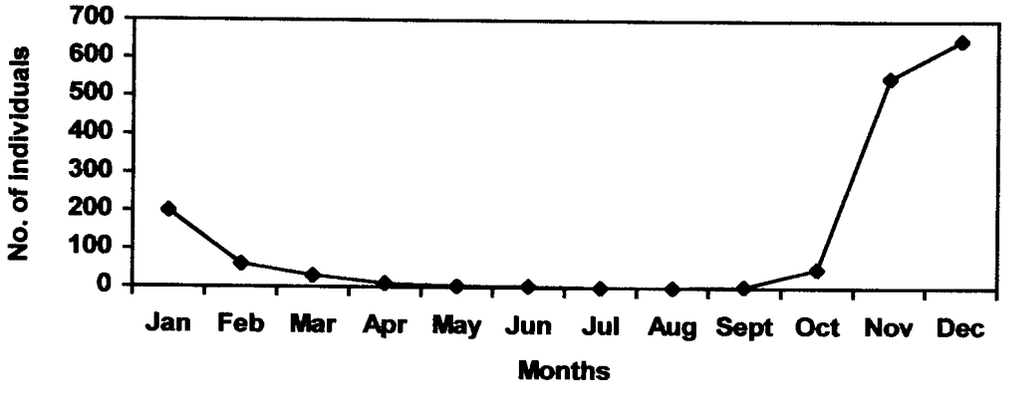


Figure 21 Observations on the calving in lechwe on the Buteka and Chimbwi flood-plain.

4.3.10.2 The rut

In all *lek* breeding ungulates yet studied, the proportion of females in or close to oestrous is higher on *leks* than in grazing herds (Balmford, 1990; 1991; Clutton-Brock & Harvey,1978). It has been found that mating is much higher on the successful *lek* territories than on ordinary groupings. However, mating rates vary widely between males holding different territories on the *leks*. It also appears that females become sexually receptive when in good condition. Condition dependent oestrous has also been shown in domestic animals (McDonald, 1989a) and may be adaptive if calves born to females in poor health have high mortality rates.

Receptive females apparently leave their herds to join the *lek* in order to avoid harassment by non-territorial males. This phenomenon is also reported in Kafue lechwe. Within grazing herds, oestrous females are frequently chased and courted by several males at the same time and attempts to mate are commonly disrupted. For example in Kafue lechwe, 39% of mounting sequences in mixed sex herds were disrupted and less than 8% terminated in copulation compared to 18% disruptions and 42% copulations on *leks* (Nefdt, 1992).

Females collect on *leks* to take advantage of the opportunity that these afford to mate choice males, gaining direct or indirect benefits from mating with particular partners (Alexander, 1975; Bradbury & Andersson,1987). Collection of females on *leks* also plays a role in protecting females from potential predators. Another interesting aspect of importance is that there is no sign of aggression among males or harassment of females on the *lek*. However, when a receptive female decides to move away to another seemingly communal breeding ground in the vicinity, the male in the *lek* will frantically try to force it back in the *lek*. Another male from the next *lek* would try to receive the absconding female. During this process, the first male will start to chase the other and in most circumstances, both end up losing out in the processes as the female may walk away.

Though the black lechwe *lekking* system is not as well defined as that of the Uganda kob (Pers. obs.) and the Kafue lechwe (Nefdt, 1992), the system indicates that the rut extends from December to March with the peak occurring between February and March. A larger proportion of the male population, especially old ones and young males, do not play much part in the rut. The peak of conception is thus mid-February, and this agrees with the observations of reproductive behaviour.

4.3.10.3 Period of gestation and number of young

The gestation period for black lechwe is approximately 260 days. The time most young are born coincides with the period of food abundance, which starts in November when the young grass is

just flushing. Lactating mothers incur high energetic demand and calf survival may depend on ideal foraging conditions. Observations made for several years suggest that births actually start towards the end of October. The Kalasa-Mukoso sub-population, however, shows to have a calving peak slightly earlier (Grimsdell, 1975).

Observations have shown that only one calf is born at a time. Due to lack of sufficient data in this respect, the possibility of twinning cannot completely be ruled out.

4.3.10.4 Seasonal breeding: Rearing of the young

Information on the season of births was obtained from regular monthly surveys over the population between 1994 and 1996. The peak of calf observations starts in November (Figure 21). This can be interpreted by the fact that it could take some days if not a week for the females to move from the areas of parturition to the flood-plains.

Most females separate from their herds when their time to deliver draws near. They often abandon their usual range and retreat to a well concealed spot, normally a thicket of *papyrus*, or other well vegetated grasses or sedges in the swamps were they give birth to their young.

When the young is born it is weak, helpless and unable to move about actively. For at least a day it remains in hiding beneath clumps of vegetation. The mother from time to time leaves the young in hiding to forage in the immediate vicinity but as dusk falls, she remains in almost constant attendance. This strict care seems to last for at least two days.

The body colour of the fawn blends so well with the vegetation that it is camouflaged against predators, which include birds of prey, pythons and crocodiles. As soon as the calf is physically stable, the mother leads her offspring away from the initial place of hiding on a long journey to the more open flood-plain where at this time the short grass is flushing.

4.3.10.5 Lactation

Udders in black lechwe are not developed externally except for small protruding teats. The young get underneath the mother and give some sudden and vigorous pushing while suckling. As the young get older, the pushing becomes more vigorous and may cause seemingly discomfort to the mother. The duration of one suckling bout takes approximately five minutes or less and this often takes place at least four times a day. As the young gets older, the process seems to lead to increased evasive action by the mother and this is the beginning of the weaning process. There is

no documentation on the period of lactation. Field observation on two known calves indicated that it lasts approximately three months.

There seems to be no close relationship between the young and the mother. A calf spends a great deal of the day feeding on its own. From time to time it wanders to the mother to suckle, but this lasts for a moment it is suckling and walks away thereafter. The defending of young against predators is rarely observed, but one interesting incidence occurred when a mother frantically defended a dying calf of not more than two months from awaiting vultures (Figure 22). Immediately after the calf died the vultures moved in but the mother kept on chasing them off and kept them at a safe distance. This continued for two days, until there were only remains of the skin of its young. This observed phenomenon could show the bond that may exist between the mother and the young in black lechwe.

Figure 22. Female lechwe defending its dying calf against vultures on the Chimbwi flood-plain.

4.3.10.6 Fecundity

The data on birth rates could not be obtained as females could not be captured for the study. However, Grimsdell & Bell (1975) carried out research on pregnancy rates in captured females examined with a foetal pulse detector. An assumption that the birth rates were equivalent to the

pregnancy rate in the animals they captured was made. The birth rate is evidently high in adult females, some giving birth once a year. It was possible to make an independent check on the birth rate in yearling females. This was done by examining two-year old females. A mature udder in a two year old examined during mid-pregnancy was taken to mean that the animal had given birth the year before. Out of 20 individuals examined, 13 were judged to have given birth the previous year. This gave a yearly birth rate of 0.65, close to the estimate (0.67) from the yearling themselves (Grimsdell & Bell, 1975), (Table 6).

Table 6. Pregnancy rate in captured females examined with a foetal ultrasonic pulse detector (Grimsdell & Bell, 1975).

Age group	Total No. Examined	No. pregnant	Pregnancy rates
1-2 years	24	16	0.67
2-3 years	25	25	1.00
3+ years	87	86	0.98
Total	**136**		

4.3.11 Lechwe measurements

4.3.11.1 Live weight

Body weight of the animal varies with several factors, the most important being sex, age and season. Literature indicates that on average adult male lechwe weighs between 50kg and 70kg (Grimsdell & Bell, 1975). The average weights of bucks shot during this study under the culling programme ranged from 45kg to 75kg. Adult females are not as large as males and their weight ranged between 40kg and 60kg. The sample size of 10 females was, however, rather small to give a conclusive average weight.

Fawns of 6 months old can weigh up to 10kg. The mass of an individual from birth increases exponentially. An estimated mean birth mass was obtained from measurements on five young calves estimated between one and two days old. This study also revealed that the animals reach a stage of development beyond which an increase in age has little further effect upon size and mass. Mean live mass data per month were compared and results suggest a seasonal pattern

characterised by a general gain in mass from December to February. A slight drop occurred in March and then an increase occurred between May and July with the lowest occurring in October (Figure 23). This observation is in agreement with the observed drop in body condition most probably due to the obvious reduction in food resources at these times of the year. In March, most of the available foliage is under water.

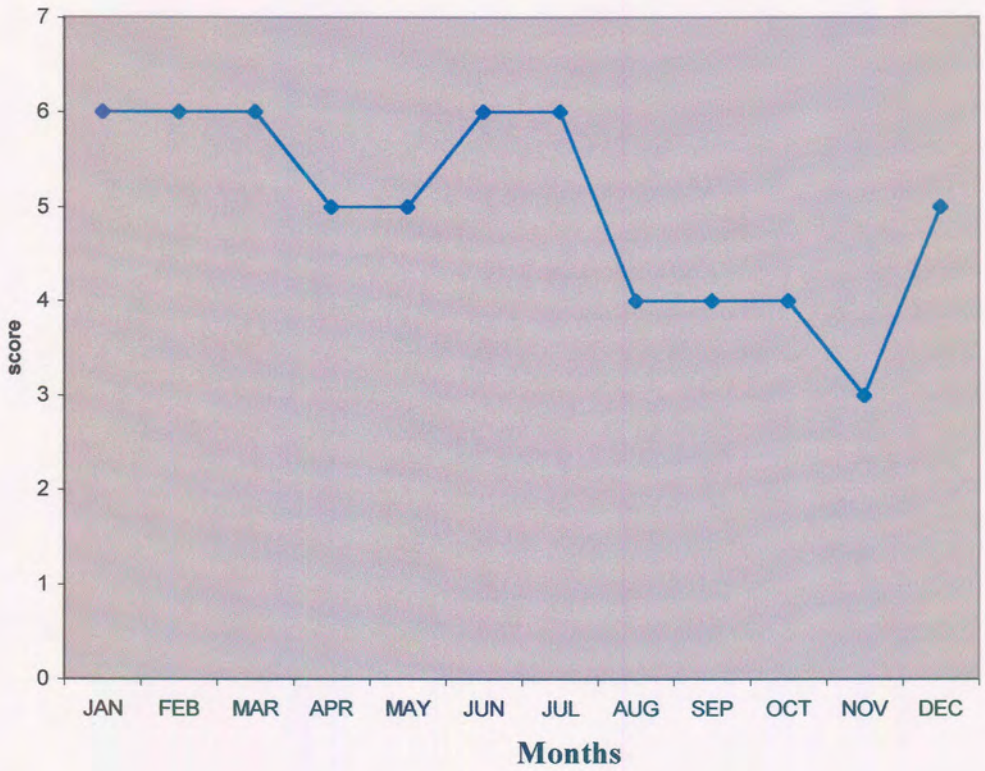


Figure23. Body condition of lechwe at different times of the year.

4.3.11.2 Dressed weight

The measure of dressed weight of lechwe was essentially applied to predict meat yield from male lechwe during the culling trial. Adult male lechwe (>3 years old) dressed carcass weights averaged 50 ± 10 kg for 200 individuals weighed.

4.3.11.3 Weight of visceral contents

The average weight of the stomach contents varied seasonally and this was apparently governed by the abundance of food. The weight of the stomach contents in adult males fell from an average

of 14.4 ± 2 kg in July to 11.4 ± 1.9 kg in October. The observation can be attributed to the abundance of vegetation which is much more in July as compared to October which is the peak of the dry season when most vegetation is in dormancy and short supply.

4.3.11.4 Body length

There was some correlation in the body length to the age of the lechwe. However, like weight, a level was reached when the length could not increase with any further increase in age, (Figure 24).

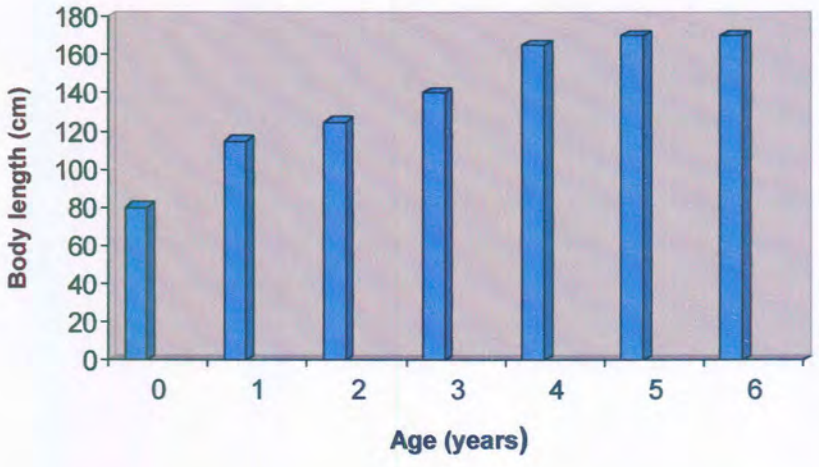


Figure 24. Average body length of lechwe measured on 200 individuals during the culling scheme.

4.3.11.5 Horn measurements

Horn lengths plotted over estimated age indicated that on the average, a one-year-old ram would have horns measuring more than 54cm in length. A four-year-old male went above 50cm. (Figure 25). However, there seems to be a wear down of horns after a specific number of years. The five year old males examined showed to have slightly shorter horns than the four year-old ones (Figure 25). It takes approximately six months for the horns in males to show. Visible horns were noted on 4 of 40 male juveniles observed carefully with the aid of a 30x spotting scope. The August and September observations showed a small number of juveniles with visible horns. However most of them showed hair covered bumps. This could support the observation that juveniles born during the previous season may not have attained the time to acquire horns.

During the time of horn growth, the horns are straight but gradually commence to curve backward and outward and later, forward and inward to give the typical lyre shape of the adult (Figures 3 &

4). Many observations showed that the maximum horn spread is not quite correlated to the age (Figure 25).

Horn rings are prominent in adult lechwe starting from two years and these may number up to 15. By three years an individual may have up to 20 rings and by 5 years maximum length averaging 24 rings is attained, but thereafter the rate of ring increment appears to slow down, (Figure 26). The rings at the apex become more compressed and less conspicuous. The various phases of horn growth could provide means of ageing others, especially at the early stage of life. The relative spacing of the rings, for example, could perhaps give a rough clue to the age of an individual animal. Measurements demonstrated some small decrease in ring spacing with age. It must be acknowledged, however, that general health and nutrition can probably influence the rate of horn growth.

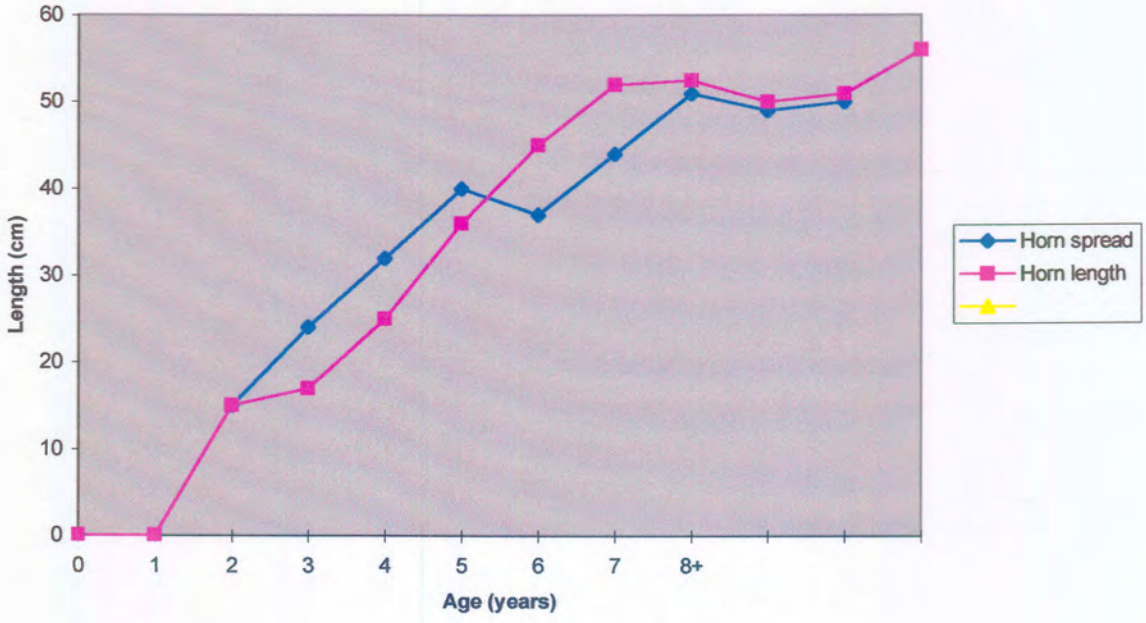


Figure25. Horn spread and horn length with age in black lechwe.

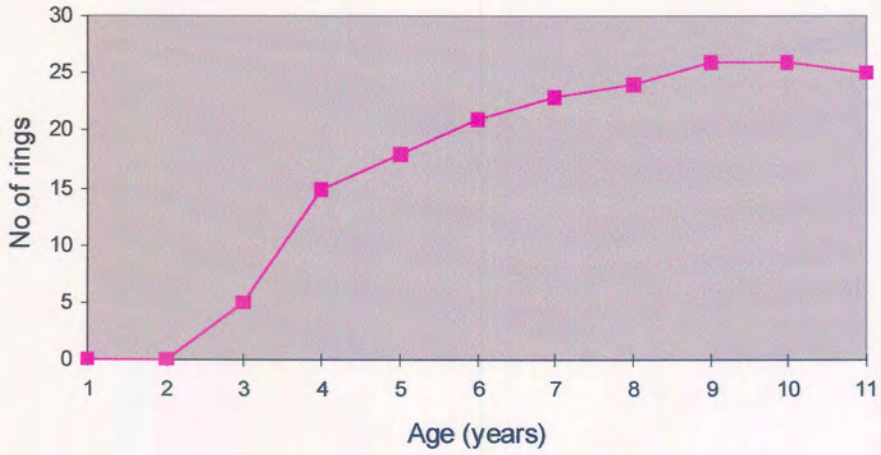


Figure 26. Number of horn rings with age in black lechwe.

4.3.12 Disease, parasites and abnormalities

No concerted effort was made to study disease and parasites of lechwe during the main study. However, some notes were taken on the more obvious parasites, diseases and abnormalities.

During the culling programme in 1992, 50 carcasses of lechwe were investigated, primarily for liver flukes, eye worms, skin warbles and nematodes as the likely transmissible parasites (Table 7). The animals were also checked for general health and nutritional status to complement field data.

4.3.12.1 Liver flukes.

Two of the animals inspected was infested with schistosomes in the liver and mesenteric veins.This gives a 4% infection rate in the lechwe (Table 7).

4.3.12.2 Eye worms

Adult and larval worms were found in two animals investigated between 1989 and 1992. The most obvious possible factor of transmission of the worms was flies, which increase in number between November and January.

4.3.12.3 Other nematodes

Animals that were heavily afflicted with nematodes appeared to be in poor condition. Poor condition was attributed to a large accumulation of gut nematodes mainly in the upper duodenum. Another type of nematode was also observed in the liver of some animals, which apparently lead to the enlargement of the gall bladder. The animal looked normal at a glance because the abdominal cavity was filled up with some fluids which puffs it up. It was, however, discovered that an animal in this condition was very inactive and was neither able to graze nor run.

The most obvious internal parasites of the lechwe are probably the tiny trematodes which where present in hundreds on the rumen linings of every lechwe examined. The real function of these organisms is out of scope of this study.

A small roundworm, tapered on both ends, was common in the liver of some sick animals. Their presence showed to have caused hardening and small tunnels in the liver. Enlargement of the spleen was common in all animals with this type of condition.

4.3.12.4 Skin warbles

Warble-flies lay the eggs under the skin (mostly the hind side) of the animal. The greatest number of grown larvae are found in the animals at the beginning of the wet season (November) and all the animals inspected during the mid-wet season showed to be free of infection. It is not known if parasitism of this nature in itself has some bearing on the health status of the animals. The adult stage was never observed and therefore the species could not be determined.

4.3.12.5 External parasites

An inspection was made for the presence of external parasites and obvious signs of disease. The most evident parasite of the lechwe is a small animal fly. The flies are particularly prevalent during the wet, warm months and they may be literally several thousands on one single animal. During the dry, hot months (October) the fly population is drastically reduced due to extreme dry conditions in most areas.

The fly is not a bloodsucker, though there is a great possibility that it could draw other fluids from the host, especially from the eyes. The fly causes seemingly great discomfort to the host since animals can be seen frantically trying to brush them off their heads and their eating is somehow hampered. Relief is restored only in the evenings when flies become inactive.

There was an outbreak of blindness in lechwe in 1991. Upon close external examination and comparison of the affected eye with a normal one, very little difference was observed and therefore it was believed that the disease was probably transmitted by the fly and only affected the retina or nerves connected to the eye. Three types of body ticks, which could probably be host specific, were also observed during the study (Table 7).

4.3.12.6 Disease

One of the most noticeable diseases among lechwe was the presence of enlarged leg joints filled with whitish fluid like pus (Table 7). The root cause of the problem was not known. Generally, black lechwe seem to be healthier than its close relative, the Kafue lechwe that has been found to be regularly infected with tuberculosis.

4.3.12.7 Abnormalities

Broken horns sustained mainly through fighting are quite common especially during the rutting periods. There are several others, which have lost their horns and limbs through snaring and gun shots. It is not known if horn re-growth takes place once a part of it is broken off.

Table 7. Diseases observed in black lechwe from the culling scheme.

Disease	Liver flukes	Eye worms	Other nematodes	Skin warbles	External parasites	Other abnormalities	Normal
No. Animals infested	1	1	2	3	22	2	19

All the animals had trematodes lining the abdomen

4.3.13 Mortality

A survey by collecting skulls and horns was made with the view of finding the lechwe death rate and the causes on and around Chimbwi plains. Losses of the animals can be classified as to occur through the following:-

- poaching (illegal hunting);
- shooting under permit;
- predation;
- disease;
- old age and;
- accidents (both natural and human induced).

4.3.13.1 Natural mortality

Natural mortality is caused by several factors, one of which is habitat loss. Habitat loss usually acts through other agents such as reduced natality. There is rarely a direct mortality factor in this species, mainly because the carrying capacity remains high.

Mortality from causes other than hunting is subject to great variation and it depends largely upon the following main factors;

- the population density with respect to disease transmission and the carrying capacity of the given area;
- the population of predators.

The other factor is human settlement in the sense that man is the most dominant predator. It is very obvious that the rate and causes of mortality exhibit marked differences from area to area. Deaths caused by starvation have never been observed. The extent of losses due to predation is not easily measured, but it can be said that this form of off-take is quite minimal due to the low population of predators in the area.

Poaching is much higher when animals migrate from the flood-plain to secluded areas where there is very little protection. The number of skulls seen represent animals dying of natural causes or preyed on by predators other than man. This is deduced since man hardly leaves heads behind. It is noted that only horns are left behind after slashing them off. This could roughly assist in estimating the number of animals illegally killed, though this presents another problem when it comes to deaths in females and young ones which do not have horns.

Evidence of mortality is in several cases difficult to determine as scavengers and decay work rather rapidly. Poaching, though difficult to measure has the most significant effect on lechwe mortality. Of the 200 skulls and pairs of horns collected on the Chimbwi from 1992 to 1995, only five were females and eight were young animals (Table 8). The cause of deaths could be ascertained only in few cases. The heaviest mortality was found to be among older males. In most instances horns appeared to disadvantage males more than females to snaring. In some situations, causes of death and injuries in males are linked to fighting during rutting.

Table 8. Number of skulls collected on the Mandamata, Buteka and Chimbwi floodplains.

Year	Females	Males	Young
1992	1	78	2
1993	2	63	3
1994	1	30	1
1995	1	16	2
TOTALS	**5**	**187**	**8**

4.3.13.2 Predation

Predation is important in wildlife resource management in the sense that when a resource, which is subjected to predation, is being harvested, there is competition. Damage caused by it, therefore, needs to be understood.

Lechwe are generally docile and disadvantaged in the bush where predators could be concealed while stalking. As a survival strategy lechwe tend to congregate on more open, short grasslands, in most cases close to water. It is a common occurrence to see lechwe take to water in order to escape land enemies. Whereas water may offer a haven of safety under certain conditions, it can be a trap for others. There is the possibility that crocodiles prey on lechwe in the water and some times local illegal hunters drive herds of animals into deep swampy areas where they are speared with ease. Humans are the major active predator of lechwe and main contributor to its population reduction. Hyena (*Crocuta crocuta)* is the only known wild predator but, considering its low population, the number of lechwe lost to it should be insignificant. Though never been observed, it is suspected that there is a high probability that a python can kill a lechwe. The occurrence of pythons in thick vegetation used by females as parturition grounds makes them, in particular the young ones, possible targets to the serpent. The population of pythons in the area should be very small and therefore this kind of predation can be considered to be quite minor.

4.3.13.3 Losses due to hunting

It is a generally accepted principle that the current basic growing stock of black lechwe cannot suffer decline if the legal hunting is not permitted to exceed 10% of the total population. Since the object of black lechwe management has been to raise and maintain its population level, legal hunting has been regulated that the annual off-take is below this standard. The hunting pressure of

this intensity may be permitted without taxing the reproductive capacity of the species. The recommended quota on three major species for 1991 and 1995 hunting, capture and culling in the Bangweulu and Kalasa-Mukoso GMAs are given in Table 9.

Table 9. 1991 and 1995 proposed hunting quota on three species in the Bangweulu (Kamweneshe *et al.*,1994).

Species	hunting		capturing		Culling	
	1991	1995	1991	1995	1991	1995
Black lechwe	400	600	0	0	300	200
Tsessebe	20	30	0	0	0	0
Sitatunga	20	20	20	20	0	0

4.3.13.4 Crop protection hunting

Lechwe scores the least of large mammal pests that cause massive crop damage (Figure 27). The species is therefore not killed under crop protection. This can partly be elucidated by the fact that the lechwe range is the least cultivated area.

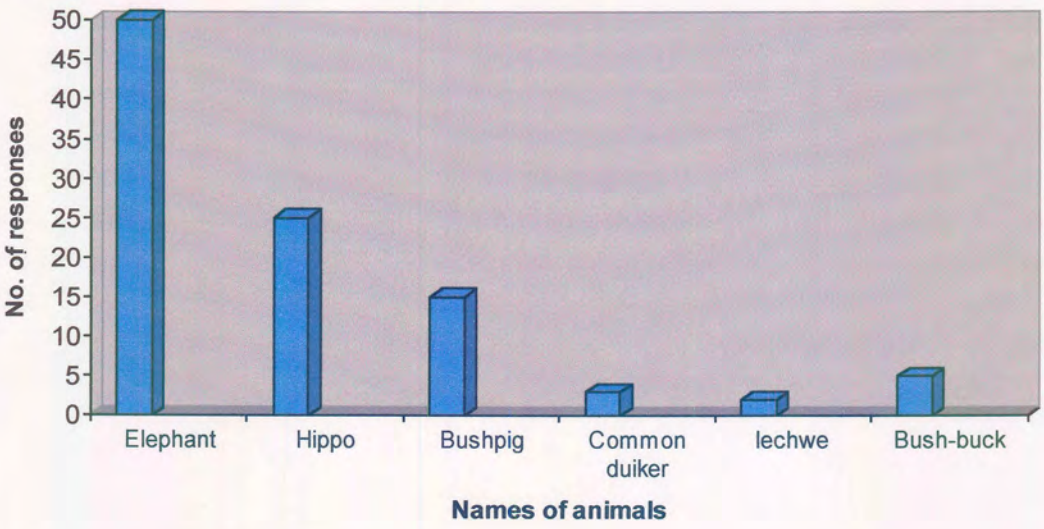


Figure 27. Responses obtained from an interview on the crop raiding by different wildlife species in Muwele and Chiundaponde.

CHAPTER 5

LECHWE AERIAL CENSUS

5.1 Introduction

Wildlife managers often ask the question of how many animals are present in a particular area. Counts are required to answer some of the questions that are important for wildlife management, especially regarding stocking rate versus grazing capacity.

Trends in wildlife populations are determined by the rates of natality and immigration versus mortality and emigration and reflect the interplay of numerous often variable environmental factors. Reliable information on the trends is central to the conservation and management of game populations, monitoring of which has largely depended on standardised aerial census as described by Grimsdell & Bell (1975). The aerial surveys of lechwe have in the past been conducted annually during the dry season in October. This is the period when they are relatively evenly dispersed in the area, thus facilitating the use of stratified random sampling methods.

Black lechwe are migratory and concentrate in high densities on shallow water flood plains during the wet season which normally starts towards the end of October and ends in April. The wet season concentrations of lechwe provide opportunities for complementing aerial surveys data with accurate total ground counts and repeated observations of the age and sex structure of the population (Thirgood *et al.*, 1992).

In this report data are presented from the current series of aerial and ground surveys of black lechwe from 1988 to 1996, and estimates of the current status and population distribution are compared with those of the 1973 and 1983 surveys.

5.2 Methods

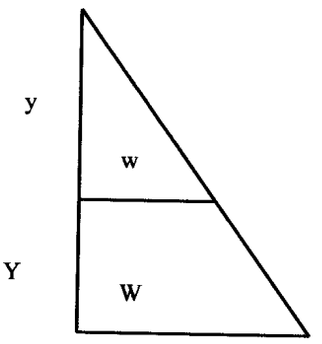
The black lechwe was surveyed by aerial stratified random sampling and aerial total counts in October of each year from 1988-1996. The aims of the surveys were to determine the general distribution and size of the lechwe population. The technique used was similar to the method described by Bell *et al.* (1973). The method requires that a preliminary survey is carried out to

assess the limits of the distribution of lechwe in order to identify different strata based on their relative densities (Figure 28) The method was equally important to identify isolated herds, which would require total counts.

1:250 000 scale maps (Ndola, Mpika, Chilonga and Mansa sheets) were used throughout the surveys. For most of the surveys, a fixed wing C-182 aircraft was used. The aircraft was flown at survey height by reference to the barometric altimeters. All photography was done with two 35mm SLR Nikon F-401s cameras, with black and white Tri-Xpan 400 films.

Having stratified the area, a series of open ended transects were flown in the south-north direction in each stratum according to random selection of 15^0, 25^0 or reverse turns of the aircraft, depending on the densities of the animals.

Two observers in the rear seat counted lechwe between strip markers tied on the aircraft's wing struts, corresponding to a ground swath width of 200m on each side of the aircraft when flown at a height of 61 m (Pennycuick & Westem, 1972). For each transect, the data for both observers were collated and treated as one sample. Large groups of lechwe were photographed with 35mm lens cameras. Animals were later counted from prints under a light binocular microscope. The number of lechwe were corrected as described by Howard et *al.* (1984) to adjust for the difference between the angles of view of naked eye and the camera. Isolated populations in the Kalasa-Mukoso Flats, Chimbwi plain and part of Lulimala were total counted, (Figure 28). Large groups, above 100, which could not be counted effectively visually, were photographed from a height of approximately 60m. The population estimates and 95% confidence limits were calculated according to Jolly's method number 1 (Jolly, 1969) as discussed by Bell *et al.* (1973).
The sample numbers obtained were added to the total count estimates to give the overall population estimate.



w = W . h / H

w = h x 200 / 51 for each observer

w = ground swath width (200m each side for each observer while flying at the survey height

h = height of the observer's eye above the ground while the plane is stationary on the ground

H = survey height (Y + y)

Aircraft type	Cessna 182
Instrumentation	Global Positioning System and altimeter
Total flying time	15 hours (1996 census)
Flying speed	90 knots (160 km per hour)
Altitude	61 m

5.3 Results and discussion

Between 1954 and 1967, a series of aerial counts were carried out by the Zambian Wildlife Department giving figures of about 17 000 to about 40 000 lechwe. It is argued on the ground of techniques described and the lack of good maps, that all these counts probably erred considerably on the low side especially that of 1966 (Grimsdell & Bell, 1975).

Between these dates, eight total counts of black lechwe were carried out, and one sample census (October 1973). The errors involved in the counts are discussed, and it was concluded that between 1969 and 1972, the population remained stable at a pre-calving level of 16 000 to 17 000. (Figure 11). However, the total pre-calving count of June 1973 showed a 25% increase over that of June 1972 (17 141-21 567). That the later count was not an over count was confirmed by the sample (post- calving) counts of October 1973 which estimated a total of 25 254 ± 19.5% (95%

confidence level). The results of aerial stratified random sampling census and total counts of black lechwe for 1996 are given in Table 10.

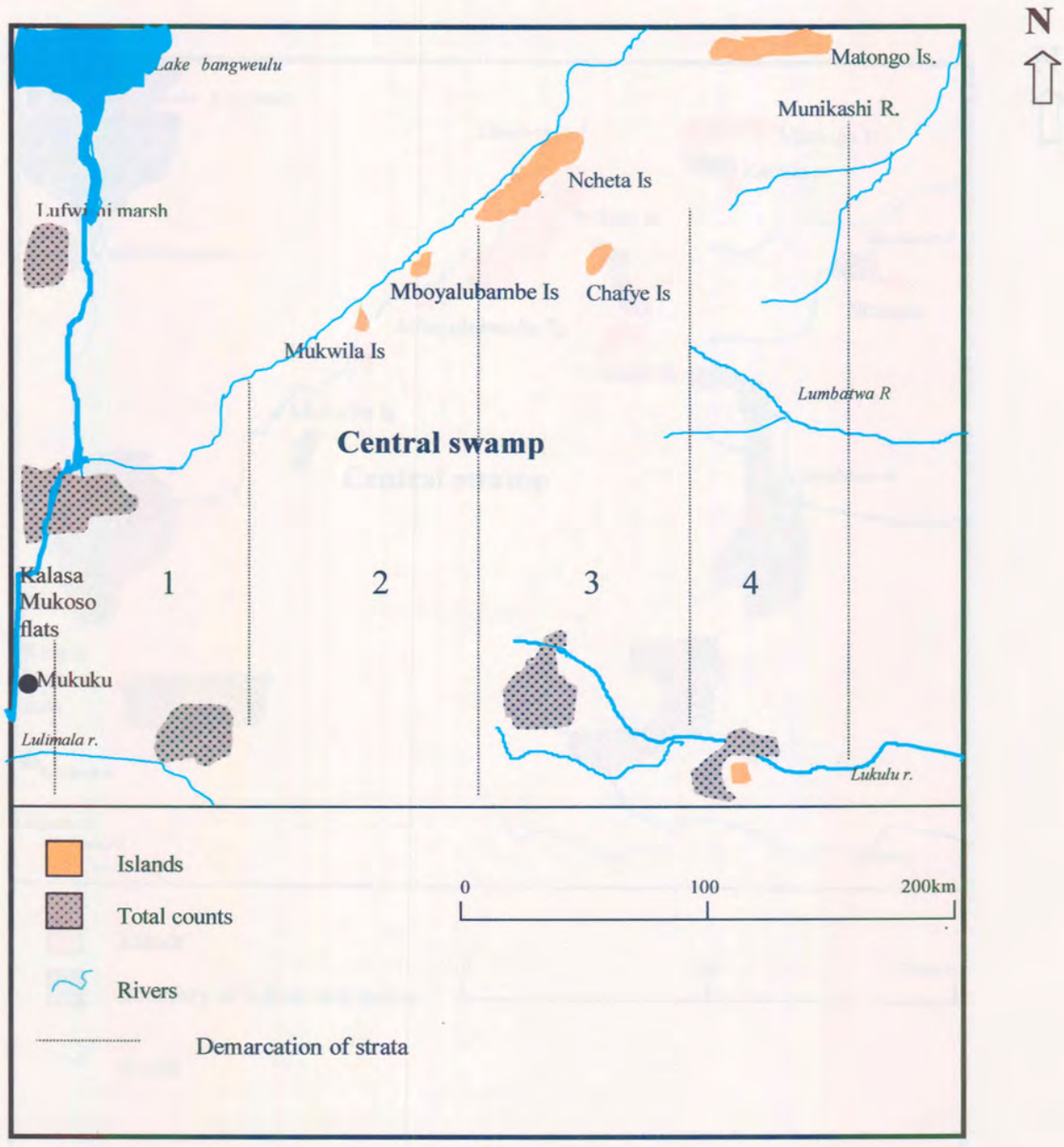


Figure 28. Map of the southern area of Bangweulu Basin, showing the four strata that were sampled in the aerial survey and the areas where total counts of lechwe were conducted.

Table 10. The results of aerial stratified random sampling census and total counts of black lechwe in the Bangweulu Basin, 1996.

Stratum No.	Nt	St	%S	Sample counts	Population est.	Variance
1	38	7	19	143	752	70 741
2	23	10	44	437	993	42 082
3	57	12	21	2 024	9 638	33 64 313
4	45	12	27	929	3 440	987 265
Totals	159	41	25	3 533	14 823	4464 401

Population estimate:		14 823
Chikuni total count		3 600
Kalasa-Mukoso total count		3 098
Lulimala total count		10 845
Total population estimate		32 366
95% confidence limits	(+/-)	5 158

Where; Nt = Total number of transects
St = Number of transects sampled
%S = Percentage of stratum sampled

Table 11. Comparison of black lechwe aerial census results in the Bangweulu swamps 1973-1996.

Year	Population	Reference
1973	25 254	Grimsdell & Bell, 1975
1983	41 041	Grimsdell & Bell, 1983
1988	33 843	Howard *et al.*, 1988
1989	32 366	Jefferey *et al.*, 1989a
1990	32 085	Jefferey *et al.*, 1990b
1991	29 600	Jefferey *et al.*, 1991
1993	33 700	Kamweneshe *et al.*, 1993
1994	33 200	Kamweneshe *et al.*, 1994
1996	32 366	Kamweneshe & Mupemo, 1996

5.3.1 Population trends and current status

The total population of black lechwe from the current series of aerial surveys is given in Table 10. Following an increase of 16% between 1973 and 1983 (Howard *et al.*,1984) The results of the 1988-1996 series of aerial surveys of black lechwe in the Bangweulu swamps suggest that the population growth experienced during this period has maintained the population around 30 000. Assuming that the environmental conditions are not limiting growth and that natural predation of black lechwe is not significant, then it should be expected that the population is growing by at least 10% per annum. Such an assumption is reasonable and conservative considering historical records of black lechwe of 250 000 and the present dearth of large predators. Taking the population to be stable around 30 000, it should be expected to increase by at least 3 000 animals per year. The assumption that the lechwe population seems to be maintaining itself at the present level suggests a mortality of a similar magnitude per annum.

Since legal harvesting removes a combined total of less than 2% of the population and that there is no evidence of large scale mortality from disease, it can be presumed that the largest portion of the population is lost through poaching. This population trend of black lechwe in the Bangweulu swamps is a cause for genuine concern if the poaching is left unabated and the off-take is allowed to exceed the current level. The results in Table 12 suggest that the population on the Kalasa-Mukoso flats has remained stable over a period of time.

Table 12. Population trends of black lechwe on the Kalasa-Mukoso flats.

Year	Population	Reference
1970	2439	Grimsdelle & Bell, 1975
1973	3148	Grimsdelle & Bell, 1975
1983	4355	Howard *et al.*,1984
1988	1579	Kamweneshe *et al.*, 1988
1989	3667	Jefferey *et al.*, 1989a
1990	2792	Jefferey *et al.*, 1990b
1991	2655	Jefferey *et al.*, 1991
1992	3366	Kamweneshe & Kamweneshe, 1992
1993	3478	Kamweneshe & Kamweneshe, 1993
1994	3828	Kamweneshe *et al.*, 1994
1995	3156	Simmon & Mupemo, 1995
1996	3098	Kamweneshe & Mupemo. 1996

The stable population of lechwe on Kalasa-Mukoso flats could mean that the off-take could be of the same magnitude as the recruitment rate. In the face of increasing economic and nutritional hardships facing people living in the swamps and its environs, it can be predicted that strong pressure on this natural resource, including others will continue to be exerted and therefore the population will start to decline.

CHAPTER 6

LECHWE SEASONAL MOVEMENTS AND USE OF THE VEGETATION TYPES

6.1 Introduction

Surveys were conducted in order to build up a picture of the seasonal intensity of use (occupancy) by lechwe over the annual range for the following reasons:

- to determine seasonal changes of the occupancy by lechwe of different vegetation types, particularly in relation to seasonal changes in flooding regime;
- to determine the performance of lechwe in the different vegetation types by relating the body condition to the occupancy pattern;
- to review the limits of the area habitually used by lechwe in order to assist in its management .

6.2 Methods

Distribution of black lechwe was determined by mapping on a 1:250 000 map in October and March. March represents the peak of the wet season and October dry season. The exercise was achieved by flying transects at 61 m altitude in a north-south direction at intervals of approximately 2.5 km over the entire lechwe home range. The location of lechwe sighted was carefully plotted on the map. Numbers of animals seen in big herds were estimated to obtain information on relative abundance of animals in different areas. This was done to calculate population structure density and habitat utilisation for the different regions of the GMA and thus to highlight the problematic areas at different times of the year.

6.3 Results/Discussion

6.3.1 Distribution of lechwe

How organisms are distributed has a strong bearing on the density of that particular organism's population in particular areas and at a given time. Individuals may be distributed randomly, uniformly, or clumped. The clumped category of distribution, which is sometimes referred to as contagious distribution, is the most encountered in black lechwe.

Clumping produces aggregations and these may be treated as responses by individuals to the habitat differences, daily and seasonal weather changes, reproductive patterns and/or general social behaviour.

Aggregation in lechwe like other grassland species may range from small to large concentrations. Depending on the condition of the environment, populations are sometimes concentrated in long bands or strips along some suitable feature of the landscape such as the flood-plain or riverbank, leaving the rest of the area unoccupied. It is mainly for this reason that boundaries of lechwe distribution are not fixed but rather fluctuate with the temporal changes in environmental conditions.

The extent of distribution of lechwe has been observed to expand in one particular year and contract in another. This normally occurs in relation to the amount of precipitation, which has direct bearing on the flooding regime and subsequently the limit of foraging range. Lechwe avoid deep water that is above 60 cm. Thus, they tend to concentrate along the edge of the floods where the water is relatively shallow. At the height of the flood, they move into the adjacent termitaria zone within two to four kilometres. A good number remain in the termitaria zone for some time until the receding flood exposes new vegetation on the flood-plains. Since lechwe generally follow the flood-line, at the peak of the dry season most of them are found very close to the central swamp, although a relatively smaller population, mostly of males, remains on the flood-plain and the termitaria.

In order to show a clear picture of the population distribution, lechwe have been divided into five major groups, which may be referred to as sub-populations, and these are more or less distinct. The populations are found in the following areas:

- Lake Bangweulu margin (around Lufwishi marsh);
- Kalasa-Mukoso flats;
- Southern flood-plain (around Lulimala estuary and Miyeya).;
- South-eastern flood-plain (around Lumbatwa estuary and Munikashi swamp including the Chikuni area);
- Central swamps (around Chafye Island, Mboyalubambe Island and Mukwila). (Figures 29 & 30)

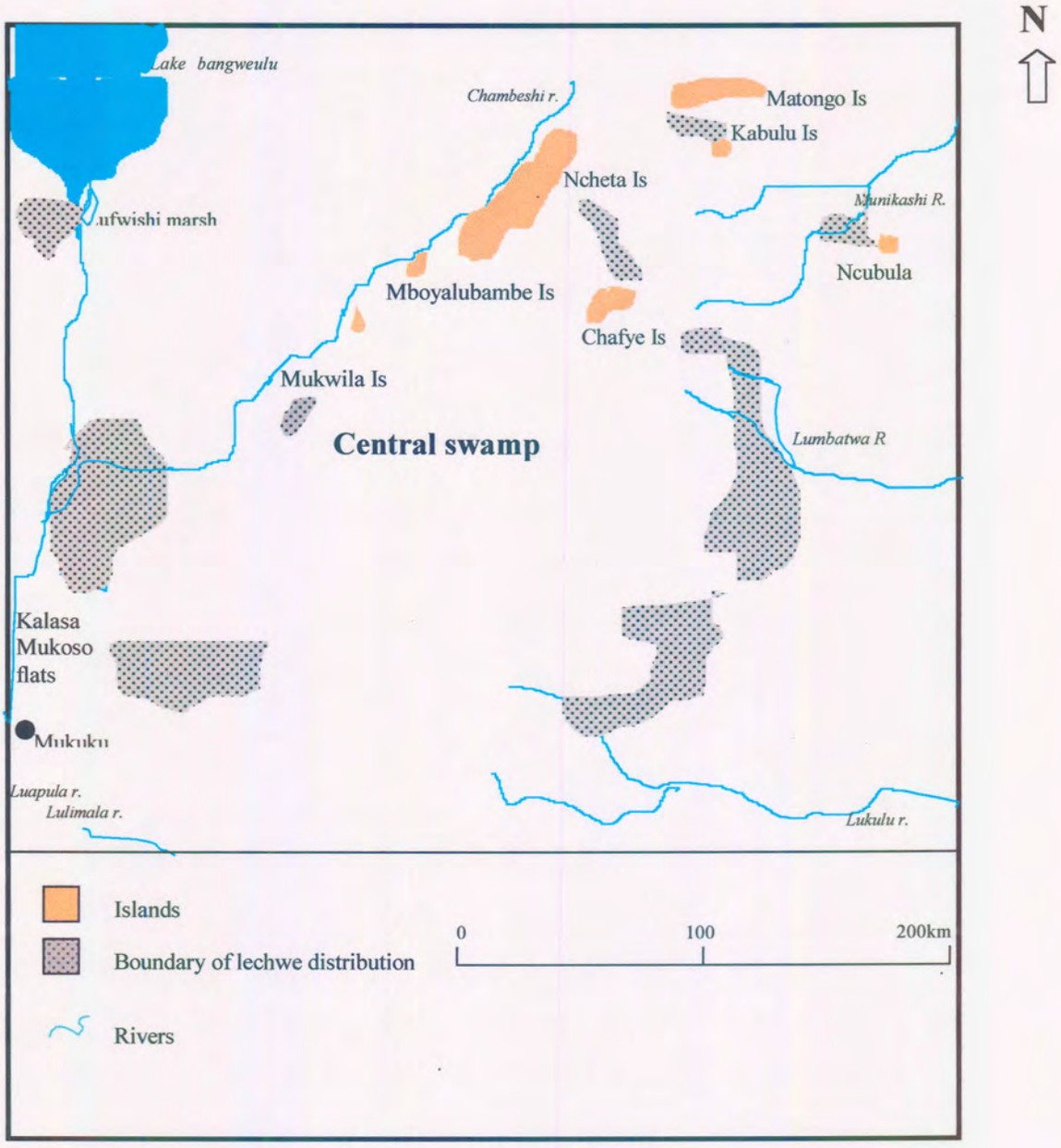


Figure 29 . General map of the Bangweulu Basin showing dry season lechwe during the months of September and October 1994.

The population around the Lufwishi is rather small and threatened by heavy poaching by local fishermen, (Figure 29) Its location has made it somehow difficult to be reached by policing personnel and hence receive very little or no protection at all.

6.3.2 Seasonal migrations

The distribution of vegetation and the pattern of flooding determine the seasonal occupancy pattern of black lechwe. Sub-populations increase is typically attributed to natality. Other factors include immigration movements into an area as a result of dispersion from other centres. Topography, vegetative cover conditions, level of water, food availability and to some extent temperature and the situation with respect to insects and predators all play a role in determining the day to day habits of any individual animal. Elevated grounds are preferred as resting grounds especially during flooding periods. The extent of seasonal movements from dry to wet range varies, from region to region and among localities within a region depending upon the prevailing conditions of cover and the density of the population. Most of these mentioned natural factors affect the distribution of males and females differently.

Spatial movements significantly influence the density of the species at a given time and locality. These changes in turn have influence on natality or recruitment and mortality as discussed under "natural Mortality" in **Chapter Four.** Table 13 gives estimated observed dates when black lechwe arrive on the Chimbwi flood plain from the swamps at the onset of rains.

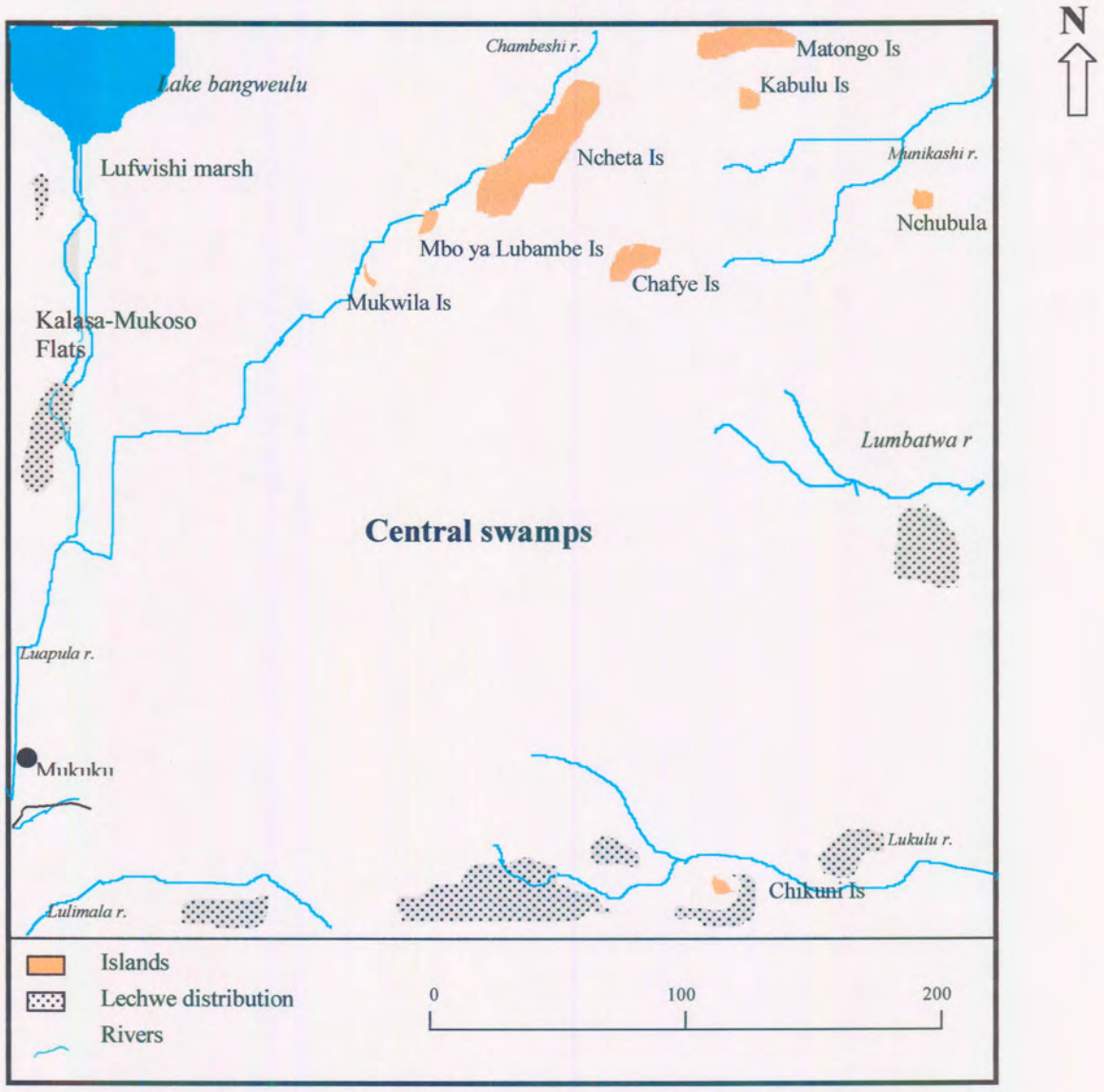


Figure 30 . General map showing wet season lechwe distribution during the months of February to the beginning of April.

Table 13. Observed dates on which the lechwe returned to the Chimbwi flood-plain.

Year	Month	Date
1989	October	29
1990	November	1
1991	November	6
1992	October	27
1994	November	2
1995	November	5

Some individual lechwe were found to range over large areas of more than 30 km^2, concentrating mainly along the flood-line. Annual flooding has been observed to often increase the home range sizes. During the floods the whole population in the central swamps is forced southwards to the edge of the swamp and the trend is reversed during the flood recession when they move back northwards. All the lechwe sub-populations tend to occupy shallower swamp peripheries when central areas are deeply inundated.

The distance from the water-ine was found to be the most important factor affecting female densities with female numbers decreasing further inland, although both sexes had their distribution affected by different vegetation community preferences. Males concentrated mainly on areas between the flood plain and the termitaria during dry months whereas females were mostly found between the flood-ain and the water meadows.

Cultivation is not one of the limiting factors that are restricting lechwe distribution, because less than 2% of the entire flood-plain is utilised for agriculture. The situation in the Bangweulu is very different from that in the Kafue flats. In the latter, a population of approximately 45 000 Kafue lechwe share their range with several thousands of cattle.

6.4 Discussion

The dry season distribution of black lechwe is much more dispersed than that of the wet season. The animals tend to occur in a more or less continuous band stretching from the Munikashi river to Luapula river near Mukuku on the main high-way, (Figures 29). Within this band, two major pockets of high concentrations are normally located around Chafye and Mbo-ya-lubambe islands. The main dry season occupance usually occurs at this time on shallow permanently flooded areas, which are dominated by *Oryza, Typha, Phragmites* and *Miscanthus* species as the major vegetation types.

Their distribution progresses as the dry season advances and the animals move into the permanent swamp and the *Vossia* and *Eliocaris* dominated vegetation on the Luapula and Chambeshi river channels and lagoons

In the case of the sub-population around Chafye and Ncheta islands, there is generally a northerly movement towards the Chambeshi river, and the population on the west of Ncheta generally moves westwards towards the Luapula river system and channels of the Chambeshi river. The movements of the sub-population on the Kalasa-Mukoso flats and the ones to the south of Lake Bangweulu are not well pronounced and less understood.

6.4.1 Trends in wet seasonal distribution

Black lechwe are the dominant large herbivores seasonally resident on the shallow water flood-plain. Smaller populations of tsessebe, buffalo and elephants occur in adjacent peripheral grasslands whilst sitatunga are common in the permanently flooded areas. There are basically four major wet season concentration areas of lechwe,.the most important being the areas on the Lukulu river system which includes the Buteka, Masenga and the Chimbwi. Between them, they support approximately 50 - 70% of the total population during the wet season. Other concentrations occur along the Lulimala river system, Kalasa-Mukoso and the Lumbatwa on the eastern flood plain (Figure 30).

Following the onset of the rains, the peripheral and intermediate grassland rapidly grow to about 10cm high. About the middle of November, most individual animals will have made rapid movements from their dry season dispersal areas in the central swamps and a large concentration starts to build up on the unflooded areas north of the Lukulu river (Buteka and Masenga plains) and the Chimbwi plain to the south of the Lukulu. ((Figure 6). The flood-plains on either sides of the Lukulu river are principally flooded by overflow of the river and local run-off between January and February.

The lechwe on the Buteka slowly trickle to the Chimbwi, apparently due to deeper water level at the peak of flooding, Buteka being slightly in advance of Chimbwi plain. By March, most of the lechwe are on the Chimbwi plain and the fringing termitaria. During this period (mid January - March). The largest concentration of lechwe is along the southern edge of Chimbwi plain, towards the mandamata woodland fringe. This coincides with the peak of the rutting and conception period. It is for this reason that Chimbwi area can be considered to be an important mating ground for lechwe and needs special protection.

The height of the floods normally occurs between mid February and late March. At this time, the general water depth on the flood-plain exceeds 50 cm. There is a further short lechwe movement away from the flood-plain fringe into the intermediate grassland and the termitaria grasslands which are relatively shallower and posses more elevated grounds.

During this period, the main lechwe concentration is a more or less continuous linear aggregation along the line of the mandamata woodland belt. In a high-water year, the concentration retreats to the south of the mandamata woodland belt and forms an arc along the northern and western edge of Namushitu plain. Here it almost becomes continuous with the Lulimala sub-population, which similarly retreats into the peripheral grassland (Figure 30). The averages of mean groups of animals at different times of the year are given in Figure 31.

The use of the main vegetation types can be roughly qualified from aerial survey maps but too much reliance cannot be placed on these data because of diurnal movements across vegetation boundaries.

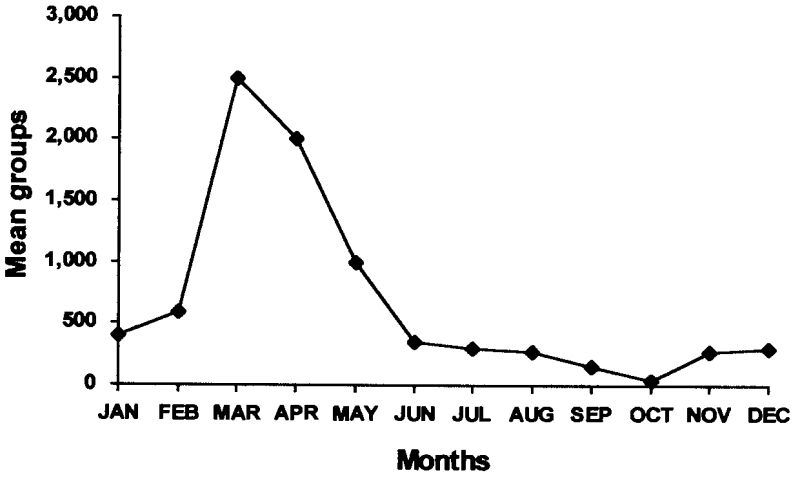


Figure 31. Mean group size changes in black lechwe on the Chimbwi flood-plain.

6.4.2 Movements from wet season to dry season range

Next to sitatunga, the lechwe can be ranked one of the most water-loving antelope in Zambia. It has little or no hesitancy in taking to water to escape land predators (i.e. including man) or to feed on green grass in flooded areas at the time when grass elsewhere is brown and in short supply. Given a choice, lechwe appear to prefer the more open and extensive grasslands close to lagoons, rivers, lakes or flood-water.

However, the shallow water flood-plains dry out between May and November. At this time the lechwe once more start a general movement towards the north. The moving groups are seen on a rather broad front but clearly defined migratory routes are not followed. However, between early June and July, a series of relatively rapid and concrete movements take place and these carry a large proportion of lechwe into the dry season range following the flood-line, deeper into the central swamps. In general, these routes are conspicuous from slightly raised tongues of land that dry out in advance of the surrounding flood-plain. This is particularly obvious in the case of the routes from Lulimala and Masenga which lead to the interior of the swamps.

6.4.3 Trends in dry season distribution.

At the end of the dry season (October), the majority of the peripheral and intermediate grasslands have been burnt and grass is in short supply, though it is just beginning to support a green flush of re-growth. The grasses on the flood-plains are short and at this time a few small herds remain throughout the dry season on the Lukulu River, using the small permanent water meadows close to the river channels. The situation in the 1994 and 1995 seasons was remarkably different. A sub-population of mainly males which remains on the Chimbwi plain until the next rainy season was not observed due to an extreme drought that persisted for two years.

The approximate boundaries of the lechwe distribution are as shown in Figures.29 & 30. It should be noted that the general distribution is more or less the same, but depends mainly on the flooding regime. Exact boundaries of the strata are not quite identical between years and thus formal statistical comparison between years is not appropriate. Nevertheless, several clear trends can be seen in the data. There has been a noticeable decline in the number of lechwe on the western end of the swamps, particularly in stratum 1, since 1983. Lechwe numbers in the central portion of the main swamp, particularly in stratum 3, appears to be stable or slightly increasing. There has been a steady increase in the dry season population on the Chimbwi whereas there has been stability in the Kalasa-Mukoso population over years (Table 12)

6.4.4 Comparison of dry season and wet season population on the Chimbwi flood-plain

The protection offered to lechwe by the permanently occupied Zambia Wetlands Project Field Station at Chikuni on the Chimbwi plain and the creation in 1990 of a 100 km^2 hunting free zone in the surrounding area has resulted in a small but encouraging increase in the number of lechwe remaining in the area throughout the dry season. There was a marked difference in the numbers of lechwe observed on the Chimbwi plain during the dry season (October) and wet season (January) total counts. On 18 October 1994, 2 200 individuals were counted in the 100km^2 census area, yielding a density of 22 lechwe km^2. In contrast, the same census area had 13 400 animals on 20 January 1995 yielding a density of 134 lechwe km^2 The findings are also in agreement with the values observed in 1990-1991 period when an average of 135 animals km^2 were counted (Thirgood *et al.*, 1994).

General density of lechwe was observed to vary on a daily basis as well as seasonally. On the basis of season, different habitats provided the animals with their preferred food source, shelter, and to some extent protection from their potential predators. The high concentration of lechwe on the flood-plains during the flooding period increases their density. It was observed that density plays some important role in the population of lechwe in the following ways:-

- increases the chance of mating and the general behavioural activities essential to the welfare of the population;
- it may also increase the chance of the spread of disease and parasites;
- it could also play a part in controlling the birth rate, mortality rates and growth rate of the population.

However important it may be, density is the parameter which is difficult to determine due to one major factor namely that individuals in a population do not occupy all the available space within a unit area because not all of it is suitable habitat. Animals therefore tend to concentrate in pockets.

The Chimbwi flood plain remains important to the species, given that approximately 30% of the total lechwe population concentrate in this relatively small area during the wet season. Mating takes place during a confined period in the wet season and the majority of copulation occurs on small contiguous approximately 1 ha territories established by adult males on the same area. It has been noticed that lechwe are particularly tolerant of human disturbance at this time.

6.4.5 Distribution of lechwe on the Kalasa-Mukoso flats

The Kalasa-Mukoso environment and its lechwe population have shown some outstanding differences from that of the southern and eastern flood-plains. Observations made are as follows:-

- there is no water meadow to the west of the Luapula river and the proportion of the intermediate grasslands of *Oryza* and *Vossia* dominated flood-plains is much more extensive than it is to either the east or south;
- human settlements are in closer proximity to the lechwe ranging areas. The banks of the Luapula are heavily settled due to their rich fishing grounds;
- the distribution of the lechwe has been observed to be more widely spread;
- the seasonal movements are much shorter and less pronounced than those of the south eastern populations.

It has been observed that there is mixing of lechwe populations on the Chimbwi plain with those on the Buteka and Masenga plains which further tend to move northwards towards Chafye, Ncheta and Mboyalubambe islands. How far the animals move during this time is not well understood. They move back to the Buteka and Chimbwi plain at the beginning of the rainy season. There is, however, no evidence to suggest that the sub-population on Kalasa-Mukoso groups interchange or mix with the sub-populations to the south. The population on the Kalasa-Mukoso, which proves to be stable, can be a good indicator that the sub-population does not migrate or mix with other sub-populations.

6.4.6 Trends in dry season distributions

A number of factors can influence the distribution and movements of different animal species during the year. These include rainfall, soil conditions (nutrients of the soil and water availability) and their effect on seasonal and overall vegetation structure, dry season water availability and vegetation response to burning.

Since soil properties play a major role in plant-herbivore interaction by affecting the absolute and relative production of plant biomass and quality which are largely dependent on soil nutrients and soil water availability, this can be treated as the primary factor in determining seasonal animal movements and distribution. Climatic change and to some extent predation and harassment are some other factors that can greatly influence the extent of the species' range.

6.4.6.1 Seasonal vegetation changes

The vegetation provides food, water, minerals, shade and cover and in the case of females and protectionl of their young at the time of birth. The features of vegetation vary in time and space and the importance of each varies for different ungulate species. Ungulates respond to the features by choosing where to live and what to eat. In other ways, physical attributes of vegetation greatly affect habitat use by various animal species.

Plant growth under local conditions is limited by soil moisture rather than by temperature. Soils in the study area differ in their water holding capacities (Chileshe & Kamweneshe, 1987). In general, soils on higher grounds from the swamps hold less water than the ones towards the swamp. Water-plants' start to grow when periodic rains increase the soil moisture. They continue growing while moisture remains available at root level and ceases when the soil dries out. Plants on alluvial soils grow for a shorter time after the rains have finished than the grasses towards the swamps that remain wet much longer. Plant productivity, particularly that of grasses is directly related to the amount of rainfall which is the determining factor for the flooding regime. The termitaria produces low quality foods with a higher content of cellulose and hemi-cellulose whilst the flood-plains produce vegetation of higher food quality (Grimsdell & Bell, 1975). The content of cellulose and hemi-cellulose increases with the age of plants. These grasses tend to be relatively palatable to various animal species at the early stage of growth when they are green and tender.

The mechanisms employed by grass species to survive annual recurring draught and fire may be classified into two main categories as follows:-

- short lived species which are entirely reliant on seed production;

species reliant on seed production only at intervals much greater than a year. These are normally perennial species, which survive for many years with a variable mechanism for protecting bud primordia (Chileshe & Kamweneshe, 1987).

6.4.6.2 Effects of fire on soil and vegetation

The effect of fire on vegetation has some pronounced indirect and direct effect on the distribution of animals (Kamweneshe & Kamweneshe, 1993). It has a prominent impact on vegetation by preventing regeneration of seedlings, inhibiting their growth and controlling woody growth which otherwise can encroach on grasslands whilst on the other hand promoting germination of various grasses. Some studies elsewhere have shown those actual soil composition changes following a fire with resultant potassium and phosphorous solubility producing a fertilising condition. The

prolific growth of various grasses in ...rm is a clear indication of this effect. The elevation of the local temperature is naturally the more immediate conservation issue of fire. The amount of thermal energy liberated evidently depends on a series of factors such as:-

- the mass of burning material;
- its degree of dryness;
- aeration;
- density of grazing animals (causing trampling and grazing) (Kamweneshe *et al.* 1994).

Plant biomass of most areas in the Bangweulu is not uniform in its different types of formation but increases gradually as one moves from woodlands to the swamp areas with a break on the flood-plain where the grass is kept short by lechwe including other animal species using the area. In addition, there is a general formation of "peat" in the swampy areas. It is for this reason that fire temperatures gradually vary along with the change in this gradient, being higher in the swamps than the peripheries. Winds are regularly strong due to lack of dense vegetation, especially trees and shrubs in most areas. This increases the aeration and propels fires. The density of grazing animals has also some direct bearing on the extent of fires. The higher the level of grass utilised due to high concentration of animals in a given locality, the lower biomass production and this leads to less fire intensity.

Local people start most of the fires in the Bangweulu Basin between August and October mainly as a tool for improving pasture and changing wildlife distribution to facilitate hunting.

Ecologically, fires do have advantages of clearing the dry grass which is not grazed and release some nutrients (like phosphate and potassium) as fertilisers to new growth. Through this process, organic matter is mineralised and the nutrient cycle is accelerated.

To counteract the detrimental effects of late fires, the NPWS has tried out early burning programmes between July and August in some parts of the Parks and GMAs in the country, though this has not been successful. Those isolated patches of grass, which survive early burning, are in most cases burnt later by unknown people, defeating the purpose of the whole programme.

Fire under control can be used as an important tool in wildlife management, but this is mostly desirable at a time of the year when animals or nests of valuable species are not subjected to damage. Burning can also be used in range management if carried out when the vegetation is in a dormant state.

CHAPTER 7

THE VEGETATION AS FOOD SUPPLY

7.1 Introduction

The vegetation of the Bangweulu basin is one of its most valuable assets. Not only does it form the vital link between the energy and available food resources for other biota in the area, but it also provides a wide range of habitats, which form the basis for the distribution and relative densities of fauna available in the area. Grasses are the most important food component of the area in terms of abundance and level of utilisation by ungulates. Big browsers, apart from elephants, which may ingest shrubs or parts of the trees are absent here.

It has been argued by Bell (1971) that wild herbivore populations are usually limited by the availability of protein and that quantity and quality of protein is in turn determined by the following factors:-

- the amount of standing crop of plant material at any one time which is dependent on the rate of production and the rate of loss due to defoliation regimes, etc.
- the protein content of various components of the vegetation (i.e. mainly plant species and plant parts);
- the structure of the vegetation; that is the relative position of the palatable plant components in the vegetation. (This determines the rate at which animals of different structures and sizes can remove selected components from the vegetation);
- The digestibility of the various vegetation components. This determines the rate and completeness with which animal can extract protein and other nutritional requirements from ingested components.

In order to assess the quality and quantity of the vegetation as a food supply for the lechwe, it is necessary to know certain ecological factors, which include the effects of the level of flooding.

Inadequacy of food in wildlife populations can be the result of poor vegetation quality or insufficient quantity or a combination of both. In most African studies on nutrition of wild ungulates, the quantity of food has been sufficient, but the quality was limiting during certain seasons (Vesey-Fitzgerald, 1955). Most of northern Zambia is on the plateau and has one short wet season.

The grass flush with the on-coming of the rainy season matures quickly with a concomitant decrease in digestibility and most mineral elements. The situation in the Bangweulu swamps is different in that the grasses of the water meadow and termitaria grassland units flush in November, but they remain green for some time after the end of the rains due to the effect of flooding. The meadow grassland stays greener much longer due to the continuous presence of water. Towards the end of April and May the floods recede slowly exposing the vegetation.

Most of these ecological components are beyond the scope of this study. However, reference is made to previous work carried out on the Chimbwi flood plain and termitaria grasses in the Bangweulu by Grimsdell & Bell (1975).

7.2 Selection of feeding habitat

Within its regular home range, lechwe show seasonal preferences for feeding habitats. Within seasonal distribution patterns, age and sex classes of lechwe also differ in their habitat selection. Females with calves often seek wetter areas with relatively lush vegetation. Bachelor males use vegetation communities peripheral to those favoured by females thereby avoiding harassment by territorial males. Sometimes it can be inferred that different individuals, both males and females, identify suitable vegetation communities for different reasons and not always connected with food.

7.3 Selection of plants and plant parts

Intake of herbage by lechwe including other local ungulates is an important but difficult parameter to determine. From an attempt made to quantify the plant species and plant parts selected during different months of the year it is concluded that lechwe are able to select. Throughout the study, it was observed that lechwe predominantly fed on five grasses out of eight dominant available ones (Table 14)

The proportion of the fragments of the plant parts and of the main grass species found in male adult lechwe is given in Table 15. The picture painted here could be very different in the case of female lechwe which normally tend to occupy different vegetation communities at different times of the year.

The proportions of leaf and stem in the rumen differed from month to month and most probably between sexes largely due to the different plant communities that they utilise at different times of the year. Very little inflorescence were found in the samples, possibly because continuous grazing by the animals prevented general flowering. No sedges were found in the diet, though some sedge like *Eleocharis dulcis* may be eaten in the meadow.

Between November and February, the diet of male lechwe consisted predominantly of grass leaves, (Table 15). By April the quantity of stems ingested grew steadily as the leafy parts of the plants are getting short (Table 15). Stems are less palatable and nutritious than leaves and this may explain the loss in body condition in lechwe. Females and some males, which occur nearer the flood-line, selected leaves for approximately two months more than the males, which were predominantly found either on the flood-plain or termitaria. This may put the females at an advantage in order to maintain their bodies in good condition during the lactating period.

The percentage occurrence of the fragments of the different grass species found in lechwe rumen is shown in Table 14. Between January 1994 and February 1995, *Echinocloa stagnina* was the most common species in the rumen providing 60% of the grass fragments identified in the samples. The second in abundance was *Acroceras macrum*. During the dry months *Echinocloa stagnina* started to decrease. This study revealed that proportions of plant parts eaten is governed by the utilisation of different plant communities at different times of the year.

In addition to the differences between seasons and years receiving different amounts of rainfall and hence flood regimes, the study suggests that selection of plant parts depends on the availability and stage of growth of the plants. The improvement of animal body condition also coincides with the period when leaf ingestion is high. During dry months when the animals increased feeding on stems and less nutritious species like *Oryza* spp. the body condition started to drop. This points to an understanding that leaves are more palatable and digestible than stems. The presence of inflorescences in the diet was observed in March. This agrees with the appearance of flowers and fruits in some grass species.

Table 14. Food plants consumed by lechwe at different times of the year.

Month	Grass species	Proportion
January-February	*Echinocloa stagnina*	60
	Acroceras macrum	20
	Leersia hexandra	8
	Unidentified	7
	Vossia cuspidata	3
	Oryza barthii	2
March-April	*Echinocloa stagnina*	48
	Leersia hexandra	32
	Acroceras macrum	8
	Unidentified	6
	Setaria anceps	4
	Themeda triandra	2
May-June	*Acroceras macrum*	40
	Leersia hexandra	38
	Echinocloa stagnina	9
	Unidentified	9
	Vossia cuspidata	3
	Oryza barthii	1
July-August	*Echinocloa stagnina*	40
	Leersia hexandra	39
	Vossia cuspidata	9
	Oryza barthii	5
	Unidentified	5
September-October	Unidentified	80
	Vossia cuspidata	15
	Echinocloa stagnina	5
November-December	Unidentified	75
	Vossia cuspidata	20
	Echinocloa stagnina	5

Table 15. Plant parts consumed by lechwe in the study area during the selected months.

Month	Leaf %	Sheath%	Stem%	Inflorescence%	n
January	64	9	25	2	15
February	65	14	17	4	12
March	70	12	10	8	12
April	62	16	16	6	13
August	63	11	19	7	15
October	53	10	35	2	15
November	54	12	31	3	16

This suggests that lechwe selection for leaf was governed by the plant quality. Lechwe feeding selection appears nutritionally advantageous compared to random feeding. The visual judgement of body conditions of a large proportion of the animals showed some correlation between the condition and the quantity and quality of plant material available in the area (Tables 14 & 15).

7.4 Causes and effects of feeding selection

Lechwe choose for feeding not only the plant community but also the plant species and plant parts. Table 14 shows that grass comprises the major components of the diet. The animals tend to prefer grasses that are usually green, short, soft and leafy. They avoided those species that grow into tall tough plants with more fibrous blades. The proportion of green grass leaf in the stomach contents increased in the wet season and decreased in the dry season. Green leaf was closely correlated with the proliferation of plants in the study area.

7.5 Comparison of flood-plain grasses with dry land grasses

The grass species can be broadly categorised into two distinct classes. The flood-plain grass species and the dry-land grass species that make up the intermediate and peripheral grasslands. The dry-land species comprise mainly of species of the genera *Themeda, Setaria* and *Loudetia*. These species are widely distributed but can only tolerate limited periods of shallow flooding (i.e. up to 30 cm). These

grass species normally grow upright with mechanical support provided by the fibres in the stems. Some flood-plain grass species in contrast are specifically adapted to prolonged or permanently flooding. The common species in this category are in the genera *Acroceras, Leersia, Echinocloa, Paspallum* and *Oryza*. Studies carried out by Grimsdell & Bell (1975) within the same area show that flood-plain grasses have about double the protein content than those of the dry land grasses (Table 16).

In addition to the protein that the flood-plain grass species offer to the animals, these grasses also have higher water content. (Table 17). This is important in that they provide a source of water to lechwe, tsessebe and other animals, which normally do not actively drink water.

Table 16. Protein content percentage of dry weight: Leaf/ stem (December-June) on the Chimbwi flood-plain (Grimsdell & Bell (1975).

Plot	No. assigned to the plots	Treatment		
		Leaf	Stem	L/S
Flood-plain grasses	1	10.83	8.39	1.29
	3	15.22	9.81	1.55
Dry-land grasses	5	5.83	2.74	2.13
	6	4.85	3.65	1.33
	8	5.79	3.07	1.89

Table 17. Grass: Water content percentage of wet weight (December-June) on the Chimbwi flood-plain (Grimsdell & Bell (1975).

		Treatment		
Plot		1	2	3
Flood-plain grasses	1	75.3	75.4	72.1
	2	81.3	80.7	78.4
Dry-land grasses	5	63.1	68.8	63.5
	6	57.1	67.6	56.9
	8	52.6	64.8	55.2

7.5.1 The dry season food supply

The dry season food supply presents some different features. The two species that make up the great majority of the dry weight are the wild rice, *Oryza barthii* and the cylindrical tubular sedge, *Eleocaris* spp. Both these species grow to great length during high flood periods, their trailing stems follow the water level and protrude to the surface. As the water level falls, the vegetation collapses in dense horizontal mats sometimes exceeding 50 cm in thickness. Through the fallen stems sprout a flush of new shoots from the nodes and small water meadow species, e.g. *Lersia hexandra* and *Acroceras macrum* germinate and grow through the mat in some places (Vessey Fitzgerald, 1955).

The dry-land grass species show the conventional decrease in protein content as the plant ages through the proliferation of structure tissue whereas flood-plain grasses show a relative decline (Grimsdell & Bell, 1975).

7.6 Rainfall and the food supply

The most important and obvious environmental factor affecting lechwe is rainfall for it directly affects the amount of food available to the animals in the dry season. It is mainly in the dry season that lack of food and the loss in animal condition becomes noticeable. Truly aquatic plants are found in lagoons, occasional pans and other marshy areas throughout the year, but this study has reviewed that the animals do not eat these plants. Under this category, the hydrophytic grasses and sedges have not been included since they are widely distributed and can survive for months without free water. One of the most striking features of the flood plain is the variability of vegetation distribution from month to month following the water regime (Grimsdell & Bell, 1975).

7.7 Food availability facilitation

Facilitation in this study is defined as the process whereby one species has a beneficial effect upon another. This phenomenon is mostly observed in bachelor groups of lechwe, which are found sharing the same habitats with tsessebe on the termitaria grasslands. Large herds of tsessebe alter vegetation structure through trampling and taking the courser plant parts as food. Through this way, lechwe and other smaller animals, which include reedbuck and oribi, are able to use the fresh lower parts of the

grass. The larger animals tend to remove the upper courser parts of the grass and by so doing expose more nutritious leaves sprouting from the base.

7.8 The role of lechwe in the ecology of the Bangweulu wetlands

Lechwe numbers on the flood-plains reach over 30 000 and faecal production may be considerable. The faecal nitrogen and mineral content is high in the droppings and become nutritionally beneficial to the soil and subsequently the vegetation.

The productivity of the Bangweulu flood-plains in the overall context of the ecosystem can be attributed to the presence of various wildlife species like buffalo inhabiting the flood-plains and termitaria grasslands (Figure 32). An assumption is made that much of the nutrients that determine the productivity of the water meadow pastures are dropped onto the flood-plain rather than brought in by rivers and tributaries. Both wild animals and birds deposit faeces rich in minerals, which include urea, nitrates and phosphates. These elements accumulate over time mainly during the dry season. In the wet season, the nutrients dissolved in water are released to the soil and readily taken up by plants. Some of these plants, like, water lilies, serve as food for birds, macro and micro-organisms and several herbivores making up part of the food chain.

Grazing and trampling of flood-plain vegetation at the peak of floods have some bearing on the opening of the area for feeding by certain waterfowl species, which include ducks and geese. The grazing by lechwe also suppresses perennial grasses in some areas in favour of the more palatable species. Fishes, especially bubble fish (*Clarias* spp.) and various micro-organisms and macro-organisms benefit from the lechwe droppings. Lechwe dung is also found to be an important breeding site for flies and various species of beetles of which the most obvious one is the dung beetle.

Figure 32 Herd of buffaloes crossing the Chimbwi floodplain to the swamps to drink water.

CHAPTER 8

CONSERVATION OF THE BLACK LECHWE POPULATION

8.1 The ecological capacity concept as it applies to black lechwe

The concept of ecological capacity refers to the density of an animal population of which growth stabilises in the presence of the following factors:

- illegal and legal off-takes;
- predation;
- immigration and emigration;
- Inter-specific competition;
- changes in population density in response to rainfall fluctuation, (odum,1971).

Food, water and vegetation cover is the main factors, which determine the ecological capacity of a given area. A dynamic equilibrium is reached once the production of edible forage by plants equals the rate at which the forage is consumed by animals (Caughley, 1979). This equilibrium point is also referred to as the saturation density or ecological carrying capacity (Caughley, 1979). The animals are not in very good condition at saturation density, but their death rate is balanced by the birth rate. At this point, the animal numbers are stable and to a layman the population is over-stocked or over-populated. In short, the carrying capacity refers primarily to the point of stability in the density of an undisturbed population. This point is what is designated as K in the logistic equation (Figure 33). The biomass fluctuation is regulated and determined by density dependent factors. The most important regulating mechanism in East Africa is mortality caused by the decreasing quality and quantity of the food available during repeated and seasonal scarcity periods. These limiting factors maintain ungulate populations at density levels which are in the long-term carrying capacity of their habitats. When over-stocking is reduced, the productivity of the ecosystem is maintained and a sustainable yield of game animals can be obtained. The carrying capacity can be calculated from the requirements of the animal species involved and which of these demands can be satisfied by the habitat.

Carrying capacity is not static but tends to fluctuate between years and seasons. Depending on the availability of high quality forage, it is higher during "fat years" and lower in "lean years" (Smith, 1989).

Fat years refer to years when there is abundant high quality forage whereas lean years are those when there is a shortage of high quality forage for a given animal species.

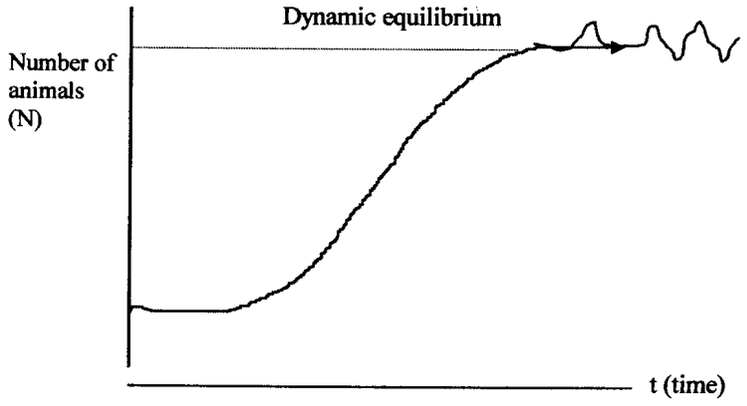


Figure 33. Plot of population density against time for a population that grows according to a logistic equation (Odum, 1971).

If there is a super abundance of food supplies the population increases rapidly and may overshoot its carrying capacity. By so doing, it reduces the food supply available to the next generation because the population utilises the available food in excess of rate of renewal. In this sequence of events, there is a big lag in time between cause and effect, resulting in a spectacular peak (eruption) followed by crash of the population (Caughley, 1979). The population will peak, crash and then return to a steady density where the rate of renewal of vegetation is balanced by the rate at which it is grazed (Caughley, 1979).

There is a difference between stocking rate and carrying capacity. Stocking rate is defined as the number of animals per unit land area for a specific time period (White, 1987). This is a management term, with no ecological assumptions. Ecological capacity is the maximum number of animals an environment will sustain (Caughley, 1979). An assumption advanced in this case is that population is regulated by food supply from the environment including the resilience of the ecological system and not by human management.

8.2 Estimating ecological capacity for black lechwe

Lechwe, being herbivorous, are important with regard to wildlife management in the sense that it has the capability to transform primary production and biomass into secondary biomass which is of high nutritive value to man. Carrying capacity can be estimated by analysing the primary production in an area in relation to the herbivores inhabiting the area and their metabolic requirements (Bell, 1971). This involves clipping of forage in randomly located enclosures after one growing season or at regular intervals through the growing season. Thereafter, determination of the carrying capacity of an area for a particular herbivore is based on the analytical estimation of calorific value, protein and mineral contents of edible biomass of clipped forage (Rees, 1978a; Bell, 1984a). It also requires good knowledge of the metabolism of animals under study and the habitat being utilised during the critical time of the year (Rees, 1978b).

Grimsdell & Bell (1975) estimated the ecological capacity of the Bangweulu flood-plain for the black lechwe by clipping the primary production of the peripheral flood-plain, the area in which the lechwe spent the high flood time which was considered to be the limiting period. It was assumed that lechwe digest 50% of total protein content available in the primary production during high flood periods and estimated 155 individuals km^2, giving a total of 185 000 as ecological capacity for the entire Bangweulu flood-plains. The problems that arise in the analytical approach of estimating carrying capacity are related to the difficulties of converting vegetation protein production estimates into animal units. Firstly, there is no known simple relationship between the total herbivore productivity and plant productivity. Secondly, the ability of different herbivores to convert any one vegetation type into animal biomass differs radically depending on the types of their food requirements, digestion, physiology, morphology and body size.

Another method of estimating carrying capacity is based on a logistical equation (Odum, 1971; Caughley, 1973,1979). This involves calculation of the carrying capacity based on the logistical equation if the sustainable yield is known for a given stable population. In other words, if the sustainable yield and the stable population are known, then it becomes possible to estimate the carrying capacity using the logistical equation (Grimsdell & Bell, 1975; Bell, 1984a). Grimsdell & Bell (1975) used a logistical equation to estimate carrying capacity of the Bangweulu southern flood-plain. They calculated that 160 000 lechwe could be sustained by the area. However, in order to have a

fair estimate for lechwe using this equation, one needs to know the rate of natural deaths and illegal off-take and make an assumption that the lechwe population follows a normal logistical curve. The problem that arises from estimating the carrying capacity using this method is that the estimates of stable population and sustainable yield are likely to contain some considerable errors. A small difference in the estimation of the sustainable yield and stable population makes a big difference in the estimation of the required carrying capacity.

Bell (1984a) indicated that due to shortage of funds and other resources in Africa, it is very difficult to estimate the carrying capacity successfully using the analytical approach. He argues that after a broad estimation of the carrying capacity has been done using the comparative approach method, this can then progressively be fine tuned by adaptive management. This involves monitoring of the trends of estimated total population with passage of time as the population is increasing towards the unknown carrying capacity.

8.3 Maximum sustainable yield as it applies to black lechwe

No matter what type of natural resources man manages, the object is to optimise the harvest. All resource management sciences have evolved around various elaborate bodies of theories and procedural know-how for obtaining maximum harvest, (Bell, 1984a). Nevertheless, the problem of achieving this maximum is rather a complicated one. A first difficulty is that all populations have an age structure and the size of the harvest depends on the age structure as well as the size of the population. We should also be specific when we talk about what we mean by a maximum harvest. Do we wish to maximise the biomass harvest, the number of animals or a number of animals in a given category? If we wish to maximise production, then we should thin out the reproducing segment of the population so that the growth of the offspring will not be stunted because of the intra-specific competition if it is present. Alternatively, if we wish to minimise wastage by natural mortality, we should harvest a number of immature individuals, which would otherwise be lost to natural mortality. We would compete with natural mortality forces for the chance of culling a member of the harvested population.

Whenever we increase the rate of exploitation of any harvested population (i.e. increase the proportion of the stock removed at each harvest) certain changes take place in the stock as well as the subsequent catches. Up to a certain rate of exploitation, the ability of the stock to replace itself is not impaired. Rate of exploitation that can be sustained is very different for different species of animals and

greatly depends on the biotic potential, reproductive rate and mean generation time. Beyond the critical level of exploitation, the chance for the population to recover becomes minimal and the stock may be exterminated quickly.

Age and size composition of the population serve as sensitive indicator of the effect that various levels of exploitation have on the homeostatic potentials of the population. Hence, age composition should be monitored very closely in this respect. The sex ratio and the age ratio (male:female) of approximately 1:2 and (Adults: young) 3:1 respectively show some good signs of the lechwe population. There is greater exploitation rate for adults through hunting. This could lead to fewer adults left in the population and less competition towards sub-adult age class. A higher proportion of the sub-adult stock is important to replace the exploited adults to perpetuate productivity

According to Chabwela (1992), an important question rises as at which point a population should be harvested when it is at its ecological capacity of the habitat or during the accelerating phase of population growth (Figure 33). A sustainable yield may be obtained from the population at any size less than the carrying capacity (Bell, 1984a; Grimsdell & Bell, 1975). According to ecologists, sustained yield refers to the number of animals that may be removed year after year from a population without causing it to decline (Caughley, 1973; 1979). The concepts "Optimum Sustainable Yield" (OSY) and "Maximum Sustainable Yield" (MSY) have been coined in order to provide a theoretical frame-work to help determine the levels of sustainable yield for a particular population in an ecosystem (Caughley, 1983; Chabwela, 1992). The definition of the OSY depends on the objective for managing a particular wildlife population. This could be for scientific or socio-economical reasons. The concept of OSY provides not only a practical option for optimum management of biological resources but also maximises sustainable yield for social benefits. It allows for harvesting to be at the level that reconciles the ecological, social, political and economic needs in order to maximise sustainable social benefits to the communities in question (Chabwela, 1992). However, the concept OSY can be abused in the sense that the term "Optimum" is rather too qualitative and has no fixed point as a "Maximum" and "Minimum" levels of harvesting.

CHAPTER 9

BLACK LECHWE AS A SUSTAINABLE RESOURCE

9.1 Introduction

Wildlife management is multi-dimensional in the sense that it involves wildlife populations, habitat manipulation and people. People and the environment are inseparable and therefore the manipulation of their attitude and behaviour can be done with strong consideration of the environment in question to achieve a set of objectives. This is possible because behaviour can be controlled and guided towards a predetermined goal. One of the ways to ameliorate antagonistic local attitude towards wildlife is to integrate local people's needs and aspirations into wildlife management programmes.

9.2 Social survey

A scheduled, structured questionnaire was designed mainly to investigate:

- Whether the landuse practices such as hunting and cultivation of the flood-plain and surrounding areas are in direct conflict with wildlife;
- The general attitude of local communities towards the current wildlife management and utilisation programmes.

The questionnaire included open ended and fixed response questions (Appendix 1). Individual households were selected as the basic unit. The Muwele village 20 km north-east of Chikuni and a few islands within the Chikuni GMA were selected as sampling areas due to the following:-

- proximity to the lechwe home range;
- possible landuse conflicts;
- marked human population densities.

A total of 50 heads of the households were interviewed in Muwele, 50 in the swamps and 50 in Chiundaponde. Chiundaponde was selected for being far (50 km) from the GMA so that answers could be compared with those of the other two areas. Community extension workers from the Zambia Wetlands Project selected respondents on the basis of chance encounter. The age of the respondents ranged between 21 and 50 years old.

Due to insufficient resources, this survey was only confined to the two areas mentioned. Some of the information reflected here is derived from long time observations and interaction with local people. The rationale behind the survey was to investigate whether the existing community-based wildlife management programmes had improved the local rural people's attitudes and perception towards management and utilisation of black lechwe. Available time, financial constraints and the pilot nature of the study dictated the overall size of the sample.

9.2.1 Household size

Average household size in the study area was 4.5. This relatively large household size is influenced by cultural factors, which merge with a high birth rate (approximately 3%). Complying with tradition, a substantial number of children symbolise prestige and status in society. Further, a large number of children in a household ensure a large workforce in most traditional activities.

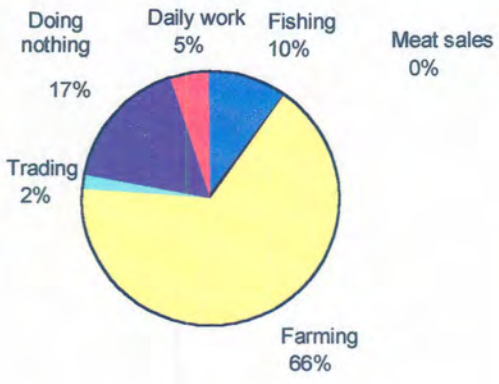
9.2.2 Education levels

The interview conducted revealed that 80% of the people in the area did not have any basic education and only 10% had primary education. It was also revealed that 10% had attained further education. The low level of education may be attributed to some extent the insufficient educational facilities. Taking population growth into consideration and in the absence of adequate educational facilities, the plight of illiteracy in the area is most likely to become more acute in the future. On the other hand lower education levels among the females has been attributed to negative cultural attitudes towards female education. Lower education levels among females are also reflected at the national level (WRI/IIED, 1989).

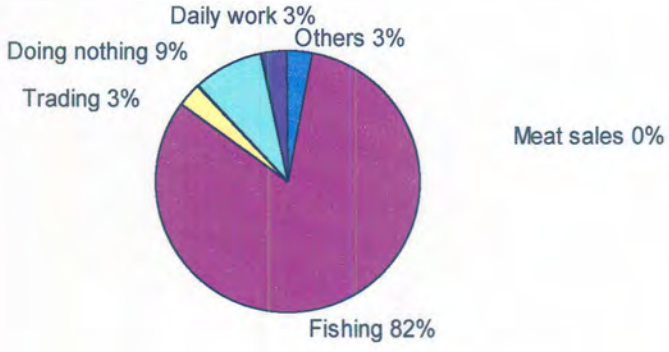
9.2.3 Occupation and source of income

Fishing is the major occupation of most people in Muwele and the swamps (82%), whereas farming predominated in the Chiundaponde area (66%) (Figures 34a & b). The difference can be explained by the fact that the areas on the peripheries of the swamps are relatively unsuitable for various farming activities. Farmers on the main land do have access to credit facilities to purchase agricultural inputs. In addition, being further away from wildlife home range, people on the mainland face less crop raiding by wild animals, though this is experienced on small scale by common duikers (*Sylvicapra grimmia)* and bush pigs *(Potamochoerus porcus)*

Villages in proximity to the wildlife range have more employment opportunities in tourism related industry than those on the mainland, though mostly on temporally basis. The prominent and obvious source of income in the areas around the swamps is sales of fish and agricultural produce for the areas on the main land. Since most of the income come from agriculture products and fish sales in the two respective areas, this points to seasonal income, which in most cases is very low. Although, none of the respondents (0 %) claimed income from meat sales, it is quite indisputable that game meat sales greatly supplements income within some households. von Ritcher (1970) observed that sale of game meat by rural small-scale farmers to augment their small income plays a significant role in the rural economies in different parts of Africa.



(a) Chiundaponde



(b) Muwele

Figure 34. Responses from interviews on the main source of income.

9.3 Wildlife utilisation and socio-economic benefits

Wildlife management is essentially applied to population dynamics requiring a sound knowledge of animal numbers and its general status. Some animals for one reason or another are exploited without this vital information. The environments in which these animals live are equally dynamic. The changes in the environmental attributes from time to time may cause fluctuations in the survival, fecundity, age distribution and the rate of increase of the animals. As such, density and distribution data obtained from the study could strengthen the baseline information for monitoring future population trends of the lechwe in the Bangweulu.

Wildlife resources of the Bangweulu Basin are utilised through various ways, which include consumptive and non-consumptive methods. Apart from the banned traditional hunting, other forms of consumptive utilisation in the following forms are practised:

- culling;
- safari trophy hunting (sport hunting);
- non-resident hunting and;
- resident hunting;

Lechwe as the flagship species in the Bangweulu, has been the centre of eco-tourism development in recent years. Capturing for ranching is one area which may be exploited in near future.

9.4 Management of wildlife resources with local communities

It has become clear that in order to achieve a positive co-management structure, three main stakeholders have to agree on an effective institutional frame work and collaborate closely: The communities, the local authorities and the department of wildlife services through the Ministry of Tourism. The communities are the primary stakeholders and the department of wildlife in collaboration with various NGOs involved in conservation of the black lechwe and other local natural resources act as technical support agency and arbitrator. The local authority is the lowest level of formal statutory accountability and the only one to which statutory law can delegate powers.

Unlike crops and domestic livestock, wildlife is a common pool resource like rivers and grazing grounds and forests. Since it is mobile, communities need to know their boundaries and form collaborative association with their neighbours. One of the ways to ameliorate antagonistic local

attitudes towards wildlife is to integrate local needs and aspirations into wildlife management programmes. One of the most appropriate measures would be to endorse some management responsibilities to local institutions and to strengthen community based resource management systems. Eaton (1985) reported that in New Papua Guinea, local people have been effectively involved in the management and protection of their wildlife. Modern wild-land conservation techniques have been effectively harmonised with the indigenous natural knowledge in the management of resources in Panama (Wright *et al.*, 1985). The welfare of transferring the custody of wildlife resources to local communities has been demonstrated in several other areas on the African continent (Western, 1982; Child, 1984; Lewis, 1988).

This study revealed that few people (3%) knew what their responsibilities were in wildlife management. The local attitudes suggest that local participation in wildlife related activities is not quite outstanding and some people still view NPWS/Wetlands project/ADMADE programme as the utmost custodians of wildlife. These local attitudes toward management of wildlife can possibly be explained from two main points of view;

- Most of the present management attitudes are residues of the colonial conservation efforts, which relied on preservationist models adopted from affluent western countries. Instead of integrating local needs and aspirations into programmes, bureaucratic management practices were imposed on local people on one-side and wildlife managers on the other. Consequently, this alienation from the resource created a break point in sustainable management practices that were inherent in traditional societies.

- The western concept looked at continued use of wildlife resources by local people as illegal, (MacKinnon *et al.* 1986). This perspective of conservation and management has been highly correlated with quasi-military operations in different parts of Africa. In virtually all National Parks and GMAs in Zambia, wildlife management has largely been dependent upon force and coercion to get conservation regulations implemented. Consequently, force has inculcated a view of wildlife management that is nothing other than law enforcement activities. This concept is further substantiated by the local opinion on proper management of wildlife resources, seen in terms of less poaching incidence. With this inclination, it is almost enigmatic for a peasant who is not involved in anti-poaching activities to conceptualise himself as a manager of his own resources.

While restoration of wildlife management by local people is being advocated, an interesting issue that needs serious consideration is the effect of the development trends on local societies. With the advent of modern socio-economic systems, indigenous societies have been disrupted leading to

sequential assimilation of characteristics of modern societies by the local people. Material and social changes aiming at economic growth have enhanced the dangers of over-exploitation of wildlife and the deterioration of their habitat. The situations evolved in Africa showed that indigenous societies did not require elaborate systems to allocate rights to use of resources, since resources were abundant and the populations around the resources were low. With growing scarcity of resources due to factors such as increased human population and reduced habitats, it is essential to allocate rights to groups of individuals on whose land wildlife occurs.

Lack of ownership of resource rights coupled with development trends seems to be fundamentally responsible for the local view that wildlife management is an obligation of NPWS/Wetlands Project/ADMADE in the area. This revelation may suggest that the project in the area has not made a good impact on the appraising of local people about their relation to wildlife. However, the percentage of respondents (60%) who have come to know more about the importance of wildlife after the inception of the project into the area and benefits from wildlife was rather encouraging. From the forgoing it is clearly evident that in the long run more and more people will respond to their responsibilities in wildlife management as the partnership in this effort is strengthened and more benefits are realised from it.

9.4.1 The Village Scout Programme

The Village Scout Programme (VSP) is highly favoured by a cross section of people surveyed (60%). The argument favouring VSP activities is the significant reduction in poaching though there are no statistics available to support this assertion. It is assumed that men and women employed as village scouts posses rich indigenous knowledge of the surrounding countryside, villages and traditional cultures. This places them in a more advantageous position than regular wildlife scouts most of which are not residents of the area. However, flaws in the programme have been detected. Many village scouts become ineffective in that they cannot apprehend offenders, most of whom are closely related to them.

The main objectives of the VSP was to integrate local people into management of wildlife and to increase employment opportunities, but apparently, some people look at the VSP as an agency bringing enmity among the villagers. This view implies that for some local people, the VSP is not seen as a process to incorporate local people into the wildlife resource management programmes, but rather a perpetuation of the hostile force of NPWS.

The present trend of arresting poachers by some local people, some of whom are related to the apprehending officers in one way or another, is evidence that the involvement of local people in the management system can work. The role of the village scout should therefore not only be restricted to combating illegal activities, but also conservation education.

9.4.2 Disbursement of funds from wildlife

The funds generated from wildlife utilisation are split as follows:-
50% goes to the central government treasury and the other 50% is given to the Wildlife Conservation Revolving Fund (WCRF) in the department of National Parks and Wildlife Service. The (WCRF) funds are subdivided as shown in Figure 35).

The management funds include salaries and allowances for village scout, food rations for anti-poaching operations, village level meetings and vehicle running costs, etc.

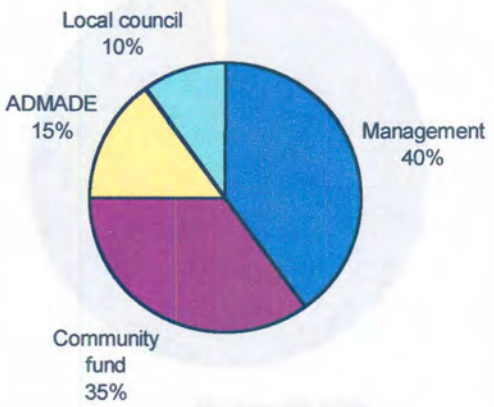


Figure 35. Allocation of funds generated from Wildlife utilisation by the WCRF.

9.5 Perception of wildlife population status by local people

Reduction in wildlife populations is quite inevitable looking at the current scenario of changing economic patterns and the growth in human populations. Subsistence hunting has not played a major role in decline of animal populations. Rather, the decline in most instances stems from commercial hunting, stimulated and supported by external demands mainly for meat and to some extent trophies. Depletion of wildlife populations is a cause of great concern to rural communities as well as the nation.

The impression gained from working with local people is that conservation efforts would be fully supported for as long as these efforts are explained to the local people beforehand and consequently fairly implemented. If the value of conservation was to be fully appreciated by local people living adjacent to the wildlife resource, residents could play a role in preventing the decline in wildlife populations. The general opinion held by most administrators was that local people were ignorant about their own wildlife conservation and were responsible for the depletion of the resource. This was somehow contrary to the revelation that has been made in the case of the Bangweulu Basin. Most villagers maintain that they would prefer a situation where their wildlife resources are managed in a sustainable way.

Although no valid data is available to show any discernible judgement on the decline of wildlife population other than of black lechwe, information from the area clearly indicates that numbers of several species seem to be on the decline. The best example is zebra *(Equus burchelli)* which used to range the Bangweulu flood-plains in several thousands in the early sixties (pers.comm. Chief Chiundaponde), but there was virtually none seen but the seven translocated recently (1996). Tsessebe were almost locally extinct about the same time, but their numbers started rising in the 1990s. The elephant population also met with great pressure for their tusks in the 80s. The population, which was in 100s, is currently less than 60.

In cases where other species have been mentioned as declined, there is lack of documented evidence. Nevertheless, based on anecdotal information, it is rational to argue that wildlife has generally declined in most parts of the GMA. Most available evidence indicate that this is partly due to over-exploitation, though habitat deterioration through encroachment and other natural factors, cannot be ruled out in some situations.

9.5.1 Subsistence hunting/poaching

While subsistence poaching is unequivocally illegal and therefore undesirable, there are aspects that warrant objective consideration. Local people get involved in subsistence poaching to obtain protein-rich game meat and to raise money for their basic needs. This situation is similar in all areas in the country. According to Bell (1984b) subsistence poaching is widespread and difficult to eradicate in many parts of Africa because it provides real benefits in terms of money and meat to the hunter. Although figures could not be obtained from the survey, it should be mentioned that poaching,. though risky, still remains popular as it benefits the hunters in terms of meat and revenue. Illegal hunting is a controversial and sensitive "profession" and hence practised in secrecy.

It could be that hunting is the largest occupation for some male respondents living around and in the swamps, but this is hardly revealed. None of the respondents indicated hunting as one of their major occupations. However, it can be argued that hunting is not an occupation as it does not pre-occupy regular time of those involved.

It is realised that when employment opportunities and availability of alternative protein are low, the incidence of poaching tends to grow. One way to mitigate the problem is to actively engage some highly skilled poachers into legal sustainable utilisation of wildlife by employing them in wildlife-related activities such as wildlife culling and the VSP. Changing attitudes of local poachers may not be as difficult as it may seem because illegal hunting is strenuous, uncomfortable, risky, dangerous and profitable only on marginal levels on the part of the local hunter. It is mainly for this reason that many local hunters (poachers) would voluntarily adopt more sustainable ways of earning a livelihood if they are given such an option. This case is supported by the views drawn from known poachers interviewed. This is also supported by the fact that some of the people engaged in various activities in the Wetlands project were at one time or another big poachers who were identified by the chiefs in liaison with his subordinate local leaders to take various positions in the project. Education alone would not bear adequate fruit in conserving the lechwe and other large species for as long as some alternatives to influence the change of attitude in local population are not put in place.

9.5.2 Commercial poaching

This form of hunting is considered to be extremely destructive, for the motive behind it is not always for subsistence, but for monetary benefits. In some cases, some local residents abet commercial poachers, who are usually town dwellers, in carrying out their illegal operations. Nevertheless, the money or benefits that such local inhabitants get from their alliance is insignificant.

Evaluation in East Africa revealed that protection of wildlife has stimulated a widespread system of black markets and smuggling (Davie *et al.,* 1973 in Marks, 1984). These underground activities not only impose high costs on the society, but in the long run would also lower the economic value of wildlife in the area. The discernment of the local people is that the decline of wildlife population, especially elephants and lechwe, is largely due to commercial poaching.

In his study on black rhino in Luangwa valley, Leader-Williams (1983) discovered that 71 % of rhinoceros deaths and a comparable percentage of elephant mortality were caused by commercial poaching. Larsen (1987) reported that poaching for rhino hom and elephant ivory in Luangwa valley robbed the economy of wildlife products worth about US$ 200 million in a period of 15 years. The situation is not very different with regard to lechwe, which is a valuable revenue generator for the country.

The revelation from this survey has shown that 90% of the respondents indicated that there was a general drop in the lechwe population, but there has been a steady increase since the wetlands project under the ADMADE programme was introduced in the area. The introduction of the wetland project, together with the introduction of the VSP, is the major factors responsible for the decrease in lechwe poaching.

9.5.3 Wildlife culling scheme

One of the arguments supporting wildlife conservation in Africa has been sustainable cropping/culling of wildlife. Eltringham (1984) has provided a detailed account of the limitations of harvesting wildlife populations. He concluded that in much of Africa in the 1960s and 1970s, at least the monetary benefits from culling programmes were marginal. An example of such a programme was attempted in the Luangwa Valley between 1965 and 1972 (FAO, 1973). At the onset of the programme, it was conceived to provide cheap meat for the local protein deficient residents. Nevertheless, there was no evidence to prove that the local people were actually protein deficient. Later, Marks (1976) established that local people were actually affluent in their protein nutrition through their own subsistence hunting. Most local people did have neither the ability to purchase expensive game meat from the programme nor the inclination to walk to and from the distribution points, several kilometres away.

Main factors contributing to the failure of most similar projects in Africa, such as the Glana Game Management scheme and Kijado cropping Project in Kenya, were mainly technical obstacles. The

stress on quality hygienic game meat production implied higher costs and this automatically excluded the rural population as potential purchasers. Meat had to be re-directed to urban areas in such instances (Eltringham, 1984).

The integration of local skills has been advocated as one of the best approaches to successful wildlife culling. Use of local technology has been reported in Zimbabwe (Child, 1984) and the Malama wildlife utilisation project, lower Lupande GMA (Lewis *et al.,* 1987). The 1991 Chikuni culling scheme of the black lechwe in the Bangweulu Basin was based on the same principles.

Wildlife culling was ranked second best as far as socio-economic benefits are concerned. The logic behind this appraisal is mainly secured in the residents' perception that wildlife culling creates employment as a source of revenue for community development activities and a cheaper source of meat for them. On the point of employment opportunities, the culling scheme employed 12 local people as hunters, skinners and meat processors. This indicates that the number of people engaged in these activities in relation to the local population is negligible and hence not quite important in terms of employment creation.

Most people interviewed did not know the purpose for which the revenue generated by the culling scheme was expended. This may possibly be due to the low level of public awareness from NPWS/Wetlands Project. Although most people claimed knowledge of the scheme through authorities, chiefs and the members of staff on the project, there seemed to be a discrepancy in the flow of information on the use of the revenue by the same informants. This could have some negative repercussion in an attempt to argue and convince local people that eventual benefits from wildlife could outweigh the current disadvantages. Information on the use of revenue generated from all kinds of wildlife utilisation needs to be passed on to the local people in order for them to appreciate.

The objective of providing cheap game meat to local communities was not achieved since many people did not purchase. Game meat, at the time of the study, was sold for ZK 200 (US $1) and ZK 400 (US $2) per kilogramme to local residents and outsiders respectively. This was much cheaper as compared to the cost of beef in urban areas in Zambia (Beef cost in the range of ZK 2000 (US $10) and ZK 3000 (US $15) per kilogramme at the time of the survey). This difference in pricing made the sale of game meat in urban areas extremely lucrative. The survey also revealed that this price was much lower than that charged by poachers locally. Despite the price of ZK 200 (US $ 1) being too low, a lot of people still wanted it to be reduced further. This reaction could be attributed to the low purchasing power of most people in the area. This assertion is also reflected in the low

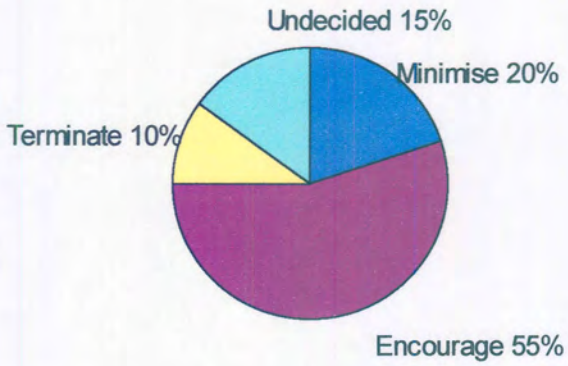
average income. In most instances, lack of money at the time of sales was the reason for not buying meat from the scheme.

While the selling of meat to Mpika (the nearest town to the study area) residents was a more profitable undertaking for the culling scheme in terms of revenue, it created tension among some local people who did not acquire any meat from the exercise. This suggests why most people wished the NPWS to increase the culling quota. In addition, taking into account costs involved in the whole process of culling up to the selling point, it was found that after maintaining the above selling price the profit level was extremely low and therefore further reduction could make the exercise fail.

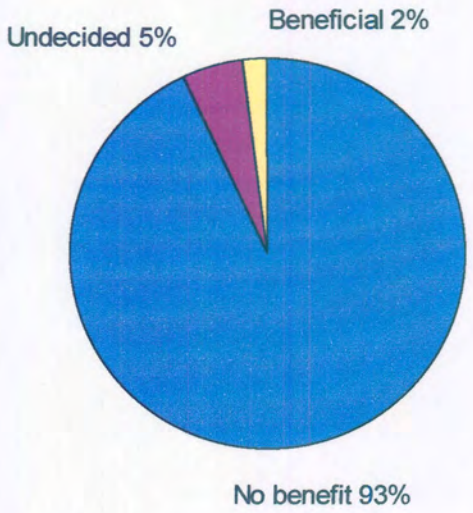
Ecologically, it is likely that culling could contribute to the removal of trophy animals from the population if not checked. It may also negatively affect the genetic diversity and stability and resilience of the wildlife population in a number of ways that make them less possible to deal with future environmental changes. Negligence and dishonesty where some hunters may harvest more than permitted are some of the hiccups found to contribute to the failure of similar programmes elsewhere. Determination of future culling quotas must be made with caution, taking into consideration factors that may affect the population or may conflict with other forms of utilisation.

9.5.4 Safari hunting

Safari hunting in the Bangweulu is leased out on a three-year basis to a registered Safari operator. It has been realised that in recent times, other interested parties are given permits to set up their tourism facilities in the area as well. Despite the fact that this set up has great potential to realise significant amounts of money, some local people feel that only the few already wealthy foreigners are able to exploit wildlife resources while the local people have very little chance. From the survey 55% were in favour of it to continue existing. However, the number of respondents who appreciated the socio-economic benefits derived from safari hunting was low (2%) (Figure 36).



(a) Responses on the allocation of quotas to safari hunting



(b) Responses on the benefits accrued to local people from safari operations

Figure 36. The views of local people on socio-economic benefits from safari hunting in Bangweulu Basin.

Safari hunting generates large income from relatively small turnover and from relatively low capital investment in infrastructure (Bell, 1984b; Child, 1984). The advantage of safari hunting as a form of

land use and the ease with which revenue is directed towards investment in rural areas has been documented in Zimbabwe (Child, 1984).

Caughley (1979) argues that safari hunting hardly disrupts the wildlife populations, since it is aimed entirely at the trophy market. On the contrary, some local people interviewed in the Bangweulu (10%) feel that this form of hunting was partly responsible for the decline in wildlife species in the area. Eltringham (1984) states, in line with some local respondents that, safari hunting is in fact more profitable to individual safari operators and their professional hunters than to local people. There have been instances in which safari hunters have killed more animals than licensed. This happens when the operator goes out in the field hunting without the company of a village scout or regular scout. There has also been cases of overshooting which takes place when accompanying officer are bribed to shoot extra animals.

Safari hunting offers employment to few inhabitants. A good cross section of the specialised workers employed by the operators are brought in from towns, reducing the chances of local people being employed and trained in various fields pertaining to the industry. The privileged few who get employed by safari operators have the advantage of accessing meat from hunting.

The high revenue generating capacity of safari hunting runs into conflict with local people's interests' in that, benefits to them are not tangible. If revenue generated from safari hunting in the area becomes visible to local communities and channelled meaningfully, the attitude would inevitably change as has been demonstrated elsewhere (Child, 1984, 1988; Lewis *et al.*, 1987). Since the safari industry is trophy oriented and game carcasses are not enterprised, if game meat is made available to local communities on a marginal or non-price basis, it may assist in creating the necessary local support. The trend in the local people's opinion can be reversed once the money accrued from it is seen to be working for them, be it directly or indirectly. On the other hand Safari operators in the area assist in anti-poaching activities. Operators should be involved in learning more about the people's needs through interaction, which would in the final analysis create a stronger public relationship.

It becomes difficult to discuss the points raised by local people that the number of animals allocated to safari companies be reduced. It should not be advisable to suppress safari hunting. To the contrary, it can be encouraged since it is the most important form of wildlife utilisation as far as revenue generation is concerned as part of the licence fee and the hunting right revenues go back to the "rightful owners of the resources".

9.5.5 District game license hunting

The number of District Game Licences bought by local people in a given hunting season is very small. Some reasons given are that;

- most of them cannot afford the licence fees;
- the process involved in the acquisition of a licence is too bureaucratic;
- many are ignorant of the procedures to follow and some of those who are involved in subsistence hunting find it unnecessary to waste money buying a licence when they can hunt without one (Ndhlovu & Balakrishnan, 1992).

The trend of the views of people interviewed was that DGL hunting offered the highest benefits in terms of game meat among the different forms of wildlife utilisation practised. Although this may not hold to be true, it can be supported that people are able to give information freely on this form of utilisation as opposed to the illegally obtained meat.

9.5.6 Special licence

The minister under the Ministry of Tourism has powers to issue a special licence whenever necessary to hunt any specified animal. All the villagers interviewed expressed ignorance of this type of licence. This type of licence is normally issued during traditional ceremonies. The number of animals killed in a year under this licence is rather quite insignificant to the overall off-take.

9.5.7 Wildlife crop damage control

Elephant, common duiker, bush pig and hippopotamus are responsible for most of the crop damage. However, no data is available on the actual cost of crop damage by wildlife in the area. In the absence of such information, it is difficult to assess the extent of the problem.

Species such as black lechwe, tsessebe, reedbuck, oribi and sitatunga are not problematic in crop damage due to the fact that their ranging areas are usually far from crop fields. Lechwe can at times be a nuisance, raiding small fields of rice and maize. However, the damage is not as profound as in the case of hippo and elephant. Elephant and buffalo are the only species whose damage are commonly reported to the NPWS, particularly because of their devastating nature.

In traditional societies, crop damage control mechanisms were developed by local residents to protect their crops. Wild animals that are often associated with cultivated areas and are agricultural pests render themselves more vulnerable to hunting.

One of the suggestions made by local people to alleviate crop damage was to shoot animals responsible for the damage. This was found to be extremely difficult to pin-point an animal, which is directly responsible for the damage. There is no clear-cut indication that control shooting has reduced the magnitude of the damage in those vulnerable areas, since it is impossible determine how much damage could have occurred had there been no control shooting. There is some benefit of meat from control hunting of large animals. This could be another reason why invasion of fields by large animals is reported rather than when small animals are involved. A combination of the above inferences suggest that wildlife crop damage control is not given priority and hence substantiates the local people's remark that this form of wildlife utilisation is virtually non existent.

The socio-economics of crop damage control is controversial and apart from its value from a public relations incentive and to its potential to generate some revenue (in the case of elephant), there is no real evidence that control shooting reduces the rate of damage to crops. From a national economic perspective, it is not appropriate to destroy large and economically valuable mammals such as elephant when the value of the crop (to the overall economy) is comparatively small. This leaves the NPWS decision-makers with complex choices. On the one hand, to offend local interests is to risk loss of public relations, whereas on the other hand to encourage it is to risk abuse of economically valuable wildlife species.

There are other ways that have been practised in alleviating the problem of crop damage. These are by fencing and patrolling by wildlife/village scouts in the areas where crop damage is prevalent. The later still proves to be difficult when it comes to nocturnal species which strike when the scouts are away. Fencing is also labour intensive and though effective for some smaller animals, they are not often sufficiently strong for elephants and are not appropriate for elusive species like monkeys. To keep away animals that can easily pass through fencing made of sticks, poles and branches, trenches around the crop field are often dug. In other instances, huge mounds are built around the field, but these do not deter species like warthogs and bush pigs.

9.5.8 General meat consumption by local people

Frequency in consumption of game meat is most likely to be much higher than disclosed during the present investigation. Generally, more people in the rural communities, which are endowed with

wildlife, consume game meat than in urban areas owing to the fact that game meat is more readily available to them. However, it is clear that local people do not usually reveal information on game meat consumption for fear of prosecution. It makes sense that there seems to be a relationship between frequency of game meat consumption and distance to areas of game concentrations. It is much easier for areas around Muwele and the islands in the swamps to access wildlife and hence easier to get their meat protein. A lot of children under five are usually under-nourished due to the fact that their diet is considerably monotonous. Vegetables, especially in the dry season are not available in most areas. The culling scheme, which was concentrated around Chikuni research station, again entailed that people living nearby had easier access to the meat than those in more remote localities.

The most preferred game, or rather the most consumed game meat, was the black lechwe due to the following reasons:-

- the species is somehow docile and can easily be hunted using less complicated methods which include hunting with dogs;
- their habitat, comprising short vegetation, puts them at a disadvantage and prone to hunting;
- their concentrations in certain areas makes it much easier for the hunters to reach them. The taste of meat has been put as a secondary factor.

9.5.9 Other general views

The apparent stability of the lechwe population in the past few years suggests that poaching may be under control, but this is difficult to determine. Law enforcement has not been vigorous and the occasional poachers who are arrested are dealt with leniently.

Inadequate manpower and lack of appropriate equipment and incentives have adversely affected anti-poaching activities throughout the area. The majority of the people in Chiundaponde, which is approximately 50 km from the Chikuni, did not see much wildlife utilisation as beneficial to their welfare. It is for this reason that 20% of the respondents indicated that they be given hard cash for their own community projects whenever they needed it. There are various reasons as to why the two communities perceived the wildlife utilisation differently among of which are the following:

- culling programme was carried out in the GMA with a provisional abattoir constructed at Chikuni;
- the people living in and around the GMA had a higher chance of getting employed in wildlife related activities;
- the wetlands project was much more active in the areas closer to the swamps.

This could account for the reason why the communities in Muwele and the swamps had a higher score on the benefits tapped from wildlife (20%). Results indicate that local people support the arrest of poachers, especially those from outside local communities. The survey indicated that 10% of the respondents do not hold positive attitudes towards wildlife law enforcement officers. This has been observed in instances where local people are not ready to give voluntary information to wildlife officers in order to assist them in their investigations. The present conservation education alone will not suffice in the establishment of a strong foundation in the conservation circles. The principal forms of extension work by the wetland project should aim at breaking down the mistrust that may exist between the local communities and the government wildlife personnel. There is strong evidence that recent involvement of local communities in conservation and management issues is most likely to mitigate against heavy poaching. For this strong reason, the future of lechwe, including other wildlife species and their habitat, will show hope of perpetuation.

9.6 Contribution of tourism to development

Tourism trade has been seen as a mechanism to justify conservation without doing much harm to the resource base and has become a major industry with wildlife serving as the primary attraction. Data on current wildlife utilisation practices and earnings is somewhat patchy. Wildlife and wilderness form the basis of the Bangweulu's fast growing tourism industry. This sector accounts for most wildlife utilisation (both non-consumptive through photo safaris and consumptive through sport and trophy hunting).

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

Black lechwe is a highly prolific and resilient species. Its population has great potential to increase once accorded adequate protection and better management. The Chimbwi flood-plain remains important to the species, given that more than 30% of the total population concentrate in this relatively small area during the wet season. Mating takes place here during a confined period in the wet season and most copulations occur on approximately 1 ha territories established by adult males on the partially inundated flood-plain. Lechwe are particularly tolerant of human disturbance at this time and given the apparent habituation to humans and vehicles shown by animals in the hunting free zone at Chikuni, the opportunity for development of eco-tourism remains high.

The partial recovery of lechwe to the present level of 32 366 appears to be related to the community based wildlife management which has most probably influenced a number of local inhabitants' attitude and perception towards general wildlife management and utilisation.

Law enforcement has historically been the primary means by which the protected area managers resolved conflicts with the local people but it may be argued that the techniques have proven to be inadequate and often inappropriate. In order to increase effectiveness of conservation efforts, emphasis should be put on enlisting more professionals other than only biologists in the conservation constituency and should include economists, anthropologists, sociologists and politicians. The current network of conservation areas needs to be revised to allow integrated rural development programmes to co-exist with wildlife conservation. Rural communities need to have a fair share in decision making and income including other benefits derived from wildlife utilisation. Conservation programmes are most likely to fail if the participation and co-operation of local inhabitants, whose livelihood largely depend on the natural resources are sidelined.

Conservation is increasingly becoming more of a social challenge than a biological one. As populations increase, the disparity of wealth, gross and unauthorised harvesting of resources within protected and semi-protected areas continue. Conflicts between protected areas and local people are most likely to increase as the surrounding natural resource base is driven to short supply. Changing the behaviour of local people towards biological resources of national concern would

require a package of direct and indirect incentives, which can be in the form of cash or kind. This development should be seen that it is linked to the conservation of natural resources;

- An adequately planned extension service should be implemented to educate and introduce the public to the need of the new approach which will incorporate them into the management of their resources;
- The proposed Chikuni GMA is important to various animal and plant species in the region, it is for this reason that it should be gazetted as a GMA and the Chimbwi plain should continue to receive special protection as a breeding ground for lechwe;
- New wildlife policies on the management of wildlife in general should be tailored to give traditional leadership enough say in the process;

The lechwe population is negatively affected mainly by poaching. There is some evidence that recent involvement of local people in wildlife management is militating against poaching in the Bangweulu. This investigation has revealed that the local communities would generally support the conservation of resources if they are clear about the benefits that they would realise from their effort. Surveys in many other parts of Africa have also shown that people tend to change in favour of conservation initiatives after seeing tangible benefits. The general belief held by many administrators/managers that local people are ignorant of wildlife conservation and are responsible for the depletion of most natural resources is to some extent contrary to the local situation in the Bangweulu. There exists unmeasurable indigenous knowledge among the locals, but mainly poverty and lack of capacity lead to the ways some resources are mismanaged. Most villagers would prefer to utilise the resources in a more sustainable manner rather than depleting them if assisted in accessing means of production and other alternatives which can support their livelihood.

The estimated population of around 32 000 can support harvesting on a sustainable basis. The estimated carrying capacity of 160 000 can give a maximum sustainable yield of at least 6 000. Based on the average dressed weight of 45 kilogramme, an off-take of 6 000 lechwe can yield a total of 270 metric tonnes of meat annually. Though the poaching rate is not known, an off-take of 6 000 animals could sustain safari hunting, non-resident hunting, resident hunting and culling without detrimentally affecting the population.

Since fire is one of the principal agents of grassland change it will be important to document its occurrence. For monitoring purposes, a monthly fire map (during dry months) could be appropriate for the entire ecosystem. Taking the vastness of the area into consideration, this can only be carried out effectively by aerial surveys. Satellite imagery could be yet another important tool to supplement the data from the above-mentioned method. From this data one can follow the extent of burning from

one particular year to the other with ease. This can provide information pertaining to early, medium and late burning. Fire management is an important tool as it has a strong bearing on the status of the vegetation and impacts on the distribution of wildlife.

As a basis for applying economic incentives and calculating the marginal opportunity costs, the government need to estimate the economic contribution that this resource makes to the overall national economy. This requires:

- ensuring that national accounting systems make explicit the trade-offs and value judgement;
- conducting research on methodologies for assessing the cross sectoral impacts positive and negative of resource utilisation;

The incentives, which are required to conserve the black lechwe at the community level, will require commensurate policies at the national level. A national or regional strategy can be an effective mechanism of reviewing such policies and determining what shifts are required to achieve the national objectives for conserving the species. Major policy components of the required integrated action may include the following considerations:

- estimate the relevant benefits which the species can produce;
- treat the resource as a capital resource and invest accordingly in preventing its depletion;
- ensure that the objectives of sustainable utilisation are met;
- address the basic needs of the local people who depend on the resource for their continued prosperity;
- the main economic and financial benefits of integrated rural development linked with conservation of biological resources need to be quantified and brought to the attention of policy makers;
- both conflicts and potential for co-operation between the various activities of agriculture, fisheries and conservation need to be identified in integrated projects and programmes;
- legislation consonant with the social economic patterns of the target group and the natural resource need to be formulated to ensure that incentives carry the power of law;
- policies and legislation need to be revealed for possible application to conservation of natural resources and community involvement in such activities;
- effective benefits need to be devised in order to accelerate integrated development to narrow any gap between what the individual sees as an investment benefit and what the government considers to be in the interest of the nation;

- the rural communities need to be involved in the design and follow-up plans and projects;
- the system should including regulation, enforcement, monitoring and feedback.

The foundation of any incentive package is community support and such support is gained through involvement. The following incentives are essential:

- potential participants must be convinced that the problem being addressed by the incentive package is a high priority of the community. This can be achieved by making the community part of the project planning process from an early stage, and making them the leading actors through the programme;
- the community should perceive the clear benefits they will derive from the planned conservation action, either through direct profits from the action or incentives themselves;
- the community needs to be informed about the incentive package including its costs and benefits and any accompanying disadvantages. The implementing agency, which in this case is the department of National Parks and Wildlife Services, need to clear up any doubts and encourage the rural people to participate fully. The expected output should be a well informed community which participates actively in conservation activities;
- the rural people need to have or obtain the skills required to implement the activities stimulated by the incentive package, which implies technical assistance and training as well as education in the broad sense;
- determining which incentives will be most useful in stimulating the desired behaviour at the community level should begin with the analysis of how current government social and economic policies are affecting the behaviour of the villagers towards biological resources. A social-economic survey could be paramount in coming up with reliable information. Such survey can also provide the necessary raw material for determining the types of incentives that are required to bring about the desired changes in behaviour. Information collected should include the following; social structure, various important community activities; standard indicators of socio-economic well-being including demographic parameters such as population, age structure as well as indicators on health and education; the pattern of economic activity, particularly in regard to how this affects the resource use; patterns of land use and access to various resources; the biological resources now being used, how the resources are being harvested, the degree of awareness about controlling regulations, and possible alternative sources of income; and the importance of the resources, both economically (food, raw materials, income) and socially (role in kin and other community relationship).

- Information in determining the necessary insights into the needs and the desires of the local people which can lead to minimising the misunderstanding and disruption when implementing incentives package. Such study can also provide necessary information to managers of biological resources appropriate level of incentives that will move individuals to respond in the socially desirable way. They can also indicate the best means of providing incentives, ensuring that they are perceived as fair, equitable and fairly earned.

The conservation and management of the black lechwe including other biological resources in the area will succeed if the communities see tangible resources. Elements to bear in mind when designing and implementing incentive packages that are effective should follow the following:

- incentives should catalyse initiatives;
- incentives should be part of an integrated approach targeted at eliminating constraints to conservation due to physical and social circumstances;
- it should not be that one group feels being neglected;
- the incentive packages should be targeted at both short and long term results, the former to make it lucrative for the target audience and the later to promote its longevity;
- the incentives should be revealed when new circumstance arise. Incentives and disincentives aimed at changing the behaviour of individuals must clearly and explicitly indicate the linkage between rewards and behaviour.
- Currently the Bangweulu does not have a management plan. This is vital in terms of guidance. The plan will spell out the objectives, the input that will lead to the desired results and the means currently available in delivering management and the additional means required to implement the plan;

Since the government conservation agency does not have sufficient funding to undertake their mandate effectively, innovative funding mechanism needs to be sought outside the traditional government sector. Other options other than the existing ones that can be considered for exploration include:

- minimal entry fee to the GMAs;
- concessional agreements;
- support from International Conservation Organisations;
- authorities should think of setting up a Foundation or Trust which will contribute to the sound conservation effort of the black lechwe.

There have been some shortfalls in terms of scientific research in the Bangweulu basin. The following could be considered when setting up future research work:

- prevent wildlife population, particularly migratory and breeding population from becoming extirpated in the area.;
- to protect the ecological health of habitat, especially from conflicts of land users;
- to assure that sustainable and desired, calculated harvests are achieved;
- to regulate the rate of exploitation of lechwe;
- to assist in balancing user satisfaction with expectation.;
- to ensure stable agency income, consistent with agency objectives by encouraging the user to pay through license and other fees;
- to protect property of the local communities;
- study and protect plant communities as habitats for wildlife;
- study the potential grazing capacity of the different communities identified in this study, for the well-being of the lechwe including other wildlife species.

SUMMARY

The present study on the Ecology and Management of the black lechwe in the Bangweulu Basin was carried out with the objective of estimating its population status, carrying capacity of the area and the potential sustainable off-take. The views of the local people on the current wildlife management practices were also investigated. Different forms of wildlife utilisation were evaluated on the basis of views of the local people and socio-economic benefits derived from it.

The study was undertaken in the Bangweulu basin located between 29^0 30' and 30^0 00' East longitude and between 10^0 45' and 12^0 40' South latitude. The catchment area covers a large proportion of the north Zambian plateau and 17 principal rivers feed the basin. Most of the water from the basin is lost through evapo-transpiration and the rest through a single outlet of the Luapula River, a headwater of the Congo River. The dominant influence in the Bangweulu system is the seasonal flooding regime, pervading every aspect of the ecology and economics of the basin.

The vegetation of the Bangweulu falls into clearly defined zones in relation to the depth and duration of flooding, from *miombo* woodland, through peripheral course grasslands, floodplains to permanent swamp and open water. Dambos, which are normally seasonal, are also common throughout the higher areas.

The black lechwe is a member of the family *reduncinae* that includes the water buck, reedbuck and the Kob of Uganda. This species is endemic to the Bangweulu Basin. The species is migratory and concentrate at high densities during the wet season on shallow flood-plain and the peripheral grasslands. A proportion of adult male population defends small, contiguous, resource based territories of approximately 1-2 ha in size. Particularly high-density concentrations of males and females lechwe occur on small raised areas that remain relatively drier. These areas superficially resemble the *leks* of some other *reduncine* antelopes.

Historical records of black lechwe numbers in the Bangweulu Swamps indicate a major population decline during the half of this century followed by a minor recovery during the years 1970-1983. Aerial censuses conducted during October 1988-1996 suggest that the increase in the population has ceased and the species is now being maintained at approximately 30 000. The illegal hunting (poaching) could account for at least 3 000 individuals lost per annum. Poaching could also contribute to the distribution of lechwe in certain areas. The conservation importance of the high-density

concentrations of lechwe, which occur during the wet season in certain localities on the periphery of the swamp, is emphasised. During the most recent aerial survey (1996), the population was estimated at 32 366 (± 5 18) at 95% confidence level.

The partial recovery of the black lechwe to the present level appears to be related to the community based wildlife management effort, which has influenced a number of local inhabitants' attitude and perception towards wildlife management and utilisation. Black lechwe is a highly prolific and resilient species. Its population has great potential of increasing once given enough protection and better management. The Chimbwi flood-plain remains important to the species, given that more than 30% of the total population concentrate in this relatively small area during the wet season. Mating takes place here during a confined period in the wet season and the majority of copulation occurs on small contiguous approximately 1 ha territories established by adult males on the partially inundated flood-plain. Lechwe are particularly tolerant of human disturbance at this time and given the apparent habituation to humans and vehicles shown by animals in the hunting free zone at Chikuni, the opportunity for development of eco-tourism remains high.

Pastures utilised by the lechwe are largely confined to the water meadow formation, which is described. As a pasture, this formation has several physical and phenological characters which make it particularly favourable for utilisation by a single species of animals that is adapted to the special flooding regime that prevails.

The main Lechwe mating period occurs between January and March and the calving time takes place between October and December. Breeding on *leks* may be beneficial to the species, as they seem to become less prone to predation because other individuals on the *lek* may increase chances of detecting predators. Males on the *leks* also achieve higher mating rates than males off *leks* as most females in oestrous often appear to actively travel to and settle on *leks*.

The carrying capacity (K) of the Bangweulu floodplains has been estimated by two methods based on the productivity of the grassland and the frequency of lechwe per km flood-line. The two methods show some general agreement that K is approximately 160,000 from the south-east floodplain and Kalasa-Mukoso Flats. The maximum yield that would be taken at half the carrying capacity population can give a maximum sustainable yield of at least 6 000 animals, harvesting on a sustainable basis. Based on the average dressed weight of 45kg, this off-take per year can yield at least a total of 270 metric tonnes of meat. Though the poaching rate is not known for sure, an off-take of 6 000 animals could sustain safari hunting, non-resident hunting, resident hunting and culling without detrimentally affecting the population.

The current network of conservation areas needs to be revised to allow integrated rural development programmes to co-exist with wildlife conservation. Rural communities need to have a fair share in decision making, income and food derived from wildlife utilisation. Conservation programmes are bound to fail if the participation and co-operation of local inhabitants whose livelihood largely depends on local natural resources are sidelined.

Conservation is increasingly becoming more of a social challenge than a biological one, as populations increase the disparity of wealth, gross and unauthorised harvesting of resources within protected and semi-protected areas continues. Conflicts between protected areas and local people are likely to increase as the surrounding natural resource base is driven to short supply.

The lechwe population is negatively affected mainly by poaching. There is some evidence that recent involvement of local people in wildlife management is mitigating against poaching in the Bangweulu Basin. This investigation has revealed that the local communities would generally support the conservation of resources if they are clear about the benefits that they would realise from their effort. There exists rich indigenous knowledge pertaining to conservation, but poverty and lack of capacity contribute to the way some resources are mismanaged.

As a basis for applying economic incentives and calculating the marginal opportunity costs, the government need to estimate the economic contribution that this resource make to the national economy and the local communities. This requires:

- ensuring that national accounting systems make explicit the trade-offs and value judgement;
- conducting research on methodologies for assessing the cross sectoral impacts-positive and negative-of resource utilisation;
- the review and policy formulation which have direct or indirect bearing on the wildlife resource;
- estimate the relevance benefits which the species can produce;
- treat the resource as a capital resource and invest accordingly in preventing its depletion;
- ensure the objectives of sustainable utilisation are met; and address the basic needs of the local people who depend on the resource for their continued prosperity.

The incentives which are required to conserve the black lechwe at the community level will require commensurate policies at the national level. A national or regional strategy can be an effective tool of reviewing such policies and determining what shifts are required to achieve the

national objectives for conserving the species. Major policy components of the required integrated action may include the following considerations:

- the main economic and financial benefits of integrated rural development linked with conservation of biological resources need to be quantified and brought to the attention of policy makers;
- both conflicts and potential for co-operation between the various activities of agriculture;
- fisheries and conservation need to be identified in integrated projects and programmes;
- legislation consonant with the social economic patterns of the target groups;
- natural resource need to be formulated to ensure that incentives carry the power of law;
- policies and legislation need to be reviewed for possible application to conservation of natural resources and community involvement in such activities;
- effective benefits need to be devised in order to accelerate integrated development to narrow any gap between what the individual sees as an investment benefit and what the government considers to be in the interest of the nation;
- the rural communities need to be involved in the design and follow-up plans of the projects.

OPSOMMIMG

Die huidige studie van die ekologie en bestuur van die swart lechwe in die Bangweulu is uitgevoer met die doel om die bevolkingstatus, drakrag van die gebied en die potensiële, lewensvatbare getalle wat ge-oes kan word vas te stel. Die siening van die plaaslike gemeenskap in verband met die huidige wildlewe bestuurspraktyke is ook ondersoek. Verskillende vorme van wildlewe benutting is ook ge-evalueer op die basis van die menings van die plaaslike gemeenskap en die sosio-ekonomiese voordele wat daaruit ontgin is.

Die studie was onderneem in die Bangweulu wat geleë is tussen 29° 30' en 30° 00' oos lengtegrade en die 10° 45' en 12° 40' suid breedtgrade. Die opvangsgebied dek 'n groot deel van die Noord Zambiese plato en 17 hoof riviere voed die gebied. Die meeste van die Bangweulu se water gaan verlore deur middel van evaporasie en die res deur 'n enkele uitlaat van die Luapula rivier, 'n voorloper na die Congo rivier. Die dominante invloed op die Bangweulu sisteem is die seisonale vloede wat elke aspek van die ekologie en ekonomie deurdring.

Die plantegroei val in duidelik gedefinieerde sones in verwantskap met die diepte en tydsduur van die vloede, van *miombo* bosveld, deur die periferale growwe grasveld, vloedvlaktes, tot permanente moerasse en oop water. Dambos, wat normaalweg seisonaal is, is ook algemeen regdeur die hoërliggende dele.

Die swart lechwe is 'n lid van die familie *reduncinae* wat die waterbok, rietbok en die Uganda kob insluit. Die spesie is endemies tot die Bangweulu. Die swart lechwe is 'n migrerende spesie en konsentreer in hoë digthede op die vlak vloedvlakte en die periferale growwe grasveld gedurende die reënseisoen. 'n Deel van die volwasse manlike diere verdedig klein, aangrensende, hulpbron ge-oriënteerde territoriale gebiede van ongeveer 1 – 2 ha groot. Hoë konsentrasies van beide manlike en vroulike diere kom op klein verhewe gebiede voor wat relatief droog bly. Hierdie areas is 'n kunsmatige verteenwoordiging van die "leks" wat in sommige ander reduncinae species voorkom.

Historiese rekords van die swart lechwe in die Bangweulu moeras toon a groot bevolkings afname gedurende die tweede helfte van hierdie eeu gevolg deur 'n effense herstel

gedurende die jare 1970 tot 1983. Lugsensusse wat gedoen is van 1988 tot 1996 toon dat die toename in getalle gestaak het en dat die spesie se getalle op ongeveer 30 000 gehandhaaf word. Onwettige jag (stropery) kan verantwoordelik gehou word vir die verlies van ten minste 3 000 diere per jaar. Stropery kan ook die oorsaak wees van die verandering in die verspreiding van swart lechwe in seker gebiede. Die belangrikheid van die bewaring van die hoë digtheid konsentrasies van lechwe, wat in die reënseisoen voorkom word beklemtoon. Gedurende die mees onlangse lugsensus (1996) is die bevolking beraam op 32 366 (± 518) op 'n 95% betroubaarheids vlak.

Dit wil voorkom of die gedeeltelike herstel van die swart lechwe getalle tot huidiglik die gevolg is van 'n gemeenskaps gebaseerde bestuurs poging wat 'n aantal plaaslike inwoners se houding en persepsie beïnvloed het ten opsigte van wildlewebestuur en benutting daarvan. Swart lechwe is 'n baie vrugbare en veerkragtige spesie. Die bevolking het groot potensiaal indien dit beskerm en korrek bestuur word. Die Chimbwe vloedvlakte bly steeds belangrik vir die spesie wanneer in ag geneem word dat meer as 30% van die bevolking kondentreer in dié relatiewe klein gebied gedurende die reënseisoen. Teling vind hier plaas gedurende 'n ingeperkte tydperk in die reënseisoen. Die meeste kopulasie vind plaas op klein, aangrensende gebiede van ongeveer 1 ha groot wat deur volwasse ramme gevestig word op die gedeeltelik oorstroomde vloedvlakte. Lechwe is besonders verdraagsaam met menslike versteuring gedurende die tyd wat gulde geleentheid skep vir die ontwikkeling van eko-toerisme.

Weiding wat deur lechwe benut word is grootliks beperk tot die water weiveld vorming wat beskryf is. As weiding het die formasie talle fisiese en fenologiese eienskappe wat dit besonder gunstig maak vir die benutting deur 'n enkele spesie wat aangepas is vir die spesiale heersende vloed regime.

Die hoof teel periode by lechwe vind plaas tussen Januarie en Maart en die lam periode is tussen Oktober en Desember. Teling op "leks" mag voordelig wees vir die swart lechwe aangesien hulle minder vatbaar is vir predasie omdat die hoër getalle diere die roofdiere makliker raaksien. Ramme wat op die "leks" voorkom bereik hoër teel persentasies as ramme wat op ander plekke voorkom aangesien die meeste ooie wat ontvanklik is vir die ramme ook op die "leks" konsentreer.

Die drakrag (K) van die Bangweulu vloedvlakte is op twee wyses beraam wat gebaseer is op die produktiwiteit van die grasveld en die frekwensie van lechwe per km vloedlyn. Die twee metodes lewer soortgelyke resultate wat daarop dui dat die drakrag ongeveer 150 000 is vanaf die suid-oos vloedlyn en Kalasa-Mukoso. Die maksimum produksie in die lechwe bevolking kan ten minste 6 000 diere lewer wat lewensvbatbaar ge-oes kan word op 'n jaarlikse basis. Hierdie grootte oes kan 'n totaal van 270 metrieke ton vleis lewer (gemiddelde karkas gewig is 45 kg). Hierdie oes-syfer van 6 000 individue per jaar kan safari-jag, plaaslike jag en verdere oes van die diere onderhou sonder om die bevolking negatief te beïnvloed.

Die huidige netwerk van bewarings gebiede moet hersien word om die geïntegreerde plaaslike ontwikkelings programme en natuurbewaring saam te laat voortbestaan. Die plaaslike gemeenskap moet 'n regverdige stem hê in die besluitneming, inkomste en voedsel wat deur die wild benutting voortgebring word. Bewarings programme sal verseker faal indien die deelname en die samewerking van die plaaslike gemeenskap nie verkry word nie.

Bewaring word meer 'n sosiale uitdaging as 'n biologiese uitdaging namate die gemeenskap die ongelykheid in rykdom, bruto en ongemagtig die hulpbronne oes beide binne die beskermde en semi-beskermde gebiede. Konflik tussen die gemeenskap en die beskermde gebiede is onvermeidelik namate die omliggende natuurlike hulpbron verminder word.

Die lechwe bevolking word hoofsaaklik negatief beïnvloed deur stropery. Daar is sommige bewyse dat die gemeenskap gekant is teen stropery in die Bangweulu. Die studie het getoon dat die gemeenskap oor die algemeen die bewarings progamme sal ondersteun indien dit duidelik is watter voordele dit vir hulle inhou. Daar bestaan 'n ryk endemiese kennis onder die gemeenskap maar 'n tekort in bydraes tot die wyse waarop die hulpbronne bestuur word. Die meeste gemeenskapslede verkies die benutting van die hulpbronne op 'n lewensvatbare wyse indien hulle daardeur gehelp kan word om hulle lewenstandaard op te hef.
As 'n basis vir die toepassing vir ekonomiese aansporing en die beraming van marginale geleentheids koste is dit nodig dat die regering die ekonomiese bydrae wat die hulpbron tot die nationale ekonomie maak te beraam.
Dit vereis:

- dat die nationale boekhou stelsel die ruil kompromie en waarde daarvan duidelik maak,

- die uitvoering van navorsing op die metodiek vir die bepaling van die negatiewe en positiewe impakte van hulpbronbenutting,
- die hersiening en die formulering van die beleid wat direk en indirek 'n invloed het op die wildlewe hulpbron,
- die beraming van die relevante voordele wat die spesie kan produseer,
- die behandeling van die hulpbron as 'n kapitaal hulpbron en die ooreenstemmende belegging daarin om die uitputting daarvan te verhoed,
- versekering dat die doel van lewensvatbare benutting bereik word en aandag moet gegee word aan die basiese behoeftes van die mense wat afhanklik is van die hulpbronne.

Die aansporing wat vereis word om die swart lechwe op gemeenskaps vlak te bewaar vereis 'n soortgelyke beleid op nationale vlak. 'n Nasionale of streeks strategie kan 'n effektiewe hulpmiddel wees in die hersiening van so 'n beleid en die bepaling van stappe wat geneem moet word om die nationale doel te bereik vir die bewaring van die spesie. Groot komponente van die beleid behels die volgende:

- die hoof ekonomiese en finansiële voordele van die geïntegreerde plaaslike ontwikkeling, gekoppel aan bewaring van biologiese hulpbronne moet gekwantifiseer word en onder die aandag van die beleidmakers gebring word,
- beide die konflikte en die potensiaal van die samewerking tussen verskeie aktiwiteite van landbou,
- visserye en bewaring moet geïdentifiseer word in geïntegreerde projekte en programme,
- wetgewing medewerkend met die sosio-ekonomiese patrone van die teikengroepe,
- natuurlike hulpbronne moet geformuleer word om te verseker dat die aansporings die krag van wet dra,
- beleide en wetgewing moet hersien word om moontlike toepassing op die bewaring van natuurlike hulpbronne en die gemeenskap se betrokkenheid in sulke aktiwiteite moonlik te maak,
- effektiewe voordele moet gesmee word om die gaping te vernou tussen wat die individu sien as 'n beleggings voordeel en wat die regering die beste ag vir die nasie,
- die plaaslike gemeenskap moet betrokke wees in die ontwerp en opvolg planne van die projekte.

ACKNOWLEDGEMENTS

I thank the Director of the Department of National Parks and Wildlife Service, Mr Ackim Mwenya for the courteous endorsement of this work. I am most thankful to the Chief Wildlife Research Officer, Mr Henry Mwima, who tirelessly supported this programme from its inception to the end.

Aerial surveys were carried out with the able assistance of Mr Richard Jeffery with financial support from the World Wide Fund International (WWF).

I wish to express my appreciation to Mr Flavian Mupemo who acted as a navigator during the 1996 aerial surveys. Mr Andrew Ngoma is also remembered for running the Chikuni research station so diligently.

I am extremely indebted to my supervising teacher, Professor Wouter van Hoven for generously giving me academic guidance, encouragement and for soliciting financial support, which saw me through this programme. I am sincerely grateful to Suzanne van Hoven and Liset Swanepoel for continuously acting as a bridge between my supervisor and me, by receiving and sending mails and all their kind assistance they rendered to me during my visits to Pretoria.

I wish to express my deepest and most sincere gratitude and appreciation to Mr Adam Pope for the counsel and encouragement during my fieldwork. The Wildlife warden, Bangweulu Command, Mr Isaac Longwe and the Assistant Ranger Mr Andrew Mukupa are thanked for their support. Ms. Monica Chundama and Modrin Sinkamba (late) greatly helped in myriad ways to keep this project on its footing. My thanks are also due to all the members of staff of the Department of Wildlife based at Chiundaponde sector headquarters including all the outpost camps.

My special thanks go to honourable chief Chiundaponde for his valuable understanding of issues pertaining to conservation and for standing by my side during times when I felt helpless. I must record my gratitude to the local people in the entire Bangweulu Swamps. My driver, Elias Kaili Chabukila, was always available whenever I needed him.

I also wish to acknowledge the assistance received from Ms Ruth Joule (late), Barbra Nayame, Ernest Shamilimo, Jeffry Miyengo and Mushinge.

I dedicate this work to my loving Wife Dora, our son Endita and daughter Chuma for their warm love.

APPENDIX 1

SCIENTIFIC NAMES OF ANIMAL SPECIES MENTIONED IN THE TEXT

Black lechwe	*Kobus leche smithemani*
Buffalo	*Syncerus caffer*
Bushbuck	*Tragelaphus scriptus*
Bush pig	*Potamochoerus porcus*
Duiker (common)	(*Sylvicapra grimmia*)
Eland	*Tragelaphus oryx*
Elephant (African)	*Loxodonta africana*
Giraffe	*Giraffa camelopardalis*
Hartebeest	*Alcelaphus lichtensteini*
Hippopotamus	*Hippopotamus amphibius*
Hyena	*Crocuta crocuta*
Jackal (side striped)	*Canis adustus*
Kafue lechwe	*Kobus leche kafuensis*
Kob	*Kobus kob*
Leopard	*Panthera pardus*
Lion	*Panthera leo*
Nile crocodile	*Crocodylus niloticus*
Oribi	*Ourebia ourebi*
Puku	*Kobus vardoni*
Red lechwe	*Kobus leche leche*
Reedbuck	*Redunca arundinum*
Rhinoceros (black)	*Diceros birconis*
Roan antelope	*Hippotragus equinus*
Sable antelope	*Hippotragus niger*
Sitatunga	*Tragelaphus spekei*
Tsessebe	*Damaliscus lunatus*
Warthog	*Phacochoerus africanus*
Waterbuck	*Kobus defassa*
Wild dog	*Lycaon pictus*
Zebra (Burchelli's)	*Equus burchelli*

APPENDIX 2

QUESTIONNAIRE

A SURVEY OF ATTITUDES AND PERCEPTIONS OF LOCAL RESIDENTS TOWARDS WILDLIFE MANAGEMENT AND UTILIZATION IN BANGWEULU, ZAMBIA

Date of interview.....

Chief .....

Village .....

HOUSEHOLD DATA

1.1 Name .....

1.2 Age .....

1.3 Sex of respondent.....

1.4 Size of household .....

1.5 Level of education

a) no education .....
b) primary education.....
c) secondary education.....
d) post secondary education.....

1.6 Main occupation

a) subsistence farmer
b) cash crop farmer
c) hunter
d) fisherman
e) businessman
f) government worker
g) other (specify)

1.7 Monthly income

a) less than K500

b) between K500 and K1,500

c) more than K1,500

1.8 Major source of household income

a) wage/salary.....

b) business earnings.....

c) sale of meat.....

d) sale of fish.....

e) sale of farm produce.....

f) beer brewing.....

g) other (specify)

1.9 Staple food.....

1.10 How often do you eat game meat in a month?

a) once...

b) twice...

c) three times or more.....

d) not at all .....

2. MANAGEMENT OF WILDLIFE

2.1 Awareness of rich wildlife resources in the Bangweulu area

a) yes.....

b) no.....

2.2 Who is responsible for wildlife management in the area?

a) WETLANDS PROJECT/NPWS.....

b) Local leaders.....

c) Village scouts.....

d) I don't know.....

2.3 (i) Do you think wildlife is properly managed?

a) yes.....

b) no.....

c) I don't know.....

(ii) If yes (or no), explain why

.....

.....

2.4 Have animal numbers declined relative to the past?

a) yes.....

b) no .....

d) I don't know.....

2.5 If yes to Question 2.5 above,

(i) Which animals indicate serious decline?

.....

(ii) What are the reasons for the decline?

.....

.....

2.6 (i) Are you in favour of the Village Scout Programme?

a) yes

b) no

c) I don't know

(ii) If yes (or no), explain why

.....

.....

2.7 With the Village Scout Programme, illegal hunting has

a) increased a lot.....

b) increased .....

c) I don't know .....

d) decreased.....

e) decreased a lot.....

3. WILDLIFE UTILIZATION

3.1 WILDLIFE CULLING

3.11 (i) Are you aware of the wildlife culling scheme at Chikuni? a) yes.....

b) no.....

(ii) If yes, did you know about it through:

a) friend

b) WETLANDS PROJECT/NPWS personnel

c) chief

d) ward chairman

e) other (specify)

3.12 (i) Have you bought meat from the culling scheme?

a) yes .....

b) no.....

(ii) If yes, is the price

a) high .....

b) low .....

c) all right .....

d) I don't know.....

(iii) If no, what is the reason?

a) lack of money.....

b) distance to scheme too far.....

c) not aware of meat sales.....

d) not interested.....

e) other (specify).....

3.13 Which of the following species do you prefer for game meat consumption?

(a) buffalo.....

(b) hippo.....

(d) warthog.....

(e) tsessebe.....

(f) elephant

(g) duicker

(h) other, specify.....

3.14 Benefits for local people from culling schemes in terms of benefits:

Very high.....High.....I don't know.....Very low.....Low

Employment.....

Meat.....

Skins ....

trophies.....

Revenue

•3.15 The culling scheme is benefiting outsiders more than the ocal people in terms of meat;

a) strongly agree .....

b) agree.....

c) I don't know.....

d) disagree .....

e) strongly disagree.....

3.16 What is the revenue from the culling scheme used for?

.....

.....

3.17 Should the numbers of animals allocated to the culling scheme be;

a) increased .....

b) decreased.....

c) stay the same.....

d) I don't know.....

3.2 SAFARI HUNTING

3.21 (i) Are you in favour of safari hunting in your area?

a) yes.....

b) no .....

c) I don't know.....

(ii) If yes (or no) explain "

.....

3.22 Safari hunting is a means of allowing rich foreigners to hunt while local people are forbidden;

a) strongly agree.....
b) agree.....
c) I don't know.....
d) disagree.....
e) strongly disagree.....

3.23 What are the benefits of safari hunting to the local people?

.....

.....

•3.24 Should the numbers allocated to safari hunting be;

a) increased.....
b) decreased.....
c) stay the same.....
d) I don't know.....

3.3 DISTRICT GAME LICENCE HUNTING

3.31 (i) Have you ever applied for a District Game Licence (DGL)?

a) yes.....
b) no.....

(ii) If yes, was your application successful? Yes.....no.....

3.32 Through DGL, most local people have access to wildlife resources;

a) strongly agree.....
b) agree .....
c) I don't know.....
d) disagree .....
e) strongly disagree.....

3.33 Should the number of animals allocated to DGL be;

a) increased .....

b) decreased .....

c) stay the same.....

c) I don't know.....

3.34 (i) Are you aware of the new system of DGL allocation under WETLANDS PROJECT?

a) yes.....

b) no .....

(ii) If yes, is it better than the old system? Yes.....no.....

3.35 What are the benefits of DGL hunting?

.....

3.4 WILDLIFE CROP DAMAGE CONTROL

3.41 Do wild animals damage some of your crops in the fields?

a) yes.....

b) no.....

3.42 Which animals cause most damage? (list them according to their level of damage caused)

a).....

b) .....

c) .....

- d) .....

3.43 Where do you report crop damage cases?

a) Wetlands Project/NPWS personnel

b) Chief

c) Ward chairman

d) nowhere.

3.44 Does WETLANDS PROJECT/NPWS have a crop damage control programme?

a) yes

b) no

c) I don't know

3.45 What could be done to minimise crop damage?.....

3.46 What are the benefits of crop damage control?

.....

3.5 SUBSISTENCE/COMMERCIAL POACHING

3.51 What are the reasons for subsistence poaching? (select three)

a) lack of access to DGL
b) lack of money to purchase DGL
c) source of protein
d) source of income
e) traditional uses
e) others (specify)

3.52 What could be done to incorporate local subsistence hunters into legal sustainable utilisation of wildlife?

•

3.53 (i) Does subsistence poaching benefit the local people in any way?

a) yes
b) no
c) I don't know "

• (ii) If yes (or no), explain

.....

3.54 Commercial poaching is largely responsible for the decline of economically valuable species;

a) strongly agree.....
b) agree.....
c) I don't know.....
d) disagree.....
e) strongly disagree.....

3.6 GENERAL

3.61 Indicate an order of preference, based on socio-economic benefits, for the following;

a) wildlife culling
b) safari hunting
c) game licence hunting
d) crop damage control
e) subsistence poaching

3.62 Should the animals allocated to the traditional ceremony be:

a) increased.....
b) decreased.....
c) stay the same.....
d) I don't know.....

3.63 Suggest how wildlife management and utilisation in the area could be improved in order to benefit the local people;

.....

.....

Appendix 3

WILDLIFE SURVEY SHEET

Game Management Area..... Counting Block No.....

Recorder.....Date.....

Time start.....Time Finish.....

Time	Total No. Observed	Adults		Juveniles	Habitat
		Males	Females		
Totals					

Notes

REFERENCES

ADEOLA, M.O. & DECKER, E. 1987. Wildlife utilisation in rural Nigeria. In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Sahara Africa. *IGF/CIC,* Harare.pp **512-521.**

AJAYI, S.S. 1971. Wildlife as a source of protein in Nigeria: Some priorities for development. *Nigerian Field 36*: 115-127.

ALEXANDER, R.D. 1975. Natural selection & specialised chorusing behaviour in coustical insects. In: Insects, Science and Society (eds). In: Pimental), pp. *35-77.* New York: Academic press.

ALLEN, L.D.C. 1963. A report of the black lechwe on the Itili & Buteka plains to the east of Lake Bangweulu. Mpika tour report No. 2 1960; GAM 10/lechwe, Wildlife Department Files.

ALLEN, R. 1980. *How to save the world: Strategy for world conservation.* Kogan Page, London.

ANSELL, W.F.H. 1968. *The mammals of Zambia,* Chilanga, National Parks and Wildlife service.

ASIBEY, E.O.A. 1974. Wildlife as a source of protein south of the Sahara. *Biol. Conserv.* 6:32-39.

ASIBEY, E.O.A. 1977. Expected effects of land use patterns on future supplies of bush meat in Africa south of the Sahara. *Environ. Conserv.* 4: 43-49.

ASTLE, W.L., WEBSTER, R & LAWRENCE, C.J, 1968. Land classification for management planning in Luangwa Valley, Zambia. *J. Appl. Ecol.* 6:143-169.

BAILEY, J.A. 1978. *Wildlife Management.* Colorado State University. John Wiley and Sons.

BALMFORD, A.P. 1990. *Lekking in Uganda Kob.* Ph.D thesis. University of Cambridge.

BALMFORD, A.P. 1991. *Mate choice on leks. Trends in ecology and evolution* 6: 87-92.

BELL, R.H.V. 1971. A grazing ecosystem in the Serengeti. *SCI. AM.* 224: 86-93.

BELL, R.H.V. 1984a. *Carrying capacity and off-take quotas.* In: Conservation and Wildlife Management in Africa. Proceedings of a Peace Corps Workshop, Malawi. R.H.V. Bell and E. McShane-Caluzi (eds). US Peace Corps, Washington D.C. pp. 145-181.

BELL, R.H.V. 1984b. *Traditional uses of wildlife resources in protected areas.* In: Conservation and Wildlife Management in Africa. Proceedings of a US Peace Corps Workshop, Malawi. In: Bell, R.H.V. & McShane-Caluzi E.(eds). US Peace Corps, Washington D.C. pp. 297-316.

BELL, R.H.V. 1984c. *Man-animal interface; an assessment of crop damage and wildlife control.* Conservation and Wildlife Management in Africa. In:. Bell R.H.V. & McShane-Caluzi, E. (eds). US Peace Corps, Washington D.C. pp. 387-416.

BELL, R.H.V. 1987. *Conservation with a human face: Conflict and reconciliation in African land use planning.* Conservation in Africa: People, policies and practices.In: Anderson, D &. Grove, R (eds). Cambridge University Press, Cambridge. pp. 79-102.

BELL, R.H.V; GRIMSDELL, J.J.R; VAN LAVIEREN, L.P & SAYER, J.A. 1973. Census of the Kafue lechwe by aerial stratified sampling. *E. Afr. Wildl. J.* 11: 55-74.

BELL, R.H.V. & McSHANE-CALUZI, E. (ed.). 1984. Conservation and Wildlife Management in Africa. Proceedings of a US Peace Corps Workshop, Malawi. US Peace Corps, Washington D.C.

BEYER, J.L. 1980. Africa. In: Klee, G.A. World systems of traditional resource management (eds). Edward Arnold, Washington D.C. pp. 5-38.

BRADBURY, J.W., & ANDERSSON, M.B. 1987. *Sexual selection: Testing the alternatives.* Chichester: John Wiley

BRELSFORD, W.V, 1944. *Fishermen in the Bangweulu Swamps.* Rhodes-Livingstone Institute, Livingstone.

BOTHMA, J. DU.P, 1996. *Predators: General Management.* In: BOTHMA, J. dU. P. (ed.s*). Game Ranch Management.* Pretoria; J.L van Schaik.

CAMPBELL, A. 1980. *Some aspects of traditional wildlife utilisation* in Botswana. In: Proceedings of the Fifth Regional Wildlife Conference for Eastern and Central Africa. Department of Wildlife and National Parks, Gaborone. pp. 151-161.

CAUGHLEY, G. 1973. *Animal populations.* Luangwa Valley Conservation and Development Project, Zambia: Game manipulation. In: Taylor, N.J. Cughley, G.J;. Abel, N.O.J. & Lieberg O (eds). UNDP/FAO, Rome. pp. 50-157.

CAUGHLEY, G. 1979. *What is this thing called carrying capacity?* In: North American elk: Ecology, behaviour and management. In: Boyce, M.S. &. Hayden-Wing, L.D (eds). University of Wyoming, Laramie. pp. 2-8.

CAUGHLEY, G. 1983. Dynamics of large mammals and their relevance to culling. *Management of large mammals in African conservation areas.* In: R.N. Owen-Smith (eds). Haum Education Publishers, Pretoria. pp. 115-126.

CHABWELA, H.N.P. 1987. Conservation and management of wetlands: A pilot project for Zambia. In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Saharan Africa. IGF/CIC, Harare. pp. 375-379.

CHABWELA, H.N.P 1992. Wildlife Management in Africa: A critic. Unpublished.

CHILD, G. 1984. Managing wildlife for people in Zimbabwe. National parks, conservation and development: The role of protected areas in sustaining society. In: McNeely J.A. &.Miller K.R (Eds). Smithsonian Institution Press, Washington D.C. pp. 118-123.

CHILD, G. 1987. *Consideration of institutional limitations and reforms for the better management of wildlife in Africa.* In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Saharan Africa. IGF/CIC, Harare. pp. 311-325.

CHILD, G. 1988. Economic incentives and improved wildlife conservation in Zimbabwe. Paper presented at Workshop on Economics, IUCN General Assembly, 4-5th February, Costa Rica.

CHILD, G. & CHILD, B. 1987. *Economic characteristics of the wildlife resource.* In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Saharan Africa. IGF/CIC, Harare. pp. 162-175.

CHILD, G & VON RICHTER, W. 1969. Observations on ecology and behaviour of lechwe, puku & water-buck along the Chobe river, Botswana. *Z.F Saugetierkunder,* 34, 275-295.

CHILESHE, J & KAMWENESHE, B. 1987. *Soil survey of the Chikuni area.* Unpublished report made to the Director of National Parks and Wildlife Service, Chilanga, Zambia.

CLUTTON-BROCK, T.H; DEUTSCH, J.C & NEFDT, R.J.C. In press. The evolution of lek breeding in angulates. *Anim. Behav.*

CLUTTON-BROCK, T.H & HARVEY, P.H. 1978. Mammals, resources and reproductive strategies. *Nature, Lond.,* 273: 191-195

.**CSO (Central Statistics Office) 1992.** Lusaka, Zambia.

DARLING, F.F. 1960. *Wildlife in an African territory.* Oxford University Press, Oxford.

DEBENHAM, F. 1952. *Study of an African swamp.* H.M Stationery Office, London

DEUSTCH, J.C. 1992. *The reproductive strategies in Uganda Kob, a lek-breeding antelope.* Ph.D. thesis. Univesity of Cambridge.

DEUSTCH, J.C & NEFDT , R.J.C. 1992. Olfactory cues influence female choice in two lek-breeding antelopes. *Nature, Lond.,* 356:596-598.

DEUSTCH, J.C & WEEKS, P. 1992. Uganda Kob prefer high visibility leks and territories. *Behav. Ecol.,* 3: 223-233.

DE VOS, M, & DOWSETT, R. J. 1996. The bevaviour and population structure of three species of the genus *Kobus. Mammalia Volume* 30, 30-55.

DODDS, D.G & PATTON. D.R. 1968. *Wildlife and land use survey in the Luangwa valley.* Unpublished report to the Government of Zambia. Report No. TA2591. FAO, Rome.

EATON, P. 1985. *Land tenure and conservation: Protected areas in the south pacific. South Pacific Environment Programme,* Noumea.

EIDSVIK, H.K. 1980. National parks and other protected areas: Some reflections on the past and prescriptions for the future. *Environ. Conserv.* **7**:185-190.

ELTRINGHAM, S.K. 1984. *Wildlife resources and economic development.* John Wiley and Sons, New York.

FANSHAWE, D.B. 1971. The vegetation of Zambia. Forest *Research Bulletin* No. 7. Zambian Government Printers, Lusaka.

FAO. 1973. *Luangwa Valley Conservation and Development Project:* Report on Project results, conclusions and recommendations. FO: DP/ZAM/68/510 Terminal Report. FAO, Rome.

GOULD. J, 1989. Luapula-Independence and Development. Zambia Geographical Association, Regional Handbook 6, Finnish Society for Dev. Studies, Monograph 3. Vammalan, 230pp.

GRIMSDELL, J.J.R. & BELL. R.H.V. 1972. Population growth of the red lechwe, *kobus leche leche* in the Busanga plain, Zambia. *E. Afr. Wild.J.*, 10:117-122.

GRIMSDELL, J.J.R. &. BELL, R.H.V. 1983. Aerial counts of the Black lechwe in the Bangweulu. A report to the Director, Department of Wildlife Services- Unpublished.

GRIMSDELL, J.J.R. & BELL. R.H.V. 1975. ecology of the black lechwe in the Bangweulu Basin, Zambia. Final Report of the Black Lechwe Research Project. National Council for Scientific Research, Lusaka.

HARCOURT, A.H., PENNINGTON, H & WEBER, A.W. 1986. Public attitudes to wildlife and conservation in the third world. *Oryx 20*:152-154.

HOWARD, G.W. & CHABWELA, H.N. 1987 The red lechwe of Busanga plain, Zambia: a conservation success. *Oryx* 21, 233-235.

HOWARD, G.W., JEFFEREY, R.C.V. & GRIMSDELL, J.J.R. 1984. Census and population trends of the black lechwe in zambia. *Afr. ecol.*, 22, 175-179.

HOWARD, G.W; MALAMBO, C.H & KAMWENESHE, B. 1988. Wild animals survey of the Bangweulu Basin. Report to the Director (Mimeo), NPWS. Chilanga

HUGHES, J.E 1933 *"Eighteen years on Lake Bangweulu".* The field, London.

IUCN. 1980. *World Conservation Strategy: Living resources conservation for sustainable development.* IUCN/UNEP/WWF, Gland.

IUCN/GRZ. 1985. The National Conservation Strategy for Zambia. IUCN, Gland.

JEFFERY, R.C.V., KAMWENESHE, B., MALAMBO, C., NEFDT, R.J.C. & MUPEMO, F. 1989. Wild mammals surveys of the Bangweulu swamps. A report to the Director , National Parks and Wildlife Services, Chilanga, Zambia.

JEFFERY, R.C.V., KAMWENESHE, B. & KAMWENESHE, D. 1991. Large Wildlife mammal surveys of the Bangweulu swamps, 1991. A report to the Director, National Parks and Wildlife Services, Chilanga, Zambia.

JEFFEREY, R.C.V., KAMWENESHE, B., MUPEMO, F., MALAMBO, C. & NEFDT, R.J. 1990. Large wild mammals survey of the Bangweulu swamps. A report to the Director. National Parks and Wildlife Services, Chilanga, Zambia.

JEFFREY, S. 1977. New Liberia uses wildlife. *Oryx* 14:168-173.

JOLLY, G.M. 1969. Sampling methods for aerial census of wildlife populations. *E. Afric. Agric.* For. J. 34:50-55.

KALAPULA, S 1987. People of the Bangweulu Basin. Unpublished paper presented at the workshop on wetlands, Chilanga, Zambia.

KAMWENESHE, B. & KAMWENESHE, D. 1992. Aerial census of black lechwe in Bangweulu . Report to the Director, National Parks and Wildlife Services, Chilanga, Zambia.

KAMWENESHE, B. & KAMWENESHE, D. 1993. Aerial census of black lechwe in Bangweulu . Report to the Director, National Parks and Wildlife Services, Chilanga, Zambia.

KAMWENESHE, B; KAMWENESHE, D & MUPEMO, F. 1994. Aerial census of black lechwe in Bangweulu. Report to the Director, National Parks and Wildlife Services, Chilanga, Zambia.

KAMWENESHE. B; MALAMBO. C & NEFDT. R, 1987. Aerial census of large mammals of the Bangweulu (Report to the Director, National Parks and Wildlife Services- Unpublished)

KAMWENESHE. B; MALAMBO. C & NEFDT. R, 1988. Aerial census of large mammals of the Bangweulu. A report to the Director, National Parks and Wildlife Services- Unpublished.

KAMWENESHE, B & MUPEMO, F. 1996. Aerial census of black lechwe in Bangweulu. A report to the Director, National Parks and Wildlife Services, Chilanga, Zambia.

KAWECHE, G.B & LEWIS, D.M. 1985. Lupande Research Project.

LANGWORTHY, H.W. 1972. *Zambia before 1890: Aspects of pre-colonial history.* Longmans, London.

LARSEN, T. 1987. Luangwa Integrated Resource Development Project. Report of a workshop on LIRDP, 21-26 June 1987, Chichele Lodge, South Luangwa National Park, Mfuwe.

LARSEN, T & LUNGU, F.B. 1985. Preparation report for Luangwa National Park. *Oryx* 19:27-34.

LEADER-WILLIAMS, N. 1983. Black rhino in South Luangwa National Park. *Oryx* 19:27-34.

LEHMKUHL, J.F., R.K. UPRETI & SHARMA, U.R. 1988. National parks and local development: Grasses and people in Royal Chitwan National Park, Nepal. *Environ. Conserv.* 15:143-148.

LEWIS, D.M. 1988. Survey of perceptions towards wildlife for two village communities with different exposure to a Wildlife Conservation Project. ADMADE/NPWS, Nyamaluma.

LEWIS, D.M; KAWECHE, G.B & MWENYA, A.N. 1987. Wildlife conservation outside protected areas: Lessons from an experiment in Zambia. In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Saharan Africa. *IGF/CIC,* Harare. pp 330-358.

LUSIGI, W.J. 1981. A new approach to wildlife conservation in Kenya. *Ambio* **10:**87-92.

LUSIGI, W.J. 1984. Future directions for the Afrotropical realm. National parks, conservation and development: The role of protected areas in sustaining society. In: McNeely J.A. & Miller K.R. (Eds). Smithsonian Institute Press, Washington D.C. pp. 137-146.

MACKINNON, J.R; MACKINNON, K; CHILD, G & THORSELL, J. 1986. Managing protected areas in the Tropics. IUCN/UNEP, Gland.

MANNING, I. 1977. Wildlife utilisation on a Botswana Ranch: A pilot project. Botswana notes and records. 170-171.

MARKS, S.A. 1976. *Large mammals & a brave people: Subsistence hunters in Zambia.* University of Washington Press, Seattle.

MARKS, S.A. 1984. *The imperial lion: Human dimensions in wildlife management in Central Africa.* West View Press, Boulder, Colorado.

MARKS, S.A 1989. *Initial interviews with local hunters in Lupande Game Management Area.* Unpublished report to LIRDP, Chipata, Zambia.

MARTIN, G.H.G. 1983. Bush meat in Nigeria as a natural resource with environmental implications. *Environ. Conserv.* 10: 125-132.

MARTIN, R.B. 1984a. Communal Areas Management Plan for Indigenous Resources (Project CAMPFIRE). Conservation and Wildlife Management in Africa. Proceedings of a US Peace Corps Workshop, Malawi. In:. Bell R.H.V & McShane-Caluzi, E (Eds). US Peace Corps, Washington D.C. pp. 279-296.

MARTIN, R.B. 1984b. Wildlife utilization. Conservation and Wildlife Management in Africa. Proceedings of a US Peace Corps Workshop, Malawi. In:.. Bell R.H.V & McShane-Caluzi, E (Eds). US Peace Corps, Washington D.C. pp. 219-232.

MARTIN, R.B. 1987. Evolving new institutions ("CAMPFIRE") and other pilot projects in Zimbabwe. In: Proceedings of the International Symposium and Conference on Wildlife Management in Sub-Saharan Africa. IGF/CIC, Harare. pp. 381-385.

McDONALD, D.B. 1989a. Correlation of male mating success in a lekking bird with male mate cooperation. *Anim. Behav.,* 37: 100-1022.

MCNEELY, J.A. 1988. *Economics and biological diversity: Developing and using economic incentives to conserve biological resources.* IUCN, Gland.

MCNEELY, J.A. & MILLER, K.R. 1984 (Eds). *National parks, conservation and development: The role of protected areas in sustaining society.* Smithsonian Institution Press, Washington D.C.

MCNEELY, J.A. & PITT, D 1985(Eds).. *Culture and conservation: The human dimension in environmental planning.* Croom Helm Ltd, London.

MISHRA, H.R. 1982. Balancing human needs and conservation in Nepal's Royal Chitwan National Park. *Ambio* 11:246-251.

Mpika Airport meterological station, Zambia.

MORDI, A.R 1989. The future of animal wildlife and its habitat in Botswana. *Environ. Conserv.* 16: 147-156.

MURRAY, M.L. 1980. Subsistence hunting in western Botswana. In: Proceedings of the Fifth Regional Wildlife Conference for Eastern and Central Africa. Department of Wildlife and National Parks, Gaborone. pp. 181-200.

MWENYA, A.N., KAWECHE, G.B & LEWIS, D.M. 1988. Administrative Management Design for Game Management Areas (ADMADE). NPWS, Chilanga.

NDHLOVU. E.D & BALAKRISHNAN. M, 1992. Wildlife Utilisation and local people: A case study in Upper Lupande Game Management Area, Zambia. *Environ. Conserv.* 19.pp.135-144

NEFDT, R.J. 1992. *Lek-breeding in Kafue lechwe.* PhD thesis, University of Cambridge.

NORTON-GRIFFITHS, M. 1978. *Counting animals.* Handbook No. 1. African Wildlife Foundation, Nairobi.

NZIMA, H.E. 1984. Law enforcement and public relations: A case history. Conservation and Wildlife Management in Africa. Proceedings of a US Peace Corps Workshop, Malawi. In: Bell R.H.V.&. McShane-Caluzi, E (eds). US Peace Corps, Washington D.C. pp. 381-386.

ODUM, E.P. 1971. *Fundamentals of Ecology.* 3rd Eds. Saunders, Philadephia.

OLAWOYE, O.O. & AJAYI, S.S. 1975. *Highlights of the problem of bush meat production and marketing in Nigeria.* Wildlife Bulletin Nigeria No. 3, Federal Department of Forestry, Ibadan.

PENNYCUICK, C.J & WESTERN, D; 1972. An investigation of some bias in aerial transect sampling of large mammal populations. *E.Afr. wildl. J.* 10: 175-191.

PITMAN, C.R.S. 1934. *Report on a fauna survey of Northern Rhodesia with special reference to Game Elephant Control and National Parks.* Government printer, Livingstone, Northern Rhodesia.

PULLAN, R.A. 1983.*The use of wildlife in the development of Zambia. Natural resources in tropical countries.*In: Ooi, J.B (eds.) Singapore University Press, Singapore. pp 267-325.

REES, W.A. 1978a. The ecology of the Kafue lechwe: soils, water levels and vegetation. *J. App. Ecol.,* 15:163-176.

REES, W. 1978b. The ecology of Kafue lechwe: the food supply. *J. App. Ecol.*,15:177-191.

ROBINETTE, W.L & CHILD, G.F.T. 1964. Notes on biology of the lechwe. *Puku, No* 2:84-117.

SIMMON, C. & MUPEMO F.K.C, 1995. Black lechwe aerial counts on Kalasa Mukoso. Unpublished October 1995.

SMITH, R. L. 1989. *Elements of Ecology.* Harper & Row, Publishers, New York.

SPINAGE, C.A. 1969. "Ageing the Uganda defassa waterbuck *Kobus defassa ugandae* Newman" *E. Afr. Wildl. J.* **5, 1-17.**

STIER, J.C. 1973. Reports on subsistence hunting, safari hunting and an economical appraisal of game cropping in the Luangwa valley. Unpublished report to NPWS, Chilanga.

THIRGOOD, S.J., NEFDT, R.J., JEFFERY, R.C.V & KAMWENESHE, B. 1994. Population trends and current status of black lechwe (Kobus: Bovidae) in Zambia. *Afr. J. Ecol.* 32:1-8.

THIRGOOD, S.J., ROBERTSON, A., JAVIS, A.M., BELBIN, S.V., ROBERTSON, D., NEFDT, R. J. & KAMWENESHE, B. 1992. Mating system and ecology of black lechwe (Kobus: Bovidae) in Zambia. *J. Zool. Lond.* 228: 155-172.

VERSI, A. 1989. The curse of the poacher. *New African* 259:9-15.

VESSEY-FITZGERALD, D. F. 1955. The black lechwe and modern methods of wildlife conservation. Northern Rhodesia Journal Volume 2 (6) 601-614.

VON RICHTER, W. 1970. *Wildlife and rural economy in south western Botswana.* Botswana notes and records 2:85-94.

WESTERN, D. 1982. Amboseli National Park: enlisting landowners to conserve migratory wildlife. *Ambio* 11:302-308.

WESTERN, D. 1984. *Amboseli National Park: Human values and the conservation of a savanna ecosystem.* National parks conservation and development: The role of protected areas in sustaining society.In:. McNeely, J.A &. Miller, K.R (eds.). Smithsonian Institution Press, Washington D.C. pp. 93-100.

WRI/IIED. 1989. World resources 1988-1989: *An assessment of the resource base that supports the global economy.* Basic Books Inc. New York.

WRIGHT, R. M; HOUSEAL, B & DE LEON, C. 1985. Kuna Yala: Indigenous biosphere reserve in making? Parks 10:25-27.

WWF- WETLANDS PROJECT records. 1996. Chilanga, Zambia.