

**THE STATUS AND DISTRIBUTION OF CARNIVORES  
IN BWINDI IMPENETRABLE NATIONAL PARK (BINP),  
SOUTH-WESTERN UGANDA**

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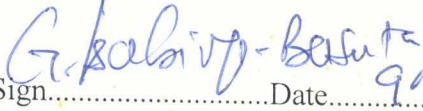
**DECLARATION**

I, Andama Edward, declare that this dissertation is my original work and has not been submitted before for a degree in this or any other University or Institution of higher learning. All information in this dissertation is a result of my personal work unless otherwise stated.

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We are now satisfied that this dissertation is ready for final submission.

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2. Mr. Robert Kityo

Sign.....Date.....

## **DEDICATION**

I dedicate this book to my dear parents; Olu and Driciru.

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## ABSTRACT

This study was conducted between December 1997 and July 1998 in Bwindi Impenetrable National Park (BINP), South Western Uganda. The aims were to determine the occurrence, population status, distribution, food habits, and to investigate human factors likely to affect the survival of carnivores. Seven sites were selected on the basis of altitude, vegetation type, and extent of forest disturbance for in-forest assessment. Population status was assessed using both direct (night survey) and indirect (scent station visitation rates) methods along transects in the forest. Geographical Positioning System (GPS) was used to map the distribution of carnivores from sightings and signs of spoor and scats. Food habits were assessed from scat analysis. And a questionnaire was administered to 107 respondents from eight parishes neighbouring the park to assess anthropogenic factors likely to affect carnivore status.

Sixteen carnivore species were recorded by this study, forming 42.1 percent of the species that occur in Uganda. The Clawless Otter, *Aonyx capensis* Schinz, Spotted necked Otter, *Lutra maculicollis* Lichtenstein, Honey Badger, *Mellivora capensis* Schreber, and African wild Cat, *Felis sylvestrus* Schreber were recorded for the park for the first time.

The results indicate that human disturbance and percentage ground vegetation cover (GVC) are important factors affecting abundance and distribution of carnivores. The carnivore species, especially side-striped jackal, *Canis adustus* Sundevall and African Civet, *Viverra civetta* Schreber that mostly depend on scavenging and crop raiding as alternative ways of obtaining food items were more common in the periphery of the park, at sites with high human activity. On the other hand Golden Cat, *Profelis aurata* Temminck, *M. capensis* and *A. capensis*, which are not scavengers, were mostly restricted to sites with minimum human presence. High GVC appeared to attract the species that are more dependent on rodents as main food items. The distribution of aquatic carnivore species, such as Water Mongoose, *Atilax paludinosus* G. Cuvier, *L. maculicollis* and *A. capensis* was associated with the presence of swamps and rivers, while Banded Mongoose *Mungos mungo* Gmelin was restricted to the low altitude parts

of the park (northern sector), with predominantly grassland vegetation.

Among the carnivore species recorded, there was no completely specialised feeder. The wild prey items featured most prominently, with rodents and insects being the most common food items. *Canis adustus* and *V. civetta* had opportunistic feeding habit, complimenting their diets with village refuse, local food crops and wild plants fruits, while the Golden Cat, *P. aurata* was the only carnivore species whose diet mainly consisted of medium sized herbivores especially Duikers.

The Local people had substantial knowledge of carnivore species: more than 80 percent of the carnivore species were known to most of them. The most important factor determining the attitude of the local residents towards carnivore conservation appeared to be the perceived economic loss resulting from livestock/poultry raiding by the wildlife. Raiding on domestic animals was reported to be on the increase (67.79 percent of the respondents), as a result of better protection accorded to the wildlife.

The use and trade in skins and other products obtained from carnivores are currently minimal and mostly limited to medicinal purposes. Genets were the only culturally revered species in the area. The status of carnivore species is most insecure outside the park as a result of habitat loss and persecution. Efforts to change negative attitude of people residing in sites close to the park periphery will probably take more time. However, this could be achieved through introduction of modern poultry farming methods and extensive conservation education programs.

# CHAPTER ONE

## 1.0 INTRODUCTION AND STUDY AREA

### 1.1 Ecological role of carnivores

The manner in which multi-species assemblages are structured as a hierarchy of energy flows within the ecosystem revolves around its trophic structure (Terborgh, 1975). Carnivores compose an important part of the trophic systems; they belong to the top predator groups. Essentially they prevent prey species from becoming too abundant and ultimately destroying the habitat (Happold, 1978). In this way carnivores play a key role of maintaining the 'balance' of nature. There is growing evidence suggesting that top predators are critical in maintenance of biological diversity by playing a key role in both structuring and functioning of natural communities (Terborgh and Winter, 1980). According to Terborgh and Winter (1980), top predators have a disproportionate importance for conservation of biodiversity because their extinction can trigger a cascade of unexpected secondary extinctions as a consequence of disruption of the evolved predator-prey relationships. As a result of their diet, sizes and physical tolerance for environmental viability, carnivores function as key stone species and umbrella species (Schonewald cox *et al.*, 1991), as such they are some of the most sensitive indicators of the relative health of the ecosystem.

Several authors have discussed the ecological importance of carnivores to the ecosystem and according to Palomare *et al.* (1995) the removal of top predators may sometimes increase prey populations of economic importance to humans. Rosevear (1974) gave one practical aspect of this with the example of leopards, which were ruthlessly killed in West Africa. This led to a vast increase in the number of baboons in many places, as a consequence there was an increase in destruction of farm crops. Another example of the importance of top predators is in rodent control, where uncontrolled destruction of the small felids for fur trade was followed by an epidemic of rodent transmitted disease in human population in South America (Theodore, 1993).

Generally the extinction of a top predator from an ecosystem can have impact on the

relative abundance of herbivore species within a guild (Jhala, 1993). In the absence of predation there is usually a decrease in biodiversity, resulting in one or two herbivore species dominating the community. The consequence of this is often a direct alteration of the herbaceous vegetation fed on by the herbivorous guild. The story of pasture deterioration in Valledela Trinidad, following coyote destruction is a classical example (Ewer, 1985). This illustrates the role of top predator groups in structuring of the communities and ultimately of ecosystems.

## **1.2. Factors affecting status of carnivores**

It is generally acknowledged that carnivore species populations are declining on worldwide basis (Theodore, 1993). In sub-Saharan Africa carnivore populations have decreased substantially during the past five decades (Stander, 1997). This marked reduction in both the number and distribution of carnivores has been attributed largely to the increased conflict with the rural livestock/poultry keepers and human developments resulting in habitat loss. Domestic and feral dogs are a major threat to many species of wild carnivores (Kingdon, 1997). Dogs harass most wildlife within one or more kilometres of their home bases. Sustained over years this persecution drives all but the most agile or arboreal species away (Kingdon, 1997). As settlement spreads, the influence of dogs (and their diseases) affects an ever-larger part of Africa's natural ecosystems. Domestic and feral cats have similar but only very localised effects.

Conflict with humans is one of the important reasons for the population decline of many endangered species including carnivores (Palomare *et al.*, 1995). Predators have historically been eliminated from large areas as a means of protecting prey species of economic concern to humans (Palomare *et al.*, 1995). In sub-Saharan Africa carnivore predation on domestic livestock and poultry invariably form the spearhead of the conflict between human development and their natural environment (Stander, 1997). Carnivores are target species of these conflicts because they threaten human life and economics (for example lions and leopards, Hamilton, 1976; wolves, Naess and Mysterud, 1987). Poisoned bait has been used to reduce carnivore populations (Theodore, 1993). This is probably wide spread in areas where natural prey populations are already low because of increased agricultural and livestock land uses. Under such circumstances carnivores

scavenge as an important alternative feeding strategy making them vulnerable to poisoning. Myers (1976) cited in Theodore (1993) mentioned chlorinated hydrocarbons such as DDT and Toxaphene, used to control ticks in livestock as principal carnivore poisons used in Africa.

Habitat loss, isolation and degradation are perhaps the most pernicious problems affecting wildlife populations around the world (O'Brien and Kinnaird, 1996). Increasing human population pressure and land developments result in habitat degradation, shrinkage and even local extirpations of some carnivore species (Jhala and Giles, 1991). Harmon (1990) estimated an average of approximately 50 percent of the original habitat in Africa as being already lost. Habitat loss in Africa is mainly caused by the intensification of agriculture, spread of semi-subsistence agriculture, livestock grazing and deforestation (Myres, 1976). Struhsaker (1997), estimated 80-85 percent of the original Tropical Moist Forests (TMFs) as already lost. TMFs covered more than 6 percent of Uganda's land area in the early 1900s (Butynski, 1984), but due to agricultural expansion, these forests have been reduced by more than half (Butynski, 1984; Struhsaker, 1987). Hamilton (1984) estimated that 2 percent of the Uganda's TMFs continue to be lost annually. Natural forests now cover less than 2.7 percent of the country and are mostly restricted to the conservation areas. TMF loss in Uganda is attributed to the high population growth rate of more than 3 percent which has led to the doubling of population since 1960 (Hamilton, 1984).

Commercial trade was, and probably continues to be one of the driving economic forces behind illegal hunting and trapping of many carnivore species, placing them at a risk of extermination. The alarming trend in imports of leopard skin into the United States in late 1960s as well as the world wide trade in leopard skin was the primary reason for listing it as an endangered species by United States and in CITES (Theodore, 1993). This indicates that the survival of viable populations of both large and small carnivores partly depends upon mitigation of anthropogenic factors (James and Charles, 1991). Although some of the carnivores are now legally protected in many conservation areas, their conservation is not guaranteed if agencies responsible for wildlife do not present sound and defensible arguments to the local people who directly interact with them.

### 1.3 Study of forest carnivores

Carnivores have been considered by Rosevear (1974) as well distributed in all habitats of Africa. Of the over 40 species of carnivores that occur in Africa, only a few have complete restriction to forest habitats, the majority occupying a wider range of habitats or vegetation zones. Most studies on vertebrate response to primary forest disturbance in Uganda and elsewhere have focused on primates (Johns and Skorupa, 1987), antelopes (Strusaker, 1997), birds (Keith, 1980), small mammals (Isabirye-Basuta, 1979; Muganga, 1989; Aleper, 1995 and Kasangaki, 1998) and few other taxa. The studies on ecology and biology of carnivores have mostly been done in fairly open habitats such as Savannahs and Woodlands (Kruuk, 1972; 1976; Hamilton, 1976; Rowe-Rowe, 1976; Hopkins, 1977; Orsdol, 1984; Cooper, 1990; Todd and Peter, 1990; Deniela, 1992). Only a few studies in general have examined the status of carnivores in forested habitats, such as by Alan and Suzan (1991) in Huai Kha Khaeng wildlife sanctuary Thailand, DuchWorth (1992) in Ethiopian Rift valley park, Ashraf *et al.* (1993) in Ghats India and Heydon and Bulloh (1996) in Borneo. Therefore, there is a general scarcity of information on the status carnivores occurring in forested habitats. This is partly due to the practical difficulties of studying carnivores in densely forested habitats and their secretive life, a problem also appreciated by Heydon and Bulloh (1996). As was observed by Rosevear (1974) and Kingdon (1977), most carnivores are nocturnal and live concealed in dense bush or holes in the ground and crevices among rocks, making it difficult to see and observe them with much continuity.

Ewer (1985) noted that destruction of primary forests is a wide spread phenomenon all over Africa. Such habitat disturbance can be harmful to some vertebrate species or encourage proliferation of others, depending on the species habitat requirements (Marshall and Swaine, 1992). As the world awakens to the problem of TMF destruction, considerable attention is now being focused on their preservation (of tropical forests) and the associated species diversity (Burman, 1988). Studies on the distribution and abundance of forest carnivores are therefore vital in order to understand their ecological requirements.

#### 1.4 The status of carnivores in BINP

Extensive transformations of Rukiga highland landscape has occurred since the 1900s due to natural population increase and migration from Rwanda (Cunningham *et al*, 1993). Due to habitat loss many carnivore populations have been pushed to small fragmented habitats or islands, which are mostly the protected areas. Habitat fragmentation leads to spatial requirements of many carnivores going beyond the existing administrative boundaries of parks and other wildlife reserves, resulting in the loss of livestock and poultry. This brings them into direct conflict with the local population in the neighbourhood and are consequently persecuted.

Like many other TMFS, BINP was faced with the problem of habitat disturbance as a result of logging. Strugnell (1994) stated that the macro faunas of BINP forest were endangered through a combination of habitat loss and over hunting. Generally there is inadequate information on the carnivore species status and record of BINP. Wilson (1995), based on past records, listed 12 carnivore species for BINP. While Butynski (1984) listed 8 species, placing seven others as 'probable', that is the species not yet confirmed from BINP but could be there, based on the understanding at the time of their geographical ranges, latitudinal ranges and habitat preferences.

Kingdon (1977) gave the first mention on the population status of some carnivore species of BINP, where he reported changes in populations of two carnivore species; the Golden Cats and Leopards following extensive tree felling in late 1960s. As a result of tree felling there was regeneration of dense undergrowth which in turn sheltered large number of rodents, duikers and monkeys. This was said to have attracted Golden Cats while Leopards, which had been common, disappeared. It is likely that this was the case almost over thirty years ago but additional factors have since come into play, such as increasing human disturbance and great fluctuations in the populations of prey species such as duikers (Davenport, 1996). Butynski (1984) attributed reduction of animal populations in BINP to hunting and he said this led to the local extirpation of the Leopards, the largest carnivore species formerly existing in the park. Surveys by Butynski (1984) indicated very low density of leopard prey species such as duikers, bushbucks, wild pigs and giant forest hogs in the forest. This was attributed to the high intensity of poaching of these species.

Therefore, it seems likely that the reduction in prey population within the park, as a result of over hunting could have led to the reduction of the leopard population or extinction, although hunting for skins could also have had a direct negative effect on leopard population. The current status of carnivores in BINP is therefore far from clear. It is not known whether the traditional hunting of carnivores for skins and to protect livestock played a considerable role in the dynamics of the status of these potentially important animals. This study therefore aimed at investigating the current status and distributions of carnivore species in BINP.

### **1.5 Objectives of study**

The primary objective of this study was to collect baseline data regarding the abundance, distribution and conservation status of carnivores. This information is critical for designing management plans and for evaluating the effectiveness of the current conservation efforts and will form the basis for making decisions on carnivore conservation efforts and studies in BINP.

Specific objectives of the study were to:-

- i) establish occurrence, distribution and abundance of carnivores in relation to different levels of forest disturbance, ground vegetation cover, major vegetation types and altitude.
- ii) determine food habits and
- iii) investigate human related factors likely to affect the survival of carnivores.

### **1.6 Study justification**

To achieve the mission of promoting carnivore conservation, the background knowledge on the ecology and status of the species is very essential. Primary information is required on the occurrence, distribution, relative abundance of individual species, habitat requirements and food habits. Information is also required on people's perceptions/attitudes towards carnivores, use of products from carnivores and other anthropogenic threats to their conservation.

There is generally no comprehensive information on the status of carnivore species of

BINP. Several studies have been carried on the fauna and flora of BINP but none of them focused on the carnivore community. Most studies on mammals in BINP concentrated on primates (Butynski, 1984; Achoka, 1993) and rodents (Aleper, 1995; ATBP, 1997; Kasangaki, 1998). Leopards are thought to be locally extinct in BINP (Butynski, 1984). The extinction of a large carnivore species, which was probably dominant in the ecosystem, can greatly affect the status of other carnivore species and the herbivore guild at large. Since gazettement of Bwindi Impenetrable Forest into a national park, there has been some decline in human impact with regard to the hunting of medium-sized herbivores such as bushbucks, duikers, wild pigs and *Cercopithecine* monkeys. Consequently it is probable that some of the remaining carnivore species now represent the group capable of exerting a controlling effect on herbivore biomass by replacing Leopard and thus ascending in the local food chain position. If none of the carnivores has demonstrated an increase in number and ascendance in food chain position, there is likelihood of greatly increased inter-specific competition amongst herbivorous guild. The consequence of which is often a direct alteration of the herbaceous vegetation fed on by the herbivorous assemblage, ultimately leading to a decrease in plant species diversity.

Carnivores depend on a wide range of food items. Apart from vegetarian diets they prey on animals ranging in size from insects, small mammals and reptiles to medium sized herbivores such as antelopes and primates (Kingdon, 1977). The wide range of prey species they depend on suggests that they have great significance on the ecology of many other animals and the ecosystem as a whole. Therefore any data on the carnivore occurrence, distribution, abundance, feeding habits and anthropogenic factors affecting their survival is of inestimable value in order to understand the conditions they need to survive and to predict changes in ecosystem dynamics. This will facilitate taking appropriate management actions.

## **1.7 Study area**

### **1.7.1 Geographical location**

BINP is located in South Western Uganda between latitudes  $0^{\circ} 53''$  S to  $1^{\circ} 8''$  S and longitudes  $29^{\circ} 35''$  E to  $29^{\circ} 50''$  E (figure 1.1.). It covers an area of  $330 \text{ km}^2$  occupying the highest block of the Rukiga highlands on the Eastern edge of the Western Rift Valley.

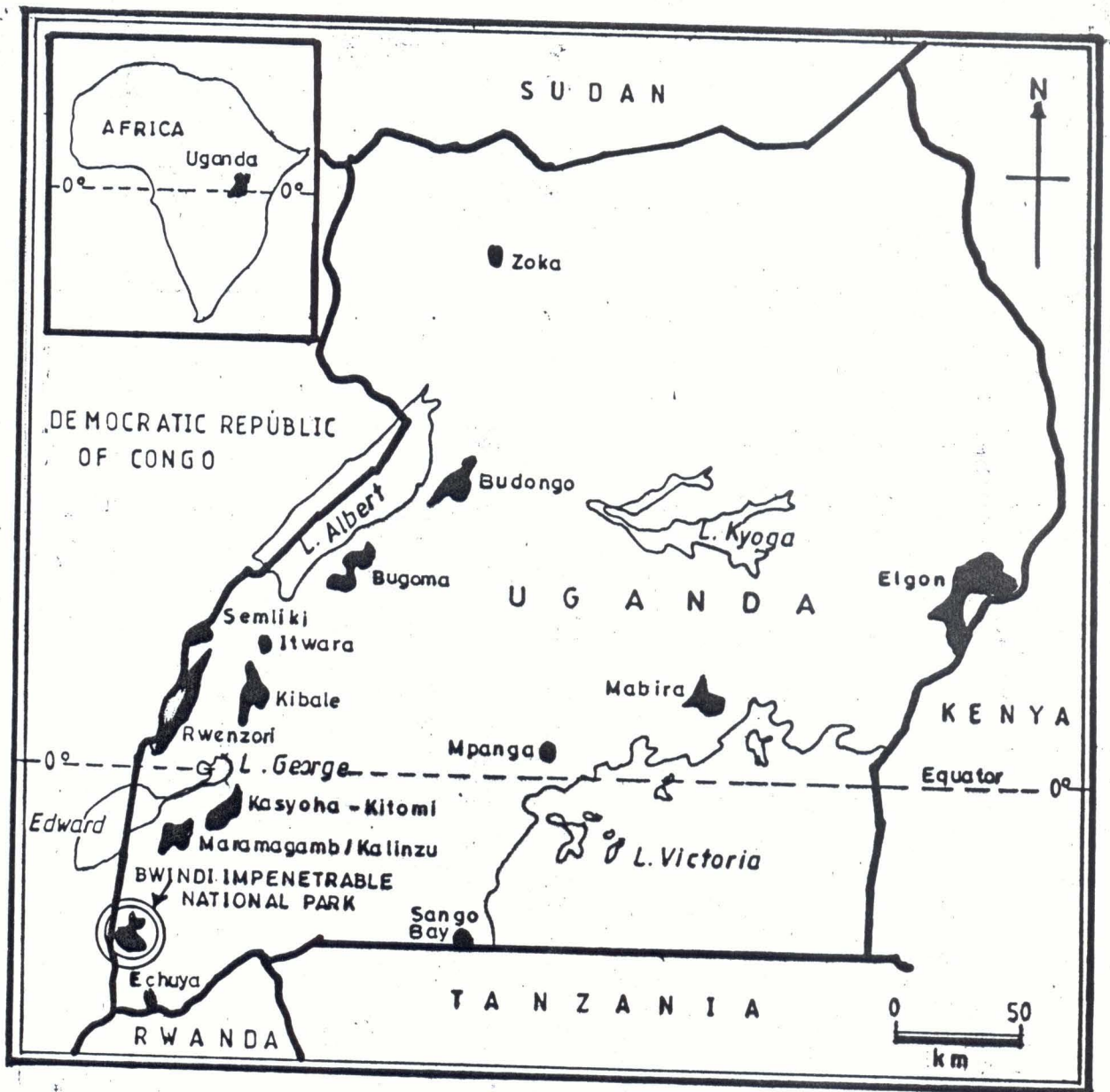


Fig. 1-1: Location of Bwindi Impenetrable National Park and other blocks of natural forest in Uganda. From *Atlas of Uganda, 1967 and Hamilton, 1982*.

The Park lies on the Uganda-Democratic Republic of Congo (DRC) (formerly Zaire) border, about 29 km North West of Kabale town, 18 km North of Kisoro town, 25 km north of the Mgahinga Gorilla National Park and about 40 km South of Lake Edward. The Park is situated in Rubanda, Kinkizi and Bufumbira counties of Kabale, Rukungiri and Kisoro districts respectively.

There are two primary ethnic groups in the region. About 90 percent of the people are Bakiga, while most of the remainder are Banyarwanda (Atlas of Uganda 1967). Batwa Pygmies probably account for less than 0.5 percent of the population.

### **1.7.2 Topography**

The topography of BINP is extremely rugged and much dissected, especially in the higher south sector. It is one of the few forest parks in Eastern Africa containing both lowland and montane forests in a continuum, with altitudinal range of 1160-2607 m above sea level (a.s.l). More than 50 percent of BINP lies above 1759 m, the only flat area is Mubwindi swamp (figure 1.2) while rest of the park consists of narrow, very steep-sided valleys that run in all directions, bounded by hill crests. The highest hill, Rwamunyonyi (2607 m) is situated next to other high hills in the south-east part of the forest. From these hills the elevation gradually descends to 1160 m at the northern point in the north sector (figure 1.2). The park is divided into "North" and "South" sectors (Figure 1.3) separated by a road crossing at the narrow neck at Kitahurira.

### **1.7.3 Climate**

Mean annual rainfall at Ruhija is 144 cm but typically ranges between 113 cm to 239 cm. There are two dry seasons, December-January and June-August. The wettest periods occurring in March-April and September-November. The mean annual temperature at Ruhija (2,350 m) is about 13<sup>0</sup>c with a mean daily minima of 7<sup>0</sup>c and maxima of 20<sup>0</sup>c. Coolest period is June-July (mean monthly temperature 4<sup>0</sup> c).

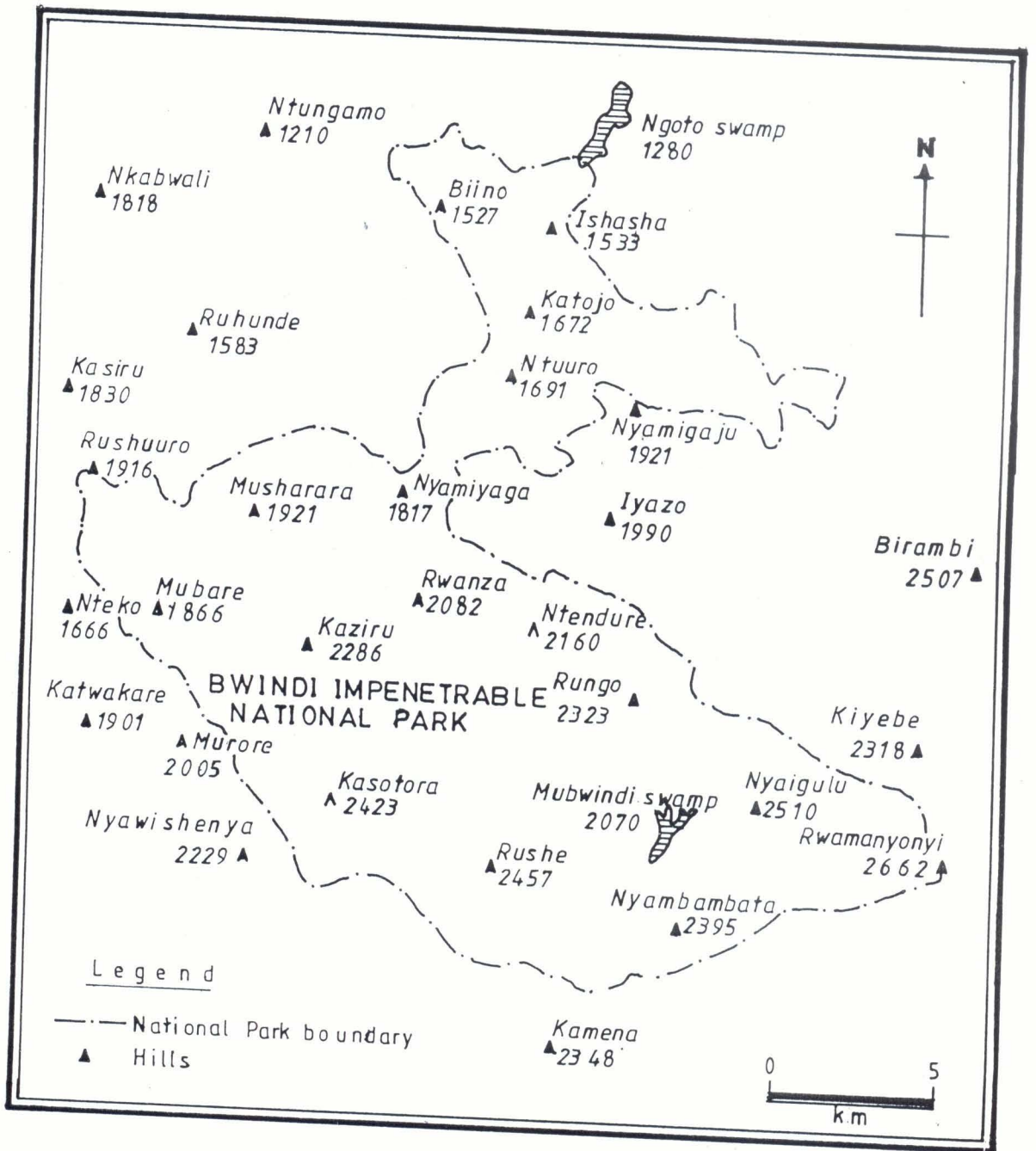


Fig. 1-2. Locations and elevations of the highest hills in various parts of the Bwindi Impenetrable National Park. Also shown are the two largest swamps in the area, Mubwindi and Ngoto. From Butynski, 1984.

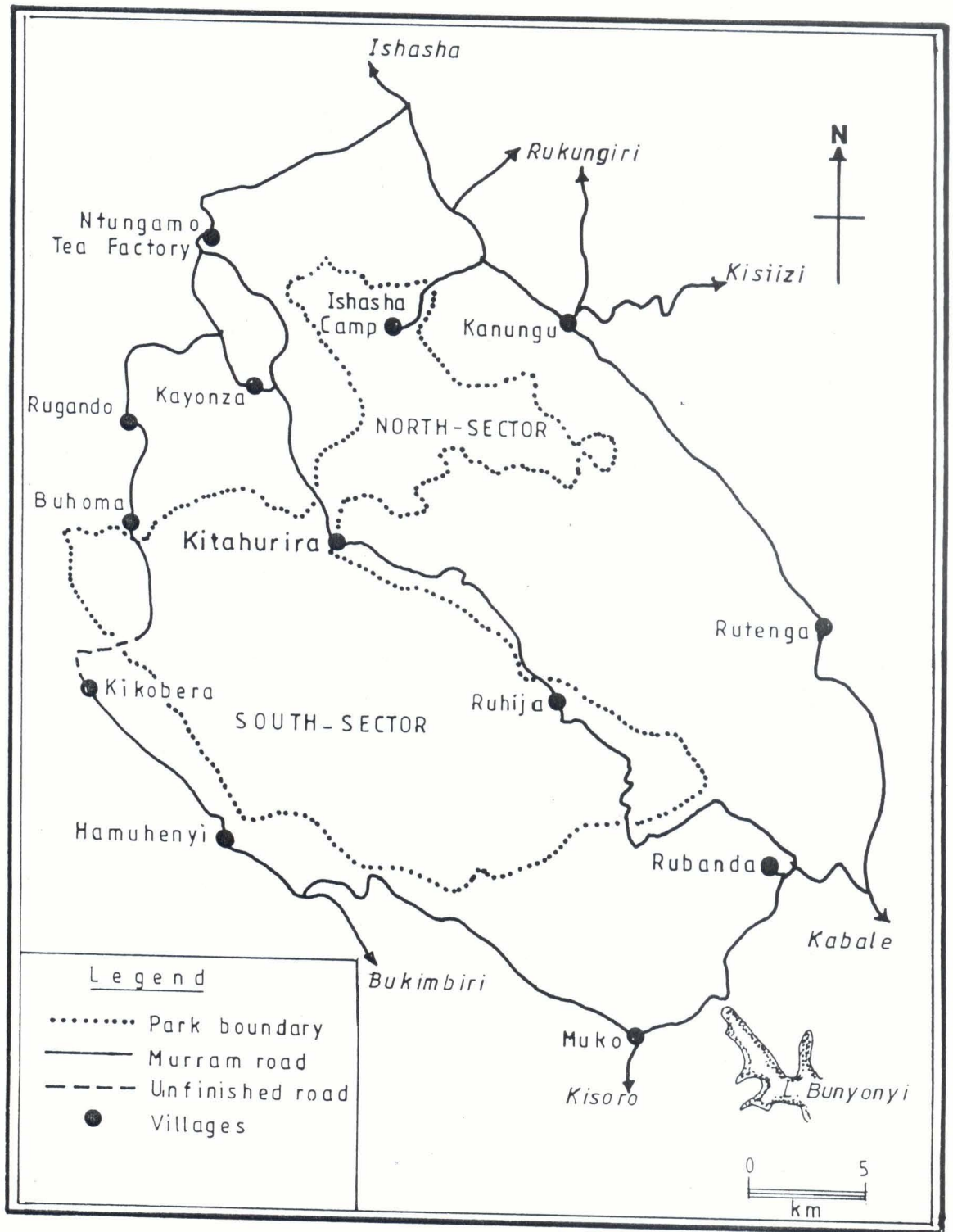


Fig. 1.3. The Bwindi Impenetrable National Park is currently divided into a "North-Sector" and a "South-Sector" demarcated by the road which runs through the narrow neck of the Park at Kitahurira.

From Butynski, 1984.

#### 1.7.4 Flora and fauna of BINP

As a result of its size, altitudinal range, and its probable role as a Pleistocene refuge, the biodiversity of Bwindi Impenetrable Forest is extremely high (Butynski and Kalina, 1993). Leggat and Osmaston (1961) noted that the vegetation of Bwindi Impenetrable Forest was very complex and greatly affected by altitude, topography and soil depth. The forest contains several vegetation types that are summarised by Howard (1991) into 10 major types (figure 1.4). Current evidence indicates that BINP is the richest forest in East Africa for tree species (Hamilton, 1974; 1976; Butynski, 1984), ferns (more than 104 species) (Nakileza, 1993), birds (Keith *et al.*, 1969; Keith, 1980; Kalina and Butynski, 1992), butterflies (Carcasson, 1964; Omoding, 1992) and probably many other taxa including mammals (Kingdon, 1971). The park contains many species of plants and birds not found elsewhere in East Africa, and many that are endemic to the Albertine Rift Afromontane Region. Owing to its rich plant diversity, BINP has been selected by IUCN's plants program as one of the 29 forests most important for the conservation of Africa's plant diversity (Butynski and Kalina, 1993). The high biodiversity and regional endemism in Bwindi Impenetrable Forest are to be expected given its location, in or near the East Congo Pleistocene Forest Refugium. Kingdon (1971) suggested that the East Zaire Pleistocene Forest harbour the largest number of forest mammals in Africa. Bigalke (1968) observed that 15 percent of the forest mammals of Uganda are endemic to Western Uganda and Eastern Zaire. Of the mammalian species, the most internationally recognised are the mountain gorilla (*Gorilla gorilla berengei*) with BINP supporting an estimated population of 300, more than a half of the world's population (Butynski and Kalina, 1993; McNeilage *et al.*, 1998). BINP also contains unique small mammal species, some of which are Albertine Rift endemic (Butynski, 1984; Aleper, 1995; Davenport, 1996).

#### 1.8 Management history

According to Leggat and Osmaston (1961), Impenetrable Forest was originally gazetted in 1932 as Kasatora and Kayonza crown forests. In 1942 the two forests were combined and additional forests added to establish Impenetrable Crown Forest (area 324 km<sup>2</sup>). In 1948 the forest reserve area was reduced to about 294 km<sup>2</sup> and named Impenetrable Central

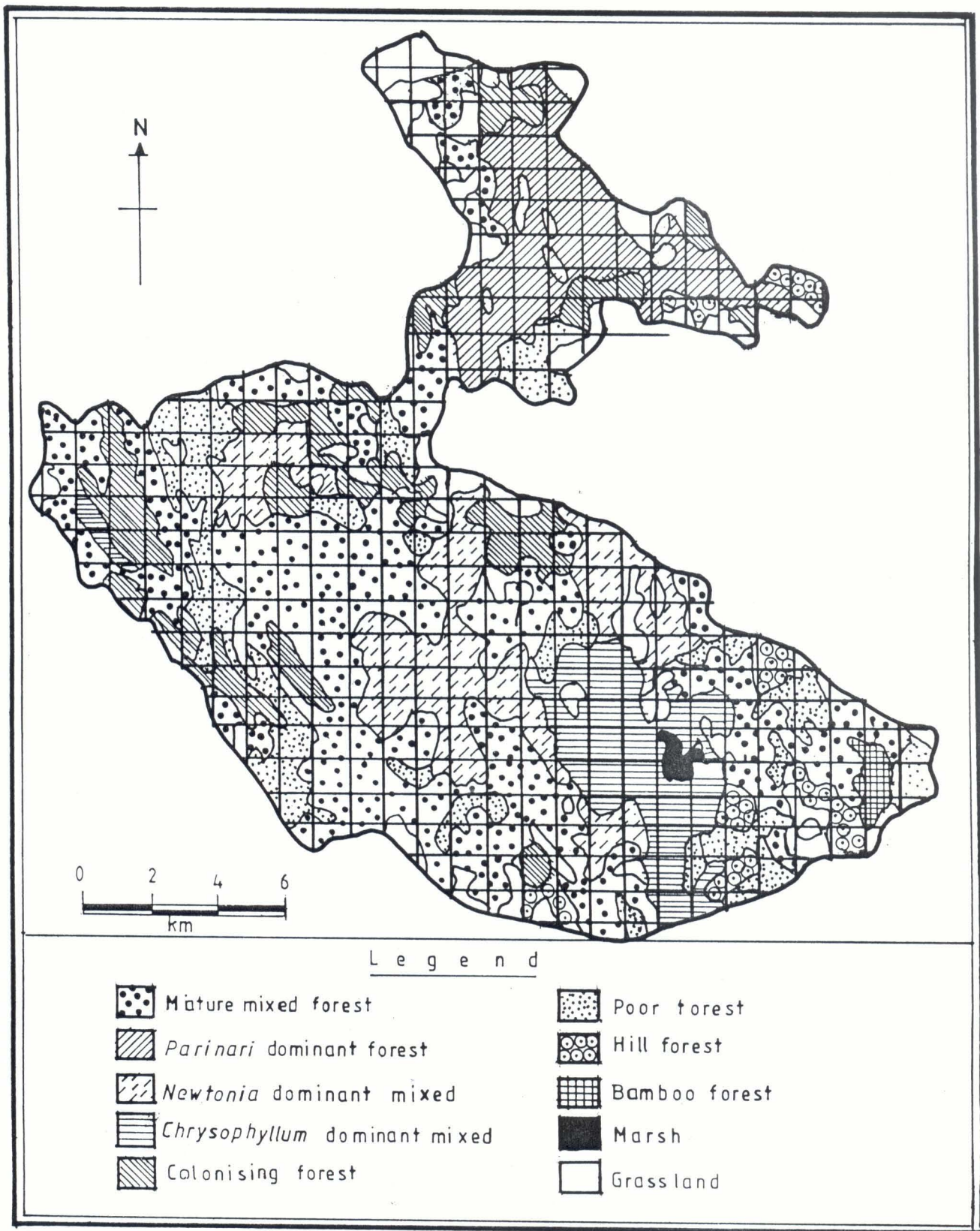


Fig. 1.4 . Vegetation types of Bwindi Impenetrable National Park.  
 Each square represents one km<sup>2</sup>.  
 From Howard, 1991.,

Forest Reserve (Leggat and Osmaston, 1961). In 1961 the reserve was gazetted as animal sanctuary with boundaries which were the same as those of the Impenetrable Central Forest Reserve. The name was changed to Bwindi Impenetrable Forest Reserve in 1968. The dual management of Impenetrable Forest by the Forest and Game Departments ceased when it was gazetted as a national Park in 1991, with incorporation of 10 km<sup>2</sup> of the Mbwa river tract to give a total area of 330 km<sup>2</sup>. Available records do not indicate any management practice taking place in BINP before 1960. The first 10-year management plan was for the period 1961-1971. This was aimed at systematic conversion of the natural irregular forest into a uniform shelter wood and finally into a normal forest with a rotation of 100 years. Harvesting by pitsawyers was arranged in three felling series at Ruhija, Rushaga and Kitahurira. Standard minimum girth was 80 cm for Mahogany and 60 cm for other species. Later however pitsawing went out of control, leading to massive clearing of natural forest trees

### **1.9 History of habitat disturbance in BINP**

Most of the TMF loss in Uganda during the last two decades has been due to the illegal encroachment by agriculturalists (FAO and UNEP, 1981; Orsdol, 1984). Forest clearance in the uplands of southwestern Uganda (Rukiga highlands) was probably initiated by Bantu-speaking people migrating into Uganda from North Angola-Katanga during the first millennium (Morrison and Hamilton, 1974). Taylor and Marchant (1994) mentioned that the most severe periods of vegetation change took place during the last three millennia. Until about 50 years ago, human activities in the tropical montane forests of Uganda were confined to shifting agriculture, housing, harvesting of food/medicinal plants, small scale logging, and mining. There has been a mention of habitat disturbance of BINP by several authors. Human occupation most probably of Batwa people occurred in Bwindi. Cunningham (1992) however, considered it likely that the Batwa could have been dependent on animal resources, as would be the case in Savannah and wetland habitats. In order to enlist local support, under the 1961-71 management plan, local miners were allowed to cut bush poles at a reduced fee and the local community allowed to take unreserved forest produce for domestic use (free). Watering livestock at salt licks near river Shongi was also allowed (Eilu, 1995). Scott (1992) carried out recent vegetation analysis of BINP using 1954 and 1990 aerial photographs of the region. He

found a reduction of 27 percent of the forest between the two dates. Survey of Impenetrable Forest between 1983-1984 (Butynski, 1984) indicated that human activity was evident in 84 percent of the 1 km square forest blocks. It was also found that the local people used 94 percent of the 1 km square forest blocks lying within 1.4 km from the boundary. About 45 percent of people around the park were involved in illegal activities, with 90 percent of the activities involving the removal of materials such as bamboo, wood, timber, minerals, honey and bush meat. Livestock forage in the forest was also common. From the survey results Butynski (1984) concluded that only 10 percent of the forest remained fairly intact from exploitation by pitsawyers. He also forecast that by 1990 most of the natural forest on public land around BINP would virtually be lost, considering the high rate of deforestation in the area. Butynski and Kalina (1993) mentioned roads, dam constructions and gold mining as additionally important illegal activities in BINP. Among its counter parts on the basis of size, Impenetrable Forest is thought to be the most heavily pit sawn forest in Uganda (Kamugisha *et al.*, 1997). People entered the forest reserve along most of its periphery to obtain poles and fuel wood, resulting in the peripheral 1 km of the reserve receiving heaviest human use, thus exhibiting the greatest amount of damage to vegetation and wildlife.

### **1.10 Hunting**

Under the Game Preservation and Control Act of 1964, hunting was forbidden in Impenetrable Forest Animal Sanctuary. Hunting was banned throughout Uganda in 1978 (Butynski, 1984). The current Uganda Wildlife Statute (1996) forbids hunting or use of any domestic animal as an aid to hunting in national parks. According to Butynski (1984) hunting of wild animals in Impenetrable Forest predates gazetted protection of the area. The traditional hunting was mainly for meat although hunting for trophies and capture of young primates for sale may with time have become the overriding objective. The people in the environs normally hunted Black-fronted duiker, Yellow-backed duiker, Bush pig, Giant forest hog and Sitatunga. The Batwa (pygmies) and Congolese (nationals from DRC) hunted all types of primates and rodents for meat. Most poaching was done using traps and Butynski (1984) captured 142 spears and removed 3559 wire traps. Based on the illegal activity report, Butynski (1984) concluded that the abundance of especially

large mammals was generally low and below the carrying capacity of the forest and that poaching was responsible for the decline in the number of wild life in Impenetrable Forest.

### **1.11 Present extent of habitat disturbance in BINP**

After attaining the status of a national park in 1991 most of the illegal activities in BINP, especially mining, were stopped. Currently illegal activities have reduced and take place along approximately 1 km of the forest periphery where livestock grazing and removal of bean stakes can some times be observed. Although pitsawing and poaching have been assumed completely under control, some isolated cases were reported during the course of this study, especially in areas around Kitahuria and parts of the forest, which are far from ranger patrol influence. Over the period of this study snares were also recovered in sites deep inside the forest (pers. obser). Roads and footpaths crossing/transversing the forest also introduce disturbance to the flora and fauna of the forest. According to Butynski (1984) large number of people and vehicles pass through the forest along the road which starts from Rubanda to Kayonza. Together with the footpaths, which exist in the forest, these continue to provide access to many parts of the park. Human settlement within BINP is currently limited to the areas where park officials and ITFC staffs reside.

## CHAPTER TWO

### 2. MATERIALS AND METHODS

#### 2.1 Study sites

Seven sites were selected on the basis of differing levels of park habitat disturbance, major vegetation zones and altitude. The undisturbed sites were located at least 4 kilometres from the forest boundary/major roads. The major vegetation zones surveyed included lowland mixed forest, high altitude mixed forest, lowland papyrus swamp with the gallery forest, high altitude swamp with the gallery forest, bamboo forest and grassland vegetation. One site was located in the northern sector, another at the neck (Kitahurira) which is a small strip of forest joining the north sector to the south sector. The remaining five sites were located in the south sector (figure 2.1) and were selected to represent altitudinal differences. Altitude readings of each study site were recorded using Global Positioning System (GPS) (Garmini GPSII) and the values were compared with Thammen TX-18 altimeter readings. Given below is a brief description of each of the seven sites.

##### 2.1.1 Ruhija (2155-2350 m. a.s.l)

This site was within 0-2 kms from the forest edge, representing disturbed forest habitat. Eilu (1995) observed evidences of Pitsawing, fire damage to vegetation and tree felling for non-timber purposes in this site. Pioneer tree species such as *Polyscias fulva*, *Maesa lanceolata* and *Macaranga* species are an indication of human activity (ATBP, 1997). A major road from Rubanda to Kitahurira passes along this site. Other disturbances in this site include human settlement by the Park and ITFC staffs, resulting in clearings, lawns and buildings. Vegetation of this site consists of mixed forest with *Chrysophyllum albidum* as dominant species. The understorey mainly consists of *Alchoria hirtella* shrubs, variety of ferns, lichens/mosses, while the valley bottoms are dominated by *Brillantaisia* species.



Figure 2.1. Map of study area showing the locations of the study sites.

Study sites

1. Ruhija
2. Bamboo zone
3. Mubwindi swamp
4. Rushamba
5. Kitahurira
6. Buhoma-Kasiru trail
7. Kasiresire

Legend

- Main road
- - - Foot path
- ▬ Main river
- ▬ Park boundary

### **2.1.2 Bamboo zone (2400-2600 m a.s.l)**

This site lies about 3 kms inside the forest, with bamboo (*Arundinaria alpina*) as the dominant plant species. Where bamboo growth is absent, poor forest featured, comprising mostly of *Hygenia abyssinica*, *Dombeya laucoderma*, *Hypericum lanceolatum*, *Nuxia congesta*, *Croton* species, *Neoboutonia macrocalyx* and *Lannea welwitschii*. It had signs of pitsawing, fire burns and elephant degradation. A major road and several trails from Rubanda to Kitahurira pass through this site, resulting in more habitat disturbances.

### **2.1.3 Mubwindi swamp (2040-2070 m a.s)**

Mubwindi swamp is a high altitude forest swamp, about 4 kms SW of Ruhija. It is characterised by three types of vegetations (Katende, 1990) which include; *Miscandium-Syzigium-Lobelia* sedge swamp, *Brillantaisia-Arlagea-Lobelia* sedge swamp, and *Myrica-Senecio-Lobelia* sedge swamp. Steep, densely forested slopes surround the swamp. Only research trails pass along this site and since there is a minimal human activity, it was considered undisturbed.

### **2.1.4 Kasiresire (2030-2080 m.a.s.l)**

This is a primary forest site, located about 6 kms from the forest edge. Being far from human activity, I considered it undisturbed. The dominant tree species is *Newtonia buchananii*.

### **2.1.5 Rushamba (1280-1570 m.a.s.l)**

This site is located within 0-3 kms from the forest edge, extending up to Ishasha river. It covered several vegetation categories that included: (i) Papyrus vegetation at Ngoto swamp. (ii) colonising vegetation near Rushamba ranger outpost, consisting of *Olea sp.*, *Prunus africana*, *Sapium ellipticum*, with a relatively thick herb layer comprising of ferns, *Pallisota manii* and *Mimulopsis arborescens*. (iii) *Parinari* dominant vegetation is mainly found along rivers and (iv) grassland vegetation in area named Hamuhingo mainly

consists of *Hyperhenia abyssinica* and a mixture of ferns and *Setaria species*. Close to the forest edge there is wooded grassland.

#### **2.1.6 Kitahurira (1500-1740 m.a.s.l)**

Kitahurira is a mid-altitude forest characterised by dominant and probably climax stands of *Parinari excelsa*, along the valleys of river Ihihizo. Above 1500 m elevation, *Entandrophragma species*, *Newtonia*, *Aningeria* and *Symphonia species* are common. Along periphery of the forest is a colonising mixture of *Albizia*, *Milletia*, and *Cathium species*. There is a large human traffic along the major road from Kitahurira to Kayonza, which passes through this site.

#### **2.1.7 Buhoma-Kasiru trail (1500m.a.s.l.)**

This site is located 4-5 kms from the forest edge and consists of a mixed forest with the dominant species being *Newtonia buchananii*. This site also contains good stands of *Carapa grandi* and *Ocotea kenyansis*. Public footpath from Buhoma to Nteko passes about 1.5 kms from the site. and was considered undisturbed as far as human activity is concerned.

### **2.2 Field methods**

#### **2.2.1 Introduction**

Assessment of population status of carnivores is very important for effective conservation management practices. However carnivores are difficult to study especially in forest habitats. Direct methods of assessing population size and density are often expensive and time consuming (Stander, 1998). As a result of this several researchers have used different indirect measures, which include: recognising spoor of individual species (Panwa, 1979), spoor counts (Stander, 1998), scent station visits (Wilson *et al.*, 1996), and dropping/scat counts (Riney, 1982). Indirect methods for sampling carnivore populations are often cost effective (Smallwood and Fitzhugh, 1995), easily repeatable and objective (Martin and de Meulenaer, 1988), but are frequently criticised for being

inaccurate (Norton, 1990). Indirect sampling occurs mostly in areas where direct methods are not possible due to financial or practical constraints. Indirect methods have also been used in food habit assessment (Kruuk, 1972; Alan and Suzan, 1991; Cavellini and Nel, 1990).

During this study the population status and relative abundance of carnivores was assessed using both direct (night survey) and indirect (scent station visits) methods; the food habits were assessed using scat analysis, while spoor/scat identification and trapping were used for assessing distribution. A questionnaire was used to assess human factors likely to affect carnivore conservation status. Given below is a description of the methods used.

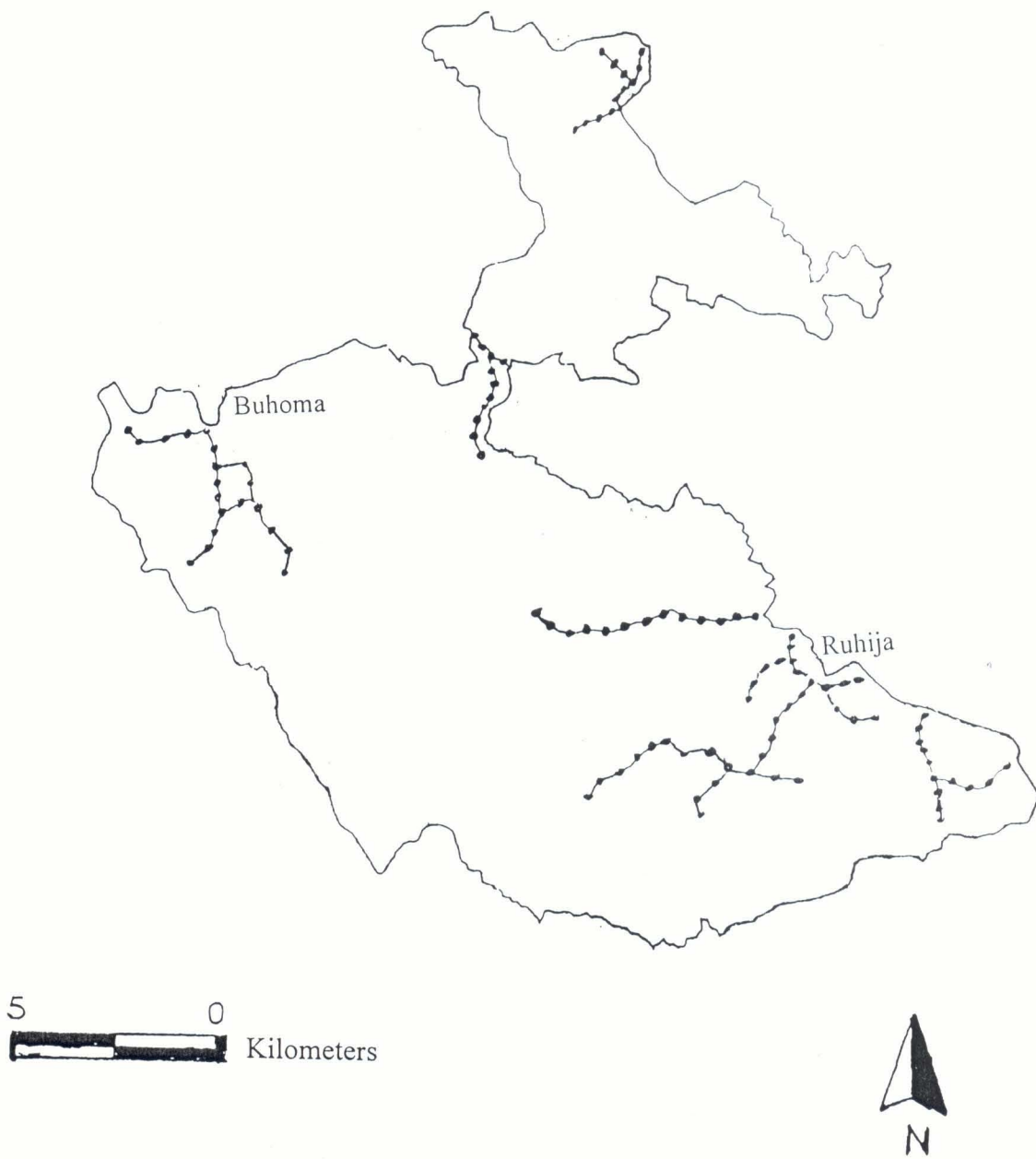
## **2.2.2 Night survey**

### **2.2.2.1 Introduction**

Documentation of the use of night surveys in population studies of nocturnal mammals in forested habitats is scanty. As a result Duchworth (1992) mentioned that nocturnal mammals are often poorly recorded in ecological studies. A few examples however, are found in Ashraf *et al.*, (1993) in Ghats India, Heydon and Bulloh (1996) in Borneo and Duchworth (1992) in Ethiopian rift valley park. Problems of night walks in forested habitats are mostly associated with threshold visibility and ability to detect and identify the target animals before they disappear from sight.

### **2.2.2.2 Field procedure**

Due to time constraints the night surveys were mostly conducted along the existing research trails in the park. However, in sites where research trail systems are absent, new ones were cut for use. Assumptions outlined for line transect methodology in Laake *et al.* (1993) were adopted for night survey. Transects used in this study are indicated in figure 2.2. They run through major representative habitats of each site, thus covering the major vegetation types of BINP described by Hamilton (1984). The transect paths varied between 1 and 1.5 meters wide with lengths between 2 and 5 kms. The night surveys were conducted on foot by two observers using flashlights (5V, 3A halogen bulbs),



Legend

- Park boundary
- Transects for night survey

Figure 2.2. Map of the study area showing the locations of the transects used for night survey.

walking at an average speed of 1 km per hour. This design was adopted to ensure thorough and simultaneous searching on both sides of the trails at all heights and therefore increasing the chances of sighting animals. To ensure a wider coverage of night hours during which carnivores are active, the surveys were conducted in two sessions; between 7.30 p.m.-2.00 a.m. and 3.00 a.m.-6.30 a.m. local times. Animals were first detected from eye shines and then identified to the species from hair colour patterns, body size and structure. Details of data recorded included; the perpendicular distance of the animals to the transect line (measured or estimated), time of sighting, habitat, and ranging/foraging habits (arboreal, terrestrial and aquatic). When the same transect was used for the return survey, observers waited for at least 30-45 minutes before starting, as was done by Duchworth (1992). This was to ensure that animals seen on the return leg were not necessarily the ones seen earlier. Duchworth (1992), Emmons (1982) and Safford and Duchworth (1990) avoided brightly moon-lit periods to avoid lower contact rates. But a preliminary night survey during this study showed that moonlight might not be an important factor affecting sightings of carnivores in BINP. Therefore night surveys were conducted regardless of the moonlit periods. In each study site night surveys were conducted over a period of 14 days, the total time taken and distance covered were recorded.

### **2.2.2.3 Sighting frequency and population density estimates**

Night survey results were transformed into sighting frequency (expressed as number of target animals observed over 100 kilometre distance) as was done by Heydon and Bulloh (1996) to ease interpretation of the result. Population densities were calculated from nocturnal transect walks using DISTANCE computer program (Laake *et al.*, 1993).

## **2.2.3 Scent station**

### **2.2.3.1 Introduction**

Use of sent stations to determine the presence of carnivores in densely forested habitats has become increasingly popular (Wilson *et al.*, 1996). Conner *et al.* (1983) compared scent station indices of Bob cats, Racoons and Grey foxes with population abundance

estimates obtained through trapping, radio-telemetry and radio isotope tagging techniques and found them to accurately reflect the population abundance of each species. The scent station method has the advantage that it can be used to determine abundance of a wide range of carnivores in a survey area (Conner *et al.*, 1983). However, between species comparisons of abundance cannot be made because of species specific visitation rates. Rowe-Rowe (pers.com) used a similar method in South Africa and recommended its use in BINP.

### **2.2.3.2 Preparation of transects and scent stations**

Roughton and Sweeny (1982) and Conner *et al.* (1983) recommended the following standardised procedures for scent station use;

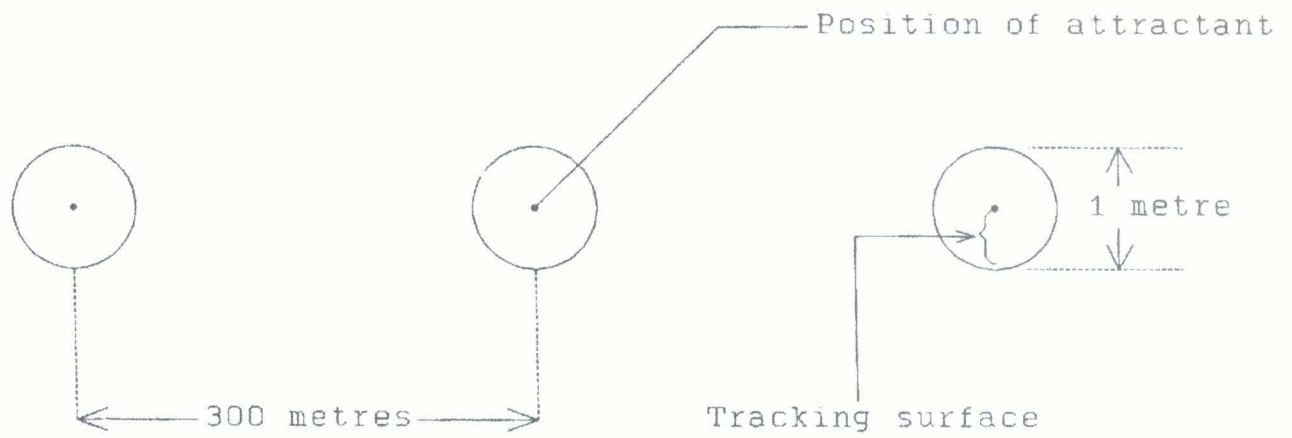
- i) scent stations should be operated when target species are most active.
- ii) stations should be placed at equal distance along transect lines and distributed proportionately among the major habitat types of the survey area.
- iii) tracking surface and attractant should be uniform and,
- iv) multiple night sampling should be considered for species that occur at low densities.

The above recommendations were adopted for this study. Conner *et al.* (1983) recommended station interval ranging between 300-500 meters. Considering the rugged terrain of BINP, an interval of 300 meters was adopted (figure 2.3) and eight scent stations were constructed along the 2.1-km transects cut in each the study site (figure 2.4).

To ensure proportionate distribution of the stations in each study site, the transects run through major habitat types. Each station consisted of a one meter diameter area, cleared of vegetation and covered with soft lime soil as a tracking surface (plate 1) (figure 2.3).

### **2.2.3.3 Preparation and presentation of attractant**

Fermented egg solution was used to lure carnivores to the tracking surface and was prepared as follows:- small circular holes were carefully made on one end of the fresh eggs (this was to avoid smashing the egg shells since it would be used later) the contents poured into a fermentation container and mixed with yeast extract. The mixture was left for 2-4 days to allow fermentation of the egg solution to take place. The fermented egg



**Figure 2.3 Dimensions used for constructing scent stations.**



**Plate 1. A scent station in one of the study sites. Note the arrow pointing to the attractant.**

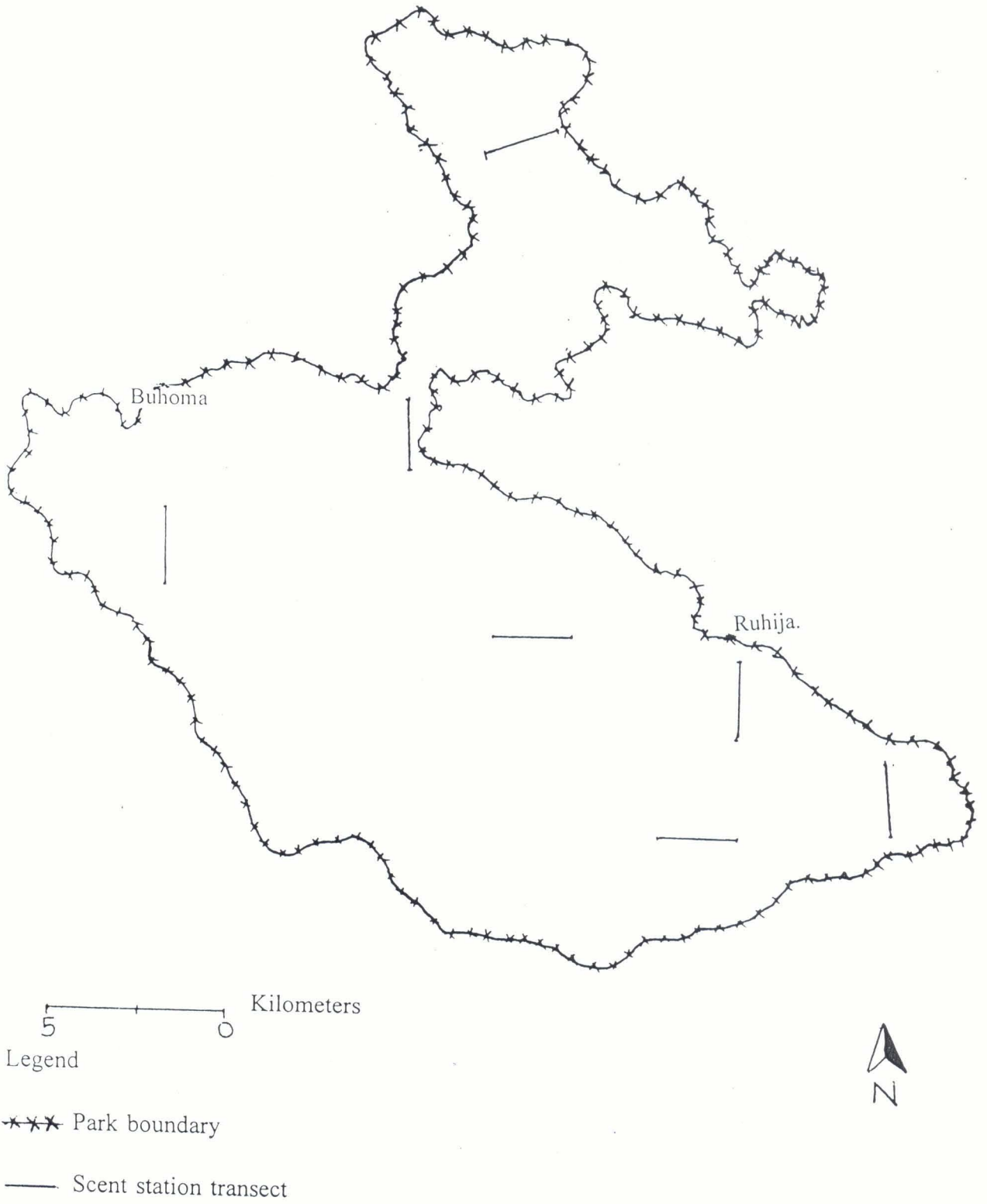


Figure 2.4. Map of the study area showing the locations of the scent station transects.

solution was then poured into the empty egg shells and buried halfway in the centre of the circular tracking surfaces (figure 2.3) in the evenings and checked for carnivore visits in the following mornings. This was repeated for 8 consecutive nights, covering a total of 64 transect nights per site. The fermented egg solution was replaced every evening to ensure that the odour of the attractant is maintained constant.

#### **2.2.3.4 Identification of visiting animal**

The visiting carnivores were identified from the tracks (spoor) left on the tracking surface. Different carnivores have different sizes and shapes of the main and small pads, making them important for identification. The tracks were measured to the nearest 0.5 mm using sliding Vanier calliper and identified by comparing with:- (i) references in the field guide books on animal tracks by Louis (1992), Chris and Tilde (1994) and Clive (1996). (ii) locally constructed tracks from trapped specimens and village kills. (iii) spoor of locally identified carnivore species traced on transparent plastic papers.

#### **2.2.3.5 Habitat analysis**

Micro-habitat of each scent station was assessed from the surrounding ground vegetation cover (GVC) as follows: one square meter quadrants were established approximately 1-3 meters away from scent stations, the quadrants were subdivided into four quarter meter squares and were individually scored as follows, 0-25% (under heavy canopy and the ground almost bare), 25-50% (sparse ground vegetation), 50-75% (fairly thick ground vegetation), 75-100% (very dense cover). These scores were given to vegetation below 1.5 meters high. The mean percentage vegetation cover per scent station was obtained by dividing the sum of the estimated cover in the four quarter meter squares by four. Similar method was used by Muganga (1989) to assess microhabitat for small mammals in Kibale National Park. The distance of the scent station transects from the park edge and major roads were measured to the nearest 20 meters. This was to assess the influence of human disturbance on visitation rates of carnivores.

### 2.2.3.6 Problems associated with scent station method

The following are possible sources of error, which could affect the result of this study;

- i) attraction to the scent station could be varying from one carnivore species to another and influenced by food preferences of individual species.
- ii) red ant species, moths, and yellow backed duikers (*Cephalophus sylvicultor*) occasionally visited the scent stations. This could lower the visitation of the target species by interfering with the attractant.
- iii) arboreal carnivore species may be less lured to the scent stations than the terrestrial species since scent stations were prepared on the ground. This could lead to a lower visitation rate for arboreal carnivore species.
- iv) carnivores may not be accurately identified to the species from spoor when their spoor are very similar in appearance. For example it was not possible to differentiate spoor of the two genet species; Small-spotted Genet (*Genetta servalina*) and Large-spotted Genet (*Genetta tigrina*).
- v) rain sometimes interfered with or washed the tracking surfaces during night, leading to poor imprints of the spoor. In such circumstance all stations were repaired and reset the following night.

### 2.2.4 Spoor and scat survey

#### 2.2.4.1 Introduction

Sighting of carnivores in forested habitats is difficult; because of this, the use of signs such as scats and spoor to assess their distribution and population status has become very popular. Although commonly in use, many authors have expressed reservations about the use of signs to assess animal abundance and stressed the potential sources of error (Wilson *et al.*, 1996). The major sources of errors in using signs as indication of animal abundance include; attributing various sets of signs to different animals species, environmental heterogeneity (differences in vegetation or topography), non-regular production of signs, detectability of the signs may also vary with habitat types and tracking conditions and lastly the decay or disappearance rates of the signs vary with weather conditions. These outlined factors can result in errors when using signs to assess

relative abundance of carnivores under forest habitats. However, the use of signs has the advantage that they are usually found in the preferred habitats and lead themselves to being closely associated with evidences of occurrence of habitat elements (Riney, 1982). They also provide indices to numbers which are not influenced by the threshold of visibility unlike those methods dependent on the observer seeing the target animal (Riney, 1982). Authors such as Rowe-Rowe (1992), Jhala and Giles (1991) and Alan and Suzan (1991) have used scats to assess the distribution, relative abundance and habitat use by some carnivore species. Stander (1998) found spoor counts of large carnivores to relate perfectly with their populations in Namibian Wildlife Reserve. Due to the heterogeneous nature of habitat of BINP, scat and spoor surveys in this study were only used to assess the occurrence and distributions and not as an index of population abundance. The locations of the scats and spoor were marked on a topographic map (scale 1:65,000) or recorded using GPSII receiver. The X and Y co-ordinates were taken at an Estimated Position Error (EPE) of about  $\pm 25$  meters. The recorded points were transformed into a data base at the Geographical Information System (GIS) laboratory, Makerere University Institute of Environment and Natural Resources (MUIENR) and the point locations marked on the map of BINP to show distribution of carnivore species (see section 3.6).

#### **2.2.4.2 Scat identification**

Each animal species produces scat of a particular shape (Chris and Tilde, 1994). Droppings of carnivores are usually cylindrical or sausage-shaped with a point at one end and many contain hairs, pieces of bones and exoskeletons (Clive, 1996). Scats may vary in size and feature, depending on season, age, diet and health condition of the animal (Riney, 1982). The best way of identifying carnivores from scats is to look at fresh dropping which are associated with fresh spoor (Louis, 1992). During this study carnivore scats/spraints were extensively searched for along roads, trails, watercourses, forest floor and suspected denning sites. Inside the forest fresh scats were easily located by the presence of butterflies and bees which are attracted to them. Fresh scats that are easily associated with particular carnivore species were collected, while degraded scats of ambiguous origin were left out. The scats were identified using field guides to mammal signs by Louis (1992), Chris and Tilde (1994) and Clive (1996). Scats from trapped carnivore specimens and latrine sites of known carnivores also acted as references for

identification. The collected scats were sun dried, stored in polythene bags with insecticide (Naphthalene crystals) to avoid insect degradation before they were later examined to determine food habits of the carnivore species.

#### **2.2.4.3 Spoor identification**

Tracking animals by spoor in dust, sand or snow is the oldest known method used to confirm an animal's occurrence in an area (Chris and Tilde, 1994). Tracks are a useful aid in identifying feeding areas, bedding areas and daily movements of animals (Louis, 1992).

Spoors were searched for along roads, trails, water courses, water points, muddy swamp shores, open forest floor and degraded areas in the forest such as those caused by elephant trampling. When spoor was discovered, the front and hind tracks were measured using a sliding Verner calliper to the nearest 0.5 mm. Identified tracks were brushed out to prepare the tracking surface for next observations. Clear spoor was also obtained using strips of fine sand or soil smoothly spread along trails and cleared areas where carnivores pass. These were swept regularly to obliterate old tracks. Identification of spoor followed the outline in section 2.2.3.4.

#### **2.2.5 Live trapping**

In this study live trapping was particularly aimed at small carnivore species. However, from a preliminary two weeks of trapping trial (which was less successful), it was clear that trapping would not yield sufficient data for use in determining population densities. Because of this, trapping in this study was redirected to identify the carnivore species, since some (such as Genets) are difficult to identify in the field. Trapping also helped in the determination of the distribution of the small carnivore species.

##### **2.2.5.1 Trap types and baits**

Two types of traps, with different dimensions (table 2.1) were used in this study. This was aimed at capturing a wide variety of small carnivore species.

**Table 2.1 The type and designs of traps used in the study.**

Trap design/type	Number of traps used	Dimensions (centimetres)
Havahart	2	18 x 18 x 78.8
„	6	50 x 62 x 165
„	15	78 x 89 x 229
Tomahawk	14	41 x 14 x 14
„	5	80 x 22 x 22
Total	42	

A variety of baits have been used to trap rodents. Studies on small mammals reveal that factors affecting bait acceptability are many. According to Smith and Blessing (1969) the availability of food in the habitat and species diet influence bait acceptability in small mammals. Response to bait is also influenced by age, sex, and among different habitats (Fitch, 1954). Preliminary bait trials during this study revealed that vegetarian bait was more successful in trapping small carnivore species than an animal bait. For this reason the bait used in this study consisted of a vegetarian meal as follows:- mixture of 20% by weight sweet bananas, 20% maize floor, 30% roasted pounded groundnut pest and 30% roasted simsim (*Sesame*) pest. At the end of each trapping session the traps were cleaned to prevent build up of bait, which could impair their efficiency.

#### **2.2.5.2 Trapping and data recording**

Trapping was conducted from January 1998 to June 1998. Traps were mainly set on the ground, near/on trees and along trails. The distance between traps varied from 10 to 20 meters. The traps were inspected once in a day, between 07.00 am. and 10.30 am. During inspection accidentally sprung traps were reset or rebaited if necessary. Sampling was done for 14 consecutive nights and an average of 574 trap nights per site was achieved. The trapped animals were identified to species level using mammal reference guide books by Kingdon (1997), Dorst and Dandelot (1988) and Happold (1978). In addition they were sexed, weighed to the nearest 0.5 kg using 10 kg Pesola spring

balance, measurements of the body and tail lengths were taken for further confirmation of their identity. The details of habitats from which the animals were trapped were also recorded. The trapped carnivore specimens were later released at the trapping sites.

## **2.2.6 Carnivore foods**

### **2.2.6.1 Introduction**

Methods adopted to study the food habits of carnivores fall into two categories namely: (i) the direct observation of kills, which is applicable only to the large carnivore species, particularly those living in relatively open terrain where kills are easily located and (ii) the indirect way is by identifying the food remains in stomachs or intestines and dropping (scats). The examination of stomach/intestinal remains entails extensive killings, which was not possible in this study. Because of the limitations associated with both approaches, scat analysis was the only appropriate method for use during this study.

The idea of scat analysis stems from observations that many predator droppings contain large amounts of the remains of hairs, bones or exoskeletons. The prey species to which these belong can be determined with practice by examining the remains under microscope. This is possible because each prey species has characteristic features of hair, bones and exoskeleton, which enable identification. For this to be successful it is however, necessary to have reference collection of parts of the prey which the predators might eat to compare their structure with those found in the droppings. Scat analysis has been used by several researchers such as Kruuk (1972), Ewer (1985), Cavellini and Nel (1990), Alan and Suzan (1991), Jhala and Giles (1991) and Jhala (1993) to determine food habits of carnivores.

### **2.2.6.2 Scat analysis**

The preserved scats (see in section 2.2.4.2) and fresh scats were teased apart and examined visually or under a stereo microscope. Hair, bones, exoskeletons and feathers were the most common remains of the prey items recorded in the scats. Scales, shells, seeds/fruits and vegetable matter were less common. Prey remains were identified using reference material of animals collected from the field or kindly availed for use from the

museum collections of ITFC field station and Zoology Museum (Makerere University). Plant food remains were identified at the National Herbarium (Makerere University). Hair remains were identified to the particular mammal species using characters such as shape, length, width, and pigmentation. This was easier for large prey species such as duikers, monkeys and mongooses, where hairs from different body regions of a specimen acted as references. Small mammal prey species, particularly rodents and shrews were identified using cranial bones to the order level. Insects were identified from exoskeletons/carapaces, while reptiles and frogs were identified from scales/bones, and birds identified from feathers.

### **2.2.6.3 Opportunistic observations**

Information on food habits of carnivores was supplemented by:- (i) direct observations of carnivores during night surveys. (ii) examinations of stomach contents of the village kills and (iii) deductions from spoors in the field associated with feeding evidence. These opportunistic observations contributed important information on carnivore food habits.

### **2.2.6.4 Food habit analysis**

Two methods are commonly used to quantify food items constituting diets of wild animals, although each has its limitations.

(i) the first method attempts to measure the percentage of the total volume constituted by each category of food remains (Ewer, 1985). This is only possible for a freshly filled stomach, this gives a clear picture of relative importance of each food item. But was not possible for this study.

(ii) the most commonly used method is by recording the percentage occurrence or frequency of occurrence of food items in the scats. That is to say the number of times a particular food item is recorded in relation to all prey items identified and expressed as a percentage (Kruuk, 1970; Leopold and Krausman, 1986; Cavallini and Nel, 1990; Alan and Suzan, 1991; Jhala, 1993). The major disadvantages when using this method include; (i) the results do not give a direct measure of the importance of each food item in the diet and (ii) differences in digestibility of prey/food items may cause a misrepresentation of prey items. Despite these disadvantages, this method has been shown to closely

approximate the proportions of different food items actually consumed for many carnivore species (Erlinge, 1977). However, this was the only possible method for use in this study. Presence of each prey/food item in each scat was scored. The scores for each food item were added and expressed as a percentage of the total number of scores of all food items, yielding relative percentage frequency. The results presented in pie charts as the percentage of scats dominated by each food item.

## **2.2.7 Survey of local people's attitude and other anthropogenic factors affecting conservation of carnivores**

### **2.2.7.1 Questionnaire design**

In this study questioning was used to survey local knowledge, human use and perception of the community about carnivores. Information was collected about respondents (age, sex, administrative boundary), their knowledge on carnivores (occurrence, interactions, and traditional uses) and attitude/beliefs about carnivores. Before administering the final questionnaire, a provisional one was tested in December 1997 in Kitojo Parish near Ruhija (ITFC field station) for a period of two weeks. This was to determine the appropriateness of the questions and their ability to solicit meaningful answers. The final questionnaire was then redesigned to elicit the desired responses from the target groups, taking into account the changes observed during the pre-testing phase. To ease the problem of language barrier, the final questionnaire in English (appendix 1a) was translated into the local language of the region, Rukiga (appendix 1 b).

### **2.2.7.2 Sampling technique**

The questionnaire was administered in 8 parishes surrounding the park (figure 2.5). Selection of households was based on the proximity to the park. It was assumed that households close to the park have more interactions with the carnivore community of the park. The questionnaire was therefore administered to households located within 0-2 kms to the park boundary. The target groups consisted of former hunters and currently allowed forest resource users in Multiple Use Zones (MUZs). Addition to these, gorilla trackers and park rangers were also interviewed. This resulted in a total of 107 respondents to whom the questionnaire was administered.



- Legend
- ✱✱✱✱ Park boundary
  - - - District boundary
  - Parish boundary
  - ▤ Study parish



Figure 2.5 Map of the study area showing parishes where the questionnaire was administered.

### 2.2.7.3 Field operation

Before proceeding to interview, letters of introduction from ITFC were first presented to the Local Council (LC) leaders (LCI and LCII) of the parishes. This allowed us to operate without problems since the local people (Bataka) were informed of our presence. It also ruled out fear or any suspicion from them. General courtesies were exchanged before the questionnaire was administered. The research interpreter, fluent in local language (from ITFC), introduced the work we were doing to the respondents. The structured questions were systematically presented in the local language by the interpreter. The answers were translated into English for recording. Use of local language and face to face interaction with respondents allowed deep coverage of the subject matter and on spot correction of any misunderstandings. The respondents were also able to express any issue important to them without a language barrier. Apart from descriptive method of identifying carnivore species, presenting selected coloured plates or illustrations (drawings and photographs) enhanced identifications from zoological and field guide books by Kingdon (1997), Dorst and Dandelot (1988) and Happold (1978). Although I initially intended to administer the questionnaire to one respondent (the family head) at a time, some of the house holds members and neighbours occasionally made important contributions. Children looking after livestock were also resourceful in providing information on carnivore species.

## CHAPTER THREE: RESULTS

### 3 ECOLOGY OF CARNIVORES:

#### 3.1 Carnivore species richness

Confirmation of the occurrence of an animal is the first step in understanding its ecology within a protected area (Ann, 1994). A species list shows which species are thought to occur in the area but have not been seen recently. It also includes those species that have been hunted to extinction. In this study, sixteen carnivore species (Table 3.1 and appendix 2) belonging to four families were recorded, representing 42.1 percent of total carnivore species said to occur in Uganda. It should be appreciated from the start that in a study of this nature of carnivores in a forested habitat, the species record may not necessarily represent the full spectrum of species occurring in the study area. Of the carnivores occurring in BINP, Honey badger (*Mellivora capensis*), Clawless otter (*Aonyx capensis*), Spotted necked otter (*Lutra maculicollis*) and African wild cat (*Felis sylvestrus*) were recorded for the first time during this study. There was no evidence of occurrence of Leopard, *Panthera pardus* Linnaeus that was formerly recorded in the park. This means that Leopard is probably extinct in BINP. As shown in table 3.1, some carnivore species such as Two-spotted palm civet *Nandinia binotata* Gray, *Felis serval* Schreber, *F. sylvestrus*, two Genet species (*G. servalina* and *G. tigrina*) and *Herpestes sanguineus* Ruppel occurred widely in the study sites while species such as *C. adustus* and *V. civetta* only occurred in sites with human habitation or those that lie in the ecotone regions of the park such as, Bamboo zone, Kitahurira and Rushamba. *Mellivora capensis*, *Aonyx capensis* and *Lutra maculicollis* were exclusively recorded in Mubwindi swamp while *Mungos mungo* was only recorded in Rushamba.

#### 3.2 Trapping records

Very few carnivores were caught (only 11 individuals in a total of 4305 trap nights). This was partly due to the high levels of traps being interfered with by other animals. Most of the disturbance to the traps came from rodents and safari ants (*Dorylus* spp) which commonly invaded the traps. These could have reduced trapping success since they ate up

**Table 3.1 Occurrence and distribution of carnivores in the study sites. Based on the sightings, trapping, and spoor/scat identification records.**

Family	Species	Study sites						
		RUJ	BBO	MU S	KSS	KIT	RUS	BKT
Canidae	<i>Canis adustus</i> Sundevall	*	*			*	*	
Felidae	<i>Felis serval</i> Schreber	*	*	*	*	*	*	*
Felidae	<i>Felis sylvestrus</i> Schreber (= <i>libyca</i> . Foster)	*	*	*	*	*	*	*
Felidae	<i>Profelis aurata</i> Temminck		*	*	*		*	*
Viverridae	<i>Viverra civetta</i> Schreber	*	*			*	*	
Viverridae	<i>Nandinia binotata</i> Gray	*	*	*	*	*	*	*
Viverridae	<i>Genetta servalina</i> Pucheran	*	*	?	*	*	*	?
Viverridae	<i>Genetta tagrina</i> Schreber	*	*	*	?	?	*	*
Viverridae	<i>Herpestes sanguineus</i> Ruppel	*	*	*	*	*	*	*
Viverridae	<i>Herpestes paludinosus</i> G. Cuvier			*	*		*	*
Viverridae	<i>Herpestes Ichneumon</i> Linnaeus	*				*	*	
Viverridae	<i>Mungos mungo</i> Gmelin						*	
Mustelidae	<i>Ictonyx striatus</i> Perry	*					*	
Mustelidae	<i>Mellivora capensis</i> Schreber			*				
Mustelidae	<i>Aonyx capensis</i> Schinz			*				
Mustelidae	<i>Lutra maculicollis</i> Lichtensitein			*		?	?	

**Key**

\* Species occurs in the site

? Species probably occurs in the site but its presence was not established during this study.

**Study sites:**

RUJ, Ruhija. BBO, Bamboo zone. MUS, Mubwindi swamp. KSS, Kasiresire.

KIT, Kitahurira. RUS, Rushamba. BKT, Buhoma-Kasiru trail.

the bait. Because of the above problems the number of individuals caught in each site (Table 3.2) could not be used as an indicator of carnivore abundance in the study sites. However, highest number of carnivore species were caught in Ruhija followed by Kasiresire, while nothing was caught in sites such as Rushamba, Buhoma-Kasiru trail and Kitahurira.

**Table 3.2 Trapping records of carnivore species during the course of study.**

Species	Sites							Total
	RUJ	MUS	BBO	RUS	KSS	BKT	KIT	
<i>N. binotata</i>	2	-	-	-	1	-	-	3
<i>G. servalina</i>	1	-	-	-	-	-	-	1
<i>G. tagrina</i>	1	-	-	-	1	-	-	2
<i>H. sanguineus</i>	1	-	1	-	-	-	-	2
<i>H. paludinosus</i>	-	1	-	-	1	-	-	2
<i>F. sylvestrus</i>	1	-	-	-	-	-	-	1
Total	6	1	1	0	3	0	0	11
Trap nights	861	574	574	574	574	574	574	

**Key to study sites.**

RUJ, Ruhija, MUS, Mubwindi swamp, BBO, Bamboo, KSS, Kasiresire, KIT, Kitahurira, RUS, Rushamba, BKT, Buhoma-Kasiru trail.

**3.3 Relative abundance of carnivore species in the study sites**

Sighting frequencies of carnivore species are given in table 3.3. These have been taken as indices of relative abundance of carnivore species and were calculated as: sighting frequency (s) = number of each carnivore species sighted over 100 kilometre trail. Generally the sighting frequencies of carnivores varied between species and between sites. Sightings of *Canis adustus* and *Viverra civetta* were mainly in localities with high human presence such as Ruhija, Bamboo, Kitahurira and Rushamba (table 3.3). Highest sighting frequencies of *Herpestes sanguineus*, *Felis serval* and *Felis sylvestrus* were in Bamboo zone, while sightings of *Herpestes paludinosus* was only recorded in sites with swamps such as Mubwindi swamp, Kasiresire, Rusamba and Buhoma-Kasiru trail.

Table 3.3. Sighting frequency and ranging/foraging habits of carnivores in BINP

Species	foraging habit	Sites															
		Higher altitude > 2000 meters								Lower altitude < 1800 meters							
		RUJ		BBO		MUS		KAS		KIT		RUS		BKT			
n	s	n	s	n	s	n	s	n	s	n	s	n	s				
<i>C. adustus</i>	T	13	26.26	8	19.51	0	0	0	0	11	28.21	4	8.33	0	0		
<i>V. civetta</i>	T	6	12.12	4	9.76	0	0	0	0	5	12.82	3	6.25	0	0		
<i>N. binolata</i>	A	2	4.04	1	2.43	1	2.33	4	8.89	1	2.56	1	2.08	5	10.42		
<i>F. serval</i>	T	3	0	4	9.76	2	1	1	2.22	1	0	3	6.25	1	2.08		
<i>P. aurata</i>	T	0	0	2	4.87	3		3	6.66	0	0	0	0	3	6.25		
<i>F. sylvestrus</i>	T	4	8.08	5	12.19	1	2.33	0	0	2	5.13	1	2.08	0	0		
Genets	T/A	2	4.04	1	2.43	0	0	2	4.44	1	2.56	1	2.08	2	4.17		
<i>I. striatus</i>	T	5d	-	0	0	0	0	0	0	1	2.56	3	6.25	0	0		
<i>H. sanguineus</i>	T/A	2	4.04	6	14.63	2	4.65	2	4.44	1	2.56	1	2.08	1	2.08		
<i>H. ichneumon</i>	T	3d	-	0	0	0	0	0	0	1d	-	1d	-	0	0		
<i>H. paludinosus</i>	H/T	0	0	0	0	2	4.65	5	11.11	0	0	3	6.25	1	2.08		
<i>M. mungo</i>	T	0	0	0	0	0	0	0	0	0	0	3d	-	0	0		
<i>M. capensis</i>	H	0	0	0	0	2	2.33	0	0	0	0	0	0	0	0		
<i>A. capensis</i>	H	0	0	0	0	1		0	0	0	0	0	0	0	0		
Total distance covered (kms)		50		41		43		45		39		48		48			

Key

n = Number sighted, s = Sighting frequency (n/100 km trail), d = sighted during diurnal walk

Ranging/foraging habits: T = Terrestrial, A = arboreal, H = Aquatic.

Sites

RUJ = Ruhija, BBO = Bambo, MUS = Muhwindi swamp, KAS = Kasiresire, KIT = Kitahurra, RUS = Rushamba, BKT = Buhoma-Kasiru trail

*Mellivora capensis* and *Aonyx capensis* were the least sighted carnivore species and were only sighted in Mubwindi swamp. *Ictonyx striatus*, *Herpestes ichneumon* were mostly sighted during the daytime in degraded forests and grasslands areas (around Ruhija, Kitahurira and Rushamba). *Mungos mungo* was only sighted in Rushamba area (table 3.3) which is a low altitude site (1280-1500m.a.s.l.), with grassland vegetation.

Scent station visitation rates are expressed as percentage of scent stations visited over 64 transect nights (table 3.4). As in the sighting frequency, the scent station visitation rate values similarly indicate trends in abundance of carnivores. For example high visits to scent stations by *C. adustus* and *V. civetta* were recorded in sites with human presence (table 3.4). Highest visits of scent stations by *N. binotata* and *P. aurata* were also in sites deeper into the park. Although scent station visits for majority of carnivore species were recorded in most study sites, *I. striatus* and *M. capensis* were only recorded in Ruhija and Mubwindi swamp respectively (table 3.4).

**Table 3.4. Percent visitation rates of carnivores to scent stations.**

Species	Sites						
	RUJ 2350m	BBO 2503m	MUB 2088m	KSS 2060m	KIT 1620m	RUS 1525m	BKT 1750m
<i>C. adustus</i>	12.50	4.68	0.0	0.0	7.81	4.68	0.0
<i>V. civetta</i>	7.81	3.12	0.0	0.0	9.37	4.68	0.0
<i>N. binotata</i>	4.68	4.68	3.12	9.37	3.12	1.56	3.12
<i>F. serval</i>	2.22	2.08	4.15	9.76	0.96	0.06	2.08
<i>F. sylvestrus</i>	7.81	4.68	1.56	1.56	0.0	0.0	0.0
<i>P. aurata</i>	0.0	4.68	7.81	6.25	0.0	1.56	3.12
Genets (two spp)	4.68	6.25	4.68	4.65	6.25	0.0	3.12
<i>I. striatus</i>	3.12	0.0	0.0	0.0	0.0	0.0	0.0
<i>H. sanguineus</i>	7.81	21.87	10.94	1.56	9.37	3.12	1.56
<i>H. paludinosus</i>	0.0	0.0	1.56	25.0	1.65	1.56	1.56
<i>M. capensis</i>	0.0	0.0	1.56	0.0	0.0	0.0	0.0

#### Key to sites

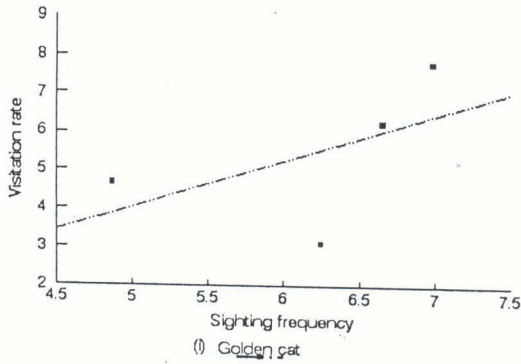
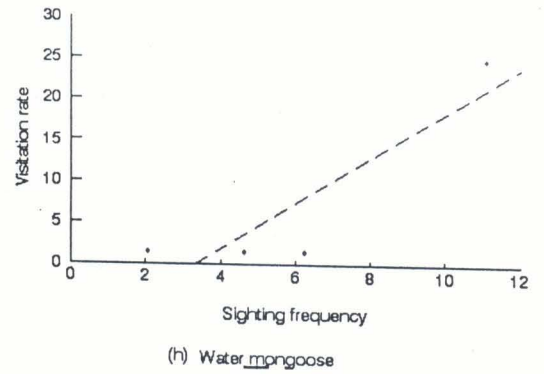
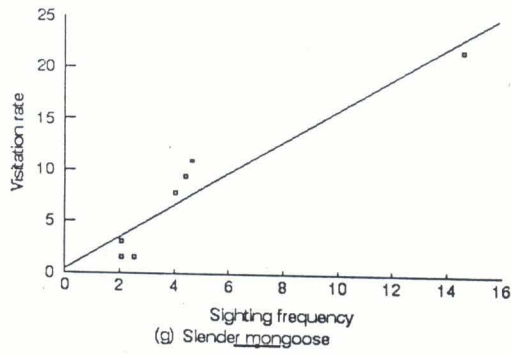
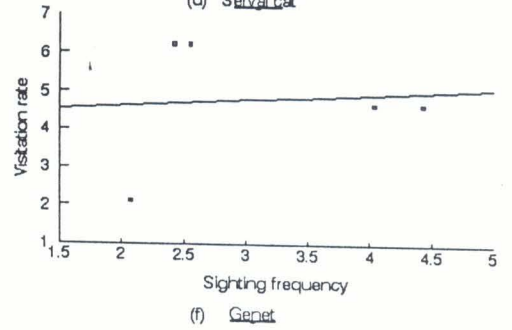
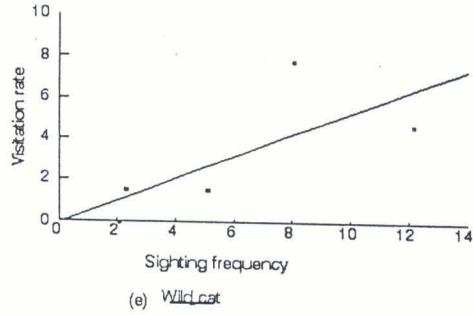
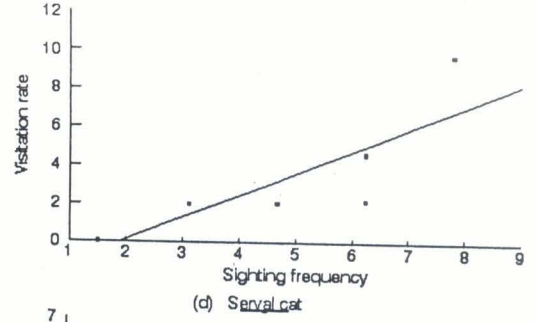
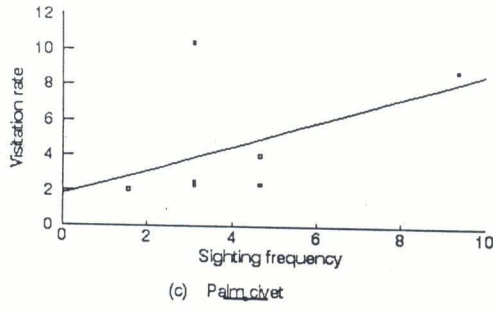
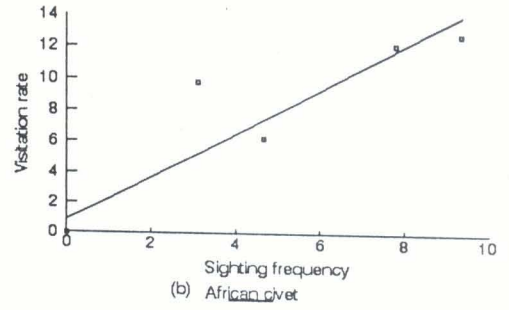
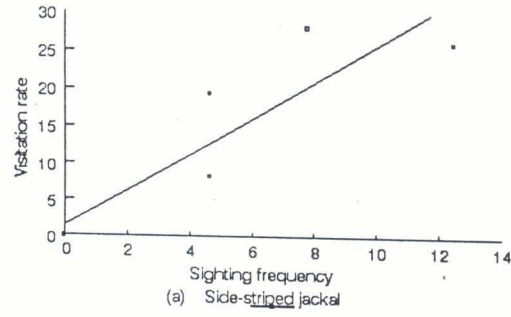
RUJ, Ruhija; BBO, Bamboo; MUB, Mubwindi swamp; KSS, Kasiresire; KIT, Kitahurira; RUS, Rusamba; BKT, Buhoma-Kasiru trail.

### 3.4 Comparison of sighting frequency and scent station visitation rates as measures of carnivore abundance

An understanding of the relationship between sighting frequencies (number of animals sighted over 100 km length) (table 3.3) and scent station visitation rates (average number of visits to scent stations in each site in 64 transect nights) (table 3.4) is important because both methods were used simultaneously to assess the abundance of carnivores in the study sites. Table 3.5 and figure 3.1 show significant positive correlation between sighting frequencies and scent station visitation rates for most carnivore species. For example highly positive correlation (table 3.5) was obtained for *C. adustus*, *V. civetta*, *F. serval*, *F. sylvestris* and *H. sanguineus*, suggesting either method was a good measure of relative abundance for these species. While weakly positive (not significant) relationship (table 3.5) was obtained for *N. binotata*, *P. aurata* and the two Genet species. Here it is not possible to tell which of the two methods is a good measure of abundance. However, considering that scent station method had minimal practical interference to the carnivores, it is probably a better measure of carnivore abundance.

### 3.5 Population density estimates

The number of sightings of some carnivore species in the study sites were insufficient to estimate their density per site using DISTANCE methodology (Buckland *et al.*, 1993). The study sites were therefore combined on the basis of altitude and vegetation/habitat types to obtain pooled density estimates particularly for Side-striped jackal, African civet, Palm civet, Genets and Slender mongoose (table 3.6). For Cat species the population density estimates were for the whole park since the number of sightings were much lower. The population densities of Water Mongoose, Egyptian Mongoose, Zorilla, Clawless Otter and Honey Badger were not estimated due to either very few sightings or their restricted occurrences. As shown in table 3.6 the density estimates for Side-striped jackal and African civet were generally higher than those recorded elsewhere, for example in South Africa (see Rowe-Rowe (1992), while the density estimates for the rest of the carnivore species were within the ranges reported. The density estimates for Palm civet, Genets and Slender mongoose were generally higher in high altitude sites than in the lower altitude sites (table 3.6). This is consistent with the regression analysis result of visitation rates with altitude (table 3.9, section 3.8.4) which shows that these species have



Regression line:  $Y = a + bx$

Figure 3.1 Plot of the relationship between sighting frequency and percentage visitation rates to the scent stations for carnivore species

preference for higher altitude areas.

**Table 3.5 Sighting frequency versus scent station visitation rates for carnivore species.**

Species	r	b	t	p<
<i>C. adustus</i>	0.91	2.43	4.97	0.004
<i>V. civetta</i>	0.75	0.82	1.64	0.042
<i>F. serval</i>	0.95	0.75	6.04	0.004
<i>F. sylvestris</i>	0.72	0.38	1.457	0.030
<i>H. sangiuneus</i>	0.94	1.53	6.759	0.001
<i>H. paludinosus</i>	0.89	2.75	2.792	0.108
<i>N. binotata</i>	0.49	0.35	1.28	0.250
<i>P. aurata</i>	0.55	1.20	0.94	0.400
Genet (two species)	0.59	0.59	1.05	0.400

**Table 3.6 Population density of carnivore species (at 95% confidence limit), estimated using DISTANCE computer package (Laake *et al.*, 1993).**

Species	Pooled density as number per Km <sup>2</sup>		Habitat types
	High altitude (>2000m a.s.l)	Low altitude (<1800m a.s.l)	
Side-striped jackal	0.16 ± 0.25	0.15 ± 0.21	Degraded habitat
African civet	0.27 ± 0.21	0.28 ± 0.29	Degraded habitat
Palm civet	3.32 ± 2.23	2.17 ± 1.71	Mature forest
Genets	4.25 ± 2.35	3.80 ± 3.12	All habitats
Slender mongoose	7.37 ± 3.24	6.45 ± 3.21	All habitats
Serval cat	0.09 ± 0.08*		All habitats
Wild cat	0.08 ± 0.07*		All habitats
Golden cat	0.04 ± 0.04*		All habitats
			Mature forest

\* Density estimates for all altitudinal ranges covered.

### **3.6 Distribution mapping of carnivore species**

#### **3.6.1 Introduction**

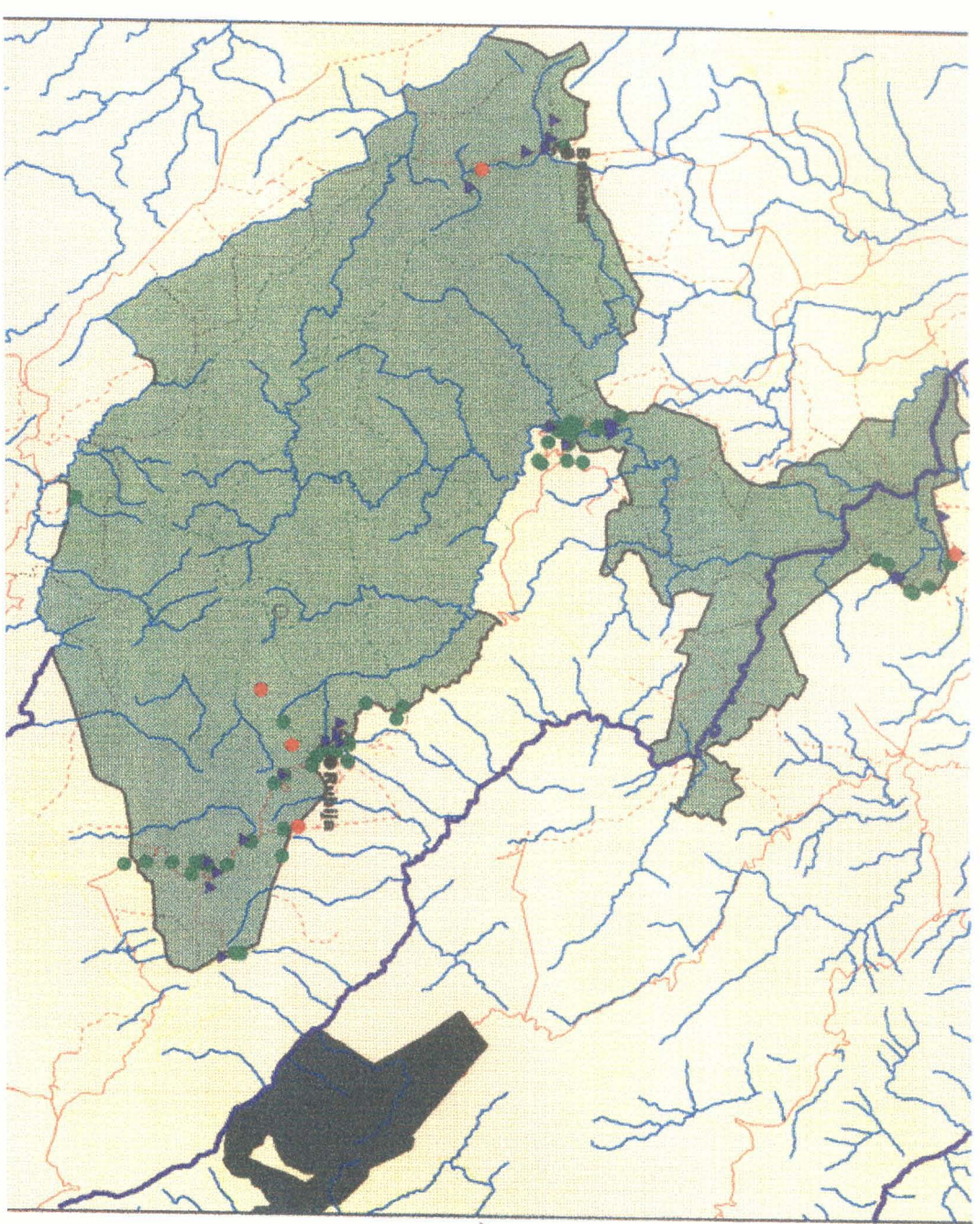
Distribution of resources determine where a species exists in large numbers (Ann, 1994). It gives important ecological information about a species such as the type of habitat that a species needs to survive and what other species are found in the same area. In every habitat mammalian carnivores exploit a large part of the available animal protein. Nonetheless, competition between species is generally minimised through differences in resource utilisation. Strategies for coexistence include feeding on different types and sizes of prey, method of finding, catching and killing the prey. Habitat preferences, activity patterns and differing response towards seasonal changes in their foods also separate carnivores (Ann, 1994). Distribution mapping records of carnivores in this study was obtained by plotting the point locations (GPS readings) of field observations of the animals and their signs (scat and spoor) on a digitised map of BINP (see section 2.2.4.1). Figures 3.2, 3.3, 3.4 and 3.5 show distributions of carnivore species in different sites of the study area. Given below is a species by species description of distribution trends.

#### **3.6.2 Canids and civets.**

Most signs of Side-striped jackal and African civet were recorded in areas towards the park periphery and where roads/village paths passed (figure 3.2), implying that they are associated with human habitation and ecotones. On the other hand Palm civets were more widely distributed, ranging from the periphery to the interior of the forest (from trapping records) (figure 3.2). This means they are associated with many habitats and vegetation types.

#### **3.6.3 Cat species**

The distribution of cat species is shown in figure 3.3. The Serval cat and Wild cat were the most widely distributed species. However most of their signs were concentrated at the periphery of the park (figure 3.3). In this way they share same habitat with Side-striped jackals and African civets. While the Golden cat signs/sightings were mostly observed in



**LEGEND**

- Obs. of scats & spoor
- ▲ African civet
- Palm civet
- Side striped jackal
- Drainage
  - Main river
  - Minor river
- Infrastructure
  - Murrann road
  - Motorable track
  - Footpath
  - Patrol/research path
  - Tourist trail
  - Footpath in BINP
  - Defunct trail



**Figure 3.2. Distribution of Side-striped Jackals and Civets in BINP**

Data from GIS data base of CARE-DTC  
 Produced by Edward Andama in RS&GIS  
 lab, MUIENR, 1998

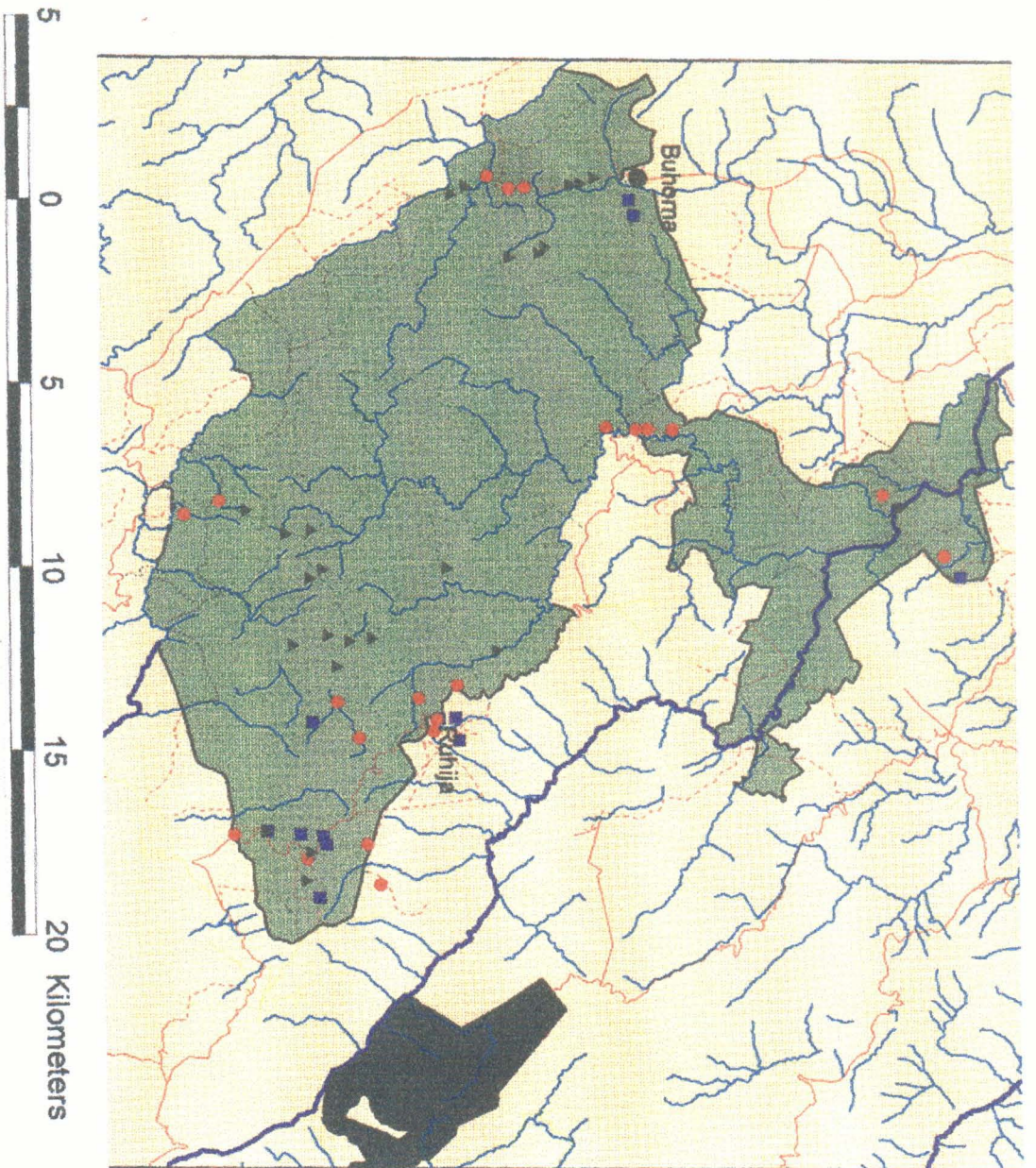


Figure 3.3. Distribution of Cat species in BINP

- LEGEND**
- Obs. of scats & spoor.
  - ▲ Golden cat
  - Wild cat
  - Serval cat
  - Infrastructure
  - Murrumbidgee road
  - Motorable track
  - Footpath
  - Patrol/research path
  - Tourist trail
  - Footpath in BINP
  - Defunct trail
  - Drainage
  - Main river
  - Minor river



Data from GIS data base of CARE-DTC  
 Produced by Edward Andarna in RS&GIS  
 lab, MULIENR, 1998

sites deep into the park, clearly indicating that the golden cat is associated with intact (relative) forest habitat.

#### **3.6.4 Mongoose species**

Mongoose species distribution is shown in figure 3.4. Slender mongoose was the most widely distributed species, ranging from forest ecotones to relatively intact forest. Water mongoose was exclusively restricted to the sites with permanent water sources, particularly swampy areas (figure 3.4). The Egyptian mongoose was restricted to the degraded habitats towards park periphery (ecotones) and outside the protected area (figure 3.4). The Banded mongoose was exclusively restricted to northern sector of the park, with abundant grassland vegetation.

#### **3.6.5 Genets, Honey badger, Otters and Zorilla**

Distributions of the Genets, Clawless Otter, Honey Badger, Spotted-necked Otter and Zorilla are presented in figure 3.5. Generally, Genets were the most widely distributed species, ranging from the interior of the park to the village banana plantations. Clawless Otters and Honey Badgers were the species with restricted distribution range within the park (figure 3.5). Their signs were only observed in Mubwindi swamp area, which lies in the interior of the park. Although the Spotted-necked Otter was only observed in the rivers south of the park, reports from the villages and fishing community indicate that Spotted-necked Otter occurs in most of the main rivers and lakes around BINP. Zorilla was mainly observed at forest periphery (ecotones) and private farmlands neighbouring the park (figure 3.5).

In summary the carnivore species with wide range distribution within the park include Palm civet, Serval cat, Wild cat, Golden cat, Genets and Slender mongoose. Their wide occurrence is probably because they do not require specific habitat conditions for survival provided their prey species are available. The species limited to forest ecotones and degraded habitats include Side-striped jackal, African civet, Zorilla and Egyptian mongoose. Populations of these species is likely to increase with mild habitat disturbance. The species restricted to interior of the forest include Honey badger, Clawless otter and

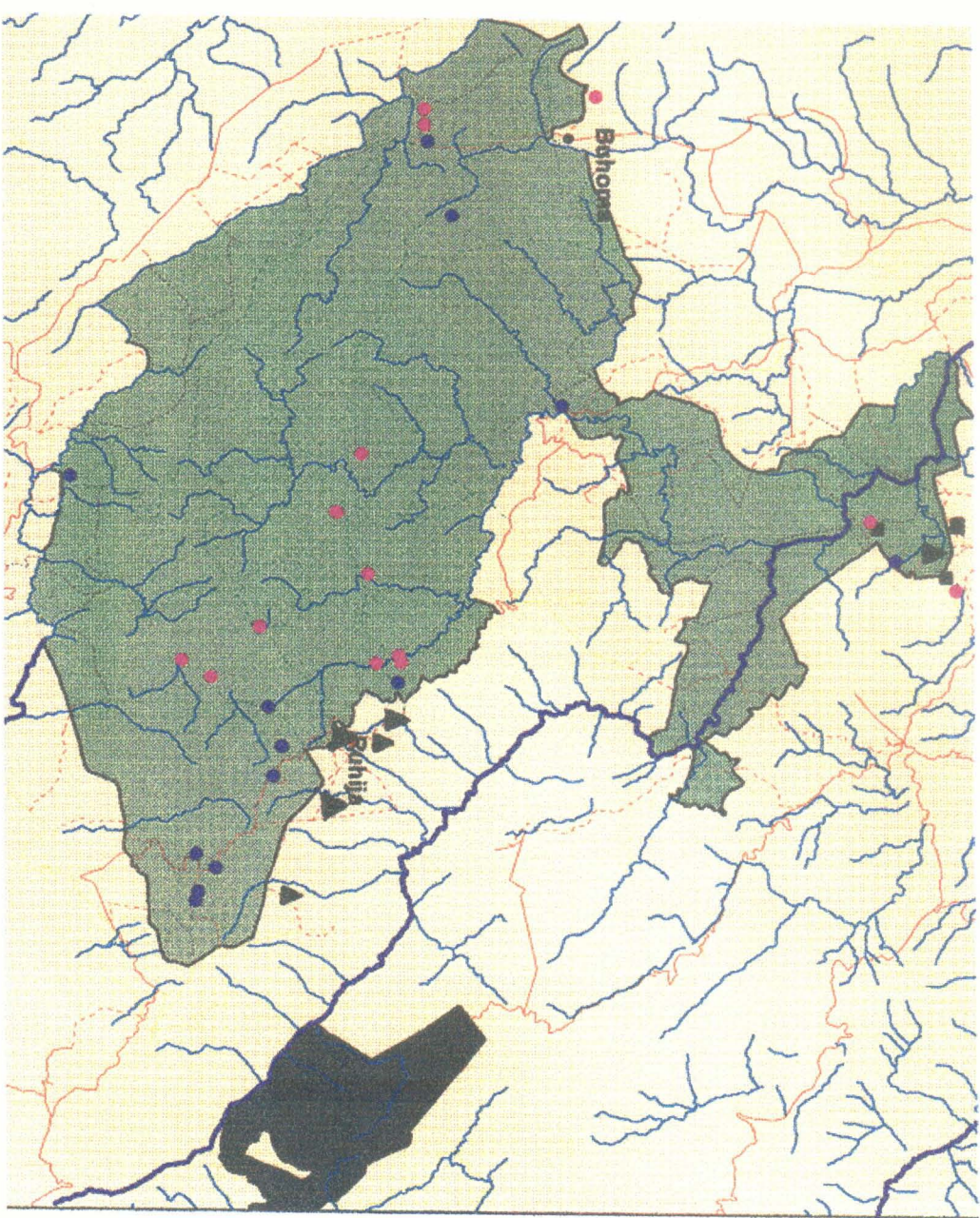


Figure 3.4. Distribution of Mongoose species in BINP

**LEGEND**

- Obs. of scats & spools
- Banded mongoose
- ▲ Egyptian mongoose
- Slender mongoose
- water mongoose
- 8 Drainage
- 25109 Main river
- 109 Minor river
- Infrastructure
- Murram road
- Motorable track
- Footpath
- Patrol/research path
- Tourist trail
- Footpath in BINP
- Defunct trail



Data from GIS data base of CARE-DTC  
 Produced by Edward Andama in RS&GIS  
 lab, MUIENR, 1998



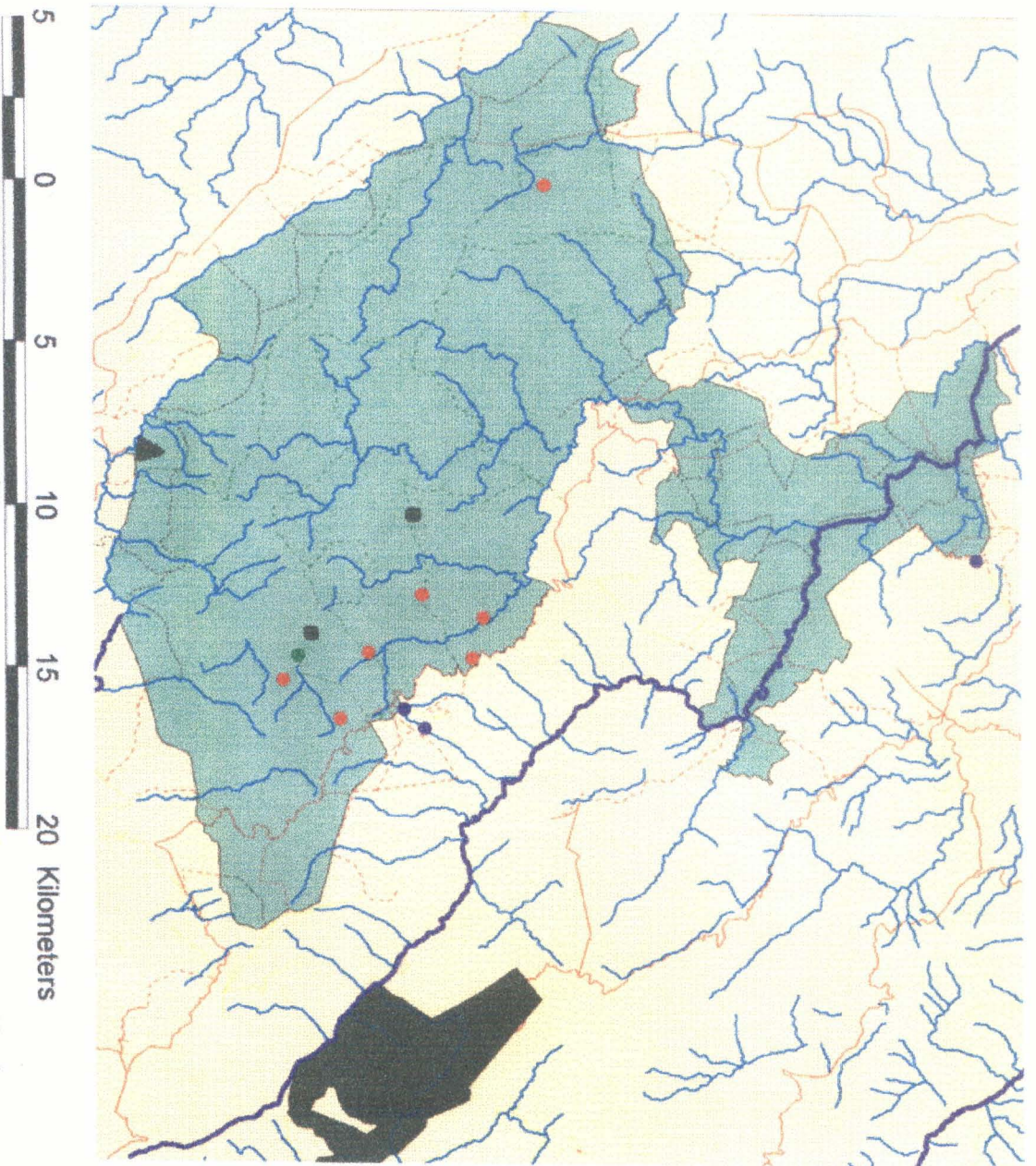


Figure 3.5. Distribution of Otters, Honey Badger, Genets and Zorilla in BINP.

- LEGEND**
- Obs. scats & spoor
  - Clawless otter
  - Genet species
  - Honey badger
  - Spotted necked otter
  - Zorilla
- Drainage**
- Main river
  - Minor river
- Infrastructure**
- Murram road
  - Motorable track
  - Footpath
  - Patrol/research path
  - Tourist trail
  - Footpath in BINP
  - Defunct trail



Data from GIS data base of CARE-DTCC  
 produced by Edward Andama in RS & GIS  
 lab, MUIENR, 1998

Spotted-necked otter. Their population probably declines with habitat degradation and could become prone to extinction with increased habitat disturbance.

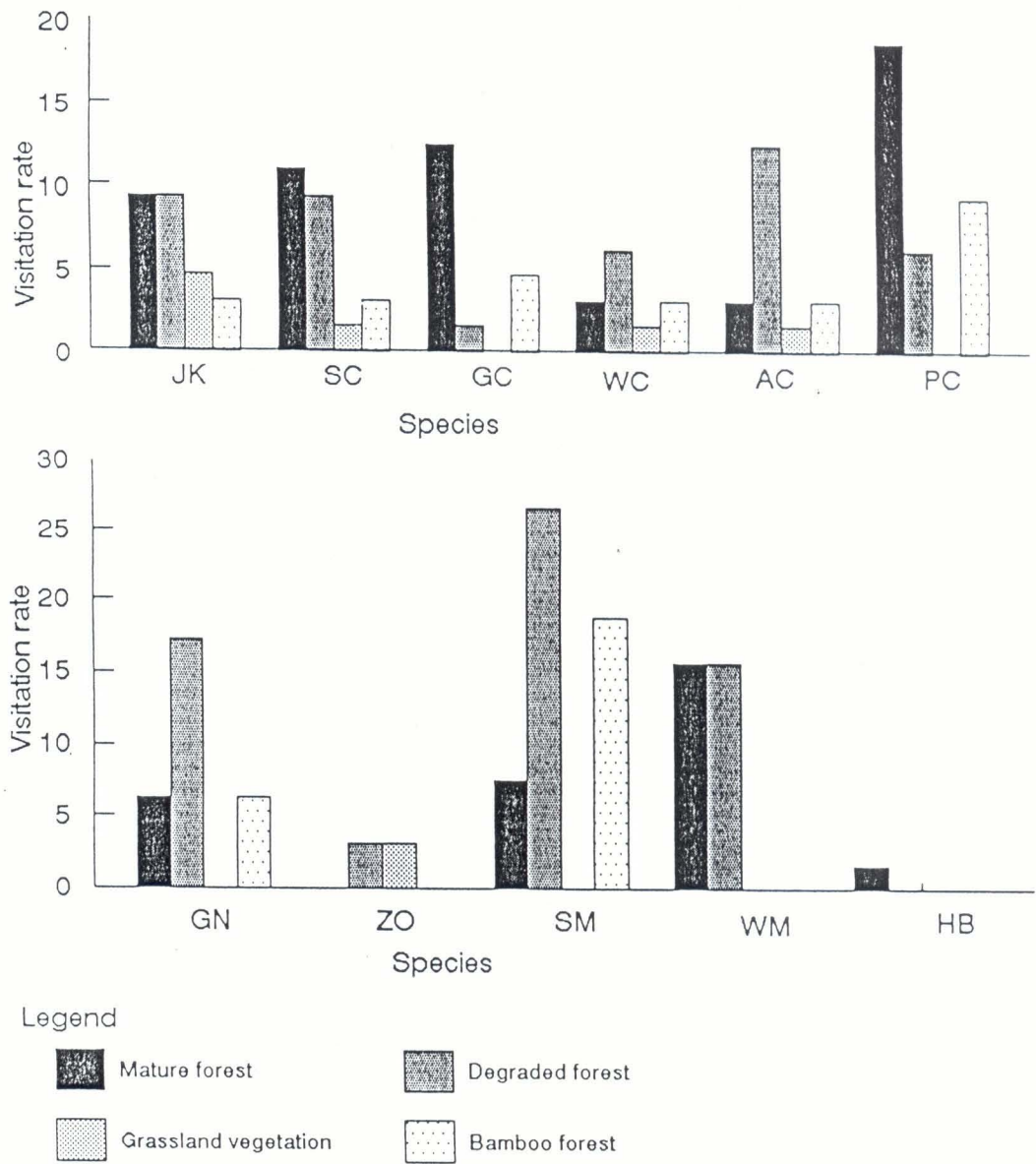
### **3.7 Habitat associations**

Figure 3.6 gives the visitation rates of carnivores in each of the four major vegetation types considered in this study, namely: mature forest, regenerating/degraded forest, grassland and bamboo forest. No attempt was made to measure the availability of the different vegetation types so that it is not possible to analyse habitat preferences. However, a comparison between visitation rates from histograms in figure 3.6 does allow differences to be seen between species and therefore revealing important ecological information on habitat associations for each species. For example high visits to scent stations for Serval cat, Golden cat, Palm civet and Honey badger were in mature forest, while visits by Wild cat, African civet, Genets and Slander mongoose were mainly recorded in regenerating/degraded forest and grasslands. Visitation rates in bamboo forest was generally moderate for most carnivore species recorded in this study. Swamps, rivers and streams could not be considered as separate vegetation categories because of being in continuum with the gallery forests vegetation. However, visits by aquatic carnivore species especially Water mongoose, Spotted-necked otter and African clawless otter were only recorded in the moist habitats.

General information on the range of habitats where the carnivores were encountered/recorded is presented in the figure 3.7. Although these may not necessarily be the preferred habitats for some of the species, they represent the habitat associations/attachments as observed in this study. And consequently provide the basis for identifying the species that require special conservation attention.

Based on the distribution of scats, spoors, sightings and visitation rate data, the carnivore species of BINP can conveniently be placed into five main groups;

- (i) forest dependent species, which include Golden cat, Palm Civet, and Honey Badger. These species were mostly restricted to the interior of the forest.
- (ii) forest edge and degraded habitat species. The Side-striped Jackal, Egyptian



Key to species

JK, Side striped Jackal	WC, Wild Cat	SM, Slender Mongoose	GN, Genets
SC., Serval Cat	AC, African Civet	EM, Egyptian Mongoose	SO, Zorilla
GC, Golden cat	WM, Water/Marsh Mongoose	PC, Palm Civet	
HB, Honey Badger			

Figure 3.6. Visitation rates of carnivores in four vegetation categories

Species	Major Habitats						
	BAB	HAF	HAS/R	LAF	DE/H	GRL	LAS/R
<i>C. adustus</i>	Shaded				Shaded	Shaded	
<i>V. civetta</i>	Shaded				Shaded	Shaded	Shaded
<i>N. binotata</i>	Shaded	Shaded		Shaded	Shaded		
<i>F. serval</i>	Shaded	Shaded		Shaded	Shaded	Shaded	
<i>P. aurata</i>	Shaded	Shaded		Shaded			
<i>F. sylvestrus</i>	Shaded	Shaded		Shaded	Shaded	Shaded	
Genets	Shaded	Shaded		Shaded	Shaded	Shaded	
<i>A. capensis</i>			Shaded				Shaded
<i>I. striatus</i>					Shaded	Shaded	
<i>L. meculicollis</i>			Shaded				Shaded
<i>M. capensis</i>		Shaded		Shaded			
<i>H. sanguineus</i>	Shaded	Shaded		Shaded	Shaded	Shaded	
<i>H. ichineumon</i>					Shaded	Shaded	
<i>H. paludinosus</i>			Shaded				Shaded
<i>M. mungo</i>					Shaded	Shaded	

Shaded bars indicate presence of carnivore species.

Key to the major habitat types:

BAB = Bamboo zone, HAF = High altitude mixed forest, HAS/R = High altitude swamp/river and gallery forest, LAF = Low altitude mixed forest, DE/H = Degraded/cultivated habitats, GRL = Grassland vegetation, LAS/R = Low altitude swamp/river and the gallery forest

**Figure 3.7** Habitat associations/attachments of carnivores in BINP. Constructed from sightings, visitation rates, spoor and scats signs and trapping results.

Mongoose, Zorilla, and African Civet fall in this category. They were frequently recorded in areas with an increased human presence however, they probably take temporary refuge into the park.

(iii) generalists species include Genets, Slender Mongoose, Wild cat, and Serval cat. The distribution of these species is much wider, ranging from the pristine forests to the degraded habitat.

(iv) Lower altitude grassland species:- only Banded mongoose fits in this category.

(v) Moist habitat (swamp/river) species:- includes the Water Mongoose, Spotted-necked Otter and Clawless otter.

### **3.8 Habitat correlates**

#### **3.8.1 Introduction**

Investigations into the effects of some habitat variables is very important in assisting to explain observed patterns of carnivore distributions and abundance's. In the present study three habitat variables investigated were:- (i) human disturbance (road/edge and human use), (ii) percentage ground vegetation cover (GVC) and (iii) altitude. Except GVC and altitude, human disturbance was difficult to quantify accurately.

The working hypotheses investigated in this study included:

(i) sites located close to the park periphery and major roads exhibit greater edge effect (and thus human disturbance) than those deeper into the park.

(ii) the forest habitat disturbance affects distribution and abundance of carnivore species equally.

(iii) the ground vegetation cover and altitude affect distribution of all carnivore species equally.

#### **3.8.2 Effects of human disturbance on the abundance of carnivore species**

The aim of this part of the study was to investigate how anthropogenic factors (influence of the major roads/park edge and human use) affect carnivore species abundance and distribution. The most commonly observed human disturbances during this study

include: human and livestock traffic, food droppings along the main roads/paths within the park, grazing of domestic livestock along the park boundary and removal of young plants for domestic use among others.

Effects of human disturbance on mammals is diverse, it can result in proliferation or decrease in their abundance and distribution, depending on species habitat requirements. There were three distribution patterns of carnivores noted in this study (see section 3.3 and 3.6): (i) widely distributed species, (ii) species mainly limited to the interior of the park, and (iii) species mainly limited to the periphery (ecotone region). These patterns of distribution are expected to result from the effects of human disturbance and are also expected to be reflected in the carnivore species scent station visitation rates (consequently their abundance). Friedman's test (appendix 3) was used to test the relationships between visitation rates of carnivore species in different study sites. The result shows an overall significant difference in visitation rates of carnivores between the study sites (Friedman's test;  $X^2_r = 18.242$ ;  $X^2_{0.05,6} = 12.592$ ). Spearman's rank correlation (appendix 3) were used to investigate the relationship between the level of human disturbance (measured as distance from the park boundary or main road) and visitation rates of carnivore species. The results (table 3.7) show that a decrease in the level of disturbance correlated negatively for peripherally occurring carnivore species such as *C. adustus*, *V. civetta* and *I. striatus*. This is probably because these species are attracted to the villages since they partly depend on domestic food remains and crop raiding. While the highly positive correlation obtained for *N. binotata* and *P. aurata* (table 3.7) indicates that they favour areas with minimal human presence. There was less strong correlation to the human disturbance by *Felis serval*, *F. sylvestrus*, and *H. sanguineus* however, these species mainly preferred the edge or ecotones. This is probably because of increase in abundance of the small mammals (especially rodents) at the ecotone region, which forms their major food item.

**Table 3.7 Spearman's rank correlation tests comparing the percentage visitation rates of carnivores with increase in distance from the road/boundary.**

Carnivore species	$r_s$	df	P
<i>C. adustus</i>	-0.7633	2	0.1
<i>V. civetta</i>	-0.7589	2	0.1
<i>N. binotata</i>	+0.663	2	0.1
<i>F. serval</i>	+0.4768	2	NS
<i>P. aurata</i>	+0.7768	2	0.05
<i>F. sylvestris</i>	+0.1964	2	NS
Genets	+0.5267	2	0.1
<i>I. striatus</i>	-0.6696	2	0.1
<i>H. sanguineus</i>	+0.1757	2	NS
<i>H. paludinosus</i>	+0.5357	2	0.1

ns, not significant at 0.1.

### 3.8.3 Influence of the ground vegetation cover (GVC) on carnivore abundance.

Differences in GVC between study sites can influence the overall distribution of mammal species. Percentage of ground vegetation cover has been found to influence distribution and abundance of small mammals (especially rodents) in Kibale Forest Reserve (Muganga, 1989). In the present study area there was no significant difference in percent GVC between all study sites investigated (Friedman's test;  $X^2_r = 0.001$ ;  $X^2_{0.05(1)} = 3.841$ ). However, when association between percent GVC and visitation rates of carnivores to the scent stations was investigated using the Spearman's rank correlation (appendix 3), a negative correlation was obtained for *C. adustus* and *P. aurata*, while positive correlation obtained for *F. sylvestris*, *V. civetta*, *N. binotata*, *H. sanguineus* and Genet species (table 3.8). The result of this study suggests that GVC alone can be an important factor in contributing to the distribution and abundance of some carnivore species. The ground vegetation cover probably affects the abundance of each carnivore species indirectly through their foraging habits.

**Table 3.8 Spearman's rank correlation test comparing the percentage visitation rates of carnivores to scent stations with percentage ground vegetation cover.**

Carnivore species	$r_s$	Df	p
<i>C. adustus</i>	-0.800	2	0.05
<i>V. civetta</i>	+0.750	2	0.1
<i>N. binotata</i>	+0.958	2	0.05
<i>F. serval</i>	+0.632	2	0.005
<i>F. sylvestrus</i>	+0.932	2	0.05
<i>P. aurata</i>	-0.958	2	0.005
Genets	+0.550	2	0.05
<i>H. sanguineus</i>	+0.800	2	0.05
<i>H. paludinosus</i>	+0.500	2	0.01

#### **3.8.4 Influence of altitude**

To assess the influence of altitude on the distribution and abundance of carnivores, a regression analysis (appendix 3) was used. Altitude was regressed against percentage visitation rates to the scent stations. The results indicate altitude as an important factor in affecting abundance and distribution of three carnivores species, *Felis serval*, *Profelis aurata* and *Herpestes sanguineus* (at  $p = 0.1$ , table 3.9). For majority of the carnivore species in this study altitude appeared not to be an important factor affecting their distribution (table 3.9).

**Table 3.9 Regression analysis of visitation rates to the scent stations with altitude.**

Carnivore species	r	B	t	p
<i>Canis adustus</i>	0.188	0.002	0.428	NS
<i>Viverra civetta</i>	0.089	0.004	0.201	NS
<i>Nandinia binotata</i>	0.462	0.003	1.164	NS
<i>Felis serval</i>	0.718	0.002	2.305	*
<i>Profelis aurata</i>	0.843	0.002	3.510	*
<i>Felis sylvestrus</i>	0.332	0.003	0.787	NS
Genets (two species)	0.578	0.002	1.583	NS
<i>Ictonyx striatus</i>	0.436	0.001	1.083	NS
<i>Herpestes sanguineus</i>	0.640	0.007	1.865	*
<i>Herpestes ichneumon</i>	0.019	0.011	0.042	NS
<i>Herpestes paludinosus</i>	0.123	0.001	0.277	NS

\* Significant at 0.1

The Influence of more than one factor in contributing to the abundance of carnivores was investigated using multiple regression analysis. In particular the influence of the combination of altitude and distance from the park boundary and main roads (edge effects) on the visitation rates of carnivores was investigated. Ground vegetation cover (GVC) could not be incorporated as a third variable in the multiple regression analysis because it varied within each study site. The results for each carnivore species (table 3.10) indicate how much both altitude and habitat disturbance contribute to the observed variations in visitation rates and thus distribution and abundance of carnivores in this study. Example for *V. civetta*, *F. serval* and *C. adustus* the  $r^2$  adjusted values of 0.82, 0.79 and 0.71 respectively (table 3.10) indicate that both altitude and habitat disturbance contribute 82%, 79% and 71% respectively to the observed variations in visitation rates. The least affected carnivore species by combination of altitude and habitat disturbance are *M. capensis*, *I. striatus*, Genets and *H. paludinosus* (table 3.10). This means that there are probably other important factors that affect the distribution and abundance of these carnivore species.

**Table 3.10 Multiple regression analysis examining the contribution of both altitude and distance from park boundary/road to the observed visitation rates of carnivores to the scent stations**

Carnivore species	r <sup>2</sup>	r <sup>2</sup> -adjusted	Standard error	n	P
<i>C. adustus</i>	0.809	0.714	2.637	7	0.036
<i>V. civetta</i>	0.884	0.827	1.620	7	0.013
<i>I. striatus</i>	0.373	0.059	1.100	7	0.329
<i>M. capensis</i>	0.164	0.000	0.846	7	0.569
<i>N. binotata</i>	0.426	0.135	2.190	7	0.329
<i>P. aurata</i>	0.651	0.477	2.204	7	0.122
<i>H. sanguineus</i>	0.574	0.361	5.676	7	0.181
<i>H. paludinosus</i>	0.389	0.083	8.614	7	0.374
<i>F. serval</i>	0.651	0.474	2.317	7	0.122
<i>F. sylvestrus</i>	0.866	0.799	1.367	7	0.018
Genets	0.385	0.077	2.054	7	0.372

### 3.9 Feeding habits of carnivores

#### 3.9.1 Foraging habits

Carnivores are mostly solitary hunters and foragers but certain mongoose species, otters, wild dogs, hyenas and lions are social. This behaviour appears to be connected with greater success in hunting (Kingdon, 1977). While in smaller mongoose it appears to be related to greater immunity from predators by increasing the number of alert eyes and noses. Observations made during this study indicate that most of the carnivore species in BINP are solitary hunters and foragers. Communal hunting/foraging habits were only observed in *C. adustus* (most of them probably mated pair), Zorilla and Banded mongoose (which were observed to be gregarious, moving in troops). Night observations indicate that most carnivore species are terrestrial in their ranging/foraging habit. *Nandinia binotata*, Genets and *H. sanguineus* were however, observed to be arboreal (table 3.3) in their foraging behaviour, while *M. capensis*, *H. paludinosus* and *A. capensis*

were observed to feed in swampy/river areas. Except for *M. mungo*, *I. striatus* and *H. ichneumon* which mainly foraged in day time (table 3.3), most carnivore species observed during this study were more active at night. Few observations of *P. aurata*, *H. sanguineus*, *C. adustus*, *F. serval*, and *F. sylvestris* were during daytime. Nocturnal foraging habit is probably associated with ease of catching prey species or increased foraging success.

### 3.9.2 Diets of carnivores

During this study I encountered few scats of Clawless otter, Spotted-necked otter and Honey badger. Due to this, these species are excluded from the food habit analysis. Assessment of seasonal fluctuations and variations in food habits from site to site were also not possible due to time constraint. Generally carnivore species recorded in this study had wide range of food habits, ranging from wild animal and plant foods to domestic animals and crops. The dietary account presented here is for all study sites covered over the seven-month study period and was mainly obtained from scat/regurgitate analysis and opportunistic observations.

#### 3.9.2.1 Side-striped Jackal

Rodents and insects were prominent food items in the diet of Side-striped Jackal followed by domestic refuse and food crops (figure 3.8(a)). Domestic refuse mostly consisted of village offal and remnants of the food thrown away as garbage. Food crops observed in the scats included maize, cowpea, sweet potatoes, Irish potatoes and millet (appendix 4). Fruits of wild plants (*Myrianthus holistii* and *Syzygium cuminii* and *Ficus* species) were also recovered from the scats. On several occasions scats of Side-striped jackal examined were wholly constituted of the Safari ants (*Dorylus* species). In one instance, five side-striped Jackals were observed at night carrying as a prey an African civet carcass.

### 3.9.2.2 African Civet

Dietary habit assessment for African civets was much easier due to their latrine habit that makes it easy to locate scats. Most of African civet scats were located near roads (plate 2) or paths. Food crops, domestic refuse and wild plant fruits dominated the diet of the African civets while rodents and insects formed smaller percentage (figure 3.8 (b)). The food crops and wild plant fruits observed in the scats of African civet were similar to those observed for Side-striped Jackal and besides those the leaves of *Setaria* grass species (Plate 2) were also recorded in the majority of the scats observed.

### 3.9.2.3 Serval and Wild Cats

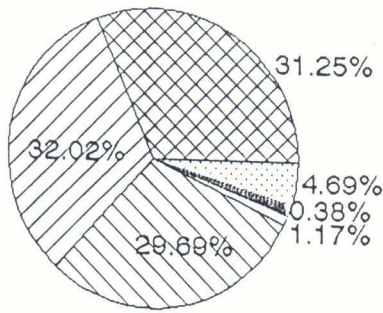
Rodents dominated diet of Serval and Wild cats, followed by insects, birds and eggs (figure 3.8 (c) and (d) respectively). There was one instance when a goat's hairs were recovered in the scat of Serval cat (appendix 4). This could have been a result of domestic animal raiding or raiding of skins from village slaughterhouses.

### 3.9.2.4 Golden Cat

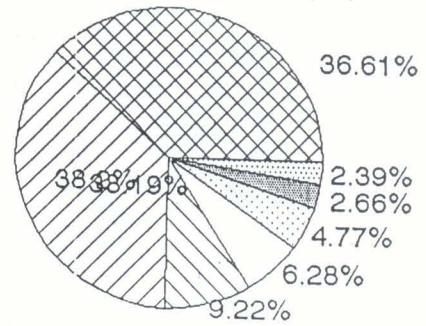
Golden cat was the only cat species whose prey consisted mainly of medium sized herbivores (figure 3.8 (e)). Important mammalian herbivore species recorded in its diet included duikers (*Cephalophus* species), *Cercopithecine* monkeys and bush pigs. The Golden cat was also observed chasing duiker in Mubwindi swamp area and the remains of the duiker recovered (Tibenda per. comm.). Other prey species identified included rodents birds and avian eggs.

### 3.9.2.5 Palm Civet

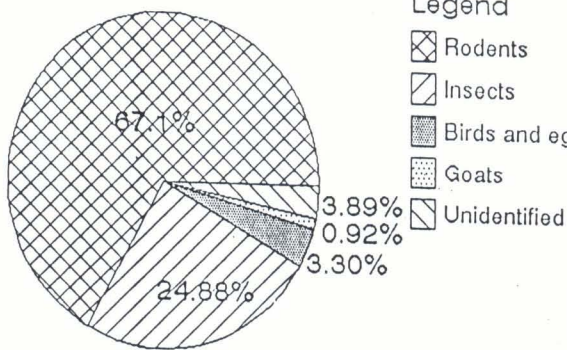
The scats examined revealed birds, avian eggs, insects, rodents and wild fruits as important food items in the diet of Palm civets (Figure 3.8 (f)). Wild plant fruits observed were from *Ficus* and *Syzyguim* species. During night surveys, Palm civets were also observed leaping from tree to tree, probably searching for fruits, birds and arboreal rodents in their roosting/foraging sites.



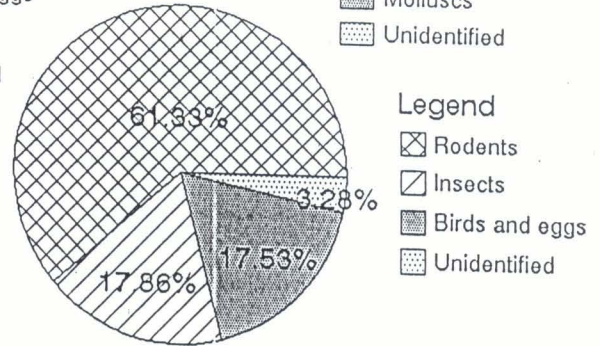
(a) Side striped Jackal (n=203)



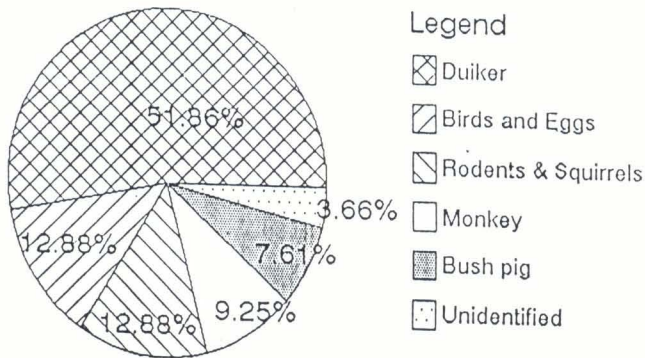
(a) African civet (n=182)



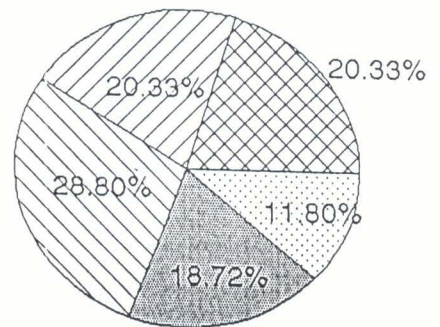
(c) Serval cat (n=141)



(d) Wild cat (n=112)



(e) Golden cat (n=41)

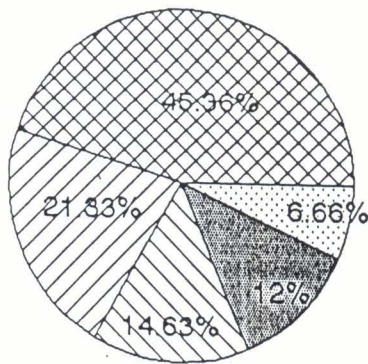


(f) Palm civet (n=48)

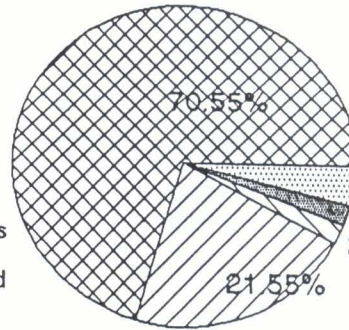


n = number of scats analyzed.

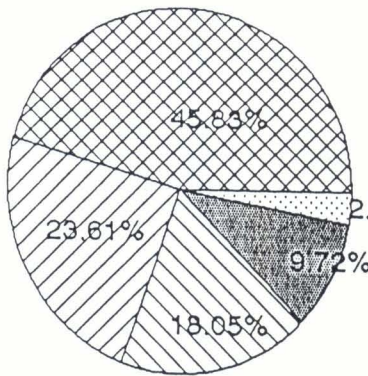
Figure 3.8 The diet of carnivore species in BINP. Expressed as percentage of scats dominated by each food item (from scat analysis).



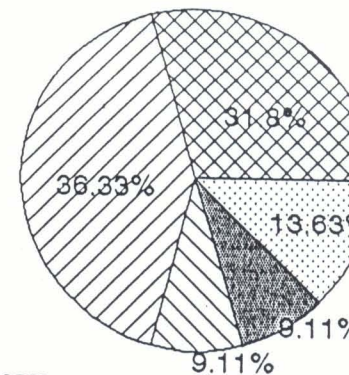
(g) Genets (n=47)



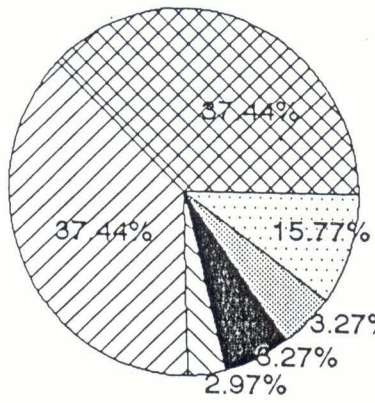
(h) Water Mongoose (n=39)



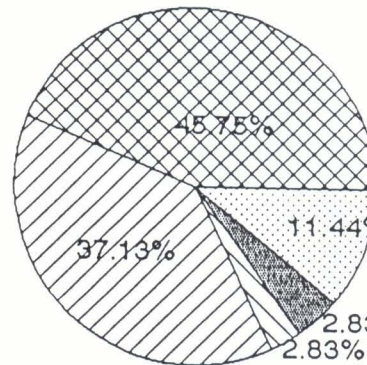
(i) Slender mongoose (n=46)



(j) Banded mongoose (n=23)



(k) Zorrilla (n=27)



(l) Egyptian mongoose (n=31)

Figure 3.8 Continued



**Plate 2. Scats in a latrine site of African Civet located on a main road. Note arrow pointing to the green leaves of *Setaria* grass species in the scat on the right side.**

### 3.9.2.6 Genets

The scats obtained from specimens of the two genet species (Small-spotted genet and large-spotted genets) were similar in size and appearance. Because of this the scats obtained from the field could not easily be assigned to either of the two genet species with certainty. Therefore the food habit given here is for both species considered together. Generally rodents formed large part of Genet's diet, followed by insects, birds and eggs respectively (figure 3.8 (g)). Wild plant fruits especially *Syzygium* and *Ficus* species (appendix 4) also constituted important part of their diet.

### 3.9.2.7 Slender Mongoose, Banded Mongoose, Egyptian Mongoose and Zorilla

There was high similarity in food habits of the above four mustelid species. Their diets were dominated by rodents and insects (figures 3.8 (i), (j), (l) and (k)).

Other food items recorded in the scats of Slender mongoose include birds, avian eggs, wild plant fruits (especially *Ficus* sp.) and banana (appendix 4). Molluscs and millipedes ranked next in importance as food items for Banded Mongoose (figure 3.8 (j)). For the Egyptian Mongoose, reptiles and avian eggs constituted the second largest part of the diet (figure (l)). Muhweezi (1991) similarly recorded avian eggs in the diet of Egyptian Mongoose at Ruhija (in BINP). In the diet of Zorilla eggs, reptiles and molluscs ranked next in importance as food items (figure 3.8 (k)).

### 3.9.2.8 Water Mongoose

Composition of Water Mongoose diet was quite different from that of other mongoose species in that much of its diet consisted of molluscs and insects (figure 3.8 (h)). Amphibians and rodents seemed to be only occasionally consumed.

### **3.10 Discussion**

#### **3.10.1 Populations of carnivore species**

For meaningful population estimates from line transect census, it is advisable that a similar study be conducted where populations are known through other reliable methods so that the sighting frequencies can be related to known populations, as was done by Waser (1980), Emmons (1982) and Glanz (1982). This is the first study of its kind that has attempted the population estimation of carnivores in BINP. The density estimates presented in table 3.6, although fairly consistent with the ranges reported elsewhere (example given by Rowe-Rowe, 1992) are very preliminary and require further verification using other methods. The density estimates for Side-striped Jackal and African civet (table 3.6) were particularly high. A possible explanation for the high population density estimates comes from habitat associations of these two carnivore species. For example most sightings of Side-striped Jackals and African civets were at the park periphery (ecotone). Considering that most of the natural vegetation outside the park is already lost, it appears that the park periphery acts as a refuge to these species, leading to the higher density value obtained during this study. Secondly the vegetation of BINP mainly consists of forest but most density estimates recorded elsewhere were obtained in non-forest habitats such as example Savannah and woodland vegetations (Rowe-Rowe, 1992). This could also lead to the differences observed in the density estimates.

#### **3.10.2 Ecological correlates**

##### **3.10.2.1 Introduction**

Animal habitat relationships and interactions provide the central core to the ecology of the species. The fact that a species is invariably associated with a certain habitat or habitat element means that there are crucial needs being effected (Riney, 1982). It is often thought that a habitat is a preferred one, because that is where a species is most frequently observed. However, this may be misleading if the species exists on marginal habitat as a result of dwindled preferred habitat or hunting pressure (Riney, 1982). Habitat utilisation

by carnivores is an important variable that can influence visitation rates, sighting frequencies and even spoor and scat counts. According to Stander *et al* (1997) predatory strategies of carnivores are shaped by ecological constraints that show extensive regional variation. Fundamental ecological and behavioural characteristics of carnivores such as density, grouping pattern, range size and prey selection are influenced respectively and individually by habitat and prey density, dispersion and richness. Understanding this apparently complex intra-specific variation in ecology and behaviour is important when addressing the conservation of carnivores. However, relatively little is known of the factors that determine the microhabitat selection/distributions of carnivores in tropical forests. In this study the factors that were found to influence the microhabitat selection, distribution and abundance of carnivores include: human disturbance, ground vegetation cover and altitude, each of which is discussed below.

#### **3.10.2.2 Impact of human disturbance on carnivore abundance and distribution**

Physical conditions along habitat edges influencing the environment far into the core of the protected areas and thus altering the distribution and abundance of interior dwelling species has been observed by Cairns (1988). Few studies have investigated the impact of forest disturbance on carnivore distribution and abundance. For example Heydon and Bulloh (1996) investigated the impact of logging on sympatric civets in Boneo. Their findings revealed an overall reduction in the density of civets in logged forest. This study attempted the investigation of how human activity as a source of disturbance affects the distribution and abundance of carnivores within the study area. Signs associated with human activity were more common at the exterior than in the interior. Certainly the history of pitsawing in BINP indicates that it was more concentrated at the edge of the park and this may have had an influence on the vegetation and consequently the distribution of fauna of the park. Harcourt (1981) found that human use was most common near the park periphery. The results of this study suggest considerable differences in distribution of carnivores within the study area. There was a significant difference (Friedman test;  $X^2_{\tau} = 18.242$ ;  $X^2_{0.5, 6} = 12.592$ ) in visitation rates of carnivores with the increasing distance from the park edge and major roads. This gives a reasonable picture of relative distribution of the carnivore species. The distribution and abundance pattern generally shows that carnivore species which depend on scavenging, crop raiding

and rodents as main food items tend to occupy the peripheral parts (ecotone regions) of the park as well as degraded habitats outside the park. This observation appeared to hold true at all altitudinal ranges covered. Since human interference (and thus disturbance to the park and its carnivores) is highest on the fringes, it is possible that the carnivore species using the edges of the park or frequenting the road prefer slightly disturbed/modified habitats. This was exemplified by the distribution patterns of Side-striped jackals and African civets, which in particular showed close relationship with human habitation. The partial dependence of these species on village refuse, food crops, and small mammals in the private farms along the park boundary is probably an important factor dictating upon their distribution.

From the distribution patterns, the occurrence of Serval cat, Wild cat, Egyptian mongoose, and Zorilla appeared to be influenced by availability of prey species (especially rodents and insects). The sighting frequency, visitation rate and spoor/scat distribution results for these species indicate that they mostly occur along the periphery or outside the park. Considerable information has previously been collected on how changes in the forest ecology as a result of human disturbance affect small mammal populations. Of particular interest is that all of the studies from elsewhere (e.g. by Delany, 1971 and Muganga, 1989) and in the present study area (for example by Aleper, 1995 and Kasangaki, 1998) documented a built up of species of small mammals in degraded or selectively logged forest. The dense understorey of degraded forests is reported to have more food, provides nesting sites and protection that attracts rodents (Isabirye-Basuta and Kasenene, 1987). This results in higher rodent species diversity and abundance at the periphery (ecotone). Since the largest part of the diet of some carnivore species (such as Serval cat, Wild cat, genets and most mongoose species) in this study consisted of small mammals, this appears to attract them to the degraded sites, explaining the observed distribution trends. Another explanation could be that some carnivores which were formerly none-forest species have taken refuge at the park periphery as a result of massive loss of natural habitat outside the park.

An inverse relationship in the distribution was obtained for Honey Badger, Golden Cat, Clawless Otter and Palm Civets. These species were mostly restricted to the interior of the forest, suggesting that they may be negatively affected by human disturbance. Studies

done elsewhere on different carnivore species, indicate that home range size depends on the distribution patterns of prey and other resources (see Richard, 1972). From the observed distribution patterns in this study there is some evidence to suggest that the distribution of Golden cats is related to the availability of their major prey items. From food habit study, duikers form a large part of the Golden cat's diet (see section 3.9.2). Although an inventory on duiker distribution and abundance was not undertaken during this study, the encounter rates of duikers was highest in sites deeper into the forest than those located close to the periphery. This therefore appears to explain the observed distribution of Golden cats in the park. The restricted occurrence of Water Mongoose, African Clawless otter, and Spotted necked otter is probably a result of human clearance of their habitats outside the park. Rowe-Rowe (1991) observed these three aquatic carnivores to coexist through out their geographic ranges. Slender mongoose and Genets had the widest distribution patterns. This suggests an elastic adaptability to the habitat conditions of the study area. The result of this study conforms with the report by Kingdon (1977), who observed Slender Mongoose as the most successful and adaptable of the African carnivores, occurring in a wide range of altitudes. A similar observation was made by Dorst and Dandelot (1988).

### **3.10.2.3 Ground vegetation cover**

Relatively little is known of the ecological factors that determine the micro-distribution and abundance of carnivores in TMFs. Most studies examining the effects of GVC on micro-distribution and abundance of mammals have focused on rodents (Jeffery, 1977; Muganga, 1989). Muganga (1989) found that GVC and small mammal population density, biomass, and species diversity were highest in the disturbed forest than in the uncut forest in Kibale Forest Reserve. Delany (1971) and Jeffery (1977) also arrived at a similar conclusion. These studies attributed the differences in the small mammal population parameter to the increase in the understory vegetation of the felled forest. Unfortunately the influence of GVC on the distribution of carnivores has been rarely documented.

The results of this study suggest that GVC influences visitation rates of some carnivore species. For example positive (significant) correlation was obtained between GVC and

visitation rates for Serval Cat ( $r_s = +0.632$ ,  $p = 0.005$ ), Slender Mongoose ( $r_s = +0.800$ ,  $p = 0.05$ ), Wild Cat ( $r_s = +0.932$ ,  $p = 0.5$ ) and Palm Civet ( $r_s = +0.958$ ,  $p = 0.005$ ). This indicates that the dense GVC could be an important factor, affecting distribution of these carnivore species indirectly through attracting their main prey species especially small mammals and insects. Small terrestrial mammals tend to be attracted to the areas with dense GVC due to the protective value it renders to them (Muganga 1989). This could form the basis of the high visitation rates of such carnivore species observed in areas with high GVC in study. However, Muganga (1989) suggested that the open and sparse canopy forest with thick undergrowth, similar to that in the present study area are too dense to allow effective hunting for large mammalian predators. Under such circumstance the least hampered predators by the dense undergrowth are the small and perhaps crawling species such as snakes. Indeed some of the medium sized carnivore species such as Side-striped Jackal ( $r_s = -0.800$ ,  $p < 0.05$ ) and Golden Cats ( $r_s = -0.958$ ,  $p = 0.005$ ) had negative correlation with the increase in GVC. This suggests that the larger carnivores may not be swift in manoeuvring the prey species in thick vegetative undergrowth. Although GVC may be an important factor in affecting the visitation rates of some carnivore species, other factors, such as hunting/foraging habits and home range probably influence their abundance and distribution rates in forested habitats.

#### **3.10.2.4 Altitude**

Bwindi Impenetrable National Park is unique in that it spans a wide altitudinal range from 1160m a.s.l. at the northern end to 2607m a.s.l. at Rwamunyonyi hill on the eastern edge of the Southern part. This results in a continuum of habitats from lowland to montane forests. Understanding of the biological mechanisms underlying different types of zonation allows prediction of how these major patterns of biodiversity on landscapes will change through time (Huston, 1994). Altitude per se has no direct influence on mammal species distribution, it is a "factor-complex" gradient (Austin and Smith, 1989). Altitude is correlated with a variety of factors such as resources and regulators that affect carnivore abundance including precipitation and temperature. Unlike for rodents, it is not easy to categorise carnivore species distribution according to elevation, but the relative abundance of each species at the different altitudes indicates which species prefer altitudes and those, which do not. The relationship between altitude and species

abundance has been examined for rodents of western Ruwenzori (Misonne, 1963) and BINP (Kasangaki, 1998). But there is no record of attempts to examine the influence of altitude on the carnivore species in Uganda.

The result of this study suggests that most carnivore species in BINP have wider altitudinal ranges. However, the abundance trends of Serval Cats, Golden Cats and Slender Mongoose showed some evidence of preference for higher altitude areas (regression result values;  $r = 0.843$ ,  $p = 0.1$ ,  $r = 0.718$ ,  $p = 0.1$ ,  $r = 0.64$ ,  $p = 0.1$  respectively). Kingdon (1977) similarly reported that Golden Cat shows higher preference for high altitude environments such as sub-alpine, bamboo and montane habitats. On the other hand, Banded Mongoose was the only altitudinally restricted carnivore species. It was only recorded in the low altitude region (1160 to 1567 m.a.s.l) of the northern sector where there is grassland vegetation. A probable explanation for this observation is that increase in altitude is associated with reduction in temperatures. The lower temperatures at high altitude areas are probably unfavourable to Banded Mongoose, which mainly occur in low altitude and warm habitats.

Multiple regression results indicated that altitude and habitat disturbance are important factors affecting the distribution and abundance of some carnivore species. Example for *C. adustus* and *V. viverra* the adjusted  $r^2$  values of 0.714 and 0.827 respectively (table 3.10) indicate that altitude and habitat disturbance account for 71.4 percent and 82.7 percent respectively for the observed variations in the visitation rates. On the other hand for some carnivore species, the combination of altitude and habitat disturbance contributes minimally to the observed distributions. Among these are Genets and *I. striatus*, where the adjusted  $r^2$  values of 0.077 and 0.083 (table 3.10) respectively, meaning that altitude and habitat disturbance only accounted for 7.7 percent and 8.83 percent respectively of the observed variations in the visitation rates. This implies that although altitude and habitat disturbance influence the distribution and abundance of these carnivore species, they are not the only factors and perhaps not the most important in play. There are possibly other important factors that influence their abundance and distribution. Some of which include climatic conditions and habitat complexity characterised by differences in slope, aspect, microhabitat, soil, vegetation, nutrients and water.

### 3.10.3 The status of carnivores

Since the range of each species is determined by its ecological requirements; the "status" in this study refers to the abundance and problems affecting conservation of the species within BINP and the surrounding parishes. The terms "rare", "common" and "abundant" are very subjective and based on the status assessments from the result of this study. The predominant/most abundant carnivore species recorded in this study were the Slender mongoose and Genets. These species were distributed over the whole altitudinal range of BINP (1160-2607 m.a.s.l), from the interior to the periphery of the park and the surrounding villages. Waser (1980) observed that the two genet species observed in this study, *G. tagrina* and *G. servalina* did not overlap in their distribution in four areas of Serengeti National Park. However, trapping records in this study show that they do overlap in their distribution in BINP. The Side-striped jackals and African civets although common and occurring over a wide altitudinal range they were mainly restricted to the periphery of the park and the surrounding villages. The manner of their distribution makes them to have a higher interaction rate with the local human population and consequently exposing them to the risk of persecution.

Although the livestock/poultry raiding rate by the Golden cats was reported to be on the decrease during this study, this does not indicate a reduction in their population. There was high sighting frequency and high visitation rate for this species in the interior of the park. This could suggest a shift in Golden cat's prey choice, from the domestic animals to the wild species. Considering the nature of habitat associations, Golden cats appear to be at a better conservation status within the park. Serval cats and Wild cats although rarely encountered in the park, occurred over the whole altitudinal range and from the interior of the park to the surrounding villages. Unfortunately they are the most commonly killed carnivore species because they frequently prey on poultry. The Zorilla and Egyptian Mongoose can be described in the category of rare to common. Although distributed over the whole altitudinal range, they are mainly restricted to the park periphery and the surrounding farmlands. Their current distribution range indicates that they are at a higher risk of habitat loss than any other carnivore species in BINP. This is because most of the land outside the park is being put under cultivation. Banded mongoose is restricted to the

north sector of the park where there is grassland vegetation. Water mongooses are restricted to the swampy and permanent water habitats and their status within the park is satisfactory. However they are rare outside the park because swamps which form their major habitat are currently being cleared for farmland.

Honey Badgers, Spotted-necked Otters and Clawless Otters are rarer than most carnivore species occurring in BINP. Honey badger unlike other carnivore species is restricted to the interior of the park. The occurrence of Spotted-necked otter was limited to large and permanent rivers. Although fewer observations were made on distributions of Spotted-necked Otter, its habitat requirements suggest that it may occur in all major rivers of BINP. Clawless otters are unlikely to occur outside the park due to their restricted habitat preferences. The large swamps occurring outside the park have been cleared with the exception of Ngoto swamp, which is protected by a local community organisation.

#### **3.10.4 Food habits of carnivores**

To understand the impact of predators on prey species, it is necessary to know what prey species they are taking, how many of them they take what age, sex, condition etc. Among the ecological aspects of forest carnivores, food habits are the least understood this is probably a result of their secretive habits. Ewer (1985) and Estes (1992) observed that few carnivores are strictly carnivorous, as are cats and weasels. Most are omnivorous to some degree, supplementing their diet with a variety of plant foods, especially fruits. This makes them very adaptable in feeding habits and not being restricted to or even largely dependent upon a single food item. Successful predators are those that are flexible in what they eat. Their diets certainly vary from place to place, depending partly on what prey species are present in different areas. For the same reason, the diet may vary with seasons as the prey species present change. If the numbers of different prey species in an area do not alter, there may be difference in their catchability, due to changes in cover or in social behaviour of the prey. Conclusions from a predator feeding study are therefore likely to be valid only for the time and place where the study was done. Measuring food preferences in nature would require assessing the availability of different food types in the habitat apart from scat analysis. This was not possible in this study due to time constraints. The time period for collecting the feeding data for this study did not cover

the whole of the annual cycle (only seven months for this study). As a result, the information on the food habits presented here is regarded as preliminary; nonetheless, the results can be used to form an opinion as regards the food habits of carnivores in BINP.

Among the carnivores species observed, there was no record of a totally specialised feeder. The results show a wide variety of food items for most carnivore species. In the diet of African civets and Side-striped jackals, wild plant fruits particularly *Myrianthus holistii*, *Syzygium cuminii* and *Ficus* species featured prominently. This suggests their probable role in seed dispersal, although it was not investigated in this study. The presence of village refuse and food crops in their diet is further evidences to suggest that these two carnivore species have scavenging habits and raid crops when the opportunity arises. This is in conformity with the scavenging habit observations by Plumptre *et al.* (1997 unpubl. report) who reported Side-striped Jackals as crop raiders around Parc National des Volcans in Rwanda and Kingdon (1977) who observed African civets as raider of papaya and maize. As was also observed during this study, stomach content analysis in Western Uganda by Kingdon (1977) revealed Safari ants (*Dorylus* species) as common food for Side-striped jackals. In this study village refuse, food crops and insects featured as important food items in the diet of African civet as compared to a study in South Africa (Bothma, 1965; Skinner and Smithers, 1990) that revealed insects and wild fruits as the most important food items in their diet, supplemented with other small animals, such as mice, reptiles, birds amphibians and millipedes. On the basis of the food habits, Side-striped jackals and African civets can be considered the most adaptable and flexible carnivore species in BINP.

In this study rodents, insects, birds, eggs and wild plant fruits of *Ficus* species and *Syzygium* species. were the important food items for palm civets and genet species. This suggests their omnivorous feeding habits. Genet food habits in this study are fairly consistent with observations from elsewhere (example by Rowe-Rowe, 1992). The variations in the diets of the genet species observed else where could possibly result from the habitat differences.

In this study, Slender Mongoose, Egyptian Mongoose, Banded Mongoose and Zorilla appeared to subsist largely on rodents and insects. Kingdon (1977), Hiscocks (1989),

Maddock (1988) and Rowe-Rowe (1992) also observed terrestrial rodents and invertebrates as making up the bulk of the diets of most terrestrial mustelid species examined in this study. This suggests that they play important role in regulating the populations of small mammals within any habitat where they exist.

The food habits of Water mongoose observed during this study shows its adaptations to the aquatic habitat feeding conditions. Prominent prey items include aquatic molluscs and insects. Elsewhere, crabs (Rowe-Rowe, 1978 and Maddock, 1988) and Louisiana Cray fish (Rowe-Rowe, 1992) have been named as very important food item in the diet of Water mongoose in fresh water habitats. This can be interpreted to indicate the versatility in the feeding habit of Water mongoose in different habitat conditions.

In this study the cat species; Wild cat (*F. sylvestrus*), Serval cat (*F. serval*) and Golden cat (*P. aurata*) were more dependent on animal food as compared to other carnivore species, which were more omnivorous. Rodents constituted over 70 percent of the food items for *F. sylvestrus* and *F. serval*. These results are consistent with the observations in South Africa by Rowe-Rowe (1978; 1992), Skinner and Smithers (1990) and Bowland (1990) who reported that Serval cats and Wild cats feed almost exclusively on small mammals supplemented with birds.

In this study over 75 percent of *P. aurata*'s diet consisted of medium sized herbivores. This is consistent with an earlier observation in Bwindi Impenetrable Forest Reserve (now BINP) by Kingdon (1977), which revealed duikers, monkeys, rodents and birds as main constituent of *P. aurata*'s diet. Observations made elsewhere, for example in Rwenzori (Kingdon, 1977), showed that Golden Cats mainly depend on rats (*Otomys* and *Dasymys* species), hyrax (*Dendrohyrax arboreus*) and red duikers (*Cephalophus callipygus*) for their food. In central parts of Uganda, Brooks (1962) singled out rodents as constituting the major part of the diet of *P. aurata* as does Basilio (1962), who added gallinaceous birds. The differences in the diet in different habitats are likely to have resulted from prey availability, competition and other ecological factors. Since leopards are believed to be locally extinct in BINP, the food habits of *P. aurata* recorded in this study suggests it as the only possible candidate to exert a controlling effect on the medium sized herbivores such as duikers, bush pigs and *Cercopithecine* monkeys.

### 3.11 Summary

This study recorded four new carnivore species not formerly included in the species list for BINP. This brings to the light the insufficiency in the knowledge on the forest carnivores within BINP.

From the distribution and abundance trends, habitat degradation and GVC are important factors affecting the distribution of carnivores. Degraded habitats and high GVCs are associated with high abundance of small mammal species, which formed the bulk of most carnivore species food item in this study. Presence of wild plant fruits in the diets of some carnivore species shows that they play an important role in seed dispersal mechanisms.

Of the carnivores in BINP, Golden Cats are probably the only dominant terrestrial species, capable of exerting a controlling effect on the medium sized mammal herbivorous guild.

## CHAPTER FOUR

### 4.0 LOCAL COMMUNITIES ATTITUDES TOWARDS CARNIVORES

#### 4.1 Demographic background of the respondents.

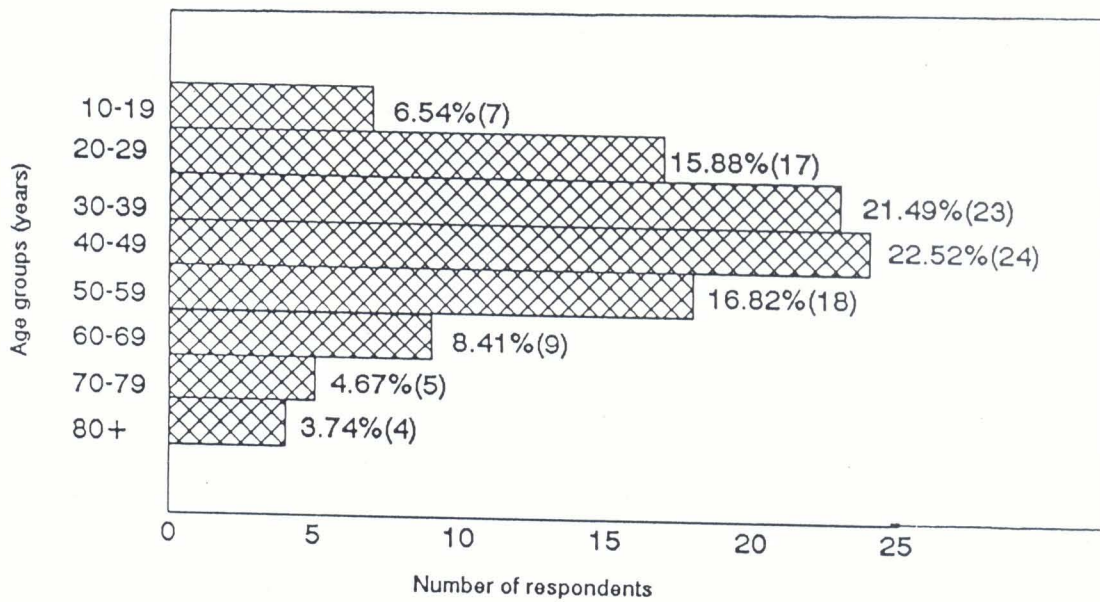
A total of 107 respondents drawn from different parishes (table 4.1) were systematically interviewed with the questionnaire.

**Table 4.1. Distribution of the respondents in the Parishes sampled.**

Parish	Respondents	(n)
Mukono	17.75 %	(19)
Mpungu	17.75 %	(19)
Bushara	8.41 %	(9)
Masya	7.48 %	(8)
Bujengwe	9.35 %	(10)
Kitojo	17.75 %	(19)
Kashasha	9.35 %	(10)
Rubuguri	12.15 %	(13)

\* For all Parishes  $n = 107$

Majority of respondents (87.85 percent) were male, only 12.15 percent were female. Ages of the respondents ranged from a minimum of 15 years to a maximum of 98 years, with the majority between 20 - 59 years age bracket (figure 4.1).



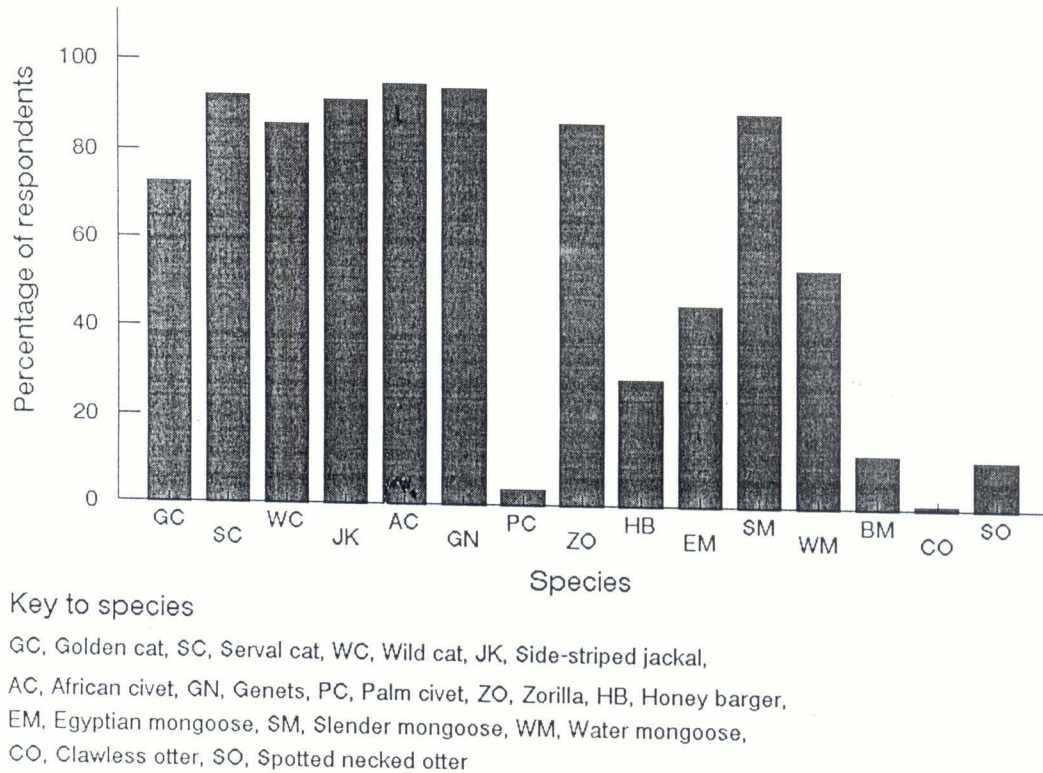
**Figure 4.1 Age group distribution of the respondents.**

Most respondents were born in the parishes in which they were interviewed, except a few who had shifted from one village around the park to another. Since there were no immigrants from distant areas, it was assumed that the respondents had spent most of their time in the study parishes and thus have a good knowledge of the park and its fauna, especially the carnivores, which are the target of this study.

#### **4.2 Local knowledge of carnivore occurrence and habitats**

The results of this study indicate that most of the respondents had substantial knowledge and potential to identify carnivore species. For example most carnivore species recorded in this study had local names (appendix 2). Most respondents gave correct descriptions of each carnivore species with the respective habits and the habitats where they are likely to be found. Of the respondents, 76.63 percent were able to identify the carnivores from scats, 52.35 percent identified from spoor, 19.63 percent identified from marks left on the prey and 13.08 percent were able to identify from smell of the species. However, respondents from Batwa community (Pygmies) showed more skill in identifying carnivores from signs. Over 70 percent of the respondents correctly described Serval cat, African civet, Genets, Side striped Jackal, Slender Mongoose, African wild cat, Zorilla

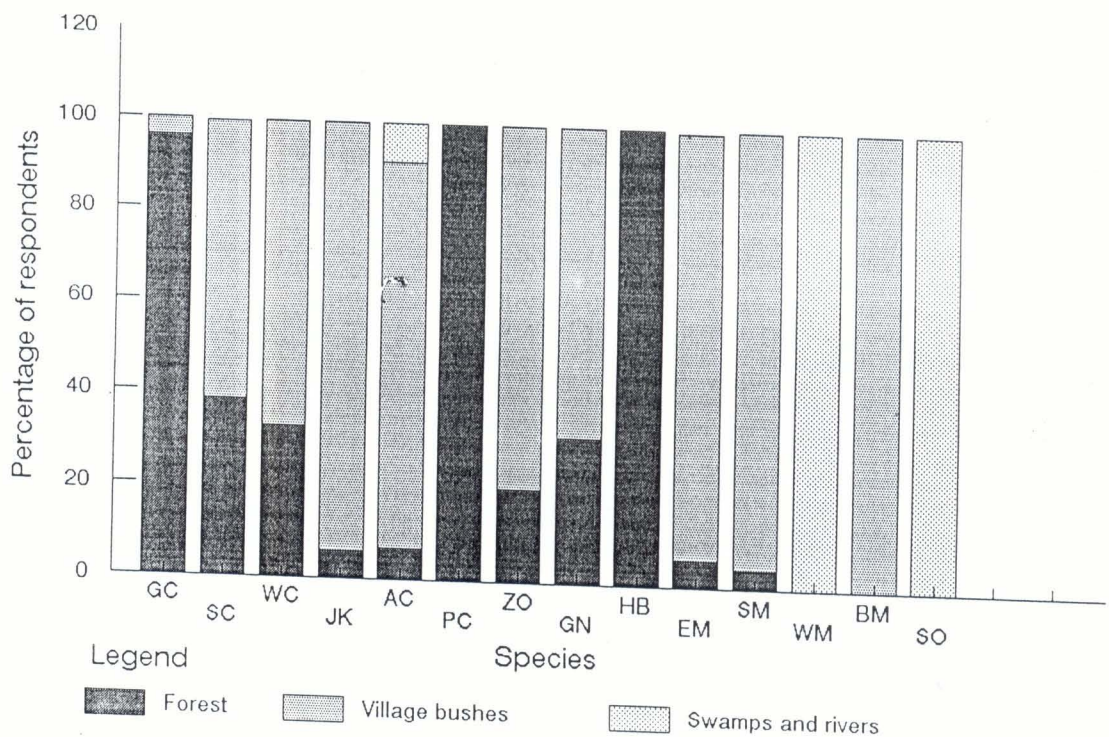
and Golden cat (figure 4.2). Fewer respondents knew Egyptian Mongoose, Water Mongoose, Banded Mongoose, Honey badger and Spotted-necked Otter. Palm Civet and African Clawless were the least known carnivore species. Only four respondents knew Palm Civet while one gave correct description and identification of Clawless otter although I presented a coloured photograph to aid its identification.



**Figure 4.2. Local knowledge on carnivore occurrence in BINP.**

Two types of Genets were described: the small sized type, which occurs widely within the park and villages and a large sized type which was reported to be restricted to the interior of the park. It is not known if they could have confused the larger carnivore species with Palm civet. However, I suspect the large species to be the Giant genet (*Genetta victorie*) which Butynski (1984) supposed exists in the Impenetrable Forest. Two species of genets are currently known to occur in BINP and both are small in size (the Small spotted and Large spotted genets). However, the occurrence of *G. victorie* in the park was not confirmed by this study. Three colour forms of Golden cat were described; a spotted reddish form, dark brown form and a black form (which was the more commonly observed form during this study). All respondents acknowledged that leopards no longer existed in BINP. The more elderly respondents (50 years old and above) estimated

leopards to have disappeared from the forest between 1945-1968. General information on carnivore species habitats from the respondent's view is presented in figure 4.3. Most of the respondents (96.15 percent) reported that of late the Golden Cats have retreated to the interior of the park. Palm Civets and Honey Badgers were also reported to be restricted to the interior of the park. The rest of the carnivore species were reported to be common in village bushes. Water Mongooses and Spotted necked Otters were reported to be restricted to the major swamps and rivers, while Banded Mongooses were reported to occupy the grassland vegetation of the north sector of the park.



**Figure 4.3 Habitats reported for carnivores in BINP.**

#### 4.3 Interactions of local community with carnivores in BINP

Types of interactions observed during this study ranged from domestic stock and crop raiding which may result in economic loss, to direct attacks of humans. These types of interactions result in conflict with humans and are the prime causes of worldwide persecution of carnivores.

### 4.3.1 Livestock and poultry raiding

Most of the respondents (96.26 percent) acknowledged attacks on their livestock and poultry by wild animals. And 67.79 percent of them acknowledged an increase in the rate of livestock raiding since Impenetrable Forest was gazetted a National Park in 1991. They attributed increase in wildlife raids to the strong protection accorded to the wildlife by the park authority. As shown in figure 4.4, the most notorious raiders are Wild cats (85.04 percent of respondents), Serval cats (81.30 percent of respondents), Genets (51.40 percent of respondents) and Slender mongoose (67.29 percent of respondents). Side-striped Jackal, African civet, Zorilla and Egyptian mongoose were reported as raiders of chickens on occasional basis. Although Golden cats were reported to prey mainly on goats and sheep, most respondents (78.1 percent of respondents) acknowledged that of late this is on the decline. Only two cases of raids by Golden cat were reported during the course of this study, in Masya and Bushara parishes, which surround the north sector. In parishes surrounding the southern sector, raids by Golden cats were last recorded in 1988. The bulk of the domestic animals raided are reported to be poultry (figure 4.4). Serval cats and Side-striped jackals were particularly reported to prey on young goats and sheep. Only three cases of carnivore attack on Rabbits were reported during the course of this study. However, this could be related to the fact that they are not commonly reared in villages.

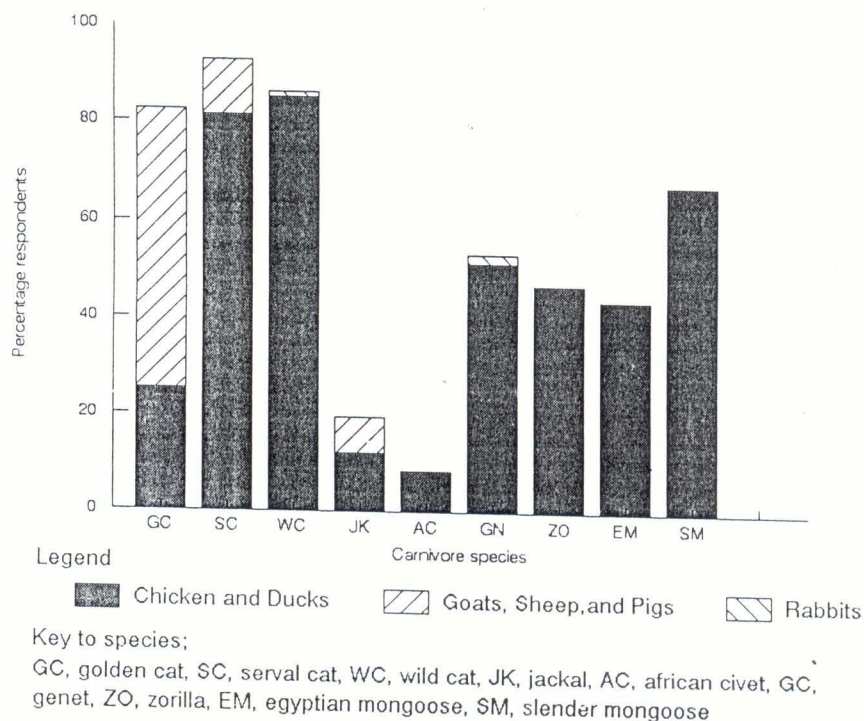


Figure 4.4 Domestic animals raided by carnivores in parishes surrounding BINP.

### 4.3.2 Crop raiding and direct attacks on humans

The results of this study show that carnivores do not only raid domestic stocks from the villages, fresh food crops and beehives were reported to be raided too. The non-stocks commonly raided are presented in table 4.2.

**Table 4.2. Non-stock items raided by carnivores**

Carnivore species	Non-stock items and number of respondents				
	Banana	Coffee	Maize and Cowpea	Potatoes	Honey/ Bees
Side-striped Jackal	19.6% (21)	–	86.9% (84)	78.5% (84)	
Genets	72.9% (98)	10.2% (11)	-	–	1.8%(2)
African Civet	16.8% (18)	–	75.7%(81)	62.6% (67)	
Honey Badger	-	–	–	–	26.2%(28)
Slender Mongoose	63.5% (68)	3.7% (4)	–	–	

Sweet potatoes and Irish potatoes reported eaten by Side-striped Jackals and African Civets probably consist of those thrown in village refuse (boiled ones), not the ones from the garden. Few respondents (26.17 percent) reported Honey Badgers as raiders of beehives, although the raids are now on the decrease as a result of using strongly built hives from wood. Genets were also reported to invade beehives for honey. Although most raids on domestic stock were reported to be by animals taxonomically categorised as carnivores, raiding by non-carnivore species particularly baboons (50.46% respondents) and raptors (40.14% respondents) were considered very important. A total of 6 cases of Side-striped Jackals attacking people were reported in Mukono, Masya and Bushara parishes.

Table 4.3 shows the ratings of carnivore species based on frequency of domestic stock and crop raiding reported in this study. The result indicates that some carnivore species recorded in this study do not pose threat to domestic animals and crops. The worst raiders of domestic fowl were Slender mongoose, Serval cat, African wild cat and Egyptian mongoose (table 4.3). While Spotted necked otter, African Clawless otter, Palm civet and Marsh Mongoose were not implicated in any raid.

**Table 4.3. Rating of carnivore species based on domestic animal and crop raiding rates documented in this study. (Arranged in descending order of scores, starting with the worse raider. See appendix 3 for details of scoring)**

Carnivore species	Score
Slender mongoose	10
Serval cat	10
African wild cats	10
Genets	9
Egyptian mongoose	9
Side striped jackal	8
African civets	7
Zorilla	4
Golden cat	3
Honey badger	3
Banded mongoose	1
Spotted necked otter	0
African Clawless otter	0
Marsh mongoose	0
Palm civets	0

#### 4.4 Mitigation of problems caused by carnivores around BINP

The most common methods of preventing livestock raiding by carnivores include constructing protective huts (70.09 percent of the respondents) and killing carnivores (29.25 percent of the respondents). Evidences of killing carnivores were witnessed during the course of this study, where one carcass of Wild cat and two for Genets were recovered

from the neighbouring villages. Dogs were present in 19.67 percent of the homes sampled, totalling over 50 in number to ward off carnivores. Five different groups of villagers were also encountered along the park boundary chasing carnivores with the help of dogs. Killing carnivores using poisoned baits may not be widespread now but was reported to be common two years back in Mukono parish (where 18 jackals were reported killed using poisoned bait).

Regarding the most appropriate method for controlling carnivore raids, 45.79 percent of the respondents proposed killing, 20.56 percent suggested keeping dogs as more convenient but feared it would bring conflict between them and the park authority. Dogs were however reported to be ineffective in controlling chicken raids by all mongoose species and Zorilla. Few respondents (26.17 percent) suggested making huts to prevent raids and one proclaimed that "only God cares".

#### **4.5 Social and cultural beliefs**

The carnivore species considered by the local population to be culturally sacred include Genets and Wild cats. 98.13 percent of the respondents believed seeing a genet carcass results in a skin disease, which eventually culminates into death. To reverse this, herbal medicines have to be administered immediately. On the other hand the local people believe that seeing a living genet results in a disease if the news is revealed to any other person. A small percentage of respondents (16.8 percent of respondents) in Mukono and Bujengwe parishes considered Wild cats as sacred animals. It is believed that an encounter with wild cat results in bad omen to women. Respect to carnivores as a sacred animal was not only limited to the wild species, as killing of domestic dogs is believed to lead to physical disabilities in children.

#### **4.6 Local use of carnivore species**

Only 19.63 percent of the respondents had various items, ranging from skins, hairs and bones obtained from carnivores (table 4.4). The remaining 80.37 percent of the respondents were aware of the various uses of items obtained from carnivores, but were not in possession of any. Commercial selling of skins obtained from carnivores is

currently minimal, but was reported to be a prosperous business for some individuals before 1990. Rwanda and the DRC were mentioned as destinations for the skins. With the onset of instability in Rwanda in 1991, the market for skins was said to have collapsed. However, remains of the skins initially prepared for commercial purpose still exist in villages as shown in table 4.4. The highest number of skins prepared for commercial purpose was of Serval cat (table 4.4), meaning that it probably faced more persecution than other carnivore species in this study. Serval cat and Genet skins were also used for making objects (ergology) in some parishes surrounding the park. Seven families in Kitojo parish had skins of Serval cat (stuffed with banana fibre to make it stand upright) prepared for ornamental purposes (plate 3). Skins of Genets were used for making hats (plate 4) especially in the communities neighbouring the DRC.

The products obtained from carnivores that are currently widely used around BINP are for medicinal purpose. The medicinal use of products from carnivores could not be quantified in this study however, bones, skins and hairs from Zorilla (table 4.4) are believed to possess strong healing powers for curing breast diseases in women as well as relieving headaches. In the Batwa community, the heart of the Side-striped Jackals is eaten to improve physical performance during work and its meat serves as medicine. The hair of Side-striped Jackal is burned to ward off evil spirits. Spotted-necked otter as a potential source of medicine was first documented in Kigezi around Lake Bunyonyi by Kingdon (1977). During this study a carcass of Spotted-necked Otter was observed being prepared for medicinal purposes in Rubuguri parish to the south of the park. A carnivore as potential source of bush meat was documented in the Batwa community, where the meat of the African Civet is a delicacy. Two non-Batwa respondents acknowledged eating carnivore meat and one commented that "with the help of salt, every wildlife is "edible". This suggests that, carnivores as a source of meat may not be limited to the Batwa community but widely spread throughout the other ethnic group in the region.



**Plate 3. A stuffed serval cat skin in one of the homes visited**



**Plate 4. Mr. Tibenda Emmanuel (my research assistant) wearing a hat made from a Genet skin.**

**Table 4.4 The use of carnivore species of mammals around BINP.**

<i>Species</i>	<i>Product and use</i>	<i>Number seen or reported in the villages</i>
Serval cat	skins (commercial)	8
	(ornamental)	7
Leopard	Skins (commercial)	1
Genet	Skins (ornamental)	1
Golden Cat	Skins (ornamental)	3
Side-striped Jackal	Hair, meat, meat (medicinal)	-
Side-striped Jackal	Skins (commercial)	1
Genets	Skins (ornamental)	-
Zorilla	Hair and bones (medicinal)	-
Spotted necked Otter	(medicinal)	-
African Civet	Flesh (bush meat)	-

#### 4.7 Attitude towards conservation of carnivores

In this survey the majority of the respondents (83.2 percent) had negative opinion on conservation of carnivores. Only 12.15 percent of the respondents supported carnivore conservation (for future generations), although they advocated for them to be restricted to the park.

#### 4.8 Species conservation importance

Carnivore species conservation importance ratings are given in table 4.5. The species with high conservation rating such as Clawless otter and Honey badger (table 4.5) would require stronger conservation measures than those lower in the conservation rating. However, some carnivore species such as Zorilla, Banded mongoose and Egyptian mongoose though not high on the conservation rating, occur marginally within the park. They are therefore at a higher risk of population decline than other species, which are well represented within the park.

**Table 4.5 Conservation importance ratings of carnivores in BINP. In descending order of importance. (see appendix 4 for details of scoring).**

Carnivore species	A	B	C	D	E	F	Total
Clawless Otter	5	5	5	0	0	15	30
Honey Badger	2	4	5	0	5	10	26
Spotted necked Otter	2	0	2	0	5	15	18
Serval Cat	0	0	0	0	3	15	18
African wild Cat	0	0	0	0	3	15	18
Zorilla	1	0	3	1	5	0	10
Banded mongoose	3	2	2	1	0	0	8
Egyptian mongoose	1	0	3	1	0	0	5
Water mongoose	2	0	0	0	1	0	3
Side striped jackal	0	0	0	0	0	0	2
African civet	0	0	0	0	0	0	2
Palm civet	1	0	0	0	0	0	1
Genets	0	0	0	0	0	0	0
Slender mongoose	0	0	0	0	0	0	0

Categories are A = habitat specificity, B = distribution range, C = commonness, D = protection in the park, E = threat/uses, E = CITES categories.

## 4.9 Discussion

### 4.9.1 Indigenous knowledge, culture and conservation of carnivores

The local residents can provide a lot of information about animals occurring in their vicinity because they are in constant interaction with them in their day to day lives (Riney, 1982). They are also familiar with the study area and some have spent much time in the wild as hunters, foresters, and honey gatherers. It is generally acknowledged that information on the species habits, habitats and identity is a vital pre-request to the conservation efforts to animal species (Riney, 1982). The result of this study shows a

large and deep zoological culture and special interest of the local population surrounding BINP in the understanding of the eco-ethology of carnivores. Obviously, the best known species are those that interact more frequently with the local community or those of special interest to them (such as for medicinal use). The wide knowledge of the local community (especially Batwa community) on the carnivores is an indication that, formerly their economy was founded on the knowledge and exploitation of the natural resources of the TMFs. Byarugaba (per. comm.) made a similar observation about Batwa community in BINP. Consequently this study provides an important contribution of the knowledge of these communities on the species habitats, habits and other aspects which are important contribution to their conservation.

Culturally, Genets seemed to be the only carnivore species in a better conservation status because the local people attached a due respect to them and hence a protection. Although traditional beliefs and practices still have strong grip on some villagers around BINP, they seemed to be limited to the elderly people. The respect to the cultural values and customs is currently poor especially among the young generation and Muhweezi (1991) also observed this.

#### **4.9.2 Carnivore problems around BINP.**

The carnivore conflicts with the local population is the important factor, determining attitude of the local population towards their conservation. The attitude survey indicates that achieving ultimate conservation of carnivores in an area where they are in conflict with the local population is a difficult and complicated task. The current problems of carnivore conservation around BINP are intricately associated with the perceived economic loss when carnivores incidentally prey on domestic stock. Slender mongoose, African Wild Cats, Serval Cats, Genets, Egyptian Mongoose and Side-striped Jackals were reported as the most notorious raiders of poultry in the neighbouring villages. This seemed to form the basis for the negative attitude and argument by the majority of the respondents who thought they had been economically disadvantaged. Most respondents expressed discontent about the restrictions imposed on killing wildlife that disadvantages them. Considering that all respondents were from the villages close to the park, this finding is expected. Docherty (1993) also recorded a similar response for respondents

close to the park due crop raiding by the wildlife. Unless the problem of carnivore preying on domestic stock is solved, efforts to ensure carnivore conservation can hardly succeed. This means that efforts should be directed towards solving the problems of domestic stock loss to carnivores.

Although Golden Cats were earlier reported by Kingdon (1977) to be common in villages, raiding hencoops, goats and sheep, this appears to be decreasing. Very few incidences of domestic animal raid by Golden cats were recorded in this study, which could be an indication of a stabilised prey population base for them within the park.

Crop raiding by carnivores is probably less important as compared to other crop raiders such as baboons and bush pigs, although this was not quantified in this study. Apart from the carnivores, other wildlife, especially the Baboons and Raptors were found as other important contributors to the livestock/poultry loss in the villages.

#### **4.9.3 Threats to conservation of carnivores**

Along side crop agriculture is the monetary oriented poultry farming, especially free-range poultry farming. In an effort to prevent chicken loss, many villagers kill the raiding carnivores using spears, with the help of dogs and using poisoned bait. These form a big threat to conservation of carnivores. Harassment from domestic dogs is increasingly becoming an important factor, considering the large number of dogs that exist in the villages.

Habitat loss is an important factor especially outside the park. The local people are primarily agriculturalists, this result in much of the natural vegetation outside the park being cleared to create room for cultivation. The park therefore appears to provide a refuge to some of the carnivore species, which initially depended on the habitats out side the forest. On the basis of distributions and habitat associations, Zorilla and Egyptian Mongoose, which mainly occur outside the park, are more likely to be affected by land developments, which are currently on the increase in the neighbourhood of the park. The status of moist habitat preferring carnivores outside the park is also uncertain due to the drainage of swamps to expand farmlands.

International trade in wildlife and wildlife products directly affects the survival of species through out the world. Of late Tigers are at a risk of extinction in China due to the demand of their body parts (CITES radio report January, 1999). Around BINP trade in products from carnivores was probably prosperous before 1984. For example Kingdon (1977) reported that skins of Golden cats were offered for sale around Impenetrable Forest. He also reported that the shore dwelling Bakiga hunt Spotted-necked otter for fur and medicine. Although trade in carnivore products has probably reduced around BINP these days, it still continues in some parts of Uganda. Skins of Serval cat, and Mongooses, including other products from carnivores for medicinal use and to serve as fetish components to ward off evil spirits are commonly seen in traditional medicine stalls in the capital city of Uganda, Kampala (personal observation). It is probable that the medicinal use of products from carnivores will continue around BINP. This may not be a serious threat to their conservation status in the future, considering that modern medicine is increasingly becoming available to the local community in the neighbourhood.

#### **4.10 Summary**

This study shows that the local communities can contribute important information on the carnivore species habitats, habits and other aspects, which are vital for their conservation. The local communities surrounding BINP have both positive and negative views on carnivores. Currently the negative views and activities have more impact on the conservation status of carnivores. The local communities consider carnivores as a threat to their domestic livestock and poultry. Therefore carnivores are killed in order to protect livestock and poultry, especially along the park periphery. Traditional use of carnivore species is currently on the decline, which means an improved conservation status for them.

## CHAPTER FIVE

### 5. GENERAL DISCUSSION, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH ON CARNIVORES

#### 5.1 General discussion

Bwindi Impenetrable National Park supports a very diverse mammalian carnivore fauna. Indeed 16 carnivore species belonging to four families were recorded in the present study. The presence of new species recorded in this study shows that mammalian carnivore species list for BINP may still be incomplete and that further inventory work is needed. The distribution of carnivores in BINP showed some relationship with habitat factors. Some carnivore species such as *C. adustus* and *V. civetta* were associated with human activity and thus had high relative abundance in areas with human presence. This is probably a result of their scavenging and crop raiding habits in the neighbouring villages. On the other hand the species such as *P. aurata* and *N. binotata* were restricted to the areas with minimal human presence. This suggests that they are negatively affected by human activity.

Of the ecological correlates, GVC has a profound impact on the distribution of carnivores. High GVC probably attracts small mammal prey species on which the smaller carnivore species depend. High GVC probably reduces the hunting/foraging effectiveness of large carnivores, suggesting that only small carnivore species which are less impaired by the dense vegetation cover are more likely to forage in sites with high GVC. This is probably the reason why the medium sized carnivore species such as *C. adustus* and *P. aurata* had a negative association with increase in GVC.

The food habits of most carnivore species indicate that the wild prey species, especially small mammals, are important constitute of their diet. Amongst the carnivore species in this study, *P. aurata* had different composition of food habit. The largest part of its prey constituted of medium sized mammal prey species. Since Leopards are believed to be locally extinct within the park, this suggests that *P. aurata* has ascended in the local food chain to replace leopards.

Habitat loss is an important factor affecting status of carnivores outside the park. The local human populations neighbouring the park are primarily agriculturalists, these results in much of the natural vegetation outside the park being cleared to create room for cultivation. The carnivore species associated with disturbed habitats, grasslands and swamps are the most affected by the agricultural activities and other forms of land developments.

The use of carnivore species by local communities around BINP is currently minimal and may not be a serious threat to their conservation status. However, carnivores face a big threat of being killed especially along the park boundary as they attempt to raid domestic stock. Poultry raiding is the leading problem along the park periphery and has contributed to the negative view about carnivore conservation. Unless alternative ways of mitigating carnivore-local community conflict is availed, killing of carnivore along the park periphery is likely to continue. Improvements in poultry farming by use of modern methods such as pen feeding and wire fencing could probably reduce loss of domestic fowl to the carnivores.

Feeding habits indicate that carnivores are important regulators of natural small mammal populations (example rodents) which are a potential pest to the agricultural community. Kasangaki (1998) reported that farmers in Nteko area, south of BINP complained about rodent attacks on their crops especially beans and he noted evidence of Root rat (*Tachoryctes ankoliae*) attacks on root crops. If the population of rodents is left to expand unchecked could reach an epidemic level. Carnivore species are thus important natural regulators of populations of small mammal community. The larger carnivores are also important in regulating the population of the medium sized herbivores such as duikers and *Cercopithecine* monkeys. This highlights the importance of carnivore community in influencing the structure and ultimately the composition entire ecosystem.

It is apparent that achieving effective conservation of large sized carnivores requires sound population base of their prey species, such as medium sized herbivores and *Cercopithecine* monkeys in the natural habitat. Sufficient population of herbivores could probably reduce the rate of domestic stock raiding. For example *P. aurata*

raiding on the domestic stock has currently reduced, suggesting an improvement in the habitat quality in terms of prey availability within BINP. Efforts to conserve carnivores should therefore be geared towards maintaining the natural habitat conditions by reducing negative human impact to the ecosystem.

## **5.2 Conclusions**

Recovering areas such as degraded forests and abandoned cultivation sites have higher microhabitat diversities and are typified by higher levels of carnivore species abundance that depend on small mammals. It may be concluded that forest degradation results in richer and abundant small mammal fauna, which consequently attracts some carnivores, leading to higher abundance of such carnivore species in the degraded forest than the primary forest. Generally, the results of this study show that carnivores play important role in controlling or contributing to the population dynamics of other animals and some plants in BINP. Raptors have also been reported as having similar food habits to that of carnivore species in BINP (Muhweezi, 1991). These two top predator groups probably play very important role in the ecology of mammals or perhaps the whole of the living systems in BINP.

Carnivore species that require more conservation effort are those that have restricted occurrence and those that occur outside or at the park periphery. Currently there is a big danger of natural habitat loss outside the park as a result of increased agricultural activities. Efforts to conserve carnivore community in BINP should therefore take into consideration the problems faced by the local communities, especially the poultry loss.

## **5.3 Recommendations for carnivore conservation**

The result of this study provides the basic information on the individual carnivore species, concerning their conservation status, food habits and distribution. What remains therefore, is to seek solutions to some of the serious problems affecting their conservation in the region. Appropriate approach should incorporate economic and social requirements along side the existing conservation education efforts in place. This could be achieved through following recommendations and suggestions;

(i) Conservation education: Extensive educational programs were started under CARE-Development Through Conservation (DTC) and ITFC but have mostly targeted the school going category. There is therefore a need to expand the current conservation education program to include the adult illiterate population and educationally disadvantaged population. These groups form the most serious threat to carnivore conservation, through deforestation, direct persecution (through poisoning and killing) and use of wildlife products.

(ii) Conservation education should emphasise the ecological indicator value of carnivores and aim at changing the local people's attitudes. It should emphasise that humans, predators, and prey can co-exist in harmony if the ecosystem is healthy. People should be shown that predators do not always endanger one's stock under stable natural prey population base. The belief that a stable prey population base for carnivores in protected areas could reduce human-carnivore conflicts has been documented in some places. A good example was in Velandar, where Wolves were observed to prey on wild game despite the presence of sheep and goats in the surrounding villages (Jhala, 1993). For BINP's case, educating the public on the carnivore food habits and citing the current decrease in raids by Golden cats as an example, could make many people to appreciate the importance of maintaining the natural habitats. This approach will perhaps be difficult at the beginning, especially to the settlements close to the park boundary, as they will continue to experience livestock/poultry raids. Although there are few respondents with positive attitude towards carnivore conservation, such educational programs could bring many people to appreciate the role of carnivores and other animals in the ecosystem.

(iii) Although most respondents favoured killing and keeping dogs as an effective way of controlling carnivore population, advocating for livestock houses which are strongly built and the introduction of modern poultry farming methods (pen feeding) could greatly reduce loss of chicken and thus reducing carnivore-human conflicts.

(iv) Legislation: The Uganda Wildlife Statute (1996) and park laws provide protection for all wildlife within and outside protected areas. Many local residents are

still unaware of the existence the wildlife laws. This calls for the need to sensitise them on the laws on hunting, capture, the penalties involved, and to stress the importance of conservation of wildlife to the local community.

(v) The results of this study revealed wetlands as important habitats for some carnivore species (such as Water mongoose, Clawless otter and Spotted-necked otter). Unfortunately the wetlands outside conservation areas are currently at a risk of being cleared to expand agricultural land. This therefore calls for conservation of wetlands outside the protected area.

#### **5.4 Suggestions for further research on carnivores.**

The assumed local extinction of the Leopards in BINP and a probable ascent of Golden cat in the local food chain are clearly of considerable scientific interest. Studies on carnivores of BINP could help in understanding the food habit changes following extinction of a large and probably dominant carnivore species. However, the following suggested topics will in particular be useful in achieving some of the research objectives.

(i) Investigation on the importance of Golden Cats as a dominant terrestrial carnivore and determination of its population using radio-tracking techniques. It will also help in providing more scientific information about Golden cats (*P. aurata*) (Davenport, 1996), especially concerning its home range and population dynamics. The most appropriate sites for carrying intensive study on Golden cat are areas around Mubwindi swamp and Bamboo zone.

(ii) Monitoring trends of livestock raiding patterns by each carnivore species on comparative basis in the neighbouring villages. For example Qium and Bleisch (1996) suggested that reports of livestock predation is an indication that the large predators may be short of their natural prey within the habitats. This is especially important for protected areas surrounded by dense human settlement where there is poaching activity. Monitoring trends of livestock raiding could form the basis for the Ecological Monitoring Programme (EMP) unit of ITFC to monitor the health of the park in terms

of natural prey availability within BINP.

(iii) As dominant predators in aquatic ecosystem, otter species worldwide, are useful indicators of the health of the wetlands they inhabit (Foste-Turley, 1990). It is therefore possible to use otter population status in BINP as an early warning system to detect effects of habitat degradation.

(iv) This was the first attempt in the investigation of the status of carnivores in BINP. Record of new carnivore species in this study indicates that the species list may be incomplete and therefore further inventory work is needed. Investigations into the biological response of carnivore species that occur marginally within the park, to the local conditions in terms of the living requirements, social organisations and population dynamics are also essential in order to prevent man-induced extinction.

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APPENDIX 1A

**SURVEY OF KNOWLEDGE, INTERACTION AND ATTITUDE OF VILLAGERS SURROUNDING BWINDI IMPENETRABLE NATIONAL PARK (BINP) IN RESPECT TO CARNIVORE STATUS.**

District;.....

Date .....

County.....

Name.....

Parish.....

Age .....

Sex .....

**Instruction to the interviewer.**

Introduce your self and state the purpose of the visit, explain how /why the respondent was selected (knowledge of animals). What the result of this finding will be used for(park management). And assure him/her of confidentiality.

1 a) How long have you been resident in this parish ?.....

b) Do you meet wild animals around this village or in the forest? Yes /No.

c) If yes do you meet the meat eating (carnivore) groups? Yes/No

d) If yes name the carnivores you have seen, stating how each can be identified using size, appearance (hair colour), body structure , track(spoor), and other special features.

Species

Identification

i).....

.....

ii).....

.....

iii).....

.....

e) In which places (villages, forests, swamps, etc) do you meet each of the species named? above (1d)?

Species

Habitat

i).....

.....

ii).....

.....

iii).....

.....

f) When were leopards last seen in Bwindi forest ? (estimated year.....)

2. a) Do carnivores raid livestock in this village? Yes/No

b) If yes can you name the carnivores and animals raided by each. Also indicate the time of raid.

Carnivore species	Domestic livestock	Time
i).....	.....	.....
ii).....	.....	.....
iii).....	.....	.....
etc.		

c) Has the rate of carnivore raid on livestock increased /remained the same or decreased since Bwindi forest became a national park? Give reasons to support your answer.

.....,Reason.....

d) which carnivore species do not follow the trend you mentioned in 2 (d) above?.....

f) Which items other than domestic livestock do carnivores attack in the villages?

Items	Carnivores
i).....	.....
ii).....	.....
iii).....	.....

e) Do you think carnivores are many, the same number as before or few these days since Bwindi was became a National park?.....

3 a) What do you do to stop or reduce the problems caused by carnivores in this village? (Kill, build protective livestock houses, keep dogs, poison them etc. specify).....

b) Do you have dogs in this village? If yes how many? (state the number).....

c) What do you think are the best ways of controlling carnivore raids on domestic stock?.....

4 a) Amongst the carnivores you have mentioned, which ones are associated or regarded as taboo/sacred or totem in this tribe? Give reasons.

Carnivore	Reason (s)
i).....	.....
ii).....	.....
iii).....	.....

iv).....

b) In case you meet or encounter the carnivores mentioned in 4a, what do you do to them? Or what happens?

.....

c) Do you use or have products from carnivores (such as bones, skins, and meat e.t.c.) in this village Yes/No.

If yes give the name of carnivore species, products (s) obtained from, their uses and how many each of the product is present in the home/village

Carnivore species	Product (s)	Use (s)	Number
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

Do you think it is important to conserve carnivores in this area? (give reason (s))

.....

Thanks very much for your contribution and participation.

## APPENDIX 1B

### EBIBUZO BYA BAHIIJI NA BARIKWEYAMBISA EIHAMBA

District;..... Date .....

County..... Name.....

Parish..... Age .....

Sex .....

### ENYOREKYERERO AHA KUBUZA OKU

Oyeyanjure, gambaho mubigufu ekitumire waija kutayaya. Oshohorereho ahabweki nari ekitumire oworikubuza yatoranwa. (Afire kitoranwa? Ahikaine na neihamba/nari namanya munoga aharyabeireho kare nanga ebiriho hati ahakweyambisa eihamba). Okumanya onwagasho gwebirarugye amubirikurondo hati kandi noku muhamiza kani enama ahamire. Handikaho bikye anukirikwe tagisibwa.

1 a) Omazire bwireki orikutura. Omuryoogu Muruka?.....

b) Nokira kubugana emyamweishwa waza omwihamba? Yego/Engaha

c) Haba nikwe wararebire emyameishwa ezirarya ezindi (nke mpisi) Yego/Engaha

d) Waba wararebireho ezo nyameishwa, zigambe oratandika nobuma nyiso obwo razimanyirano (nke rangi zabyo, empu hamwe nebindi)

Enyameishwa

Obumanyiso

i).....

ii).....

iii).....

e) Nibicweka ki ryeihamba eryorakira kuzibunganamu? (Ni omugwerere, omubiti bingi, ahaguru yemishozi, mumpanga, murusharara, nari ahandi ahorikumanya)

Species

Habitat

i).....

ii).....

iii).....

f) Okaheruka kuhurira byari engwe?.....

2. a) Ezi nyameishwa nizekura kurya, amatungo gawe omubiro ebi? Yego/Engaha

b) Yaba nizirya amatungo nobasa kuzigamba amazine eitungwa ebizikurya

Enyameishwa

Amatungo

- i).....
- ii).....
- iii).....
- iv).....

c) Dratekyereza ngu emirundi ezi ezo nyameishwa zariakyira kutayayira amokagwe eyoyengyeire kwiha ba kore bwindi opaka narishi? Habweki?

.....Habweki?.....

d) Enyameishwa ezo ezitareyongyeire ninganshi ezayeyongyeire nko ku wa wagambire nizi ha?

.....

e) Ezo nyameishwa zirakyira kurya kyi mu byaro? (nke bihingwa, abantu nebindi)

Enyameishwa

Ekyizirarya

- i).....
- ii).....
- iii).....
- iv).....
- v).....

f) Notekateka ngu ezinyameishwa ninyini nizingana nkekuzabeire ziri kare nari nikyeahabwahali? .....

3. a) Orakyira ku korakyi ku ngu ezo nyameishwa zitagaruka ku teganisa ebyaro byangu? (orazita? Orombeka enju zigumire? Oratunga embwa, nebindi)

.....

b) Oine embwa? Zingahe?.....

c) Oratekyerezo ngu nyameishwa ezirate ganisa ebyaro nkokuwaziga mbireho turabasa ku zizibira tuta ngu zitateganisa ebyo?

.....

4 a) Ezo nyameishwa eziwawagambireho, niziha ezibara twaramu nke miziro? Habwenki?

Enyameishwa (Yomuziro)

Habwenki

- i).....
- ii).....

- iii).....
- iv).....

b) Ezo nyameishwa ezi murazira ezi wawa gambireho wa zibugana orakorerakuji?  
 .....

c) Orako zesa ebintu ebirarunga mu nyameishwa (ezirya ezindi nke mpu, amagufa, omubezi nebindi)?  
 .....

d) Wa ba orabikozesa nko wa wagambire, nibiha? Kandi nibingahe nko muri ekyi kyaro?

Enyameishwa	ebirarugamu	Nibirogahe
-------------	-------------	------------

- |           |       |       |
|-----------|-------|-------|
| i).....   | ..... | ..... |
| ii).....  | ..... | ..... |
| iii)..... | ..... | ..... |
| iv).....  | ..... | ..... |
| v).....   | ..... | ..... |

e) Oratekyereza ngu nikiyirungi narishi kyineho omugasho kurinda ezo nyameishwa ezo muri ekyi kyoro? Habwenkyi?  
 .....  
 .....

Webale munonga okutwikiriza tutaganira naiwe

## APPENDIX 2

### The Carnivore species of BINP.

Common names	Scientific names	Local names
Side-striped Jackal	<i>Canis adustus</i>	Muhwa/Ekishamagwe
African Civet	<i>Viverra civetta</i>	Ekinyampimbi/Ekitente
Palm Civet	<i>Nandinia binotata</i>	Mbala/Omuhemankungu
Golden Cat	<i>Profelis aurata</i>	Embaka
Serval Cat	<i>Felis serval</i>	Emondo
African wild Cat	<i>Felis sylvestrus</i> *	Enturu
Honey Badger	<i>Mellivora capensis</i> *	Eshambo
Zorilla	<i>Ictonyx striatus</i>	Akashamuniga
Clawless Otter	<i>Aonyx capensis</i> *	Ekishambo
Spotted-necked Otter	<i>Lutra maculicollis</i> *	Engonzi
Small-spotted Genet	<i>Genetta genetta</i>	Omutone
Large-spotted Genet	<i>Genetta tigrina</i>	Omutone
Water/Marsh Mongoose	<i>Herpestes paludinosus</i>	Ekihura
Slender mongoose	<i>Herpestes sanguineus</i>	Obusamunyiga
Egyptian Mongoose	<i>Herpestes inchneumon</i>	Omuterere
Banded mongoose	<i>Mungos mungo</i>	Omuterere
Congo clawless Otter	<i>Aonyx congica</i> **	N/A
Giant Genet	<i>Genetta victorie</i> **	Omutone
Alexanders Cusimanse	<i>Crossarchus alexandri</i> **	N/A
Leopard	<i>Panthera pardus</i> ***	Engwe

\* Confirmed present for the first time by this research.

\*\* Not confirmed by this research but proposed to exist in the forest by Butynski(1984).

\*\*\* Probably extinct in BINP.

N/A: Local name not available.

## APPENDIX 3

### DATA ANALYSIS

#### 1. Regression analysis

A regression analysis is applied to situations where the relationship between two variables may be one of a functional dependence of one on the other. That is, the magnitude of one of the variables (the dependent variable) is assumed to be determined by magnitude of the second variable (the independent variable). The functional relationship of one variable to another in a population is represented by the linear regression equation given as;

$$Y_i = \alpha + \beta X_i \text{ (Zar, 1984).}$$

Here  $\alpha$  and  $\beta$  are population parameters. The parameter  $\beta$  is termed as regression coefficient, or the slope of best fit regression line. The best estimate of  $\beta$  is  $b$  and given as;

$$b = \frac{\frac{\sum xy}{n} - \frac{(\sum x_i)(\sum y_i)}{n^2}}{\frac{\sum x^2}{n} - \frac{(\sum x_i)^2}{n^2}}$$

The value of  $b$  theoretically can range from  $-$  to  $+$  including zero. The regression coefficient expresses what change in  $Y$  is associated, on the average with a unit change in  $X$ .

(i) altitude was regressed against visitation rate to give an indication of the effect of altitude on visitation rates.

(ii) regression analysis was also used to establish the relationship between the sighting frequency and scent station visitation rate data.

The regression analysis was done using Plot (MSTA-C data analysis package)

#### 2. Spearman rank correlation coefficient

The linear relationship between two variables where neither is assumed to be functionally dependent upon the other is simple linear correlation. The spearman's rank

correlation coefficient analysis is used to investigate the significance of the associations (correlation) between two series of observations obtained in pairs, which are not normal.

It is computed using the equation

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n^3 - n} \quad (\text{Zar, 1984})$$

Where  $d_i$  is the difference between X and Y ranks. The value of  $r_s$  is an estimate of the population rank correlation coefficient. Its value may range from  $-1$  to  $+1$ .

The ecological parameters; distance from the periphery/major roads and percentage ground vegetation cover were correlated with visitation rates in order to pin down the influence of these factors on the abundance of carnivores.

### 3. Friedman's test.

The Friedman's test (Zar, 1984; Gopal, 1993) is a non-parametric analysis method used to investigate significance of the differences in multiple treatment of a series of subjects.

For example the significance of the difference in response of  $k$  treatments applied to  $n$  subjects. The test is especially useful with the data that do not meet the parametric analysis of variance assumptions of normality and homoscedasticity. And was therefore suitable for the data collected in this study. The test is calculated as;

$$G = \frac{12}{nk(k+1)} \sum_{j=1}^k R_j^2 - 3n(k+1). \quad \text{With } (k-1) \text{ degrees of freedom.}$$

Where R denotes the rank sum of each of the  $k$  treatments.

### 4. Species conservation/human importance rating system.

A scoring system developed by Bourguin (1990) and modified by Rowe-Rowe (1991) was adopted to assess the conservation importance of each carnivore species and its human importance value. In assessing the conservation importance, a score of between 0

and 5 was allocated subjectively, depending on the status aspects recorded during this study. These included, habitat specificity, distribution range, commonness/rarity, protection within the park and threats/uses. Scores of 10 and 15 were allocated for the CITES categories II and III (Faure, 1989) respectively.

Human importance value ratings were based on the problems resulting from conflicts of each carnivore species with the local population such as domestic stock raiding. A score of between 0 and 10 was allocated, based on the frequency of raids of domestic animals and crops.

#### Appendix 4

**Food habits of carnivores estimated using frequency of occurrence method. The figures represent the percentage frequency of each food item recorded.**

Food items recorded in the scats	SSJ n=203	AFC n=186	SEC n=141	WIC n=112	GOC n=41	PAC n=48
Monkeys	0.0	0.0	0.0	0.0	12.19	0.0
Duikers	0.0	0.0	0.0	0.0	68.29	0.0
Bush pigs	0.0	0.0	0.0	0.0	9.75	0.0
Goats	0.0	0.0	1.42	0.0	0.0	0.0
African Civets	0.49	0.0	0.0	0.0	0.0	0.0
Rodents/Shrews	39.90	11.29	97.87	77.68	7.32	25.0
Squirrels	0.0	0.0	3.46	6.25	9.76	2.08
Birds	0.98	6.98	4.96	18.75	14.63	27.08
Zorilla	0.0	0.0	0.71	0.0	0.0	0.0
<b>Arthropods:</b>						
<i>Dorylus</i> spp.	7.0	0.0	0.0	0.0	0.0	0.0
Beetles	8.87	6.99	20.57	14.28	0.0	18.75
Bees( <i>Meliponula</i> spp).	2.46	0.0	0.0	0.0	0.0	0.0
Other spp.	15.27	9.67	17.02	7.14	0.0	6.25
Molluscs	0.0	4.84	0.0	0.0	0.0	0.0
Village refuse.	3.94	6.45	0.0	0.0	0.0	0.0
Eggs	0.0	1.61	0.71	5.35	2.43	8.33
Unidentified animal remains	2.95	3.76	2.12	1.78	2.43	4.16
<i>Myrianthus holistii</i> (fruits)	0.98	4.31	0.0	0.0	0.0	0.0
<i>Syzygium</i> spp. (fruits)	0.49	8.06	0.0	0.0	0.0	6.25
<i>Ficus</i> spp. (fruits)	0.49	2.15	0.0	0.0	0.0	16.66
<i>Setaria</i> spp. (leaves)	0.0	46.77	0.0	0.0	0.0	0.0
Maize (fruits)	0.0	1.07	0.0	0.0	0.0	0.0
Cowpea (seeds)	7.88	4.83	0.0	0.0	0.0	0.0
Millet (fruits)	0.49	3.76	0.0	0.0	0.0	0.0
Potatoes	16.74	45.16	0.0	0.0	0.0	0.0
Unidentified plant remains	3.44	0.54	2.83	2.68	2.43	8.33

*n* = number of scats analysed.

#### Key to species;

SSJ = Side-striped Jackal, AFC = African Civet,  
 SEC = Serval Cat, GOC = Golden Cat, WILC = Wild Cat and  
 PAC = Palm Civet.

### Appendix 4 continued

Food items recorded in the scats	GEN n = 37	WMG n = 39	SMG n = 46	BMG n = 23	EMG n = 31	ZOR n = 27
Small mammals (rodents/shrews)	89.18	1.50	63.04	60.86	51.61	44.44
Amphibians	0.0	2.56	0.0	0.0	0.0	0.0
Squirrels	2.70	0.0	8.69	0.0	0.0	0.0
Reptiles	0.0	0.0	0.0	4.34	9.68	3.70
Birds	21.62	0.0	23.91	0.0	0.0	0.0
Arthropods:						
Beetles	16.21	5.12	32.60	73.91	25.80	33.33
Bees ( <i>Meliponula</i> spp.)	2.70	0.0	0.0	0.0	0.0	0.0 11.11
Other species	24.32	3.37	4.34	13.04	19.35	
Molluscs	0.0	23.07	0.0	17.39	3.70	0.0
Eggs	8.10	0.0	4.35	0.0	3.22	7.41
Unidentified animal remains	5.40	0.0	2.17	4.34	3.22	11.11
<i>Syzygium cuminii</i>	10.81	0.0	0.0	0.0	0.0	0.0
<i>Ficus</i> spp.	13.51	0.0	10.86	0.0	0.0	0.0
<i>Musa</i> spp. (edible type)	0.0	0.0	4.34	0.0	0.0	0.0
Unidentified plant remains	8.11	5.12	2.17	21.73	9.68	7.41

*n* = number of scats analyzed.

**Key to species;**

GEN = Genets, WNG = Water Mongoose,

SMG = Slender mongoose, BMG = Banded mongoose,

ZOR = Zorilla.