THE STATUS AND MANAGEMENT OF HERPETOFAUNA IN SOME PROTECTED AREAS OF MALAWI: A CASE STUDY OF MUGHESE, NTCHISI, AND TSAMBA FOREST RESERVES.

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A thesis submitted to the University of Malawi in partial fulfillment of the requirements for the Degree of Master of Science in Biology.

APRIL 2007

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University. All sources of information have been acknowledged.

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DEDICATION.

I dedicate this work to my mother, Mrs. Joyce Mazibuko for her encouragement and support. Without her, I could not have been where I am today. May the Almighty Lord bless her abundantly!

ACKNOWLEDGEMENTS

This study was conducted with assistance from several individuals and organizations that participated either directly or indirectly. Since it is not possible to acknowledge all of them, I would like to thank everyone who took part in this research for their time and effort. However, the following organizations and individuals deserve special mention.

Firstly, I would like to express my sincere gratitude to the German Technical Co-operation (GTZ) through the National Herbarium and Botanic Gardens of Malawi for providing financial support for research on "Management of Biodiversity in some Protected Areas of Malawi", from where this component was extracted.

Secondly, I wish to thank the Department of Forestry for allowing me to conduct the research in selected forest reserves and the Museums of Malawi for providing logistical and technical support towards the production of this thesis.

Many thanks should also go to my supervisors, Dr. John Kazgeba Mfune, Dr. Jean-Marc Hero and Mrs. Chimwemwe Mhango-Mawaya for their untiring effort in their supervisory role. Their suggestions and criticisms were very valuable.

My thanks also go to the then Director of the Museums of Malawi Dr. M.E.D. Nhlane for his word of encouragement, Mr. W.N. Chitaukali and Prof. C.O. Dudley for proof-reading the manuscripts. I am thankful to Messrs P.M. Kaliba, Late V.T. Chilembo, N.B.E. Kalimira, N.H. Gawani, J. Vuthula, late J. Jailosi, Mwambo, Ntaja and W. Chitaukali for their help with fieldwork. Thanks also go to Mr. Jameson S. Kamwendo for coordinating the GTZ project well and for making funds available for the research. I also wish to thank Mrs. Esther Msiska and Mrs. Loveness Ndawala for typing this thesis.

Lastly but not least, I am greatly indebted to Dr. Jean-Marc for providing the necessary tuition fee for this degree programme.

ABSTRACT

The study on herpetofauna in selected protected areas of Malawi was undertaken from July 2001 to February 2003 in Mughese, Ntchisi and Tsamba Forest Reserves. Specifically, the study aimed at investigating the herpetofauna, collect data on human use, determine the conservation status and sustainable utilization of the herpetofauna of Mughese, Ntchisi and Tsamba Forest Reserves. Data for the research were collected by reviewing the existing literature, carrying out primary field data collection as well as conducting socio-economic surveys through use of questionnaires.

The results of the study revealed that each study area had a high level of herpetofaunal diversity. Endemics were restricted to Mughese Forest and these were France's Squeaker (*Arthroleptis francei*) and Reiche's Squeaker (*Arthroleptis reichei*). However, the three study areas also share a number of species. New records were also recorded: the Common Platanna (*Xenopus laevis*) and Savanna Ridged Frog (*Ptychadena anchietae*) at Mughese Forest; and Marbled Snout-burrower (*Hemisus marmoratus*), Guibe's Ridged Frog (*Ptychadena guibei*), Mascarene Ridged Frog (*Ptychadena mascareniensis*), the Gray Tree Frog (*Chiromantis xerampelina*) and all but two species of snakes; Puff Adder (*Bitis arietans*) and Striped Skaapsteker (*Psammophis tritaeniatus tritaeniatus*) at Ntchisi Forest. However, due to lack of previous records, all amphibians and reptiles of Tsamba Forest are new distributional records. Two threatened species: *A. reichei* and *A. francei* were also recorded. Both of them were recorded at Mughese Forest and none at Ntchisi and Tsamba Forests.

For reptiles, the Striped Skink (*Mabuya striata*), Variable Skink (*Mabuya varia*) and Flap-necked Chameleon (*Chamaeleo dilepis*) were the most common species at all three study areas. However, due to lack of previous records on reptiles, all the recorded species are new records for the areas.

Results of the socio-economic survey revealed that the local people in these areas derive some benefits from herpetofauna. Some species are harvested for food while others are harvested for medicinal purposes. Herpetofaunal species exploited for medicine purposes include: - the Black Mamba (*Dendroaspis polylepis*), Monitor

Lizard (*Varanus niloticus*), the African Python (*Python sebae*), Flap-necked Chameleon (*C. dilepis*), Puff Adder (*B. arietans*), Mozambique's Rain Frog (*Breviceps mossambica*), the *M. striata*, just to mention a few. Leopard Tortoise (*Geochelone pardalis*) is exploited for both food and medicine.

Threats to herpetofauna are numerous. These include killing out of fear and dislike for certain classes of reptiles e.g. snakes. Other threats include habitat loss and pollution. Very few are harvested for food.

To address the situation, there is need to carry our more research on herpetofauna in other protected areas to determine their current distribution and conservation assessment. Hence, the need to have well trained personnel who should do the job cannot be overemphasized. The survival of our biodiversity, including herpetofauna would very much depend on carrying out sensitization campaigns to educate the communities living in areas surrounding the forests on the dangers of environmental degradation and loss of biological diversity and bring in the concept of sustainable utilization of our biodiversity.

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

PAGE

LIST OF PLATES

PAGE

LIST OF TABLES

PAGE

LIST OF APPENDICES

PAGE

LIST OF ACRONYMS AND ABBREVIATIONS

CBNRM	:	Community Based Natural Resources Management
CITES	:	Convention on International Trade for Endangered Species
DNPW	:	Department of National Parks and Wildlife
FRIM	:	Forestry Research Institute of Malawi
ICMSR	:	Integrated Catchment Management Strategies and Restoration
IUCN	:	International Union for the Conservation of Nature
MoM	:	Museums of Malawi
MPRSP	:	Malawi Poverty Reduction Strategy Paper
NHBG	:	National Herbarium and Botanical Gardens of Malawi
NGO	:	Non-Governmental Organization
NHBG	:	National Herbarium and Botanic Gardens of Malawi
SHCA	:	Small Holder Coffee Authority
UNICEF	:	United Nations Children's Fund
UNIMA	:	University of Malawi
VNRC	:	Village Natural Resources Committees
WESM	:	Wildlife and Environmental Society of Malawi

CHAPTER ONE:
GENERAL INTRODUCTION

1.1 BACKGROUND INFORMATION

In Malawi, large mammals, birds and even fishes have received considerable attention from naturalists, perhaps because of their popular appeal and economic value. However, few publications have been prepared for the identification and study of amphibians and reptiles. *Snakes of Nyasaland* (Sweeney 1961, 1971), *Animal Life of Malawi Volume II - Vertebrates* (Sweeney 1970) and *An Introduction to the Common Snakes of Malawi* (Royle 1989) are the only books that provide some identification materials for the known species of snakes that occur in Malawi. The zoological and faunistic significance of Malawian amphibians were discussed by Loveridge (1953a), Mfune & Mhango (1998), Poynton (1964b) and Stewart (1967). *Amphibians of Malawi* by Stewart (1967) is probably the only detailed book that deals with Malawian amphibians. Sweeney (1970) listed fifty species of amphibians as being recorded from Malawi while Stewart (1967) listed fifty-six species of amphibians consisting of fifty frogs, five toads and one caecilian. Mfune & Mhango (1998) estimated that there were about sixty-three amphibian species and just over hundred reptilian species that occur in Malawi. This richness of amphibian fauna is largely influenced by the fact that Malawi has a variety of habitats where members of both tropical and "temperate" faunas are represented. Additionally, there are several endemic species that have evolved on the high land areas of the country such as Nyika and Zomba Plateaux as well as Mulanje Mountain (Stewart 1967). Mughese, Ntchisi and Tsamba Forest Reserves are situated on Misuku Hills, Ntchisi Mountain and Tsamba Hill respectively. The first two sites are amongst high altitudinal areas where endemic species of both amphibians and reptiles occur.

1.2 PROBLEM STATEMENT

Presently, in Malawi, there are over eighty forest reserves, five national parks and four game reserves. In addition to these conservation areas, there are also two private game parks, two nature sanctuaries and three national botanic gardens. Together, these constitute what are known as protected areas of Malawi (Seyani 1991). Some protected areas are managed privately or with the assistance of various Non-Governmental Organizations (NGOs) while the majority are publicly owned. Historically, forests on public land were managed poorly such that degradation was common. This led to the establishment of forest reserves and national parks through the Forestry Act (Malawi Government 1942) and the National Parks Act (Malawi Government 1965), respectively. Although the Forestry Act only came into existence in 1942, Mulanje Mountain had already been declared as a protected area by 1927. National parks came into existence with the gazettement of Nyika National Park in 1969. While national parks were established to protect selected animals, forest reserves served mainly to protect timber and important water catchment areas. As a result, comprehensive inventories of both plants and animals in forest reserves are non-existent (Seyani 1991).

Besides that, most of these protected areas are situated in areas with dense human occupation (Seyani 1991). Since the economy of Malawi is based on agriculture, large tracks of land have been and are still being cleared to create crop fields. Relict fragments of forests are scattered in protected areas, with very little left in private land. The high human population has resulted in more farmland being created and due to inadequate land for agriculture; the people have resorted to encroaching into protected areas or cultivation of marginal lands which act as buffer zones to protected areas. This leaves the ground bare thereby making the land susceptible to soil erosion during rainy seasons. This, compounded by collection of thatching grass and fuel wood, grazing of animals, bushfires leads to severe forest degradation. This has in turn resulted in the destruction of habitats and breeding sites for lower vertebrates such as herpetofauna, hence posing threat to their survival (Dudley 2004). Sensing danger, managers of protected areas introduced policing mechanisms (where the local people were barred from entering the forests to harvest forest products) in order to protect the remaining vegetation. This strategy did not go down well with the local people who felt alienated from the protected areas; hence they developed resentment towards conservation efforts. Today, efforts are being made through the Forestry Department,

Wildlife and Environmental Society of Malawi, relevant Government departments and other NGOs to win back the support of local communities through participatory approach where they realize a share of some benefits including allowing them limited access to protected areas for collection of thatching grass, dead wood, insects and other forestry products (Dudley 2004). In this respect, protected areas face an eminent danger of over-utilization of biodiversity and hence destruction of habitats and breeding sites for lower vertebrates such as herpetofauna unless proper studies are conducted to bring the concept of sustainable utilization of our biodiversity.

Unlike other vertebrates, herpetofauna have generally received little research attention in Malawi. Previous research works were mainly confined to systematics and what is recorded (known) to date is that we have 228 herpetofauna comprising of 83 amphibians and 145 reptiles (Mazibuko 2005). Research gaps identified included: incomplete inventories for some protected areas; the ecology of herpetofauna; human use and threats to herpetofauna. This study was carried out to address these gaps in order to have a better understanding of herpetofauna in Mughese, Ntchisi and Tsamba Forest Reserves for appropriate conservation measures to be identified. The study was a component of a project on "*Management of Biodiversity in some Protected Areas of Malawi*" funded by the Project Implementing the Biodiversity Convention of Deutsche Gesellchaft fur Technische Zusammenarbeit (GTZ) GmbH on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ). The project involved several stakeholders: the Museums of Malawi (MoM), Forestry Research Institute of Malawi (FRIM), Wildlife and Environmental Society of Malawi (WESM) and the National Herbarium and Botanic Gardens of Malawi (NHBG), with the latter as the leading agency. The general objective of the GTZ funded project was to evaluate the biodiversity of Mughese, Ntchisi and Tsamba Forests, their richness, conservation status, management practices and utilization by people of the surrounding communities.

A better understanding of herpetofauna in the said protected areas will assist in coming up with mitigation measures. This is crucial from both a scientific as well as from an economic perspective, as the results will be used by conservation managers in managing biological resources in general and herpetofauna in particular in the selected forest reserves. Given the severe forest degradation and coupled with the fact that habitat loss is the principal threat to biodiversity (Hero & Shoo 2003), I hypothesize that: 1) the species composition in the three

study areas are different owing to different vegetation types found in the study areas, and 2) there has been loss of herpetofauna in the study areas. To test the hypothesis, the study should be able to answer the following questions:

1. What is the composition of herpetofauna of the study areas?
2. What are the past and current distribution and population abundance of herpetofauna?
3. What are the utilization patterns of herpetofauna?
4. What are the conservation status of herpetofauna?
5. What strategies could be put in place to ensure conservation and management of herpetofauna in the three protected areas?

CHAPTER TWO:
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is divided into three sections, namely: the history of herpetofaunal studies in Malawi, the zoological and faunistic significance of herpetofauna of Malawi and the history of herpetofauna studies in the study areas. The section on the history of herpetofaunal studies in Malawi is further divided into two, namely: Amphibians and Reptiles.

2.2 HISTORY OF HERPETOFAUNA STUDIES IN MALAWI

2.2.1 Amphibians

The Amphibians of Malawi have been investigated by a number of authors. Collection of amphibians in Malawi dates back to 1890's when Boulenger (1897) listed fifteen kinds of frogs and toads collected by Alexander Whyte, a naturalist to the British Protectorate and Principal Scientific Officer in British Central Africa. He and others collected for Sir Harry Johnstone, British Commissioner and Consul General in the then Nyasaland Protectorate (now Malawi). Twelve of the amphibian species collected were from Nyika Plateau, 1800 – 2100m above sea level. Johnstone (Stewart 1967) later listed twenty-three species of amphibians in 1906 collected from different parts of the country. Since then, the other major collection was in 1946 by Mr. B.L. Mitchell of the Nyasaland Game and Tsetse Department (Mitchell 1946). While serving as a Biologist, he collected thirty-four species; seventeen of which were reported by Hoffman (1944). From July 1948 to April 1949, Arthur Loveridge, then Curator of Herpetology at Museum Comparative Zoology at Harvard University in the United States, made intensive collections across the country, concentrating mainly on denuded highlands. During the exercise, 1680 amphibians were collected, representing 50 species, seven previously unknown (Loveridge 1953a). Dr Archie Carr, on the Berner Carr Entomological Expedition, collected in the Shire Valley-Lake Malawi area and added two species to the Malawi list (Loveridge 1953b).

In January 1959 Dr. John Poynton (Poynton 1964a), then working as lecturer at the University of Natal in South Africa, collected amphibians in Southern Malawi. In December 1962, another trip was made in Southern Malawi by Dr. Donald Broadley (Broadley 1963), of the Umtali Museum, Zimbabwe. From September 1963 to July 1964 Dr. Margaret M.

Stewart, of Albany University in the United States accompanied her husband to Malawi where she made extensive field studies and collections on amphibians, primarily in the northern region of the country. During that time, she added nine species to those previously reported from the country, bringing the total to sixty species and subspecies (Stewart 1967). Two additional species Beaded Pyxie (*Pyxicephalus tuberculosus*) and Ornate Burrowing Frog (*Hildebrantia ornata*) are probably present since they occurred in the surrounding areas (Poynton 1964b).

2.2.2 Reptiles

Unlike amphibians, fewer collections and publications on reptiles have been made in Malawi. These include: Boulenger (1897), Broadley (2001), Mazibuko *et. al.* (2003), Mfune & Mhango (1998), Stevens (1974), Stewart (1968, 1969), Stewart & Wilson (1966) and Sweeney (1960, 1961). Sweeney's *Snakes of Nyasaland* (1970, 1971) offers a simple introduction to snakes of Malawi. It is intended for those interested in identifying, without much difficulty, any of the known species of snakes that occur in Malawi.

During 1963-64, Dr. Margaret Stewart while working on amphibians of Malawi also made collection on reptiles of the northern Malawi. Areas covered included Nyika Plateau and Mughese Forest among others. Dr. R. Andrew Stevens also made extensive herpetofaunal collections in southeastern Malawi between 1966 and 1971 whilst resident in Mulanje District. During this time, several species were collected including those, which had not been previously recorded in Malawi. In 1998, Dr. John K. Mfune and Ms. Chimwemwe R. Mhango, both of the Biology Department of the University of Malawi at Chancellor College, participated on the Lake Chilwa studies at the request of Malawi Government. The data was needed to assist in designating Lake Chilwa as a wetland of international importance, and so accede to the RAMSAR Convention, the International Convention for Conservation and Sustainable Use of Wetlands. During the survey, nine species of reptiles were collected and three were new records for Lake Chilwa. Between June and July 2003, Mr. Lovemore Mazibuko, Ms. Catherine Tabor and Ms. Rachel Olson participated in a Biosearch Nyika Scientific Exploration of the Nyika National Park to document amphibians and reptiles of Nyika National Park. The aim was to provide biological data on the amphibians and reptiles of Nyika and assess the current distribution pattern in the areas covered, in order to promote conservation of biodiversity of Nyika. During the field survey, 9 reptiles were recorded in

Nyika with one additional record, the Large-scaled Grass Lizard (*Chamaesaura macrolepis miopropus*).

2.3 HISTORY OF HERPETOFAUNA STUDIES IN THE AREAS UNDER STUDY

The herpetofauna of Mughese Forest Reserve have previously been studied by Loveridge (1953a) and Stewart (1965, 1967) and those of Ntchisi Forest Reserve by Loveridge (1953a), and Sweeney (1961). Thirty-four herpetofauna were recorded in Mughese Forest comprising of seventeen amphibians and seventeen reptiles. In Ntchisi Forest, twenty-one herpetofauna were recorded. Out of these, eleven were amphibians while ten were reptiles. However, very little or nothing at all is known of the herpetofauna of Tsamba Forest Reserve. This work is probably the first of its kind that is aimed at studying amphibians and reptiles of Tsamba Forest. Even in areas where previously some surveys had been conducted like in Mughese and Ntchisi Forests, research was largely confined to taxonomy (Loveridge 1953a, Poynton 1964a & b and Sweeney 1961), and not assessment on conservation and utilization of herpetofauna by local people.

2.4 THE ZOOLOGICAL SIGNIFICANCE OF HERPETOFAUNA OF MALAWI

The zoological and faunistic significance of herpetofauna of Malawi were discussed by Mfune & Mhango (1998) and Mphande (1987). Mphande (1987) reported that the Nile Crocodile (*Crocodylus niloticus*) is exploited for skin, which is exported to other countries in Europe such as Germany and France. Mfune & Mhango (1998) reported that people of the Lake Chilwa wetland utilize toads and frogs as bait when hooks are used for fishing. Besides the above usage, Mfune & Mhango (1998) also reported that amphibians play an important role as ecological indicators of the health of ecosystems especially wetlands. Because they have soft permeable skin, amphibians are susceptible to water pollutants, especially agricultural chemicals (Channing 2001; Mfune & Mhango 1998 and Miller 1994). Amphibians are also known to be early indicator species of community or ecosystems degradation especially in relation to drying (Miller 1994). Amphibians are sensitive to prolonged droughts because this leads to drying up of their breeding sites. Decline in population of amphibians may be considered as an early warning sign of drying and drought.

Amphibians have also occupied and still occupy an important place in the ecosystem as representatives of land vertebrates at the most elementary levels. Van Dijk (1966) reported that frogs and toads are extremely useful in that they eat large numbers of insects, including many harmful ones such as mosquitoes. Mosquitoes transmit malaria to human beings. This is particularly true of the Guttural Toad (*Bufo gutturalis*), which feeds on mosquitoes (personal observation). Tadpoles of many species feed on mosquito larvae. Van Dijk (1966) reported that a remarkable feature of a wide range of wetlands searched for tadpoles is the extreme rarity of mosquito larvae and pupae in bodies of water, which yield tadpoles. Since tadpoles are frequently seen feeding on the materials on the water surface, it seems probable that mosquito eggs are eaten before they can hatch (Van Dijk 1966).

Amphibians, on the other hand, provide food to other animals within the ecosystem. Snakes, fishes, and water birds such as cranes and herons, feed heavily on tadpoles and adult amphibians (Stewart 1967). In Malawi, many snake species live exclusively on frogs and toads (Royle 1989). Wager (1965) stated that water snakes primarily feed on banded and ridged frogs (*Ptychadenas*), while grass snakes thrive on reed frogs. Tadpoles provide food for most insects such as dragonfly larvae, water beetles, water bugs and scorpions (Wager 1965). Despite the above numerous benefits derived from herpetofauna, in Malawi, these animals are largely not well known to human beings and their importance not appreciated by most people. This is evident from the few publications on the ecology and conservation of both amphibians and reptiles of Malawi.

CHAPTER THREE:
METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research sites, research design, population, sampling procedure and methods of data collection and analysis. It also outlines some of the problems that were encountered in the field, and the ethical considerations that were used as standards for interacting with the respondents.

3.2 RESEARCH SITES

The three study forests were chosen principally because they are all formally protected areas and two of these forests (Mughese and Ntchisi) have montane forest patches that probably contain some of the highest levels of floristic and faunistic biodiversity in Malawi (Chapman & White 1970). Mughese is of special significant as it was expected to contain a high number of species that have their centres of distribution further north in East and Central Africa (Stewart 1965). Their locations within Malawi are shown in Figure 3.1.

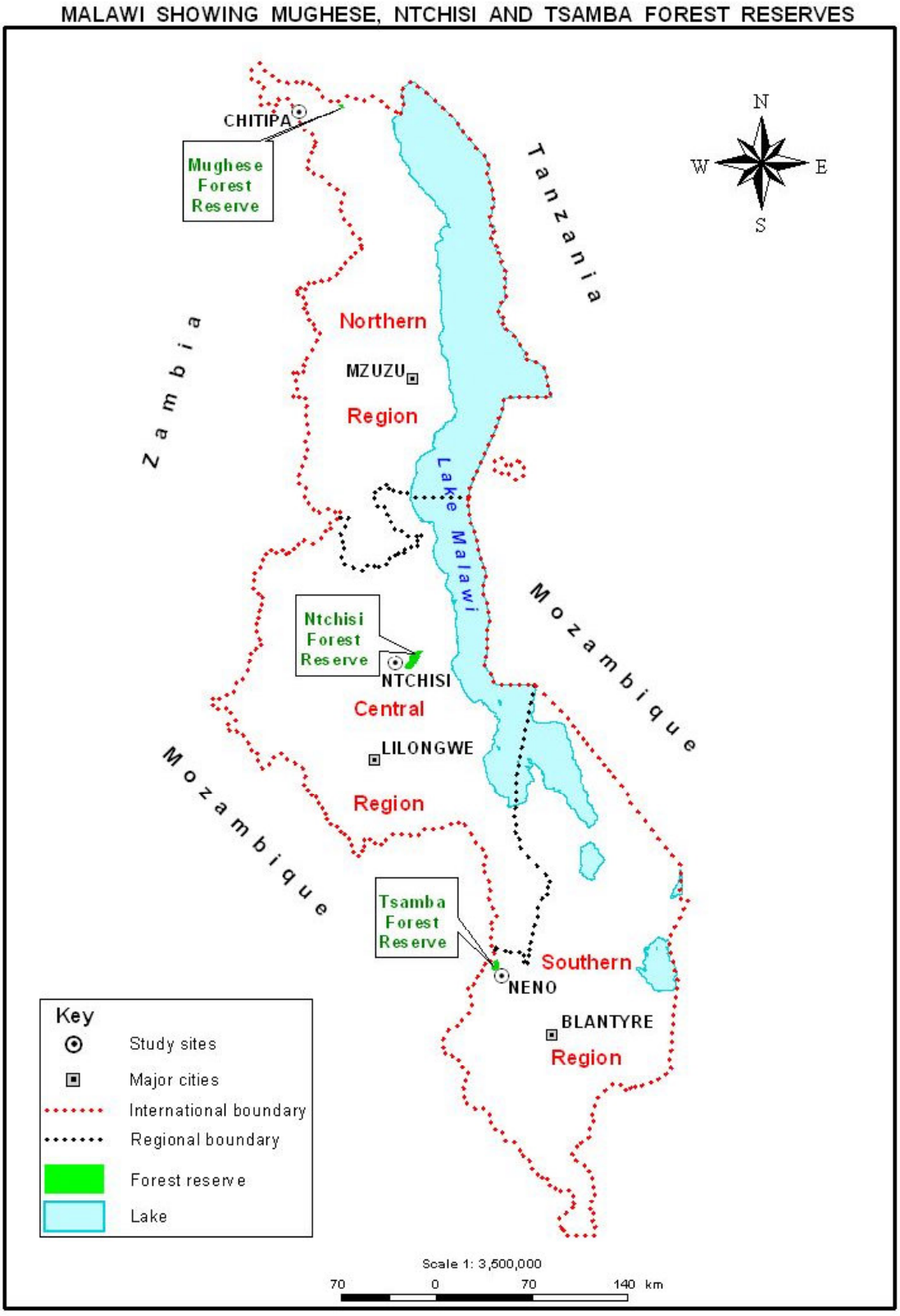


Figure 3.1: Map of Malawi showing Mughese, Ntchisi and Tsamba Forest Reserves.

3.2.1 Mughese Forest Reserve (9°36' and 9°45'S –33°23' and 33°37'E)

3.2.1.1 The Protected Area

The submontane evergreen forest of Mughese Forest Reserve (Figure 3.2) and its two satellite forests of Matipa and Wilindi Reserves are situated on the Misuku Hills close to the Tanzania border in Malawi's Northern Region. The three forests are remnants of what was at one time a much larger continuous forest occupying the higher ridge crests. Their present extent is 3, 120ha. Mughese occupies an area of approximately 720ha along a ridge and extending in the valleys down to an altitude of 1,580m a.s.l. (Dowsett-Lemaire 1989). The central peak rises to 1,888m. Mughese Forest Reserve was gazetted in 1948 as a reserve mainly to protect the Lake Malawi catchment system, and conserve soils particularly in the upland areas where soils are unstable (White *et. al*. 2001). The reserve is managed on a complete protection regime. There is a team of forest patrol personnel, headed by a forest guard, who are involved in the management of the reserve. The patrol personnel guard the forest against encroachment, bush fires, illegal procurement of forest products such as firewood, poles, timber and wild game.

The reserve is surrounded by the following villages: Chanya, Chinongo, Lupugho, Kasambara, Mwamdima, Yapoma, Walasa and Mwangurukuru. People of these communities are allowed access into the reserve to collect firewood after paying a fee ranging from K7 to K20. Only firewood from dead trees or branches is allowed for collection. Villagers are also allowed to harvest edible mushrooms and insects for free (Kamwendo & Dudley 2004).

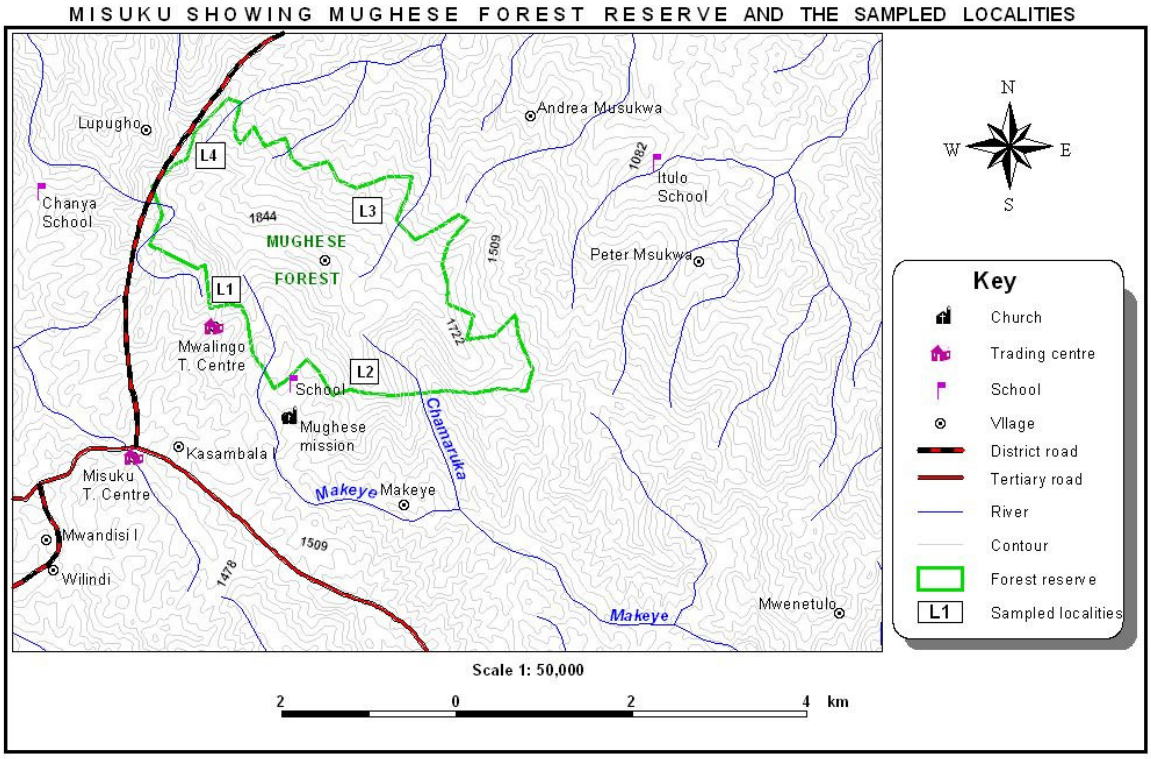


Figure 3.2: Map of Misuku showing Mughese Forest Reserve and localities sampled.

3.2.1.2 Relief, Drainage and Geomorphology

The Chitipa–Karonga area can be divided into several natural topographic units (Stobbs & Young 1972). The topographic features of Mughese Forest Reserve are characterized by steep-sided hills, which are remnants of plateaux of Wilindi, Mafinga and Misuku Hills with altitude ranging between 1,400 and 1,900m a.s.l. In the East, the Karonga Lakeshore plain forms a gently undulating platform, which lies between 472-610m above sea level. The forest reserve has numerous perennial and seasonal rivers, which supply water to the surrounding human populations and make part of the Lake Malawi water catchment system. The major perennial rivers include the Lufira, Mbalise, Kaseye, Songwe River's tributaries and other seasonal streams such as Makeye, Chambo, Mkamasi and Kasisi. The flow of the rivers is controlled by folds and strikes of bedrocks. Most rivers therefore form reticulate drainage pattern (Kamwendo & Dudley 2004). The Mughese Hills are underlain by cataclastic gneisses and sediments of Pleistocene rocks derived from igneous rocks. These rocks are overlain by calcimorphic soils and in valleys by hydromorphic soils (Andrew & Bailey 1910).

3.2.1.3 Climate, Vegetation and Animal Life

The Chitipa-Karonga area experiences a tropical continental climate with a single rainy season from December to March, and sometimes to April. Rains fall on the forest for 10 months of the year, September and October being the only normally dry months, and the mean annual rainfall may reach 2, 200mm (Ray 1975). A cold season starts from May to August and hot season from September to November. The temperature varies with season. The coldest month is between July and August, and the hottest month is between October and November. The mean annual temperature ranges from 12.8^{o}C to 20.3^{o}C. The Lakeshore plain and the rift valley areas experience very high temperatures ranging from 18.3^{o}C to 25.0^{o}C during the months of September to November.

Mughese, along with its satellite forests (Plate 3.1), are among the finest evergreen forests in Malawi consisting of three canopy layers with emergents such as *Entandrophragma excelsum, Pouteria adolfi-friedericii* and *Chrysophyllum gorungosanum* (known locally as "*mukarikari*" and "*mufu*" respectively) reaching nearly 50m in height. The vegetation is lush, streams permanent and the forest floor always moist. A small area of *Brachystegia* woodland exists within the forest reserve at lower altitude on the northern frank. These forests are described by Chapman & White (1970).

The degraded areas of the south-west, north-east and southern parts of the reserve are plantations of *Eucalyptus* spp., *Pinus patula* (Pine), and *Coffea arabica* (coffee) plantations respectively. However, most of the land surrounding the forest has been cleared and is cultivated to the border and/or is used to graze cattle. Hence, Mughese, Matipa and Wilindi are important forest island refuges for biodiversity (Kamwendo & Dudley 2004).

Plate 3.1. The submontane evergreen vegetation in Mughese Forest

Previous records show that several rare amphibians and reptiles occur in or at the forest. These are the Pitless Pigmy Chameleon (*Rhampholeon nchisiensis*), Tiny Cricket Frog (*Phrynobatrachus ukingensis*), Garmani's Bufo (*Bufo garmani*), the Spotted Reed Frog (*Hyperolius puncticulatus*), the White-lipped Snake (*Crotaphopeltis hatamboeia tornieri*), Rungwe Tree Viper (*Atheris rungwensis*) and Forest Cobra (*Naja melanoleuca*) (Stewart 1965).

Bird life is very diverse but poaching has decimated the larger terrestrial mammals. However, arboreal species are in abundance with very large numbers of blue monkeys and bush babies.

3.2.1.4 The Socio-economic and Ethnic Characteristics of the People around Mughese, Forest Reserve.

Mughese Forest Reserve is situated on the Misuku Hills close to the Tanzanian border in the Northern Region of Malawi. According to the Population & Housing Census of 1998 (Malawi Government 1998), Misuku area around the Mughese Forest had a total population of 22, 672. The people in Misuku are mainly of the *Sukwa* tribe. Their languages are *Chisukwa* and *Chindali*. They produce crops such as coffee, maize, Irish potatoes, groundnuts, beans, sweet potatoes, and vegetables, among others. Tobacco has recently been introduced in the area and the production is at a very low scale. They also rear different types of livestock including poultry, cattle and goats (Malawi Government 2000).

Most farmland in Misuku is on steep slopes and conservation work on farmlands started as far back as 1950s. Then there were very few farmers in the area. With the growth in population in recent years, pressure on land has increased leading to encroachment into the reserve. More land has been subjected to farming with poor conservation measures in newly opened gardens. Small Holder Coffee Authority (SHCO) promoted some conservation practices like construction of bunds and terraces in some farmer's fields especially among the coffee-growing farmers (Malawi Government 2000).

Misuku is one of the areas that had thick natural vegetation mostly *Brachystegia* woodlands particularly on the north and eastern sides. But at present, most of the forest area is gone due to opening of new gardens, bushfires, charcoal burning, fuel wood selling and shifting cultivation for millet farming. There is a cultural practice known as *Ifishinge* that leads to

destruction of forest areas. This practice is done in line with millet production where a number of households reserve a stretch of land for a period of time and cut and burn it at once to produce millet. Shifting cultivation is very pronounced in the area for millet production and this is a major threat to biodiversity (Malawi Government 2000).

Close to half of the houses in the area were built with unburned bricks, others were built with mud while few were built with burned bricks. These houses were mostly thatched with grass. Very few were roofed with iron sheets. This meant that grass was an important natural resource to the people living in areas surrounding Mughese Forest as most people used it for thatching their houses. Most people (about 78%) in this area believe in use of tradition medicine. Consequently they utilize different parts of plants and animals including leaves, bark of tree and roots (Malawi Government 2000).

3.2.2 Ntchisi Forest Reserve (13° 15' and 13°23' S - 33° 59' and 34°06'E)

3.2.2.1 The Protected Area

Ntchisi Forest Reserve is found in Ntchisi District on Ntchisi Mountain within Malawi's Central Region (Figures 3.1 and 3.3). It is about 32 km from Lake Malawi and covers an area of about 9, 700ha, 253ha being evergreen forest on the crest of the mountain ridge (1, 645m a.s.l.) and extending to about 1,350m on its southern frank. To the west and north a large area of *Brachystegia* woodland borders the forest and extends to much lower elevations. The full reserve lies between 600-1, 675m above sea level. It was gazetted in 1924 mainly to protect the Lake Malawi water catchment system and in 1957 it was considered a plantation unit forest (Kamwendo & Dudley 2004).

The reserve is surrounded by the following villages: Nyanja, Chifwerekete, Nsambakusi, Nyanga, Mpamila, Kasakula, Chipalanjira and Mkomba. The reserve is currently managed for biodiversity and catchment conservation. There is a team of forest guards, headed by a forest assistant, who guard the reserve against encroachment, bush fires and poaching. Villagers surrounding the reserve are allowed to harvest firewood (from dead trees and branches) at a cost but sometimes licenses are issued to saw timber and charged according to government gazetted rules and regulations (Malawi Government 2001a). Harvesting of insects, mushrooms, and medicine for subsistence consumption is free of charge and in most cases permission is not required to access these products (Kamwendo & Dudley 2004).

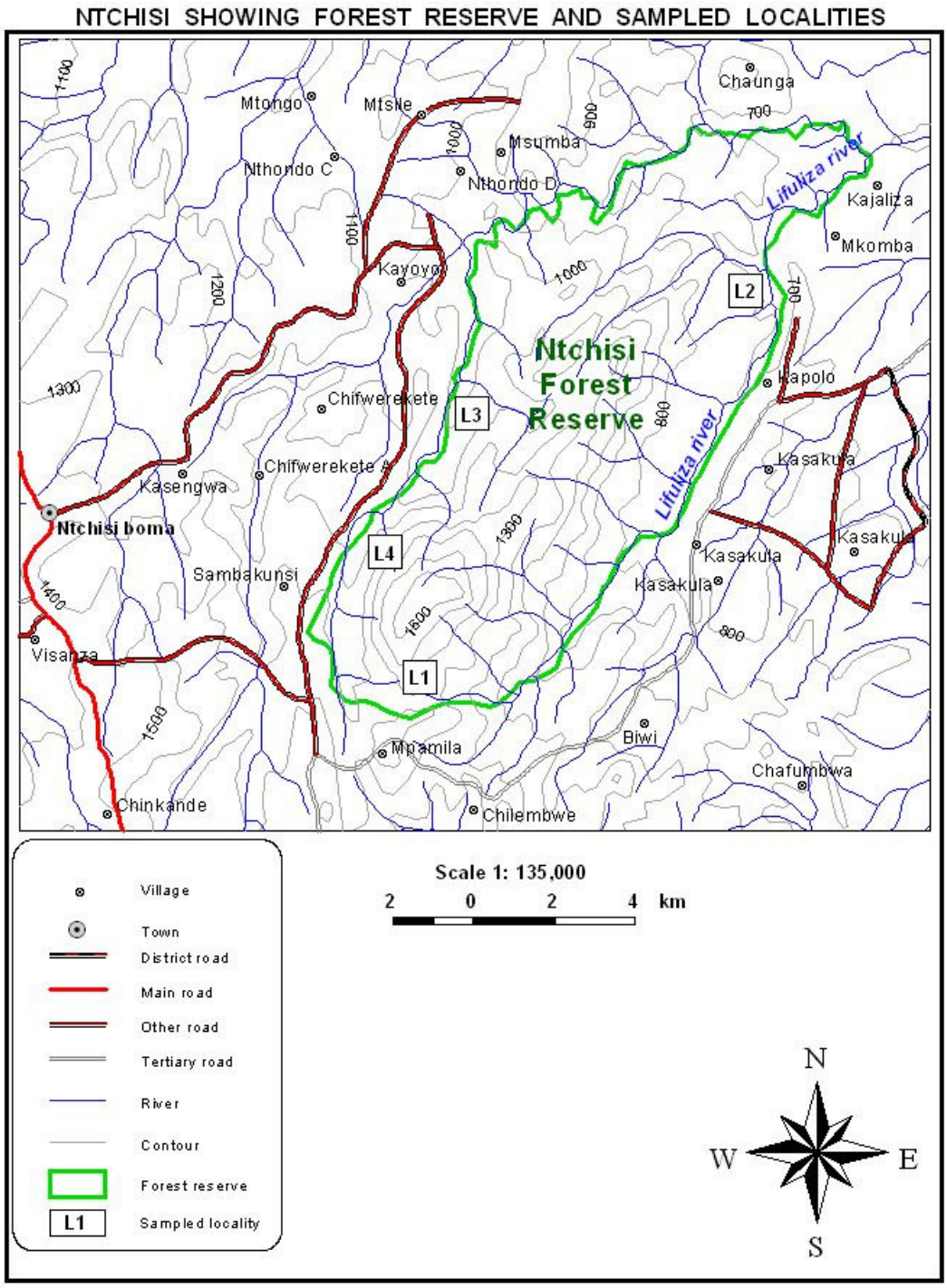


Figure 3.3: Map of Ntchisi showing Ntchisi Forest Reserve and localities sampled.

3.2.2.2 Relief, Drainage and Geomorphology

In general, two major physiographic units characterize the Ntchisi District and the surrounding areas. These are the fault scarp zones, which are part of Lake Malawi and the plain areas forming the eastern part of Kasungu and two-thirds of the western Ntchisi Mountain (Bellington & Bromley 1973). The forest reserve forms a steep sloping spur between Lifuliza and Chafumbi Rivers, which is also part of the Lake Malawi catchment system (Bellington & Bromley 1973). The Lifuliza River on the south-eastern slopes is perennial and has its source on the mountain. There are numerous small streams, which originate within the forest reserve but most of them stop flowing during the dry season and forest floor becomes very dry. The Ntchisi Plain area is drained by three rivers systems, the Bua River and its two tributaries (Kamwendo & Dudley 2004).

The Ntchisi Mountain is underlain by basement complex rocks. Drummond (1888) identified sedimentary rocks with coal ashes. In 1910, Andrew & Bailey described igneous and metamorphic rocks, which later differentiated into sedimentary rocks through lithithication and metamorphic processes. Many fragments of sedimentary rocks are deposited in the plain areas due to erosion.

3.2.2.3 Climate, Vegetation and Animal Life

Ntchisi Forest Reserve also experiences a tropical continental climate, which is characterized by a cool dry season from May to august, a hot season from September to November and a hot wet season from December to April. The average annual temperature ranges from 17-20^{o}C while plain areas experience higher temperatures. The mean annual rainfall ranges from 890 to 1,270mm. Lower elevations in the extreme northeast are again characterized by high rainfall (1, 000 to 1, 270mm). The rainy season is mainly concentrated in late December through January to February (Bellington & Bromley 1973).

According to Brown & Young (1965), there are three broad vegetation types in the area. *Brachystegia-Julbernadia* (Plateau woodland) is most widespread and occurs throughout, except for small areas of relatively fertile ferruginous soils, which are found in the south central part. These fertile areas support *Combretum-Acacia-Bauhinia* (savanna woodland). The hilly or mountainous scarp zone areas in the east support *Brachystegia* (hilly woodland) and the high relatively wet region around Mvera Hill supports montane forest and grassland.

This evergreen forest is classified as both mid-altitude and submontane with *Aningeria* and *Chrysophyllum* the principal emergents (Dowsett-Lemaire 1989). Outside of this forest reserve, on its eastern and southern flanks, the area has been extensively cleared and annually burnt, few *Brachystegia* trees remain and grassland predominates. Details of this forest's botanic diversity and structure can be found in Chapman & White (1970). The stream banks are covered with a rich riparian forest where *Newtonia buchananii* is prominent. These vegetation types are influenced by amount of rainfall, type of climate and type of rocks, which form the soils. For example, although the Ntchisi Forest is drier than Mughese, having only a six months rainy season from November to April with no rain falling from May to October, south-easterly winds from the lake cause overcast conditions for much of the dry season and early morning dews maintain the evergreen vegetation.

In 1951, *Pinus patula* and *Cypress* species along with *Eucalyptus* were introduced in the forest reserve as plantation forest units planted along the upper southern edge and along the lower edge of the forest. By 1958 plantation covered an area of 243 hectares. Fire has been used as a management tool in *Brachystegia* woodland. The pine did not do well and has been cleared (Chapman & White 1970).

Bird life is abundant and small antelopes, hyenas, blue and velvet monkeys exist in small numbers (Kamwendo & Dudley 2004). Night poaching with guns and pitfall traps is common.

There is one private business lady operating in the reserve, who has a keen interest in natural resource management in this area. This lady was given concession to operate a guesthouse in the forest reserve. She is currently working with communities and the Forestry Department to control bush fires and animal poaching in the southern part of the reserve. Tourists and insect collectors frequent the reserve (Kamwendo & Dudley 2004).

3.2.2.4 The Socio-economic and Ethnic Characteristics of the People around Ntchisi Forest Reserve.

According to the Population & Housing Census of 1998, Ntchisi District has a total population of about 167, 880 with a population density of 57 people per km². The population of villages surrounding Ntchisi Forest is at 32, 545 (Malawi Government 1998). Most of the people in villages surrounding Ntchisi Forest are of the *Chewa* tribe. Illiteracy is very high and a larger proportion of schools going children are boys. The people of Ntchisi cultivate maize for food, tobacco and groundnuts for sale (Kamwendo & Dudley 2004).

Most houses in this area were grass thatched and were mainly built with mud and unburned bricks. Very few houses were built with burned bricks and roofed with iron sheets. Livestock kept in the area included: poultry, goats, cattle, rabbits, sheep and pigs. Interviews with villagers indicated that many people also raise livestock in the area for food and income. In addition, some people are fishermen. They catch fish in Lifuliza River, which forms the forest boundary to the east of Ntchisi Forest. Just like in Mughese, most people (about 70%) in this area also use traditional medicine.

Biological diversity in the area is under threat due to high population growth coupled with poverty and low income. Illegal tree felling inside the reserve was reported as far back as 1969 and this has continued to date. Worse still, the forest has been subjected to bush fires, poaching and encroachment since 1969 (Kamwendo & Dudley 2004). Bush fires tend to destroy the biological diversity of the forest reserve and this poses great threat to the survival of the biological diversity. Customary woodlands are almost non-existent just outside the reserve, as the woodlands have been cleared for cultivation of crops and settlement (Kamwendo & Dudley 2004). However, there are a few scattered indigenous trees and small patches of indigenous woodlands in graveyards. There were several Village Natural Resource Committees (VNRCs) established mainly under the Malawi Social Action Fund (MASAF) project to plant trees on bare hills around the reserve. Only one of these committees, Kasakula, appears to be functional at present. There is only one Non-Governmental Organization (NGO) active in this area - World Vision International. Its focus is on development works such as construction of schools, bore holes and health clinics. World Vision International is active in Nthondo area. One NGO taught people bee keeping and provided equipment in Kasakula. This NGO has since left and abandoned everything.

The people in this area expressed disappointment as they were very prepared to work with this NGO to develop bee keeping (Kamwendo & Dudley 2004).

3.2.3 Tsamba Forest Reserve (15.21ºS 34.37ºE)

3.2.3.1 The Protected Area

Tsamba Forest Reserve is a small (3,280ha) hilly upland area with an altitude range of approximately 800-1,500m. It is situated in the Southern Malawi District of Neno, close to the western boarder with Mozambique, some 100 km north-west of Blantyre (Figure 3.1). It lies between 15°18' and 15°23' S and 34°35' and 34°39'E. Mkulumadzi, a perennial stream, which also forms the forest boundary on the eastern side, has its source in the forest on the north-eastern slopes. Matandani Mission of the Seventh Day Adventist Church is to the north-east of the forest reserve. Traditional Authority Dambe Headquarters is on the south-western side of the forest, while Neno Catholic Mission is to the south (Figure 3.4).

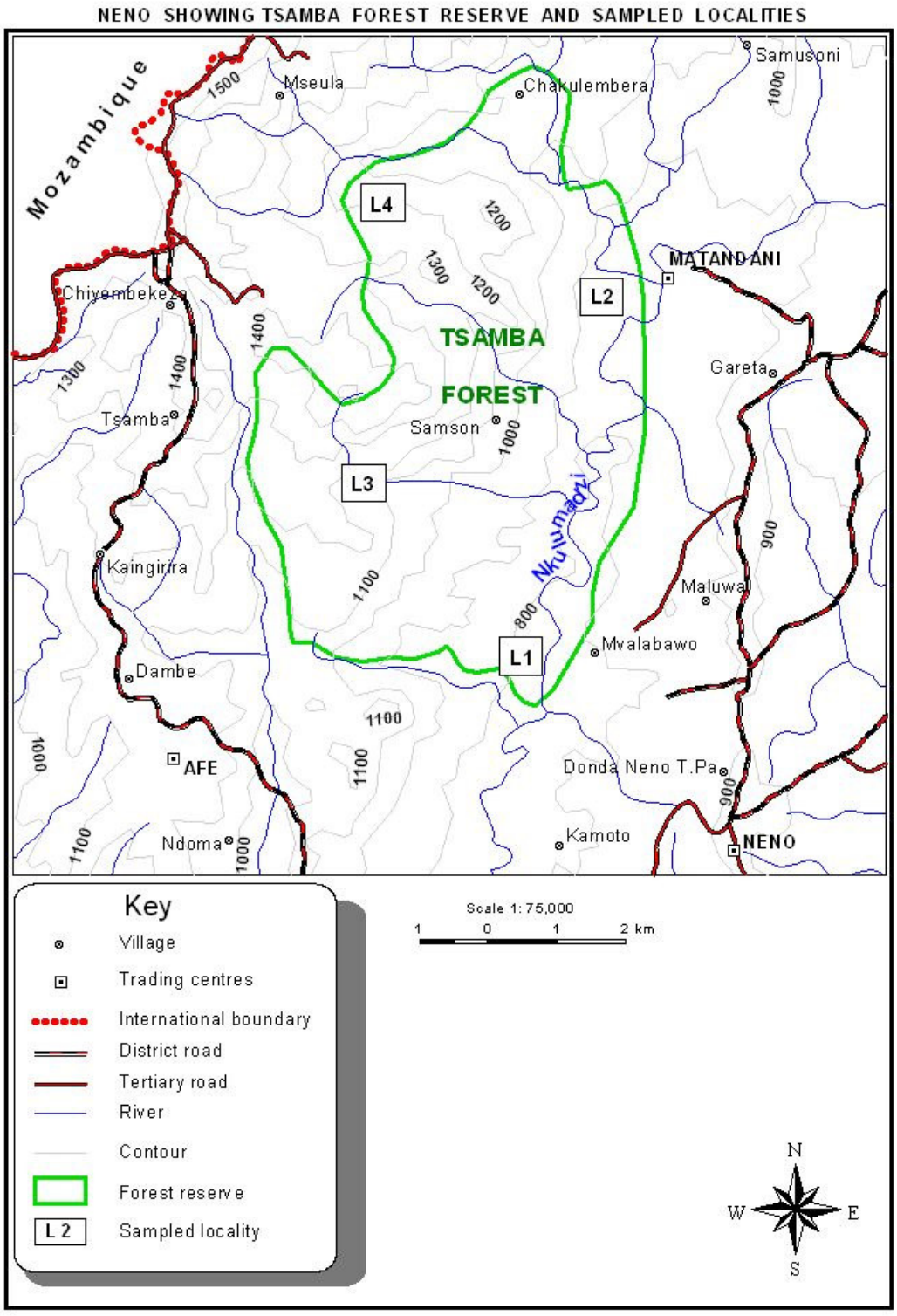


Figure 3.4: Map of Neno showing Tsamba Forest Reserve and sampled localities.

3.2.3.2 Relief, Drainage and Geomorphology

The central feature of the area is the Tsamba Hill, which is 1,312m high. To the west of the hill is low relief that consists of biotite-gneiss. But about five kilometers away there are sharp standing ridges of quartz-mica-schist, quartzite and siliceous granulite. On the eastern side of this reserve, there is a belt of hornblende-gneiss, which forms ridges of harder rocks. Tsamba peak stands at the northern end and forms long mass of nepheline syenite-gneiss, which joins the north-south ridges. The ridges are underlain by rocks, which continue eastwards and drawn into the Mwanza River. Some places are marked by both small low ridges, and sharp ridges of hard rocks. Thus, they exert considerable influence on the drainage pattern and so on the distribution of alluvial corundum, and other metrical minerals Tsamba hill is made up of nepheline-syenite or gneiss, formed by the metasomatic alteration of metasediments (Cooper & Bloomfield 1967).

Wamkulumadzi River has its source from Tsamba Forest Reserve and is the most important water source for the surrounding population. Some of the rivers in the area include the Mwanza, Namitembo and Ngona, which drain into the Lower Shire Valley. The area is also drainage for Matembo River (Cooper & Bloomfield 1967).

3.2.3.3 Climate, Vegetation and Animal Life

The area experiences a tropical continental climate, characterized by a cool dry season from May to August, a hot dry season from September to November and a fairly hot wet season between December and April (Bellingham & Bromley 1973). The mean annual temperature ranges from 18º to 21º C. Tsamba is drier than the two other study sites and rainfall ranges from 963 to 1,000mm. These climate conditions have great influence on the type of vegetation growing in the area and animals found (Cooper & Bloomfield 1967). The forest reserve is mainly dominated by *Brachystegia* species. Also dominating some parts of the reserve are *Uapaca kirkiana* commonly know as *Masuku* (Plate 3.2) and the bamboo *Oxytenanthera abyssinica*. Elephant grass (*Pennisetum purpureum*) and reeds (*Phragmites mauritiana*) are common in riverine areas. The tree canopy is very discontinuous and open, although in some areas it formed almost a closed cover. Canopy height seldom exceeded 12m. A woody under story was not well developed, perhaps due to repeated bush fires as a result of a dense grass ground cover. Much of the reserve has been degraded by human activity where it lies near the town of Neno (Kamwendo & Dudley 2004). Bellingham &

Blomley (1973) reported both small and large mammals, birds, reptiles and amphibians were common. Little of the larger mammals remain today. However, most of these were not documented.

3.2.3.4 The Socio-economic and Ethnic Characteristics of the People around Tsamba Forest Reserve.

The population of Neno around Tsamba Forest is approximately 138, 015 people with a population density of about 60 people per km² (NSO 1998). The people in the Tsamba area are principally of the *Ngoni* and *Mang'anja* tribes with a few individuals from Mozambique. They rely on subsistence agriculture, growing maize, wheat, tangerines (citrus fruits), cotton, Irish potatoes, beans, pigeon peas, sweet potatoes and various vegetables. Livestock kept in the area included: poultry, cattle and goats (Kamwendo & Dudley 2004). Villagers indicated that they keep livestock in the area for food and income.

Most of their houses were built with burned brick and roofed with iron sheets, particularly on the eastern side of the forest reserve, perhaps because of the influence of the early missionaries (Matandani Seventh-Day Adventist and Neno Catholic Missions). These missionaries brought religion and education to the people in this area much earlier than in other parts of the countries hence they helped quite a lot in uplifting the living standards of the surrounding communities. Houses of villagers on the western side of the forest were mostly built with mud or unburned bricks and thatched with grass (Kamwendo & Dudley 2004).

Due to poverty, exacerbated by low education and low income, adjacent rural communities must gather their required natural resources from the few pockets of indigenous customary woodlands near Neno and Tsamba Forest Reserve. While illegal tree felling and firewood collection was reported as far back as 1964, the current rate of deforestation is unprecedented. This deforestation, coupled with unsustainable collection of biological resources, uncontrolled bushfires, and poaching has led to loss of biological diversity in the area (Kamwendo & Dudley 2004). In the past, the reserve was protected against forces of deforestation by its remote location and lack of demand for non-forestry products. However, access to the large city of Blantyre has recently improved and this has led to the opening up of the reserve to charcoal burning and marketing of timber. This threatens the slow growing

miombo (*Brachystegia*) woodland and the animal life it supports (Kamwendo & Dudley 2004). The major traditional dance performed by the people around Tsamba Forest is *Ngoma*. Very few people (about 30% of the people) in this area believe in use of traditional medicine; again, perhaps because of religious influence.

Plate 3.2. Brachystegia woodland dominated by *Uapaca kirkiana* in Tsamba Forest

3.3 RESEARCH DESIGN

The following procedures were undertaken during the research study in Mughese, Ntchisi and Tsamba Forests:

1. Conducting literature review
2. Conducting field survey to document and determine conservation status of herpetofauna
3. Conducting interviews using appropriate tools (semi-structured questionnaire, key informant schedule and focus group discussion guide) to collect data on the human use of herpetofauna
4. Compilation and analysis of the data obtained from the field.

3.4 DATA COLLECTION

The two main methods used to collect data in this study were documentary evidence and primary data collection. Primary data collection involved field survey and interviews.

3.4.1 Documentary Evidence

This method was used to collect data relating to the description of the study area, history of herpetofaunal studies in Malawi and information on human use as well as the general importance of Malawian herpetofauna.

3.4.2 Primary Data Collection

3.4.2.1 Field Survey

Field surveys to collect data on diversity, distribution and population status of amphibians and reptiles were conducted from July 2001 to November 2002 in Mughese, Ntchisi and Tsamba Forest Reserves. Each area was visited three times for eighteen to twenty-one days. The visits were planned so that they were conducted at different times/seasons of the year. According to the State of Environmental Report (Malawi Government 2002a), there are two major seasons of the year in Malawi, which are also prevalent in the areas under study. These are wet season (between October and March) and dry season (between April and September). But these are often split into three distinct seasons, namely cool-dry season (between May and August), warm-dry season (between September and December) and warm-wet season (between December and April) (Clarke 1983; Malawi Government 2001b). The visits were planned in order to coincide with these three seasons of the year. This was done in order to sample as many herpetofaunal species as possible since many species are more easily encountered at one particular time of the year. However, it was not practically possible to visit each area according to plan because the disbursement of project funds could not coincide with these seasons. As a result, some study areas such as Ntchisi and Tsamba Forest Reserves were visited twice during the same seasons. Table 3.1 shows the period and time of the year spent surveying at Mughese, Ntchisi and Tsamba Forest Reserves.

Table 3.1: Period and season spent surveying at Mughese, Ntchisi and Tsamba Forest Reserves, Malawi.

STUDY AREAS	DATES SURVEY CONDUCTED	NO. OF DAYS	SEASON OF THE YEAR
Mughese	06/01/02 – 24/01/02	18	Warm-wet
	05/05/02 – 26/05/02	21	Cool-dry
	03/11/02 – 24/11/02	21	Hot-dry
	TOTAL	**60**	
Ntchisi	11/09/01 – 30/09/01	19	Hot-dry
	08/07/02 – 29/07/02	21	Cool-dry
	08/09/02 – 28/09/02	20	Hot-dry
	TOTAL	**60**	
Tsamba	19/07/01 – 08/08/01	20	Cool-dry
	08/11/01 – 29/11/01	21	Hot-dry
	02/10/02 – 21/10/02	19	Hot-dry
	TOTAL	**60**	

3.4.2.1.1 Sampling localities

In each forest reserve, four sampling localities were identified. These localities were chosen because their vegetations were representative of the different vegetation types that are found in the areas under study. The sampling localities were as follows:

3.4.2.1.1.1 Sampling localities in Mughese Forest Reserve

The localities that were sampled in Mughese Forest were those adjacent to Mwalingo, Mwenetulo, and Lupugho Villages as well as the Forest Top (Figure 3.2).

Mwalingo Residential Training Centre. **(1590m a.s.l.)**

This locality is on the valley with short vegetation mostly shrubs. Species were sampled along the riparian vegetation, around the dam, amongst the shrubs and in marshy areas along the stream.

Mwenetulo **(1500m a.s.l)**

This locality is to the east of the reserve near the Mughese Catholic Mission. A number of habitats were sampled including the montane vegetation, swamps, disturbed open areas, and grassland.

On the "Mountain Top" **(1858m a.s.l.)**

This locality is situated on the forest top deep inside the reserve. Vegetation type mostly comprised *Brachystegia* species and montane evergreen forest dominated by *Entandrophragma excelsum*, *Aningeria adolfi-friendericii* and *Chrosophyllum gorungosanum* species.

Lupugho. **(1680m a.s.l.)**

The fourth locality is on the western side of the forest overlooking Lupugho Village and Chanya Primary School. This area had a dense canopy, since most of the forest is evergreen. Habitats sampled were introduced vegetation, montane evergreen vegetation, terrestrial and in open vegetation.

3.4.2.1.1.2 Sampling localities in Ntchisi Forest Reserve.

In Ntchisi forest, the localities that were sampled were those adjacent to the following surrounding areas or villages: Kasakula, Mpamila, Nsambakunsi and Chifwerekete (Figure 3.3).

***Kasakula* (825m a.s.l.)**

The second locality in Ntchisi is situated on the north-eastern side of the forest overlooking Traditional Authority Mwansambo Headquarters. This area mainly comprised of *Brachystegia*, *Acacia* and *Newtonia*. Four quadrats were sampled in riparian, rocky, terrestrial and marshy habitats. The area had thick vegetation especially along the perennial stream called Lifuliza, which runs through the area and forms the forest boundary to the east.

***Mpamila* (1275m a.s.l.)**

This locality is on the southern end of the forest reserve near the Forestry Station. The dominant vegetation in this area is *Brachystegia* woodland dominated by *Uapaca kirkiana*. The following habitats were sampled: riparian, introduced vegetation, rocky habitats and montane evergreen forest patch. Sampling during the first visit was done at the time when area had just been burnt.

***Nsambakunsi* (1290m a.s.l.)**

The last locality in Ntchisi forest is situated on the south-western part of the forest. Sampling was done on riparian, grassland, disturbed and introduced vegetations.

***Chifwerekete* (1050m a.s.l.)**

This locality is situated on the north-western side of the forest overlooking Chifwerekete Village. Vegetation comprised typical *Brachystegia* woodland. Habitats sampled were riparian, rocky, introduced vegetation and general terrestrial habitats.

3.4.2.1.1.3 Sampling localities in Tsamba Forest Reserve

In Tsamba Forest, the localities sampled were those adjacent to Mvalabawo, Matandani, Tsamba, and Dambe (Figure 3.4).

***Mvalabawo Village* (900m a.s.l.)**

This locality is situated on the south-eastern side of the forest reserve. Vegetation comprised of *Brachystegia* woodland and bamboos especially along the Mkulumadzi River which forms the forest boundary on the eastern side of the forest. There was a lot of human activity in this area. Sampling of species was done in riparian, disturbed, and rocky vegetations/habitats.

***Matandani* (1050m a.s.l)**

This site is located on the north-eastern side of the reserve overlooking Matandani Seventh Day Adventist Mission. The Dominant vegetation was *Brachystegi*a and bamboos along the streams that drain the area. The area had reeds and elephant grass especially on the swamps. Grazing was a major human activity as evidenced by goats' and cattle droppings.

***Dambe* (1125m a.s.l.)**

The third locality was on the south-western side of the reserve overlooking Traditional Authority Dambe Headquarters. The area had less undergrowth and the main vegetation type was *Uapaca kirkiana*. Rocky habitats, swamps, forest floors and grassland were some of the habitats sampled.

***Tsamba* (1425m a.s.l.)**

The fourth locality was on the north-western side of the reserve. Vegetation comprised of evergreen forest especially along the valleys and *Brachystegia* woodland. The following habitats were sampled: riparian, rocky habitats and on montane evergreen forest patches.

3.4.2.1.2 Field Data Collection

3.4.2.1.2.1 Sampling and Processing Techniques for Amphibians

Sampling of amphibians was done during the day and night in different habitats. These habitats included streams, ponds, reeds, waterlogged areas, trees, among leaves on forest floors, roadsides etc. Headlamps and flashlights were used to sample amphibians at night. A total of sixty days were spent surveying in each forest reserve. One trained person assisted by three other people were involved in sampling amphibians for at least eight hours a day (day and night time). Two main methods used to collect the data were systematic sampling and quadrat sampling techniques.

Systematic sampling technique included drift fences & pitfall traps, use of long hand-held nets (Plate 3.3), and free hand catching. Drift fences were used to intercept amphibians moving on the ground and redirect them into pitfall traps. One drift fence was located in each locality. Each fence was made from a 60 cm wide plastic sheeting placed in a 10 cm trench, backfilled with soil and fastened every meter to a stick using staples. The pitfall traps were made from large plastic buckets (diameter 30 cm, height 40 cm) buried in the ground, with the opening flush with the surface. Fifty meters of fencing with eleven traps were placed near

the possible amphibian breeding sites (swamps, ponds, streams). The traps were checked twice a day, in the morning and in the afternoon for four days and then moved to another locality.

Plate 3.3: Collection of amphibians using long hand-held nets in Ntchisi Forest

This method was employed with the goal of finding as many amphibian species as possible. Selective species were also sought in their refuges (e.g. under stones, tree barks or fallen logs, in leaf litter or among the branches of trees). Night searches were carried out with the aid of headlamps and flashlights. Once collected, specimens were kept alive in labeled aerated plastic jars, with a bit of water to provide a moist environment before taking them to the camp for processing. The calls of different amphibians at breeding sites were also recorded using a Sanyo Tape Recorder. These calls were used to detect presence of different amphibian species.

Quadrats sampling consisted of laying out a series of squares at randomly selected sites within the area of interest and thoroughly searching those squares for amphibians. Four localities were sampled in each forest reserve. Four quadrats were sampled in each locality bringing to sixteen, the total number of quadrats sampled in each forest reserve. Quadrats were laid out using a marked string. One trained person assisted by three other people were involved in sampling amphibians for at least 60 to 120 minutes. Within each quadrat every rock, piece of wood, and leaf litter was disturbed and turned, and the number of individuals of each species was recorded. As much as possible, observations were done carefully so as not to disturb sections of the quadrats that had not yet been sampled. This technique was used in order to determine the species richness and their relative abundances. There were two categories that were used to determine species abundance. If the number of recorded individuals for each species exceeded eight (8), that species was considered as common. But if the number of recorded individuals was less than eight (8), that species was considered as uncommon.

The sizes of quadrats were determined based on the size of each forest reserve. This was done in order to achieve proportionally equal sampling effort for the three study sites as the number of days spent surveying in each forest was the same. Table 3.2 shows the relationship between the total area of the forests and sizes of quadrats sampled for Mughese, Ntchisi and Tsamba Forest Reserves.

Table 3.2: Relationship between total areas of forests (m^2) and sizes of quadrats (m^2) for Mughese, Ntchisi and Tsamba Forest Reserves, Malawi.

NAME OF FOREST	TOTAL AREA COVERED BY FORESTS (M^2)	NO. OF QUADRATS SAMPLED	MEASURE-MENTS OF EACH QUADRAT (M)	SIZE OF EACH QUADRAT (M^2)	TOTAL AREA SAMPLED IN EACH FOREST (M^2)	% OF FOREST AREA SAMPLED IN RELATION TO TOTAL AREA OF FOREST (%).
Mughese	6,730,000	16	16 by 16	256	4,096	0.06
Ntchisi	97,120,000	16	60 by 60	3,600	57,600	0.06
Tsamba	32,370,000	16	35 by 35	1,225	19,600	0.06

Photographs of specimens were taken to document their natural colouration and pattern variation. As much as possible, identification of specimens was done on live specimens using identification keys such as *Amphibians of Central and Southern Africa* (Channing 2001), *Amphibians of Malawi* (Stewart 1967) and *Amphibia Zambesiaca*, (Poynton & Broadley 1985a, 1985b, 1987 & 1988). Collection information on name of species, mass, snout-vent length, amount of webbing, reproductive condition (presence or absence of eggs), name of collector, locality and date of collection was recorded on the labels and attached to each specimen bottle. Once identified and measurements recorded, amphibians were anaesthetized and killed by putting a few drops of ether on a piece of cotton wool placed together with the specimen in a closed container. Specimens were then tagged, slit open to allow flooding of internal organs and stored in specimen bottles in 70% ethanol. Collection information on name of species, mass, snout-vent length, tail length, reproductive condition (presence or absence of eggs/foetuses), name of collector, locality and date of collection was recorded on the labels and attached to each specimen bottle. Voucher specimens were deposited at the Museums of Malawi in Blantyre to confirm identification.

3.4.2.1.2.2 Sampling and Processing Techniques for Reptiles

Reptiles live in habitats that range from aquatic, amphibious, fossorial, and terrestrial through to arboreal (Dudley *et al.* 1979). As was the case with amphibians, collecting and sampling methods for reptiles comprised of systematic sampling and quadrat sampling techniques. A total of sixty days were spent surveying in each forest reserve. One trained person assisted by three other people were involved in sampling reptiles for at least eight hours a day (day and night time).

Systematic sampling techniques included drift fences and pitfall trapping and active diurnal and nocturnal searching with the aid of long sticks, headlamps and nets (Simbotwe & Friend 1985). Each drift fence was made from a 60 cm wide plastic sheeting placed in a 10 cm trench, backfilled with soil and fastened every meter to a stick using staples. The pitfall traps were made from large plastic buckets (diameter 30 cm, high 40 cm) buried in the ground, with the opening flush with the surface. Fifty meters of fencing with eleven traps were placed near the possible reptilian habitats (swamps, along the streams, etc.). The traps were checked twice every day, in the morning and in the afternoon for four days and then moved to another locality. Fishing rods with slip knots were used to noose lizards, agamas and

skinks; thick leather gloves and boots, hooks, tongs and "T" or Y shaped sticks were used to catch snakes. The above methods were used in order to sample as many reptilian species as possible.

Quadrats sampling consisted of laying out a series of squares at randomly selected sites within the area of interest and thoroughly searching those squares for reptiles. Four localities were sampled in each forest reserve. Four quadrats were sampled in each locality bringing to sixteen, the total number of quadrats sampled in each forest reserve. Quadrats were laid out using a marked string. One trained person assisted by three other people were involved in sampling reptiles for at least 60 to 120 minutes. Within each quadrat every rock, piece of wood, and leaf litter was disturbed and turned, and the number of individuals of each species was recorded. As much as possible, observations were done carefully so as not to disturb sections of the quadrats that had not yet been sampled. This technique was used in order to determine the species richness and their relative abundances. As was the case with amphibians, there were two categories that were used to determine species abundance. If the number of recorded individuals for each species exceeded eight (8), that species was considered as common. But if the number of recorded individuals was less than eight (8), that species was considered as uncommon.

The sizes of the quadrats were determined based on the size of each forest reserve (Table 2.2). This was done in order to achieve proportionally equal sampling effort for the three study areas as the number of days spent surveying in each forest was fixed. Before each search was done, the exact locality, date, weather condition, habitat type, vegetation, starting time were recorded. When a habitat had been adequately sampled in the judgment of the investigator or no new species had been located within a given period of time, the observers moved to another location.

Specimens were collected as vouchers for identification, analysis and future use. Once collected, specimens were taken to the camp for processing. Live specimens were photographed before they were processed. Identification of specimens was done using proper identification keys such as *Snakes of Nyasaland* (Sweeney 1961) and *Field Guide to the Snakes and Other Reptiles of Southern Africa* (Branch 1998) (Plate 3.4).

Plate 3.4: Identification of specimen using scale counts.

Once identified and measurements recorded, specimens were anaesthetized and killed by putting a few drops of ether on a piece of cotton wool placed together with the specimen in closed container. Specimens were examined by means of standard herpetological methods (i.e. they were weighed and measured, relevant ecological data on sex, reproductive condition, weather conditions as well as habitat and date of collection were recorded) (Plate 3.5). Specimens were then tagged, slit open to allow flooding of internal organs and stored in specimen bottles in 70% ethanol. Collection information on name of species, mass, snout-vent length, tail length, reproductive condition (presence or absence of eggs/foetuses), name of collector, locality and date of collection was recorded on the labels and attached to each specimen bottle.

Plate 3.5: Processing of reptilian specimens

3.4.2.1.2.3 Strength of Quadrat Sampling

The strength of quadrat sampling is that with randomly placed quadrats, effects of habitat heterogeneity do not compromise the results provided that they randomly fall into each vegetation type or if not, the quadrats should be stratified by vegetation and then randomized within each vegetation type.

2.4.2.1.2.4 Limitations of Quadrat Sampling

This method loses effectiveness in habitats with dense ground cover and on irregular or steep terrain where it is difficult to place quadrats, especially with fixed quadrat sizes and shapes. This was the case with Mughese Forest Reserve where certain areas within the forest were very thick, steep and inaccessible. Secondly there are chances that some specimens could be driven out of their quadrats during the course of searching.

3.4.2.1.3 Analytical Methods

Comparison on the average and relative abundance of herpetofauna (amphibians and reptiles) of the three forest reserves was done using data obtained from Quadrat Sampling Technique while that on species richness in the study areas was done using data obtained from both Quadrat Sampling and Systematic Sampling Techniques. Species abundance was determined from the tally of the number of species found in each study area.

3.4.2.1.4 Conservation Status of Species

Guidelines for International Union for the Conservation of Nature (IUCN 2002) were used to determine conservation status of each species encountered. The guidelines take into account the following factors: -

- Extent of occurrence (population status),
- Area of occupancy,
- History of its presence in the country,
- Continuation of the habitat in adjoining counties,
- Rate of habitat loss, and
- Illegal trade if any.

Information from the literature was used to assess the history of species presence in the areas under study and the range of the species occurrence throughout Malawi and beyond. This was done to assist in determining conservation status of each species.

3.4.2.2 Interviews

Interviews were conducted to obtain data on socio-economic importance of herpetofauna to the local communities. The socio-economic survey was conducted from December 2002 to March 2003 in villages surrounding the study sites. The study was restricted to villages, which share boundaries with the reserves. Four villages out of an average of fourteen were randomly identified around each forest reserve. Each study area was visited once where between sixteen and eighteen days were spent interviewing people. An average of four days were spent in each village (Table 3.3).

Table 3.3: The number of people interviewed (by sex) and the period spent on interviews at each village in Mughese, Ntchisi and Tsamba Forest Reserves.

FOREST RESERVE	NAMES OF VILLAGES	NO. OF DAYS SPENT PER VILLAGE	NUMBER OF FEMALE RESPONDENTS	NUMBER OF MALE RESPONDENTS
Mughese	Mwalingo	4 days	13	13
	Mwenetulo	4 days	12	14
	Lupugho	4 days	12	12
	Andrea Musukwa	4 days	6	17
	Total	**16 days**	**43**	**56**
Ntchisi	Mpamila	4 days	14	11
	Kasakula	5 days	12	12
	Chifwerekete	5 days	10	14
	Nsambakusi	4 days	12	11
	Total	**18 days**	**48**	**48**
Tsamba	Dambe	4 days	6	17
	Tsamba	4 days	14	12
	Matandani	5 days	12	11
	Mvalabawo	4 days	11	13
	Total	**17 days**	**43 respondents**	**53 respondents**

In order to collect data on the socio-economic importance of herpetofauna in the study areas, the following methods were employed: semi-structured questionnaires, key informants interviews, focus group discussions and personal observations. Triangulation technique, in which more that three methods of data collection are used, was employed to confirm and substantiate data that had been collected in one method or the other.

3.4.2.2.1 Semi-structured Questionnaire

Forty questionnaires (ten per village) were administered to villagers to collect individual data for each forest reserve (Tables 3.4, 3.5, 3.6). The questionnaires were semi-structured, containing both open-ended and closed-ended questions (See Appendix 3.1). Open-ended

questions were used to avoid limiting people's responses. During the interviews, villagers were asked to provide data on utilization patterns of herpetofauna (which species are exploited, how they are used and for what reason). Villagers were also asked whether they take part in conserving forests either directly or indirectly.

3.4.2.2.2 Key Informants Guide

Five key informants were interviewed in Mughese while in Ntchisi and Tsamba Forests four were interviewed (Tables 3.4, 3.5, 3.6). These key informants included people such as traditional doctors, village headmen, forestry personnel and teachers, among others. The categories of informants were purposely selected but individuals were randomly chosen in all villages around the forest reserves. Where random sampling could not be achieved owing to limited number of respondents, the researcher had no choice but to use the people that were available. These categories of people were chosen because of the specialized knowledge that they hold on the topic under study. A key informant guide was used to gather information from the key informants to ensure consistency in the interviews (See Appendix 3.2). During these interviews, informants were, among other things, requested to provide information on utilization patterns of some herpetofaunal species found in their respective forest reserves and how herpetofauna could be conserved and managed.

3.4.2.2.3 Focus Group Discussion Schedule

This method was employed to collect qualitative data on the topic under study. For each forest reserve, eight Focus Group Discussions were conducted (two in each village) (Tables 3.4, 3.5, and 3.6). The Focus Group Discussions were planned in such a way that one was for males and the other one was for females. This was done in order to facilitate free participation in the discussions since men and women have different experiences and perceptions on matters relating to the environmental. There were no age restrictions on who to participate in the discussions as long as they met the sex criteria for each group. The discussions took a free flowing format and villagers in most case were allowed to come up with general consequences on issues of environmental degradation. However, in Mughese Forest at Andrea Musukwa Village, there were no male respondents readily available to take part in the Focus Group Discussions. In view of this, the researcher had no choice but to do with female respondents who were available at that time (Table 3.4).

Table 3.4: Techniques used in data collection and the number of respondents by gender involved in each technique for each village in Mughese Forest Reserve.

DATA COLLECTING TECHNIQUE	NUMBER OF RESPONDENTS IN MUGHESE FOREST					
	GENDER	Mwalingo	Mwenetulo	Lupugho	Andrea Musukwa	Total
Questionnaires	Male	5	4	5	5	19
	Female	5	6	5	5	21
Key Informants	Male	2	0	0	1	3
	Female	0	1	1	0	2
Focus Group Discussions	Male	1(6)	1(6)	1(6)	0(0)	18
	Female	1(6)	1(6)	1(6)	2(6)	30
Total	**Male**	**13**	**10**	**11**	**6**	**40**
	Female	**11**	**13**	**12**	**17**	**53**

Note: Numbers in brackets represent the number of people in each discussion group.

Table 3.5: Techniques used in data collection and the number of respondents by gender involved in each technique for each village in Ntchisi Forest Reserve.

DATA COLLECTING TECHNIQUE	NUMBER OF RESPONDENTS IN NTCHISI FOREST					
	GENDER	Mpamila	Kasakula	Chifwerekete	Nsambakusi	Total
Questionnaires	Male	5	5	4	6	20
	Female	5	5	6	4	20
Key Informants	Male	1	1	0	0	2
	Female	0	0	1	1	2
Focus Group Discussions	Male	1(6)	1(6)	1(6)	1(6)	24
	Female	1(6)	1(6)	1(6)	1(6)	24
Total	**Male**	**12**	**12**	**10**	**12**	**46**
	Female	**11**	**11**	**13**	**11**	**46**

Note: Numbers in brackets represent the number of people in each Focus Group Discussion.

Table 3.6: Techniques used in data collection and the number of respondents by gender involved in each technique for each village in Tsamba Forest Reserve.

DATA COLLECTING TECHNIQUE	NUMBER OF RESPONDENTS IN TSAMBA FOREST					
	GENDER	Dambe	Tsamba	Matandani	Mvalabawo	Total
Questionnaires	Male	5	5	5	5	**20**
	Female	5	5	5	5	**20**
Key Informants	Male	1	1	1	0	**3**
	Female	0	0	0	1	**1**
Focus Group Discussions	Male	1(6)	1(6)	1(6)	1(6)	**24**
	Female	1(6)	1(6)	1(6)	1(6)	**24**
Total	**Male**	**12**	**12**	**12**	**11**	**47**
	Female	**11**	**11**	**11**	**12**	**45**

Note: Numbers in brackets represent the number of people in each Focus Group Discussion.

The number of participants per Focus Group Discussion was limited to six people. This was done in order to ensure that everybody participated in the discussions since experience has shown that if the number of participants in a Focus Group Discussion is large, some members do not participate adequately (Mazibuko 2005). The researcher started by introducing the topic for discussion. The researcher, however, acted as a facilitator and moderator intervening only when it was necessary but ideally providing direction of interest to the research. The researcher recorded important points that were agreed upon through consensus. Data collected during Focus Group Discussions focused on the utilization patterns of herpetofauna of the study areas. Efforts were also made to find out if the communities derive any benefits from the forests and whether they take part in looking after these forest reserves. Participants were also asked to suggest some of the strategies that could be put in place to conserve and manage herpetofauna in the forest reserves. A group discussion schedule was used to facilitate the discussions (See Appendix 3.3). The discussions lasted approximately for two hours for each group.

3.4.2.2.4 Personal Observation

The researcher is aware of the difficulties that arise from the use of the questionnaire in failing to capture some of the needed information for the study due to inability or reluctance by some respondents to provide the correct information, which may be sensitive. In view of this, the researcher made personal observations to crosscheck some of the information given on the use of herpetofauna. This was done in randomly selected villages within the study areas. Four villages were visited in each forest reserve where at least one villager in each village was requested to provide exhibits or proof of some of the human uses of herpetofauna.

3.4.2.2.5 Methodology Limitations

There were a number of limitations in this study. Firstly, one of the problems that arose was that in some cases, when random sampling had to be used, very few people were available for interviews. The researcher had no choice but to do with whoever was available at that time.

Another limitation was that the respondents in the three study areas suspected that the researcher was on a spying mission. As a result, some respondents resorted to withholding the information allegedly for fear of being arrested. But the researcher assured all respondents that the information they were providing was purely for research and would be treated with utmost confidentiality. This helped quite a lot in relaxing most respondents such that at the end of the day, they were able to give out information freely.

Ulterior motive was another problem that the researcher encountered in the field. Some respondents expected to get some kick-backs in form of cash for their participation in the research. But the researcher explained to those respondents, the objectives and significance of undertaking this research and why it was important that they should participate in the study. After this explanation, most respondents became cooperative and participated.

3.4.2.2.6 Data Analysis Technique

Data were analyzed both qualitatively and quantitatively. Data collected using structured questionnaires were processed, analyzed, and the findings were presented in tables of frequencies and figures showing relationships between different variables. Qualitative data from structured interviews and focus group discussion were analyzed systematically and presented using verbatim quotations where necessary.

3.4.2.2.7 Ethical Issues

The following were some of the ethical considerations that were used as standards for interacting with the respondents in this study: All prospective respondents were informed of the purpose of the research and their concert was sought. Only those who gave concert participated in the study. The researcher ensured that confidentiality of respondents was not violated by not disclosing names to anyone either verbally or in writing. The researcher adhered to ethics of social science research.

CHAPTER FOUR:
STUDY FINDINGS

4.1 INVENTORIES OF HERPETOFAUNA OF THE STUDY AREAS

A total of sixty-two herpetofauna comprising of twenty-one amphibians and forty-one reptiles were recorded during the study in the study sites. Totals of thirty-five, thirty-eight and thirty-seven herpetofaunal species were recorded at Mughese, Ntchisi and Tsamba Forests respectively. These were apportioned among twenty-seven, twenty-seven and twenty-four genera; and sixteen, seventeen and fourteen families, respectively. The distribution of these species across various taxonomic categories is shown in Table 4.1 with the numbers collected in this study in brackets. Numbers not in brackets are from the previous records.

Table 4.1: Number of herpetofaunal taxa under different categories recorded at Mughese, Ntchisi and Tsamba Forest Reserves, Malawi. Numbers collected in this study are in brackets. Those not in brackets are from previous records. All Tsamba records are collected in this study.

TAXA	MUGHESE			NTCHISI			TSAMBA		
	Species	Genera	Families	Species	Genera	Families	Species	Genera	Families
Amphibians	19 (16)	12 (10)	8 (6)	15 (14)	10 (9)	7 (7)	11	7	4
Reptiles	27 (19)	21 (17)	10 (10)	31 (24)	22 (18)	11 (10)	26	17	10
Total	**46 (35)**	**33 (27)**	**18 (16)**	**46 (38)**	**32 (27)**	**18 (17)**	**37**	**24**	**14**

4.1.1 Amphibian

4.1.1.1 Amphibian Inventories

In this study, Mughese Forest had the highest number of amphibian species than Ntchisi and Tsamba Forests (sixteen species for Mughese, fourteen for Ntchisi and eleven for Tsamba) (Table 4.1). This was also reflected at the generic level where Mughese recorded more amphibian genera than Ntchisi and Tsamba (ten genera for Mughese, nine for Ntchisi and seven for Tsamba). But at family level, Ntchisi Forest recorded more amphibian families than Mughese and Tsamba Forests (Table 4.1). Out of the eight amphibian families recorded in the three study areas, three (Bufonidae, Ranidae and Arthroleptidae) were spread across the three forests - representing about 38% similarity; while two families (Rhacophoridae and Hemisotidae) were restricted to Ntchisi Forest. The other three families (Pipidae, Microhylidae and Hyperoliidae) were recorded in either one or two of the three forest areas (Table 4.2).

In Mughese Forest, seventeen amphibian species were previously recorded. Out of these Mughese species, fourteen were captured/encountered during this study. Two species: France's Squeaker (*Arthroleptis francei*) and the Common Platanna (*Xenopus laevis*) were new records for Mughese Forest (Table 4.2). This now brings the total number of amphibians known to occur in Mughese Forest at nineteen. Three species that were previously recorded by other researchers but were not encountered during this survey include: Garman's Toad (*Bufo garmani*), Kisolo Toad (*Bufo kisoloensis*) and Plain Squeaker (*Schoutedenella xenochirus*) (Table 4.2).

In Ntchisi Forest, eleven amphibian species were previously recorded. Out of these Ntchisi species, ten were captured/encountered during the survey. Four others: Mascarene Ridged Frog (*Ptychadena mascareniensis*), Guibe's Ridged Frog (*Ptychadena guibei*), Grey Tree Frog (*Chiromantis xerampelina*) and Marbled Snout-burrower (*Hemisus marmoratus*) were new records for the area. This now brings the total number of amphibians known to occur in Ntchisi Forest at fifteen. The only species that was not recorded based on previous records was Bocage's Tree Frog (*Leptopelis bocagii*) (Table 4.2).

Table 4.2: Distribution of amphibian families, genera and species recorded for Mughese (M), Ntchisi (N) and Tsamba (T) Forests Reserves, Malawi.

√ = Indicates species collected in this study
- = Indicates species not collected in this study
L = Species recorded from the literature only
N = New record for the forest collected in this study.
* = Species listed as threatened in present study.

Species Account for Amphibians		Study area		
Family	**Genera**	**M**	**N**	**T**
BUFONIDAE	*Bufo gutturalis*	√	√	√N
	Bufo maculatus	√	√	√N
	Bufo garmani	L	-	-
	Bufo kisoloensis	L	-	-
MICROHYLIDAE	*Breviceps mossambicus*	√	-	√N
PIPIDAE	*Xenopus laevis*	√N	√	-
RANIDAE	*Afrana angolensis*	√	√	√N
	Ptychadena oxyrhynchus	√	√	√N
	Ptychadena anchietae	√	√	√N
	Ptychadena mossambicus	-	√	√N
	Ptychadena mascareniensis	√	√N	√N
	Ptychadena guibei	-	√N	-
	Phrynobatrachus natalensis	√	√	√N
	Phrynobatrachus mababiensis	√	-	-
ARTHROLEPTIDAE	*Arthroleptis stenodactylus*	√	-	√N
	Arthroleptis reichei *	√	-	-
	Arthroleptis francei *	√N	-	-
	Schoutedenella xenodactyloides	√	√	√N
	Schoutedenella xenochirus	L	-	-
HYPEROLIIDAE	*Hyperolius puncticulatus*	√	-	-
	Hyperolius nasutus	-	√	-
	Leptopelis flavomaculatus	√	-	-
	Leptopelis bocage	-	L	-
RHACOPHORIDAE	*Chiromantis xerampelina*	-	√N	-
HEMISOTIDAE	*Hemisus marmoratus*	-	√N	-

In Tsamba forest a total of eleven amphibian species were recorded (Table 4.2). Since this work is the first documented account of the amphibians of Tsamba Forest, all species recorded represent new distributional records.

Out of the 21 amphibians recorded, eight species: Guttural Toad (*Bufo gutturalis*), Flat-backed Toad (*Bufo maculatus*), Angola River Frog (*Afrana angolensis*), Sharp-nosed Ridged Frog (*Ptychadena oxyrhynchus*), Anchieta's Ridged Frog (*Ptychadena anchietae*), Mozambique Ridged Frog (*Ptychadena mossambica*), Natal Puddle Frog (*Phrynobatrachus natalensis*) and Dwarf Squeaker (*Schoutedenella xenodactyloides*) were found in all the three study sites. Species that were restricted to Mughese Forest were Bocage's Tree Frog (*Leptopelis bocagii*), Spotted Reed Frog (*Hyperolius puncticulatus*), France's Squeaker (*Arthroleptis francei*), Reiche's Squeaker (*Arthroleptis reichei*) and Mababe Puddle Frog (*Phrynobatrachus mababiensis*). Those that were restricted to Ntchisi Forest were: Gray Tree Frog (*Chiromantis xerampelina*), Marbled Snout-burrower (*Hemisus marmoratus*), Long Reed Frog (*Hyperolius nasutus*) and Guibe's Ridged Frog (*Ptychadena guibei*). Tsamba Forest had no species that were restricted to it because all of them were also recorded either in Mughese or Ntchisi Forests (Table 4.2).

4.1.1.2 Population Abundance for Amphibians

Results of the amphibian study revealed that the most abundant species varied from one study area to another.

In Mughese Forest, four species: Spotted Reed Frog (*Hyperolius puncticulatus*) (Plate 4.1), Mozambique's Rain Frog (*Breviceps mossambicus*), Guttural Toad (*Bufo gutturalis*) (Plate 4.2), Flat-backed Toad (*Bufo maculatus*) (Plate 4.3) were abundant with numbers of individuals sampled ≥8. The remaining twelve species were uncommon with numbers of individuals sampled <8 (Appendix 4.1).

In Ntchisi Forest, there were five abundant species with numbers of individuals sampled ≥8. These were Angola River Frog (*Afrana angolensis*), Sharp-nosed Ridged Frog (*Ptychadena oxyrhynchus*), Guibe's Ridged Frog (*Ptychadena guibei*), Mozambique's Ridged Frog (*Ptychadena mossambica*) and Dwarf Squeaker (*Schoutedenella xenodactyloides*). The remaining nine species were uncommon with numbers of individuals sampled <8 (Appendix

4.2). Four species: Guibe's Ridged Frog (*Ptychadena guibei*), Mascarene Ridged Frog (*Ptychadena mascareniensis*), Gray Tree Fog (*Chiromantis xerampelina*), and Marbled-snout Burrower (*Hemisus marmoratus*) were new records for Ntchisi Forest (Table 4.2).

Plate 4.1: Spotted Reed Frog (*Hyperolius puncticulatus*)
Photo: Channing (2001)

Plate 4.2: Guttural Toad (*Bufo gutturalis*)

Plate 4.3: Flat-backed Toad (*Bufo maculatus*)
Photo: Channing (2001)

In Tsamba Forest Reserve, eleven amphibian species were recorded. Out of the eleven amphibian species recorded, four species: Flat-backed Toad (*Bufo maculatus*), Sharp-nosed Ridged Frog (*Ptychadena oxyrhynchus*), Mascarene Ridged Frog (*Ptychadena mascareniensis*), Natal Puddle Frog (*Phrynobatrachus natalensis*) were abundant with numbers of individuals sampled ≥8. The remaining seven species were uncommon with numbers of individuals sampled <8 (Appendix 4.3). Since this work is the first documented account of the amphibians of Tsamba Forest, all species recorded during the study represent new distributional records (Table 4.2).

Results of the study also revealed that different species have different habitat preference. Some species were found to be habitat specialists while others were generalist species. For example, Guttural Toad (*Bufo gutturalis*) occurs in all six habitats sampled (Table 4.3).

Table 4.3: Habitats/microhabitats for amphibians of Mughese (M), Ntchisi (N) and Tsamba (T) Forest Reserves.

SPECIES NAME	VEGETATION HABITATS FROM WHERE AMPHIBIAN SPECIES WERE SAMPLED					
	Montane Evergreen Forest	Brachystegia Woodland	Riparian Forest	Marshy Areas/ Swamps	Earth Surface	Open Grassland
Bufo gutturalis	N	MT	MT	N	M	T
Bufo maculatus			NMT		M	M
Breviceps mossambicus		MT			M	
Xenopus laevis			MN	M		
Afrana angolensis			MNT			
Ptychadena oxyrhynchus		M	MT		M	N
Ptychadena mascareniensis				MT		T
Ptychadena anchietae			MN			MT
Ptychadena mossambicus		NT				N
Ptychadena guibei						N
Phrynobatrachus natalensis		N	T	N		
Phrynobatrachus mababiensis				M		M
Arthroleptis stenodactylus		MT	N		MT	
Arthroleptis reichei	M					
Arthroleptis francei			M			
Schoutedenella xenodactyloides				MNT		
Hyperolius puncticulatus	M		M	M		
Hyperolius nasutus		N				
Leptopelis flavomaculatus			M			
Chiromantis xerampelina		N				
Hemisus marmoratus				N		
NUMBER OF SPECIES/HABITAT	**3**	**8**	**11**	**8**	**5**	**8**

Nine species: the Angola River Frog (*Afrana angolensis*), Guibe's Ridged Frog (*Ptychadena guibei*), France's Squeaker (*Arthroleptis francei*), Reiche's Squeaker (*Arthroleptis reichei*), Dwarf Squeaker (*Schoutedenella xenodactyloides*), Long Reed Frog (*Hyperolius nasutus*), Yellow-spotted Tree frog (*Leptopelis flavomaculatus*), Gray Tree Frog (*Chiromantis xerampelina*) and Marbled-snout Burrower (*Hemisus marmoratus*) were recorded in one habitat type only. But the rest tolerate more than one habitat types (Table 4.3).

4.1.1.3 Threatened Amphibian Species for Malawi.

According to the International Union for the Conservation of Nature (IUCN 2002), there are about thirty-seven threatened amphibian species known from Central and Southern Africa. Out of these, twelve species are reported from Malawi. Of the twelve species reported from Malawi, two: France's Squeaker (*Arthroleptis francei*) (Plate 4.4) and Reiche's Squeaker (*Arthroleptis reichei*) (Plate 4.5) were recorded from Mughese Forest. No threatened species were recorded in Ntchisi or Tsamba Forests. Names of threatened and endemic amphibian species of Malawi including those that were recorded during this study are given in Table 4.4 below.

Table 4.4: Names of threatened and endemic amphibian species of Malawi (IUCN 2002)

Family	Common Name	Scientific Name	Endemicity	IUCN GAA Status
Arthroleptidae	France's squeaker	*Arthroleptis francei* *	Endemic	Endangered
Arthroleptidae	Reiche's squeaker	*Arthroleptis reichei* *	Not endemic	Near threatened
Bufonidae	Nyika dwarf toad	*Bufo nyikae*	Endemic	Endangered
Hyperoliidae	Variable reed frog	*Hyperolius pictus*	Not endemic	Vulnerable
Hyperoliidae	Spiny throated reed frog	*Hyperolius spinigularis*	Not endemic	Near threatened
Ranidae	Johnston's river frog	*Afrana johnstoni*	Endemic	Endangered
Ranidae	Mongrel frog	*Nothophryne broadleyi*	Endemic	Endangered
Ranidae	Broadley's ridged frog	*Ptychadena broadleyi*	Endemic	Endangered
Ranidae	Stewart's puddle frog	*Phrynobatrachus stewartae*	Endemic	Data Deficient
Ranidae	Ukinga puddle frog	*Phrynobatrachus ukingensis*	Not endemic	Vulnerable
Ranidae	African bullfrog	*Phyxicephalus adspersus*	Not endemic	Near threatened
Ranidae	Kirk's caecilian	*Scolecomorphus kirkii*	Not endemic	Vulnerable

* Indicates species found during the study (at Mughese Forest Reserve)

Plate 4.4: France's Squeaker (*Arthroleptis francei*)

Photo: Channing (2001)

Plate 4.5: Reiche's Squeaker (*Arthroleptis reichei*)

4.1.2 Reptiles

4.1.2.1 Reptilian Inventories

A total of forty-one reptilian species were recorded during the study in three forest areas. In this study, Tsamba Forest had the highest number of reptilian species than Ntchisi and Mughese Forests (twenty-six species for Tsamba, twenty-four for Ntchisi and nineteen for Mughese). However, at the generic level Ntchisi Forest had higher species diversity than Tsamba and Mughese Forests (eighteen for Ntchisi against seventeen for both Tsamba and Mughese). But at family level, the diversity was the same (ten families for each forest reserve) (Table 4.1).

Out of the twelve families recorded in three study sites, seven families were spread across all three forests - representing about 59% similarity while only one family (Rhinotyphlopidae) was restricted to Mughese Forest. The remaining four families were recorded in either one or two of the three forest areas (Table 4.5).

At species level, six reptilian species were spread across all the study sites. These were: Variable Skink (*Mabuya varia*) (Plate 4.6), Striped Skink (*Mabuya striata*) (Plate 4.7), Flap-necked Chameleon (*Chamaeleo dilepis*) (Plate 4.8), Yellow-throated Plated Lizard (*Gerrhosaurus flavigularis*), Nile Monitor (*Varanus niloticus*) (Plate 4.9) and Rhombic Adder (*Causus rhombeatus*).

In Mughese Forest, seventeen reptilian species were previously recorded. Out of these Mughese species, nine were captured during this study and ten others (two snakes and eight lizards) were new records for the area (Table 4.5). The total number of reptilian species of Mughese forest now stands at twenty-seven. Eight species previously recorded by other researchers were not recorded during this survey. These were: Short-tailed Chameleon (*Rhampholeon nchisiensis*), Stripe-bellied Sand Snake (*Psammophis orientalis*), Sand Snake (*Psammophis phillipsi*), Western Green Snake (*Philothamnus angolensis*), White-lipped Snake (*Crotaphopeltis tornieri*), Vine Snake (*Thelotornis capensis*), Puff Adder (*Bitis arietans*) and Rungwe Bush Viper (*Atheris rungwensis*).

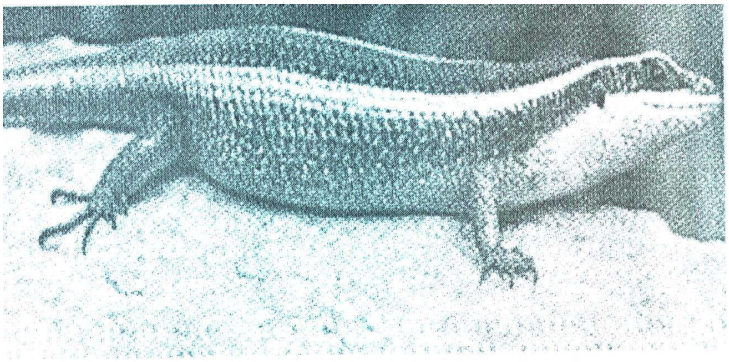


Plate 4.6: Variable Skink (*Mabuya striata*)

Plate 4.7: Striped Skink (*Mabuya varia*)

Plate 4.8: Flap-necked Chameleon (*Chamaeleo dilepis*)

Plate 4.9: Monitor Lizard (*Varanus niloticus*)

In Ntchisi Forest, only ten reptilian species were previously recorded (these were mostly snakes). Out of these Ntchisi species, two were captured during the study and twenty-two others were new records for the area (Table 4.5). Thirteen of these new records were lizards while nine were snakes. Eight species previously recorded by other researchers in Ntchisi were not recorded during this survey. These were: Short-tailed Chameleon (*Rhampholeon nchisiensis*), Sand Snake (*Psammophis phillipsi*), Western Green Snake (*Philothamnus angolensis*), Green Water Snake (*Philothamnus haplogaster*), Boomslang (*Dispholidus typus*) (Plate 4 10), Forest Cobra (*Naja melanoleuca*) (Plate 4.11) and Green Mamba (*Dendroaspis anguisticeps*), Black Mamba (*Dendroaspis polylepis*).

In Tsamba forest a total of twenty-six reptilian species were recorded (Table 4.1). Since this work is the first documented account of the reptiles of Tsamba forest, all species recorded represent new distributional records.

Table 4.5: Comparison of reptilian families, genera and species recorded between July 2001 and November 2002 in Mughese (M), Ntchisi (N) and Tsamba (T) Forests.

√ = Indicates species presence in the area
- = Indicates species not collected in this study
L = Species recorded from the literature only
N = New record for the area.

Species Account for Reptiles			Study area		
Class	**Family**	**Genera**	**M**	**N**	**T**
Lizards	**SCINCIDAE**	*Mabuya striata*	√ N	√ N	√ N
		Mabuya varia	√ N	√ N	√ N
		Mabuya margaritifer	-	√ N	√ N
		Mabuya bourengeri	-	-	√ N
		Mabuya maculilabiris	-	√ N	-
		Proscelotes arnoldi	√ N	-	√ N
	AGAMIDAE	*Agama atra*	-	√ N	√ N
		Agama aculeata	-	√ N	√ N
		Agama mossambica	-	-	√ N
		Acanthocercus atricollis	-	√ N	-
	GECKONIDAE	*Hemidactylus platycephalus*	√ N	-	-
		Hemidactylus mabouia	-	√ N	√ N
		Lygodactylus bradfieldi	-	√ N	√ N
		Lygodactylus waterbergensis	-	-	√ N
	CHAMAELEONIDAE	*Chamaeleo dilepis* √ N	√ N	√ N	
		Rhampholeon nchisiensis	L	L	-
	GERRHOSAURIDAE	*Gerrhosaurus flavigularis*	√ N	√ N	√ N
	LACERTIDAE	*Nucras holubi*	-	√ N	-
		Tropidosaura montana	√ N	-	-
	VARANIDAE	*Varanus niloticus*	√ N	√ N	√ N
		Varanus albigularis	-	-	√ N
Snakes	**COLUBRIDAE**	*Psammophis mossambicus*	-	√ N	√ N
		Psammophis subtaeniatus orientalis	L	√ N	√ N
		Psammophis brevirostris	√ N	-	-
		Psammophis sibilans	-	√ N	-
		Psammophis phillipsi	L	L	-
		Psammophylax tritaeniatus	-	√	√ N
		Philothamnus semivariegatus	√	-	√ N
		Philothamnus angolensis	L	L	-
		Philothamnus haplogaster	√	L	-
		Philothamnus natalensis	-	√ N	-
		Crotaphopeltis hatamboeia	√	√ N	-
		Crotaphopeltis tornieri	L	-	-
		Thelotornis capensis	L	√ N	√ N
		Lycophidion capense	-	-	√ N
		Lamprophis fuliginosus	√	√ N	-
		Dispholidus typus	√	L	-
	RHINOTYPHLOPIDAE	*Rhinotyphlops schlegelii*	√	-	-
		Typhlops obtusus	√ N	-	-
	ELAPIDAE	*Naja melanoleuca*	√	L	√ N
		Naja mossambica	-	-	√ N
		Dendroaspis anguisticeps	√	L	-
		Dendroaspis polylepis	-	L	-
	VIPERIDAE	*Bitis arietans*	L	√	√ N
		Causus rhombeatus	√	√ N	√ N
		Atheris rungwensis	L	-	-
	BOIDAE	*Python sebae*	-	√ N	√ N

Plate 4 10: Boomslang (*Dispholidus typus*)

Plate 4.11: Forest Cobra (*Naja melanoleuca*)

4.1.2.2 Population Abundance for Reptiles

As was the case with amphibians, the most abundant reptilian species varied from one study area to the other.

In Mughese Forest, three species, namely: the Striped Skink (*Mabuya striata*), Variable Skink (*Mabuya varia*) and Arnold's Skink (*Proscelotes arnoldi*) were abundant with numbers of individuals sampled ≥8. The remaining sixteen species were uncommon with numbers of individuals sampled <8 (Appendix 4.4). The Common Mountain Lizard (*Tropidosaura montana*) (Plate 4.12) was a new record for Mughese Forest and also for Malawi (Table 4.5).

In Ntchisi Forest, six species were abundant with numbers of individuals sampled ≥8. These species were the Striped Skink (*Mabuya striata*), Variable Skink (*Mabuya varia*), Rainbow Skink (*Mabuya margaritifer*), Southern Tree Agama (*Acanthocercus atricollis*), Flap-necked Chameleon (*Chamaeleo dilepis*), Yellow-throated Plated Lizard (*Gerrhosaurus flavigularis*). The remaining eighteen species were uncommon with numbers of individuals sampled <8 (Appendix 4.5).

In Tsamba Forest Reserve, twenty-six reptilian species were recorded. Out of these, five species: the Striped Skink (*Mabuya striata*), Variable Skink (*Mabuya varia*), Rainbow Skink (*Mabuya margaritifer*), Arnold's Skink (*Proscelotes arnoldi*), Southern Rock Agama (*Agama atra*), were abundant species with numbers of individuals sampled ≥8. The remaining eighteen species were uncommon with numbers of individuals sampled <8 (Appendix 4.6).

Total of ten, twenty-two, and twenty-six species were new records for Mughese, Ntchisi and Tsamba Forests, respectively (Table 4.5).

As was the case with amphibians, results of the study also revealed that different reptilian species have different habitat preference. Some species were found in one habitat type while others were found in two or more habitat types (Table 4.6).

Plate 4.12: Common Mountain Lizard (*Tropidosaura montana*)

Results of the study also revealed that different reptilian species have different habitat preference (Table 4.6). However, the Variable Skink (*Mabuya varia*) was recorded in four different types of habitats while others such as African Python (Python sebae) were recorded in only one habitat type. This shows that some species have a wide range of habitat preference while others do not.

4.1.2.3 Threatened Reptilian Species

Unlike for amphibians, there were no threatened reptilian species recorded during the study.

Table 4.6: Habitats/microhabitats for reptiles of Mughese (M), Ntchisi (N) and Tsamba (T) Forest Reserves.

SPECIES NAME	VEGETATION/ HABITATS FROM WHERE REPTILIAN SPECIES WERE SAMPLED						
	Evergreen Forest	Brachystegia Woodland	Riparian Forest	Grassland	Disturbed Open Areas	Marshy	Introduced Vegetation
Mabuya striata		MN	MT		T		
Mabuya varia		MNT	N	M	MN		
Mabuya margaritifer		N	NT				
Mabuya maculilabiris			N				
Mabuya bourengeri		T					
Proscelotes arnoldi	M	T					
Agama atra	N	NT					
Agama aculeata					N		
Agama mossambicus		T					
Acanthocercus atricollis		N					
Hemidactylus mabouia		T					
Hemidactylus platycephalus		M	NT				
Lygodactylus bradfieldi		T			T		
Lygodactylus waterbergensis		T					
Chamaeleo dilepis	M	N			NT		
Gerrhosaurus flavigularis			MT		T		
Tropidosaura montana			MNT				M
Nucras holubi					N		
Varanus niloticus			MNT				
Varanus albigularis		T					
Psammophis mossambicus					NT	N	
Psammophis sibilans				N			
Psammophis brevirostris							M
Psammophis subtaeniatus orientalis			N		T		
Psammophylax t. tritaeniatus		NT					
Philothamnus natalensis			N				
Philothamnus semivariegatus			MT				
Philothamnus haplogaster			M				
Crotaphopeltis hatamboeia					MN	N	
Lamprophis fuliginosus					N		
Thelotornis capensis		T	N				
Lycophidion capense					T		
Dispholidus typus typus	M						
Typhlops obtusus							M
Rhinotyphlops schlegelii		M					
Naja mossambica		T			T		
Naja melanoleuca		T	M				
Dendroaspis anguisticeps		M					
Bitis arietans					N		
Causus rhombeatus			MN				
Python sebae			N				
TOTAL NUMBER OF SPECIES / HABITAT	**4**	**19**	**15**	**2**	**13**	**2**	**3**

No. of habitat types
Mughese = 6
Ntchisi = 6
Tsamba = 3

4.2 USE, THREATS AND STRATEGIES FOR CONSERVING HERPETOFAUNA

4.2.1 Herpetofauna known by Local People in Forest Reserves.

From the interviews conducted, it was possible to compile the checklist of herpetofauna thought by the local people to occur in Mughese, Ntchisi and Tsamba Forest Reserves. About 54% of respondents in Mughese, 62% in Ntchisi and 61% in Tsamba took part in compiling the checklists of herpetofauna of the three study sites. Table 4.7 shows a list of amphibians and reptiles thought (by local people) to exist in Mughese, Ntchisi and Tsamba Forest Reserves.

Table 4.7: Amphibians and reptiles thought (by local people) to exist in Mughese, Ntchisi and Tsamba Forest Reserves.

STUDY AREA	LOCAL NAME	SCIENTIFIC NAME	ENGLISH NAME
MUGHESE FOREST	Chipiri	*Bitis a. arietans*	Puff Adder
	Fulu	*Geochelone pardalis*	Leopard Tortoise
	Kawawa	*Varanus niloticus*	Monitor Lizard
	Mucruso	*Naja melanoleuca*	Forest Cobra
	Naluwinduwindu	*Philothamnus semivariegatus*	Spotted Bush Snake
	Nkhomi	*Dendroaspis p. polylepis*	Black Mamba
	Nsato	*Python sebae*	African Python
	Nyakarukukutwe	*Thelotornis c. capensis*	Vine Snake
	Swila	*Typhlops schlegelii*	Schlegel's Beaked Blind Snake
NTCHISI FOREST	Chilele	*Typhlops schlegelii*	Schlegel's Beaked Blind Snake
	Dududu	*Agama atra*	Ground Agama
	Finye	*Breviceps mossambica*	Mozambique Rain Frog
	Fulu	*Geochelone pardalis*	Leopard Tortoise
	Gulo	*Acanthocercus atricollis*	Southern Tree Agama
	Kalilombe	*Chamaeleo dilepis*	Flap-necked Chameleon
	Kasanthi	*Thelotornis c. capensis*	Vine Snake
	Khwakhwawe	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard
	Mamba	*Naja melanoleuca*	Forest Cobra
	Mamba	*Naja mossambica*	Mozambique Spitting Cobra
	Mbuvi	*Lycodonomorphus rufulus*	Common Brown Water Snake
	Mphiri	*Bitis a. arietans*	Puff Adder
	Mphirimbedza	*Causus rhombeatus*	Rhombic Adder
	Mwazi	*Varanus niloticus*	Monitor Lizard
	Nsato	*Python sebae*	African python
	Songo	*Dendroaspis p. polylepis*	Black Mamba
TSAMBA FOREST	Birimankhwe	*Chamaeleo dilepis*	Flap-necked Chameleon
	Bwantasa	*Bufo gutturalis*	Guttural Toad
	Finye	*Breviceps mossambicus*	Mozambique's Rain Frog
	Fulu	*Geochelone pardalis*	Leopard Tortoise
	Gulo	*Acanthocercus atricollis*	Southern Tree Agama
	Kam'masamba	*Philothamnus semivariegatus*	Spotted Bush Snake
	Kanchikusa	*Lycophidion capense*	Cape Wolf Snake
	Khwakhwawe	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard
	Mamba	*Naja mossambica*	Mozambique's Spitting Cobra
	Mphiri	*Bitis arietans*	Puff Adder
	Nalikukuti	*Thelotornis capensis*	Vine Snake
	Ng'azi	*Varanus niloticus*	Monitor Lizard
	Njokandala	*Mehelya capensis*	Cape File Snake
	Nsalulu	*Psammophis subtaeniatus*	Striped-bellied Sand Snake
	Nsato	*Python sebae*	African Python
	Songo	*Dendroaspis Polylepis*	Black Mamba

4.2.2 Human Use of Herpetofauna

Results of the socio-economic survey revealed that local people utilize herpetofauna of Mughese, Ntchisi and Tsamba Forests in various ways.

4.2.2.1 Use of Herpetofauna in Mughese Forest Reserve

In Mughese, herpetofauna are exploited for the following reasons:

4.2.2.1.1 Medicinal Use

Amphibians are used as medicinal animals by people in villages surrounding Mughese Forest. For example, Mozambique's Rain Frog (*Breviceps mossambicus*) is used by the locals around Mughese Forest to equip women to enable them prepare more food from limited supplies. The medicine is applied to the hands of a woman through incision. It is alleged that a woman who has been equipped with this treatment is able to use small amount of flour to prepare food that would be enough to feed many people. About 10% of the respondents testified to this (Table 4.8). People associate this frog to the above function because of its ability to inflate itself if it is alarmed.

The Flap-necked Chameleon (*Chamaeleo dilepis*) is an effective treatment for certain skin infections. The treatment is administered by rubbing a live chameleon against the infected body parts of a person (Table 4.8). About 25% of the respondents testified to this.

The shell of a Leopard Tortoise (*Geochelone pardalis*) is used as planting apparatus for pumpkins. Pumpkin seeds are first placed in the tortoise shell from where they are dropped on the planting station. It is believed that pumpkin plants that are planted in this manner produce high quality pumpkin fruits. About 15% of the respondents gave this testimony (Table 4.8).

Table 4.8: Human Use of Herpetofauna in Mughese Forest Reserve.

SPECIES NAME	REPORTED HUMAN USAGE	% RESPONDENTS WHO SUPPLIED INFORMATION ON HUMAN USE OF HERPETOFAUNA (N = 40)
Breviceps mossambicus	It is believed that if a woman is treated with powder drug made from the skin of this frog, she is able to prepare food that would be enough for many people using small amount of maize flour.	10.0%
Chamaeleo dilepis	Effective treatment for skin infections. Its skin is used to rub against the infected body part to treat certain fungal skin infections.	25.0%
Geochelone pardalis	The tortoise shell is used as planting apparatus for pumpkin to produce high quality pumpkin fruits.	15.0%
Bitis arietans	Skin is used and mixed with other herbs to boost business. Portion of its tail is mixed with other herbs to form anti-snake bite. Portion of its skin is drug for curing malnourishment in babies where the mother is suspected to be unfaithful to her husband. The medicine is administered by way of tying part of the animal skin in a rope around the baby's waist. Used by snake charmers for entertainment	5.0% 15.0% 10.0% 10.0%
Python sebae	Portion of its backbone is mixed with other herbs, burnt and crushed into powder to form a cure for treating backache. The cure is administered by rubbing the powder on the small cuts made using a razor blade.	10.0%
	Total	**100.0%**

5% of the respondents reported that they use Puff Adder (*Bitis arietans*) as charm for boosting business. The charm is made by mixing portion of the animal skin with other herbs. This mixture is said to possess the magic of attracting customers to one's business. Besides being used as business charm, 10% of the respondents also reported that Puff Adder is used for curing malnourishment in newly born babies, especially in cases where the mother was suspected to be flirting around with other men during her pregnancy. The medicine is administered by way of tying portion of the animal skin in a rope around the baby's waist. Puff Adder is used as an effective anti-snake bite. Portion of its tail is mixed with other herbs burnt and crushed into powder. The powder is applied to the body through small cuttings made on the skin using razor blade. 15% of the respondents said this.

The African Python (*Python sebae*) is also used for medicinal purposes. 10% of the people interviewed testified that a portion of the backbone of an African Python is mixed with other herbs, burnt and crushed into powder to form a cure for treating backache. The cure is administered by rubbing the powder on the small cuts made on the skin along the spinal column using a razor blade.

4.2.2.1.2 For Entertainment

Besides being used as medicine, some snake species such as Puff Adder (*Bitis arietans*) and Green Mamba (*Dendroaspis anguisticeps*) are used for entertainment by snake charmers in villages around Mughese Forest Reserve. 10% of the respondents interviewed testified to this.

4.2.2.2 Use of Herpetofauna in Ntchisi Forest

In Ntchisi, herpetofauna are exploited for the following reasons:

4.2.2.2.1 Human Food

About 13% of the respondents interviewed during the survey said that they exploit Leopard Tortoise (*Geochelone pardalis*) for food. Although tortoises have hard outer shells, respondents explained that there is plenty of meat inside the shell, which is cherished very much by the people who partake in the meat. Another reptile exploited for food is the Monitor Lizard (*Varanus niloticus*) and 5% of the respondents testified to this (Table 4.9).

4.2.2.2.2 Medicinal Use

Besides being used as human food, Leopard Tortoise (*Geochelone pardalis*) is exploited for medicinal purposes. 5% of the respondents testified that the Leopard Tortoise is cure for treating paroids in human beings. Respondents attributed the use of Tortoise as cure for paroids because of the manner in which it withdraws its head into the shell, which is likened to the withdrawing of paroids into the rectum in a patient.

About 13% of the respondents said that the Flap-necked Chameleon (*Chamaeleo dilepis*) is used as juju for goalkeepers in soccer in order to bring the best reflexes out of the goalkeepers in the same manner the long sticky tongue of a chameleon traps prey into its month. Besides being used as juju, about 13% of the respondents interviewed also reported that the chameleon is used as medicine for camouflage. People associate this reptile to the above function because of its ability to change colours to suit that of the environment, hence making it difficult for it to be spotted by its enemies.

The African Python (*Python sebae*) is used as medicine to cure backache. About 8% of the people interviewed testified that a portion of the backbone of an African Python is mixed with other herbs, burnt and crushed into powder to form a cure for treating backache. The cure is administered by rubbing the powder onto open small cuts made using a razor blade. Besides being used as cure for backache, 5% of the respondents said they use African Python skin for making belts and bags.

Table 4.9: Human Use of Herpetofauna in Ntchisi Forest Reserve.

SPECIES NAME	REPORTED HUMAN USAGE	% RESPONDENTS WHO SUPPLIED INFORMATION ON HUMAN USE OF HERPETOFAUNA (N = 40)
Geochelone pardalis	It is used as human food Medicine for curing paroids in human beings.	12.5% 5%
Varanus niloticus	It is also exploited for food Exploited for its skin, which is good material for making drums used during performances of the "Big Dance" commonly known as *Nyau*.	5% 10%
Chamaeleo dilepis	It is used as juju for goalkeepers during football matches to bring the best reflexes out of the goalkeepers in the same manner the long sticky tongue of a chameleon traps the prey into its month. It is also used as medicine for camouflage so that one is not easily seen by his/her enemies.	12.5% 12.5%
Python sebae	Its skin is used for making belts and bags. The backbone from python is crushed into power and is used to treat certain ailments such as backache.	5.0% 7.5%
Dendroaspis polylepis	Its head is burnt and crushed into powder and is used as anti-snake bite after mixing the powder with other herbs	20.0%
Beaked-blind snake	Encountering this snake is associated with luck.	10.0%
	Total	**100.0%**

About 20% of the respondents said that the Black Mamba, (*Dendroaspis polylepis*) is used as an effective anti-snake bite. The head of this snake is burnt together with other herbs and then crushed into powder. This powder is applied to a small cut made with a razor blade on the back of each hand between the thumb and forefinger, and likewise on the feet. Most people regard this as preventive measure and it is believed that no snake (irrespective of race or species) will attempt to bite any person equipped with this defence (Table 4.9).

4.2.2.2.3 Skins/Hides

There is also evidence of Monitor Lizard (*Varanus niloticus*) being exploited for its skin in Ntchisi Forest (Table 4.9). 10% of the respondents reported that Monitor Lizard skin is used for making drums for performing various traditional dances such as *Gule Wamkulu*. In Ntchisi about 90% of the male respondents belonged to the secret cult of the highly respected "big dance" popularly known as *Gule Wamkulu*. *Gule Wamkulu* is a spirit dance masquerading as animals (*Virombo*) dressed in their strange costumes and danced to expert drumbeats. Normally, they would come in different facial masks with different dancing styles. The dance is popular among the Chewa people in Central Malawi.

4.2.2.2.4 Foretelling Luck

Certain reptilian species are associated with luck. For example, in some parts of Ntchisi such as Chifwerekete Village, it was reported that if a person comes across the Schlegel's Beaked-blind Snake (*Rhinotyphlops schlegelii*), it is a sign that he/she will meet good things ahead. The locals associate this species with the above belief because this reptile is rarely found. 10% of the respondents interviewed testified to this.

4.2.2.3 Use of Herpetofauna in Tsamba Forest

Just as was the case in Mughese and Ntchisi Forests, herpetofauna of Tsamba Forest are exploited for food, medicine and for their skins.

4.2.2.3.1 Human Food

Although amphibians are not commonly used as food by most people interviewed, 2.5% of the respondents in Tsamba testified that they sometimes go to hunt for amphibians for food when they are faced with problem of relish at home (Table 4.10). The amphibian species mostly exploited appear to be those of the Genus *Ptychadena*, according to the description.

4.2.2.3.2 Medicinal Use

Just as was the case in Mughese Forest, the Flap-necked Chameleon (*Chamaeleo dilepis*) is also used for treating certain skin infections by the locals around Tsamba Forest. The treatment is administered by rubbing a live chameleon against the infected body parts (Table 4.10). About 10% of the respondents testified to this.

About 8% of the respondents who took part in this survey said that Leopard Tortoise (*Geochelone pardalis*) is used by thieves to equip themselves so that they don't feel pain when beaten once they are caught stealing. Portion of the tortoise shell is mixed with other herbs, burnt and crushed into powder. The powder is applied on small cuts made on the skin using a razor blade. People associate this reptile to the above function because of its hard shell.

The Puff Adder (*Bitis arietans*) is also exploited for medicinal purposes. Portion of its bone is mixed with other herbs, burnt and powdered to form treatment for curing wounds. The cure is administered by applying the powdered stuff on an open wound. 5% of the respondents interviewed said this.

As was the case in Mughese, the African Python (*Python sebae*) in Tsamba is also used for medicine to cure backache. About 8% of the people interviewed testified that a portion of the backbone of an African Python is mixed with other herbs, burnt and crushed into powder to form a cure for treating backache. The cure is administered by rubbing the powder onto open small cuts made using a razor blade.

Table 4.10: Human Use of Herpetofauna in Tsamba Forest Reserve.

SPECIES NAME	REPORTED HUMAN USAGE	% RESPONDENTS WHO SUPPLIED INFORMATION ON HUMAN USE OF HERPETOFAUNA (N = 40)
Ptychadena spp.	It is used as human food	2.5%
Chamaeleo dilepis	Its skin is rubbed against a person's infected body part to treat fungal skin infections.	10.0%
Geochelone pardalis	Because of its hard shell, thieves use the tortoise shell as part on treatment to equip themselves so that they don't feel pain when beaten once they are caught stealing.	7.5%
Bitis arietans	Portion of its bone is mixed with other herbs, burnt and powdered to form treatment for curing wounds.	5.0%
Python sebae	Its skin is mixed with other ingredients from herbs to attract customers in business. Skin used to make regalia for traditional dances such as *Ngoma* and *Nyau*. Portion of its backbone is mixed with other herb ingredients, burnt and make them into powder to form a cure for treating backache. Python skin is also illegally exported to other countries in the west where it is used to make belts, shoes etc.	10.0% 17.5% 7.5% 5.0%
Dendroaspis polylepis	Its head is with other herb ingredients, charred in a fire and powdered to be administered into the body through small openings made of razor blade. This forms an effective anti snakebite. Used by snake charmers for entertainment	12.5% 5.0%
Varanus niloticus	Fat from this reptile is reported to be used as treatment for healing perennial wounds.	5.0%
Mabuya striata	It is used as treatment for curing Pneumonia. Pancreas extracted from this lizard is used to cure Pneumonia. It is used to enhance love portion between partners. The animal skin is mixed with other herbs and administered to men through food. The treatment is said to be effective in keeping men around their homes by way of increasing their love intimacy towards their wives.	5.0% 7.5%
	TOTAL	**100.0%**

Besides being used as medicine for healing wounds, the African Python is also used as charm to boost one's business. Portion of the skin is mixed with other herbs to attract customers. 10% of the respondents testified to this.

Secondly, 7.5% of the respondents said that they use backbone from this snake to mix with other herb ingredients, burn them and make them into powder to form a cure for treating backache. The cure is administered to a patient through small cuttings on the skin made of razor blade (Table 4.10).

About 13% of the respondents said that Black Mamba, (*Dendroaspis polylepis*) is used as an effective anti-snake bite. The head of this snake is burnt together with other herb ingredients and then crushed into powder. This powder is mixed with other herb ingredients and is applied to a small cut made with a razor blade on the back of each hand between the thumb and forefinger, and likewise on the feet. Most people regard this as prevention and it is believed that no snake (irrespective of race or species) will attempt to bite any person equipped with this defence (Table 4.10).

5% of the respondents said that Monitor Lizard (*Varanus niloticus*) is medicine for treating perennial wounds. Fat from this lizard is extracted and then smeared on the wound (Table 4.10).

About 8% of the respondents interviewed said that the Striped Skink (*Mabuya striata*) is used as love charms between married partners. The skin from this skink is mixed with other herbs and administered through food. The treatment is said to be effective in keeping men around their homes. People associate this skink to the above function because it is associated with human habitation. Besides being use as love portion, this lizard is also used as medicine for curing Pneumonia. 5% of the respondents interviewed said that they mix pancreas extracted from this lizard with some herbs. The mixture is then applied to small incisions made on the skin around the chest (Table 4.10).

4.2.2.3.3 Skins/Hides

There is also evidence of the African Python (*Python sebae*) being exploited for its skin in Tsamba Forest (Table 4.10). The Python skin is allegedly illegally exported to German and France where it is used for making belts, shoes and other products. 5% of the respondents testified to this. The locals around Tsamba Forest also use the skins for making regalia for traditional dances such as *Ngoma* and *Gule Wamkulu*. 17.5% of the respondents said this.

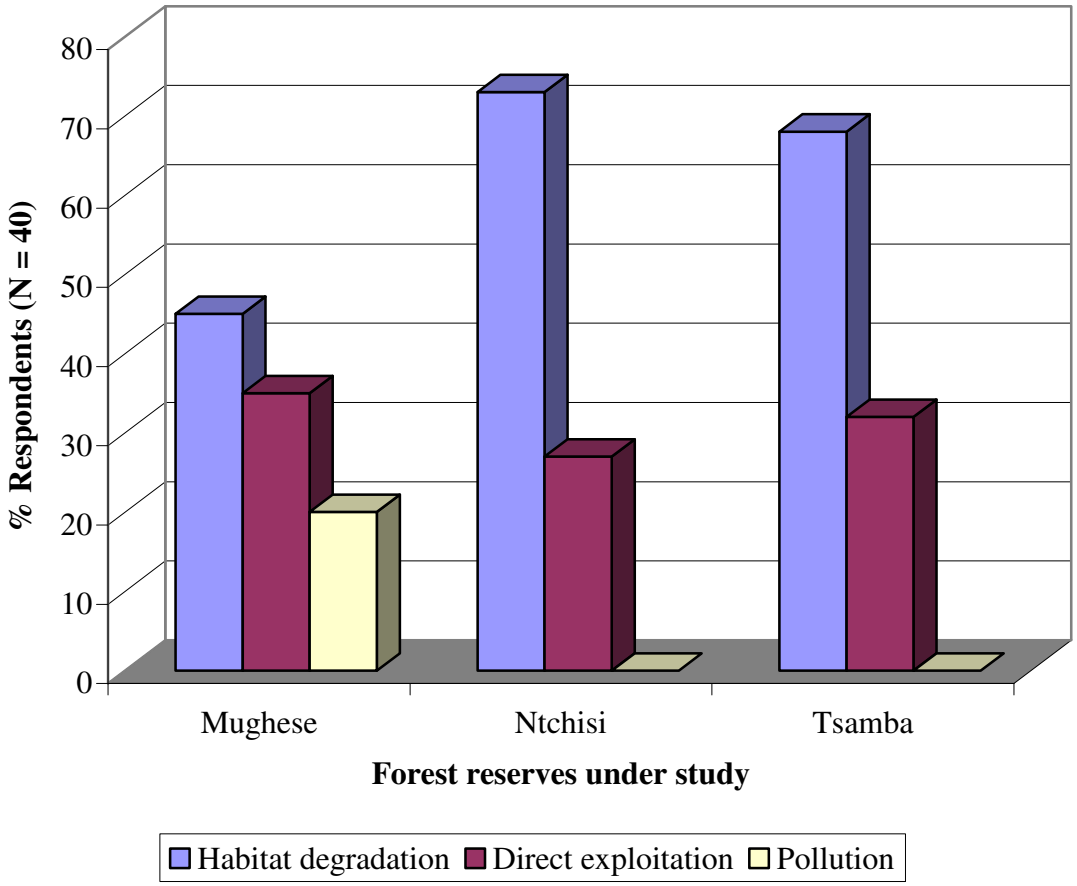
4.2.2.3.4 Entertainment

Besides being used for medicine, some snake species such as Black Mamba (*Dendroaspis polylepis*) are also used for entertainment by some snake charmers in villages around Kambale Trading Centre in Tsamba Forest. 5% of the respondents reported that the Black Mamba is used by snake charmers for entertainment.

4.2.3 Threats to the Herpetofauna of Mughese, Ntchisi and Tsamba Forest Reserves.

Threats to herpetofauna are numerous. However, during the survey, the people interviewed cited human activities such as cattle and goat grazing; cutting down of trees for the production of timber; hunting; charcoal burning, bushfires; collection of fruits, insects, mushrooms and medicinal animals; careless killing of animals and pollution as some of the threats to herpetofauna. These human activities could be summarised under three major threats, namely: habitat loss/degradation, direct exploitation and pollution (Figure 4.1).

Figure 4.1: Respondents views on the major threats to herpetofauna of Mughese, Ntchisi and Tsamba Forests



4.2.3.1 Habitat Loss/Degradation

As it can be seen in Figure 4.1, habitat degradation was reported to be the major threat to herpetofauna in the three forest reserves. But of the three forests, degradation was reported to be more serious in Ntchisi Forest than in the remaining two. This is also reflected in the figures where about 73% of the respondents in Ntchisi said this, against 68% and 45% for Tsamba and Mughese, respectively (Figure 4.1). The high rate of habitat degradation in Ntchisi Forest was attributed to intensified human activities such as cattle grazing (Plate 4.13) and unsustainable harvesting of insects where the locals fell trees in order to harvest caterpillars (Plate 4.14). In Tsamba Forest, human activities that led to habitat loss were charcoal burning, bushfires and partly cattle grazing. Of the three forests, Mughese was fairly well managed, as degradation was not as serious as those in the other two forests. However, cattle grazing were still prevalent, particularly near the forest boundary.

Plate 4.13: Cattle grazing in Ntchisi Forest Reserve.

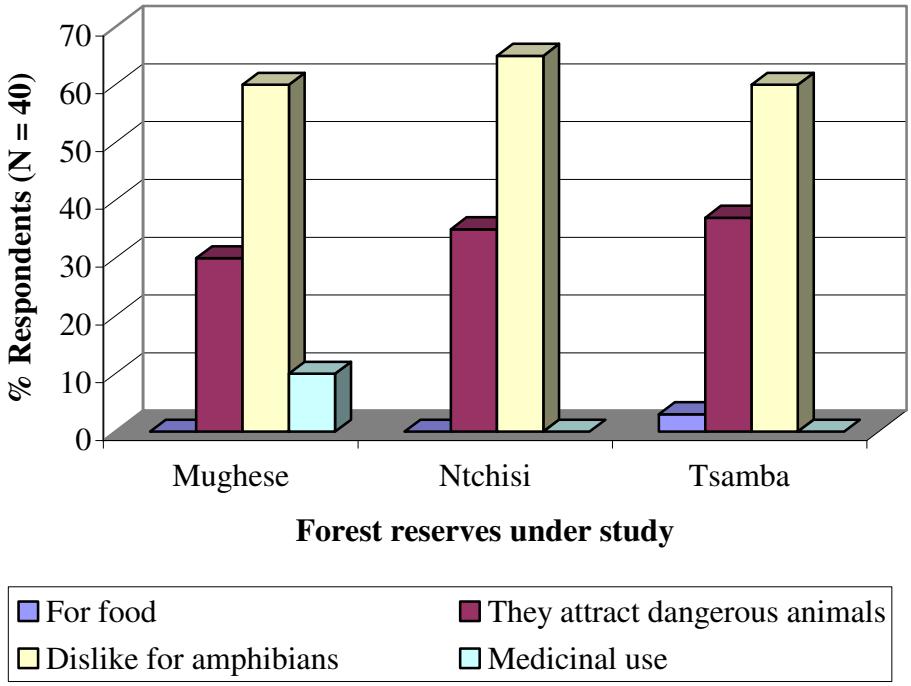
Plate 4.14: Unsustainable harvesting of caterpillars through cutting of trees in Ntchisi Forest.

4.2.3.2 Direct Exploitation

Factors such as poaching/collection, road kills, commercial trade, scientific research (where some specimens are sacrificed and collected by scientists as voucher for future use) and wanton killing are considered under this threat category. Of the total number of respondents interviewed in each site, 35%, 27% and 32% cited direct exploitation as being the major threat to herpetofauna in Mughese, Ntchisi and Tsamba Forests, respectively (Figure 4.1).

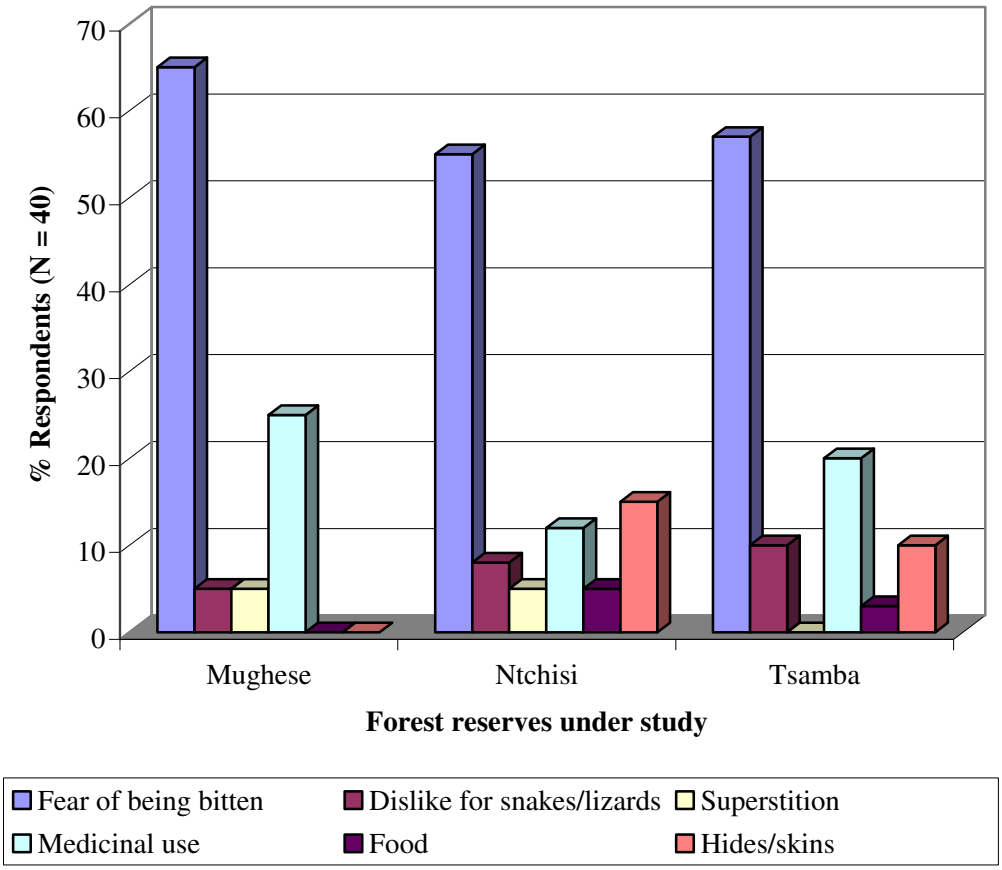
As for amphibians, many amphibians are killed because of their alleged unpleasant looks and out of dislike for these animals. 60% of the respondents in Mughese, 65% in Ntchisi and 60% in Tsamba explained that they kill amphibians because of dislike for these animals while 30% in Mughese, 35% in Ntchisi and 37% in Tsamba said they kill these animals because they attract dangerous animals such as snakes in homes. About 3% of the respondents in Tsamba said they kill amphibians for consumption. There were no amphibians that were reported to be exploited for food in Mughese and Ntchisi Forests. Use of amphibians for medicinal purposes was restricted to Mughese where the Mozambique's Rain Frog (*Breviceps mossambicus*) is said to be used equipping women to cook more food from limited supply. 10% of the respondents said this in Mughese Forest (Figures 4.2).

Figure 4.2: Reasons given by respondents on why they kill amphibians on sight in Mughese, Ntchisi and Tsamba Forests



When asked why they kill snakes and lizards, 65% of the respondents in Mughese, 55% in Ntchisi and 58% in Tsamba said they do so out of fear that one day these animals will bite them while 5%, 8% and 10% of the respondents in Mughese, Ntchisi and Tsamba said that they kill snakes and lizards because of their unpleasant looks or dislike for these animals. 5% of respondents in Mughese and Ntchisi separately explained that they kill snakes and lizards because these animals are associated with superstitious stories. 25% in Mughese, 13% in Ntchisi and 20% in Tsamba explained that they kill snakes and lizards for medicinal purposes. Only 5% and about 3% said they exploit these animals for food, in Ntchisi and Tsamba, respectively. In Mughese, no snakes and lizards were reported to be exploited for food. However, some snakes and lizards such as the Monitor Lizard and the African Python are exploited for their skins. 15% of the respondents in Ntchisi and 10% in Tsamba said they kill these animals for their skins (Figures 4.3).

Figure 4.3: Reasons given by respondents on why they kill reptiles on site in Mughese, Ntchisi and Tsamba Forests



4.2.3.3 Pollution

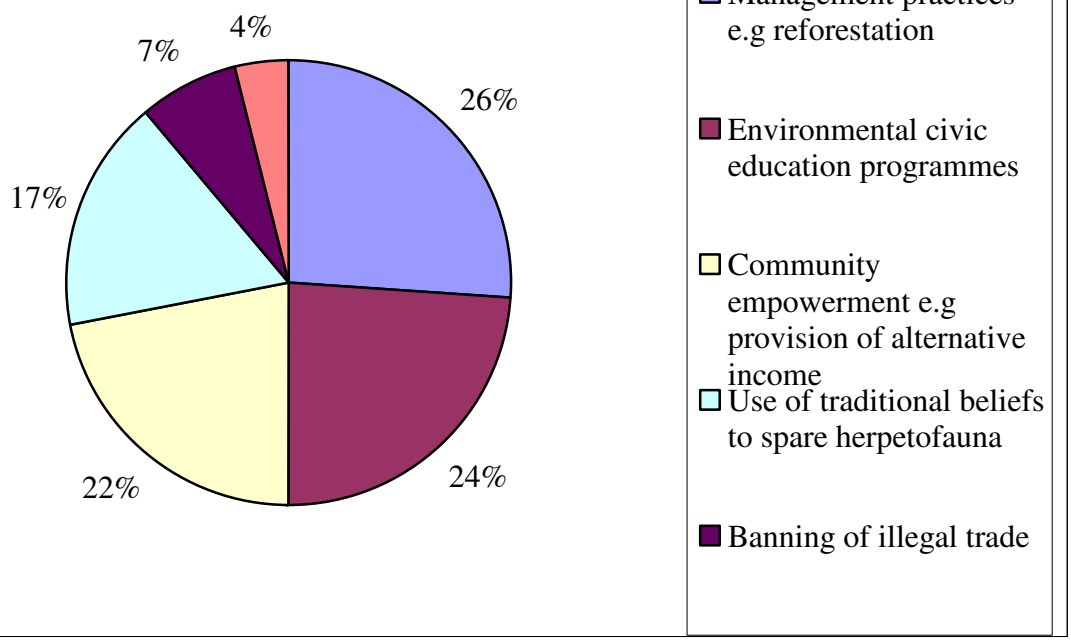
Pollution as a threat to herpetofauna was mentioned at Mughese Forest Reserve. It was reported that during the rainy season, a number of amphibians die near and along the streams that run through the coffee plantations into the forest reserves. 10% of the respondents interviewed in Mughese Forest attributed this to pollution arising from the application of insecticides and chemical fertilizers, especially in coffee plantation. However, nobody has conducted research to find out whether the amphibians that have been reported dead in the streams do so because of the effects of agricultural chemicals in the area.

4.2.4 Strategies for Conservation and Management of Herpetofauna in Mughese, Ntchisi and Tsamba Forests.

Forests, which are an important part of the environment, were plentiful in this country a century ago. Over the years, large parts of our forests have been cleared to pave way for extensive farming and human settlement (Seyani 1991). The services rendered by the Department of Forestry towards the conservation of selected protected areas are of immense value. However, these services usually lack the support of the local communities living in areas surrounding the forests. Since the conservation strategies that were in place (such as barring people from entering forest reserves to harvest forestry products) were not formulated in consultation with the local communities, villagers generally developed resentment towards conservation issues (Seyani 1991). This realization made it necessary that the study be undertaken to outline clear guidelines, with inputs from the local communities, on how best forest reserves could be managed for the betterment of the people themselves.

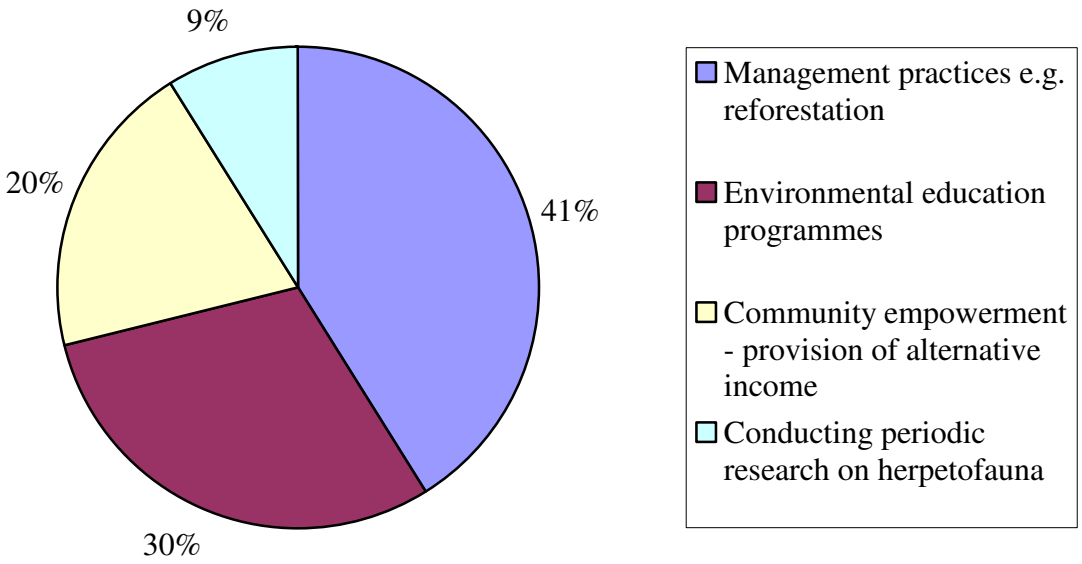
Respondents interviewed during the survey proposed six strategies for conserving and managing biodiversity in general and herpetofauna in particular in Mughese Forest (Figure 4.4). The strategies are: 1) undertaking management practices such as reforestation programmes on all bare ground within the forest (26% of the respondents), 2) environmental civic education programmes aimed at educating the local communities on the importance of herpetofauna and the need to conserve them (24%), 3) empowerment of the local community through the provision of alternative income generating activities in order to divert people's reliance on natural resources for their livelihoods (22%), 4) use of traditional beliefs such as the belief that some herpetofauna like the Beaked-blind Snake are associated with luck (17%), 5) banning of illegal trade in herpetofauna (7%), and 6) conducting periodic research to determine population status of herpetofauna, particularly targeting more rare species (4%).

Figure 4.4: Respondents' opinions on the proposed strategies for conservation and protection of herpetofauna of Mughese Forest



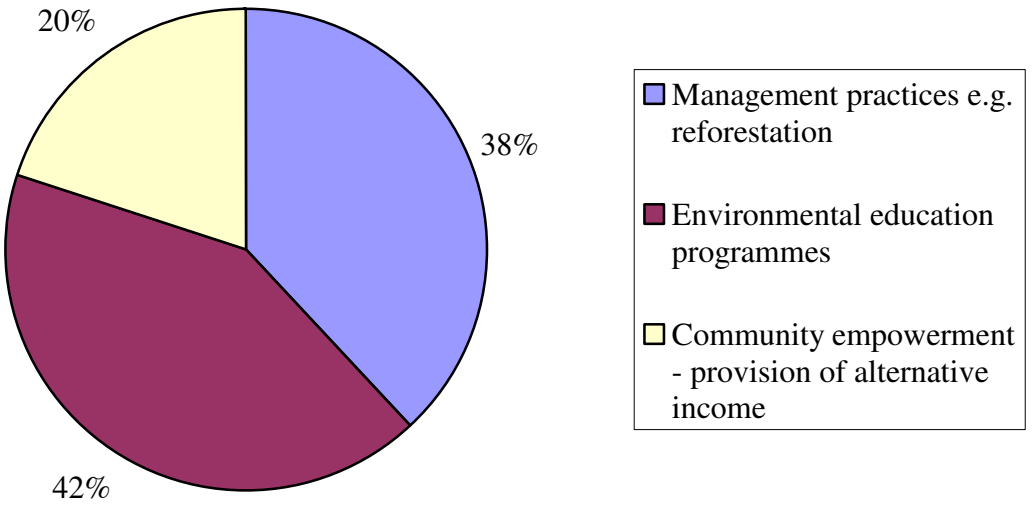
In Ntchisi Forest, the proposed strategies for conserving herpetofauna were similar to those proposed for Mughese Forest, except for two. These include: undertaking management practices such as reforestation programmes (41% of the respondents), environmental civic education programmes (30%), empowerment of the local community through the provision of alternative income generating activities in order to divert people's reliance on natural resources for their livelihoods (20%) and conducting periodic research (9%) (Figure 4.5).

Figure 4.5: Respondents' opinions on the proposed strategies for conservation and protection of herpetofauna of Ntchisi Forest



As for Tsamba Forest, respondents only proposed three strategies for conserving and managing herpetofauna in the area. These include: undertaking management practices such as reforestation programmes (38% of the respondents), environmental civic education programmes (42%) and empowerment of the local community through the provision of alternative income generating activities in order to divert people's reliance on natural resources for their livelihoods (20%) (Figure 4.6).

Figure 4.6: Respondents opinions on the proposed strategies for conservation and protection of herpetofauna of Tsamba Forest



CHAPTER FIVE:
DISCUSSION, RECOMMENDATIONS & CONCLUSIONS

5.1 DISCUSSION

5.1.1 Amphibians

Taxonomically Mughese, Ntchisi and Tsamba Forest Reserves share a relatively high number of amphibian families, genera and species. Of the eight amphibian families recorded during the study, three families (Bufonidae, Ranidae and Arthroleptidae) were spread in all the forests - representing about 38% similarity, while only two families (Rhacophoridae and Hemisotidae) were restricted to Ntchisi Forest Reserve. The other three families (Microhylidae, Pipidae and Hyperoliidae) were recorded in either of the two forest reserves. The high percentage of species overlap in the three forests could be attributed to the fact that most amphibian species recorded during the survey such as Guttural Toad (*Bufo gutturalis*) and Sharp-nosed Ridged Frog (*Ptychadena oxyrhynchus*) have a wide sub-continental distribution (Channing 2001). The absence in the catches of Rhacophoridae and Hemisotidae species in Mughese Forest Reserve could be attributed to the fact that both (Gary Tree Frog (*Chiromantis xerampelina*) and Marbled-snout Burrower (*Hemisus marmoratus*) occur in Savannas in most of the Sub-Saharan Africa, excluding the rain forests (Channing 2001). Ntchisi and Tsamba Forests are largely regarded as Savanna forests (Chapman & White 1970). But although Mughese Forest is not regarded as a typical rainforest, it has some characteristics of rain forest (Stewart 1965), hence chances that the two species could be found there are unlikely. At Tsamba Forest, the possibility that these two species could be found is very high. The absence in the catches of the two species in Tsamba Forest could therefore be attributed to lack of proper timing (area not surveyed in wet period), limited time spent in the field as well as the lifestyles of the two species. For example most Hemisotids are burrowing species and therefore are difficult to find since they spend most of their time in the soil. On the other hand, Rhacophorids are primarily arboreal species and usually mimic their environment and therefore encountering them is not easy.

Despite the similarities at family level, there are some notable differences among the amphibians of the three study areas if considered at species level. For instance, Mababe Puddle Frog (*Phrynobatrachus mababiensis*), Reiche's Squeaker (*Arthroleptis reichei*), France's Squeaker (*Arthroleptis francei)*, Spotted Reed Frog (*Hyperolius puncticulatus* and

Yellow-spotted Tree Frog (*Leptopelis flavomaculatus*) were recorded only in Mughese Forest and not in Ntchisi or Tsamba Forests. The explanation to this is that these species are rain forest forms of which Ntchisi and Tsamba are not amongst them. The other explanation could be the time of the year field studies were conducted. In Mughese, the three field visits were conducted during different seasons of the year (including the rain season) but this did not work out for Ntchisi and Tsamba Forests because the project funds could not be released on time due to logistical problems. As a result some visits in Ntchisi and Tsamba Forests were conducted during the same seasons (dry seasons) for the two-year period that the research was undertaken. On the other hand, amphibian species such as the Guibe's Ridged Frog (*Ptychadena guibei*) and Long Reed Frog (*Hyperolius nasutus*) were recorded in Ntchisi Forest and none in Mughese and Tsamba Forests. The explanation of this observation could be a matter of relative catchability as some amphibian species were escaping before they could be identified.

As was reported in the results section, three amphibian species in Mughese and one in Tsamba Forest that were previously recorded by other researchers were not recorded during this survey. This was not expected as these species were found to be common during pervious studies (Stewart 1965, 1967). The possible explanation for the absence of these species could be due to forest degradation that has led to the destruction of habitats in which these amphibians were found resulting in loss of some species. This is particularly true for Kisolo Toad (*Bufo kisoloensis*) (Mughese Forest) and Bocage's Tree Frog (*Leptopelis bocagii*) (Ntchisi Forest) because these species are sensitive to habitat destruction (Channing 2001). This observation supports the hypothesis. Tsamba Forest had no species restricted to it as most of them were also recorded in Ntchisi Forest. This is so because Tsamba and Ntchisi are predominantly *Brachystegia* woodland forests, except for the presence of a small evergreen forest patch on the crest of Ntchisi Mountain ridge which is at 1, 645m a.s.l. (Bellington & Blomley 1973).

Different amphibian species have different habitat preference. Some species are habitat specialists while others are generalist species. However, several species that have wide habitat preference were recorded in fewer habitat types. The absence of these species in other habitats could therefore be attributed to inadequate time spent in the field as well as failure to visit the study areas during different seasons of the year, as was the case with Ntchisi and

Tsamba Forests. The lifestyles of various species were found to closely relate to the type of habitat/microhabitat occupied. For example, burrowers such as Marbled-snout Burrower (*Hemisus marmoratus*) were found in wet soils under the leaf litter and arboreal species such as Gray Tree Frog (*Chiromantis xerampelina*) were found perching on branches of trees. As such, any conservation attempt will have to ensure that all the habitats/microhabitats in which these species occur are adequately protected.

Two threatened species: the France's Squeaker (*Arthroleptis francei*) and Reiche's Squeaker (*Arthroleptis reichei*) were recorded at Mughese Forest during this study with the former also recorded as new record for the area. From the field data and the information gathered during the literature review, it was clear that although Mughese Forest is a new distributional locality for France's Squeaker (previously recorded on Zomba and Mulanje Mountains only, Stewart 1967 and Stevens 1974), its extent of occurrence is probably still not greater than 20, 000m^2 (Channing 2002). The presence of France's Squeaker in Mughese Forest could be attributed to the fact that just like Zomba and Mulanje Mountains, Mughese has montane evergreen rain forest similar in character, with very moist and cool environment, which is ideal for this species. This also applies to Reiche's Squeaker, an East African species whose geographical range is confined to the Poronto, Rungwe, Uzungwe and Uruguru Mountains of southern Tanzania and its extent of occurrence is less than 20, 000 km^2 (Channing 2002). Mughese Forest, being at the extreme north of Malawi, its vegetation and climate is similar to those of Tanzanian reported localities. Stewart (1965) observed that Mughese Forest has some species that are unique to Malawi because it is one of the southernmost extensions of the more northerly tropical rainforest distribution.

The extent and quality of the habitats for the two species are also declining as reported earlier on, thus making the species qualify to be listed as threatened. Furthermore, the relative abundances for the populations of each of the two species are low (Appendix 2.1). This, coupled with the fact that the forest habitats in Mughese, Mulanje and Zomba are in danger of excessive logging confirms that the two species are indeed threatened as previously reported.

Despite Mughese being a home for two threatened amphibian species, the other seventeen species found in this forest are also found in other localities across the country. Field

observations also suggest that the distribution of most amphibians in the three protected areas was largely dependent on the presence of water, availability of food, shelter, and species adaptation to major topographical features including woodlands, marshy areas and the riparian. Microhabitats function as sources of food and shelter (Simbotwe & Patterson 1983).

5.1.2 Reptiles

Mughese, Ntchisi and Tsamba Forests registered eight reptilian families each. Despite registering the same number of reptilian families, some families were recorded in particular forest reserves. For example, lizards of the family Agamidae were recorded in Ntchisi and Tsamba Forests and none from Mughese. The reason could be that Agamas are Savanna forest species of which Ntchisi and Tsamba Forests are among them (Branch 1998). On the other hand, although Mughese Forest is regarded as Savanna forest, it has some characteristics of rain forest (Stewart 1965); hence chances of encountering agamids in the forest were unlikely. Two species of the family Rhinotyphlopidae, namely: Schlegel's Beaked-blind Snake (*Rhinotyphlops schlegelii*) and Slender Blind Snake (*Typhlops obtusus*) were recorded in Mughese Forest and none in Ntchisi or Tsamba Forests. This could be attributed to the fact that the two are essentially burrowing species and therefore are difficult to find since they spend most of their time in the soil. The other problem is the timing of the field surveys. Unlike in Mughese Forest, the periods of sampling in Ntchisi and Tsamba Forests did not include the rainy seasons as originally planned due to delays in the disbursement of project funds. This meant that some burrowing species such as Rhinotyphlopids could not be encountered since they usually come of the ground after some heavy rains. Similarly, unlike in Mughese and Tsamba, no species belonging to the family Elapidae were recorded in Ntchisi Forest. However, previous records show the presence of several species from this family in Ntchisi Forest. The absence of these species from the list is a matter of lack of coincidence.

Of all the reptilian species recorded, Striped Skink (*Mabuya striata*) was found in abundance in all study areas. The Striped Skink has varied habitat preference from mangrove swamp to arid savannah and the species range is from East Africa all the way to the north-eastern Cape, extending along the Orange River and to the west through Zambia, Angola and southern Namibia (Branch 1998). This is equally true of Variable Skink (*Mabuya varia*),

Rainbow Skink (*Mabuya margaritifer*), Southern Rock Agama (*Agama atra*) and Flap-necked Chameleon (*Chamaeleo dilepis*), all of which have wide distribution and have varied habitat preference (Branch 1998). The preferred vegetation/habitats for the abundant reptilian species included dug holes, in glass/bushes, hollow logs/stems, rock crevices, leaf litter and under tree barks. Most of these habitats had provisions where reptiles could retreat when alarmed. These were burrows, holes and cracks within the rocks. This suggests that reptiles are fond of habitats that have hideouts to provide them with security when they are in danger.

As was the case with amphibians, several reptiles in Mughese and Ntchisi Forests that were previously recorded by other researchers were not recorded during this survey. This was not expected as these species were found to be common during pervious studies (Stewart 1965, 1967). Just as was the case with amphibians, the possible explanation for the absence of these species could be due to forest degradation that has led to the destruction of habitats in which these reptiles were found resulting in loss of some species. This is particularly true for Short-tailed Chameleon (*Rhampholeon nchisiensis*) (Mughese and Ntchisi Forests), Sand Snake (*Psammophis phillipsi*) (Mughese and Ntchisi Forests), White-lipped Snake (*Crotaphopeltis tornieri*) (Mughese Forest) and Rungwe Bush Viper (*Atheris rungwensis*) (Mughese Forest) because these species are sensitive to habitat destruction (Stewart 1965).

Unlike for amphibians, there were no threatened reptilian species recorded during the survey. IUCN (2002) does not have reptilian species recorded from Malawi that are currently listed as threatened. Information on distribution of reptiles obtained from the literature, revealed that almost all tolerate a wider range of habitat types throughout Malawi and beyond (Branch 1998). In addition, some high altitudinal species recorded during the study such as the Arnold's Skink (*Proscelotes arnoldi*) are also found in several other Malawi Highlands of Zomba, Shire and Mulanje (Stevens 1974).

The Common Mountain Lizard (*Tropidosaura montana*), a new record for Malawi recorded at Mughese Forest – 1888m, previously had its distribution range extending from Cape Fold Mountains through the Eastern Cape and Amatola Mountains, to Kwazulu-Natal midlands and Drankensberg foothills in South Africa (Branch 1998). Most of these mountains in the range have altitudes of between 1, 000 and 1, 500m, with the highest rising to more than 2,

000 m (Branch 1998). Hence, the new record for Common Mountain Lizard falls well within the known altitudinal range for this species. However, this species is probably a relic population to that found in South African mentioned localities.

5.1.3 Importance of Herpetofauna

As reported in the results section, the local people in villages surrounding the study sites took part in compiling the checklist of herpetofauna that occur in Mughese, Ntchisi and Tsamba Forest Reserves. However, use of indigenous knowledge to compile checklists has its own shortfalls because different individuals can sometimes be grouped into a single species and hence given the same local name when in fact those individuals belong to different species. For example, Mfune & Mhango (1998) reported that the Common Egg-eater (*Dasypeltis scabra*) and the Rhombic Adder (*Causus rhombeatus*) are both known by the same local name *Kasambwe* in Lake Chilwa wetland in Malawi and yet these two individuals belong to different species. Results also showed that generally, little is known by the local people about the amphibians in the three study sites. For example, there were no amphibians that were reported by the local people to occur in Mughese while only one amphibian species: (Mozambique's Rain Frog) was reported in Ntchisi Forest and two: (Guttural Toad and Mozambique's Rain Frog) were reported in Tsamba Forest. The explanation of this observation could be attributed to limited use of vocabulary in the vernacular languages to allow for the recognition of individual species but more importantly, because of the perceived notion by most people that amphibians are of less or no economic value, hence they do not see the need to dwell very much on them.

Nevertheless, herpetofauna play an important role in uplifting the socio-economic status of the people living in areas surrounding Mughese, Ntchisi and Tsamba Forest Reserves. Some amphibian species (*Ptychadena* spp.) were reported as human food in Tsamba Forest while others such as the Mozambique's Rain Frog (*Breviceps mossambicus*) are used for medicinal purposes. In Nsanje District in the Shire Valley, the Mueller's Platanna (*Xenopus muelleri*) and the African Bullfrog (*Pyxicephalus adspersus*) are also exploited for consumption by the *Sena* people (Mitchell 1946). Limited use of anurans as human food has also been reported in Southern Africa. There are a number of references to African Bullfrog, having been eaten by the indigenous people and explorers (Livingstone 1860, Lord & Baines 1876). Bones of the Common Platanna (*Xenopus laevis*) occur at some archaeological sites in South Africa

and have been reported to be eaten by people surrounding these areas (Hey 1986). Today, the African Bullfrog is still eaten by people in many parts of the African continent (Channing 2001).

Just like amphibians, reptiles were also reported as human food, for medicinal purposes, for entertainment and for making drums and dancing costumes. Elsewhere in India, snakes are exploited for their skins. Snakes of commercial importance include the Rat Snake (*Ptyas mucosa*), Spectacled Cobra (*Naja naja*), the Checkered Keelback Water Snake (*Xenochrophis piscator*), Russell's Viper (*Dabola russelii*), Common Sand Boa (*Eryx conicus*), Common Freshwater Snake (*Atretium schistosum*) and Indian Rock Python (*Python molurus*) (Das 2001). Besides snakes, almost all species of monitor lizards found in India are involved in the trade, including the Water Monitor (*Varanus salvator*), Land Monitor (*Varanus bengalensis*), Yellow Monitor (*Varanus flavescens*) and Desert Monitor (*Varanus griseus)* (Das 2001). In 1932, India exported 2.5 million reptilian skins to the west and prior to the ban in 1979; it was one of the world's largest exporters of reptilian leather (Andrew & Birkshaw 1988, Inskipp 1981). Despite the ban on export, large numbers of these reptilian skins still leave the country, both legally and illegally, particularly over the land border with Bangladesh (Das 2001).

5.1.4 Threats to the Herpetofauna of Mughese, Ntchisi and Tsamba Forest Reserves.

Habitat loss is the greatest threat to biodiversity including the herpetofauna of Malawi. During interviews with the communities, many people testified that Mughese, Ntchisi and Tsamba Forest Reserves had fewer trees today than they were some ten to fifteen years ago. This was attributed to intensified human activities in the forests such as cattle and goat grazing, cutting of trees for the production of timber, hunting, bushfires, collection of fruits, mushrooms and medicinal animals, among others. Hero & Shoo (2003) reported that habitat loss is the principal threat to biodiversity and that halting deforestation is the greatest challenge in this 21st century because the development of agriculture and infrastructure is seen as the first step toward economic development and reduction of poverty and food insecurity.

As reported in the results section, forest degradation was more serious in Ntchisi and Tsamba Forests but not very serious in Mughese Forest. As a result of habitat loss through forest destruction, many amphibians and reptiles have become more vulnerable to natural predators and other domestic animals such as cats and dogs (personal observation). Some birds such as eagles and domestic cats were observed preying on small agamas, geckos, skinks, and frogs at Mughese, Ntchisi and Tsamba Forests. Besides, habitat degradation destroys breeding sites for herpetofauna and in some cases exposes their eggs to harsh weather conditions such as high temperatures and rainfall. This would, in turn, affect the viability of the eggs (Mazibuko 2005). This explains how habitat degradation would lead to loss of species.

Direct exploitation such as poaching/collection, road kills, commercial trade, scientific research, wanton killing was also reported as the major threat to herpetofauna. Wanton killing of herpetofauna in the three study sites is done out of fear all herpetofauna, particularly snakes are dangerous and can bite a human being. In addition, snakes are killed due to certain traditional beliefs/myths. For example, it was reported at Ntchisi Forest that if a person is bitten by a snake and does not kill it, the wound would remain open until the cause (the snake) of that wound has been destroyed. Sometimes herpetofauna are killed out of dislike for these animals and also because of their unpleasant looks. Out of this ignorance, a number of herpetofauna are killed in areas surrounding Ntchisi Forest. Sadly, many of these are in fact of considerable benefit to man. For instance, most snakes seek human habitations in order to feed on the rodents that often abound in storehouses, barns, maize and granaries (Sweeney 1961).

The application of insecticides and chemical fertilizers especially in coffee plantation areas surrounding Mughese Forest is steadily increasing (Malawi Government 2000). Although these chemicals are applied in cultivated land, some of them find their way into the reserve through rivers and streams. This would adversely affect the insects' population, an important food source for most of the amphibians and reptiles. Mfune & Mhango (1998) reported that amphibians feed on insects such as mosquitoes and grasshoppers. These chemicals may sometimes be toxic to herpetofauna, which are associated with water such as amphibian species of the Genus *Ptychadena*. Amphibians have soft and permeable skins which make them susceptible to water pollutants, especially agricultural chemicals (Mfune & Mhango 1998).

5.2 RECOMMENDATIONS

A number of recommendations were made by the local people that if implemented, would help in management of herpetofauna in the three reserves. The following were some of the suggested recommendations:

5.2.1 Implementing Conservation Management Practices.

Habitat loss was identified by the local communities in the study sites as one of the major threats to amphibians and reptiles. Tilman *et. al.* (2001) reported that human beings currently appropriate for more than a third of the production of terrestrial ecosystems and about half of the usable fresh waters on earth. Deforestation for agriculture is projected to rise sharply in the next few years, with approximately one billion hectares of natural forests to be converted to agriculture, including more than a third of remaining tropical and temperate forests, savannah, and grasslands (Laurance 2001; Tilman *et. al.* 2001). In view of this, urgent conservation measures are needed to identify and halt sources of habitat destruction and protect the remaining vegetation. In this respect, respondents and participants in the Focus Group Discussions proposed the introduction of conservation management practices. Examples of conservation management practices include: reforestation programmes; avoidance of cattle and goat grazing; avoidance of cutting down of trees; avoidance of hunting; avoidance of bushfires; sustainable collection of fruits, insects, mushrooms as one way of checking habitat degradation. Conservation management practices would therefore provide for protection of water quality and connectivity of habitat patches for herpetofauna within Mughese, Ntchisi, and Tsamba Forest Reserves.

5.2.2 Environmental Civic Education Programme.

Respondents and participants in the Focus Group Discussions explained that there is need to conduct environmental civic education programmes to make the local communities aware of the need to conserve and protect the reserves. The level of awareness to be achieved is if people start appreciating that herpetofauna, just like any class of animals, have the right to live and that they stop killing them anyhow. Secondly, if the people are sensitised to appreciate that not all herpetofauna are dangerous to human being. If anything, herpetofauna are of great importance to human beings in one way or the other. It was also proposed that educational activities relating to nature conservation should be promoted among school children, especially for those surrounding the study areas, as they are the future leaders.

Since in some areas such as Ntchisi, there were cases whereby the villagers were cutting down trees in order to harvest insects, the respondents proposed conducting awareness programmes to the general public on the concept of sustainable utilisation of natural resources where harvesting of caterpillars (*Imbrasia ertli*) could be done but without cutting the trees.

5.2.3 Empowerment of Local Communities.

The villagers surrounding the forest reserves confessed engaging in forest destruction in order to earn a living, as most of them are very poor. Poverty in Malawi is widespread and prevalent in both urban areas (estimated at 65%) and rural areas (estimated at 60%) (UNICEF 1993). Poverty in this context means the lack of basic necessities in life such as clothes and food. Respondents said they invade forest reserves to harvest forestry products for sale in order to meet their daily needs. Respondents and participants in the Focus Group Discussions proposed if the Government of Malawi and other relevant NGOs could help empower the local communities economically by providing them with alternative source of income generating activities in order to divert their attention of relying too much on natural resources for their livelihoods. Another way of empowering the local communities is to promote Community Based Natural Resources Management (CBNRM) by encouraging villages surrounding the forest reserves, through their traditional leaders, to form Village Natural Resource Committees (VNRCs) or reactivate those committees that are inactive. Participants in the Focus Group Discussions and respondents said that these VNRCs would avail them with the opportunity to take part in managing forest reserves by keeping a watchful eye on the forests and report any suspects engaged in unlawful activities to authorities (their traditional leaders and forestry personnel) for disciplinary action.

5.2.4 Periodic Research Activities

Participants in the Focus Group Discussions, which also included some forestry personnel, suggested that periodic research activities should be encouraged and supported in order to have a wider coverage and more data so as to establish the population numbers and conservation status of herpetofauna, particularly the more rare species for sustainable management of our three forest reserves for sustainable management. Das (2001) observed that databases pertaining to the biology and conservation of the amphibians and reptiles could be established and this could include information on locality, habitat preference and

breeding biology, etc. all of which could be useful in biodiversity monitoring and conservation requirements. In this regard, the importance of having well trained researchers to undertake such studies cannot be overemphasized. Pimm *et. al.* (2001) observed that training of in-country professionals and building local capacity is vital to promoting conservation in developing countries and this requires educational and financial support for local scientists (Sodhi & Liow, 2000). Training and capacity building could be enhanced by:

- Increased budgetary allocation by government to research institutions in the country such as the University of Malawi (UNIMA), Museums of Malawi (MoM), National Herbarium and Botanical Gardens of Malawi (NHBG), Department of National Parks and Wildlife (DNPW), Forestry Research Institute of Malawi (FRIM) and other institutions involved in natural history research,
- Ensuring that international funds are available to provide a network of grants to support collaborative research projects,
- Ensuring that there are international funds to provide graduate scholarships for our scientists to study oversees, based on field work done in Malawi, and
- Increased accessibility to journals and conferences. This could be done with support from donors and our cooperating partners as well as the Government.

On pollutants such as agricultural chemicals, especially around Mughese Forest, participants suggested that further research should be carried out on wild populations of amphibians and reptiles in order to determine the seriousness of the problem.

5.2.5 Use of Traditional Beliefs/Myths in Conservation of certain Herpetofauna.

There are some socio-economic value of amphibians and reptiles, where a variety of beliefs centre on the local herpetofauna, some of which protect the species, as is the case with the Beaked-blind Snake, which is associated with luck. Respondents and participants from the Focus Group Discussions recommended incorporation of these beliefs into local conservation programmes for herpetofauna, particularly for Ntchisi Forest, where these beliefs were reported. Das (2001) support the idea of using traditional beliefs that centre on the local herpetofauna to promote their conservation. He observes that public education programmes relevant to the conservation of herpetofauna are essential and where possible,

local traditions and skills should be employed in conservation education. These beliefs may be incorporated into local conservation programmes for herpetofauna.

5.2.6 Illegal Trade

Although illegal trade in animal skin was reported in Tsamba Forest, the extent to which this occurs is very low as only 5% of the respondents said this. Nevertheless, respondents and participants from the Focus Group Discussions expressed the need to monitor and probably discourage trade in wild species especially for the African Python (*Python sebae*), both at local and international level, owing to dwindling numbers of this species in the country. This could best be achieved through close liaison between Government Agencies entrusted with protection and organisations that are specialized on wild species in trade such as the Department of National Parks and Wildlife (DNPW) and the Convention on International Trade for the Endangered Species (CITES).

5.3 CONCLUSION

In conclusion, results of this study have shown that all three forest reserves have been understudied in as far as herpetofauna are concerned. This is particularly true for Tsamba Forest Reserve where essentially no biological studies have been conducted before. This is less true for Mughese and Ntchisi Forests where some work have been done particularly on amphibians and less so on reptiles. This observation is supported by the recording of several species that were new records for the areas. Endemics were restricted to Mughese Forest Reserve, and none in Ntchisi and Tsamba Forests. Herpetofaunal inventories of the three forest reserves are far from complete; several areas are still to be surveyed. This is particularly true for Tsamba and Ntchisi Forest Reserve where sampling periods did not include the rainy season as previously planned. Clearly more equipment and working days are required in order to have a wider coverage and more data so as to establish the population numbers and conservation status of the more rare species.

Several amphibian and reptilian species that were previously recorded by other researchers in Mughese and Ntchisi Forests were not recorded during this survey. This was not expected as these species were found to be common during pervious studies. This underlines the fact that some herpetofauna in the two forest reserves are on the decline.

While some species were recorded in all the three study sites, there were some that were restricted to Mughese Forest. This is so because of the presence of montane evergreen forest in Mughese Forest, which makes this forest unique from the other two forests of Ntchisi and Tsamba.

Studies on the socio-economic importance of herpetofauna have also revealed that local communities in areas surrounding the three forest reserves exploit herpetofauna from the forests for various reasons. Some herpetofaunal species are exploited for food while others are exploited for medicinal purposes. This underlines the importance of herpetofauna to the people and the need to conserve and use them sustainably.

Conservation of herpetofauna of the three forest reserves faces several challenges. These include wanton killing, habitat destruction pollution as well as direct removal for human consumption and sale of herpetofaunal products such as skins. Habitat destruction is

probably the most serious threat faced by herpetofauna in Malawi. Unfortunately, habitat loss arising from forest destruction is common in the three forest reserves.

Ultimately, the success of conservation of biodiversity including herpetofauna in the study areas will largely depend on educating the people on the dangers of environmental degradation. Without conservation work, which will encourage the full participation of local people to implement and maintain conservation plans in their areas, there are few good prospects for the protection of herpetofauna and other wildlife species in these areas of Malawi. I hope this work will provide a stimulus for future researchers to fill some of the obvious gaps in our knowledge of Malawi's herpetology.

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Appendix 4.1: Distribution of amphibian species by quadrats collected in Mughese Forest between July 2001 and November 2002.																											
Quadrat Number	Bufo guttralis	Bufo maculatus	Breviceps mossambicus	Xenopus laevis	Afrana angolensis	Ptychadena oxyrhynchus	Ptychaena mascareniensis	Ptychadena anchietae	Phrynobatrachus natalensis	Phrynobatrachus mababiensis	Arthroleptis stenodactylus	Arthroleptis reichei	Arthroleptis francei	Schoutedenella xenodactyloides	Hyperolius puncticulatus	Leptopelis flavomaculatus	**TOTAL**										
1	6	3	6	0	3	2	1	0	1	1	0	1	0	0	14	3	**41**										
2	3	2	2	0	0	0	0	1	0	0	0	0	0	1	8	0	**17**										
3	1	3	8	1	0	1	0	0	0	0	0	0	0	0	9	0	**23**										
4	4	1	4	0	0	2	0	0	0	0	0	0	1	0	4	0	**16**										
5	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**										
6	1	1	2	2	0	0	0	0	0	0	0	0	0	0	1	0	**7**										
7	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**										
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	**2**										
9	0	0	1	0	1	1	0	2	1	1	0	0	0	0	0	0	**7**										
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**										
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	**3**										
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**										
13	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**3**										
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**										
15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**										
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**										
Total	**15**	**14**	**32**	**3**	**4**	**6**	**1**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**42**	**3**	**133**										
Abundance																											
Average	0.9	0.9	2.0	0.2	0.3	0.4	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	2.6	0.2	8.3										
Realtive (%)	11.3	10.5	24.1	2.3	3.0	4.5	0.8	2.3	1.5	1.5	1.5	0.8	0.8	1.5	31.6	2.3	100										
Species richness		**16**																									
No. of quadrats		**16**																									

Appendix 4.2: Distribution of amphibian species by quadrats collected in Ntchisi Forest between July 2001 and November 2002.

Quadrat Number	Bufo guttralis	Bufo maculatus	Xenopus laevis	Afrana angolensis	Ptychadena oxyrhynchus	Ptychadena anchietae	Ptychadena guibei	Ptychadena mossambica	Ptychadena mascareniensis	Phrynobatrachus natalensis	Schoutedenella xenodactyloides	Hyperolius nasutus	Chiromantis xerampelina	Hemisus marmoratus	**TOTAL**
1	3	0	3	8	6	0	8	6	2	1	0	2	0	0	**39**
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**2**
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
5	1	1	0	2	1	1	0	0	0	0	0	0	0	0	**6**
6	0	0	0	0	0	0	0	0	0	0	9	0	0	0	**9**
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
8	0	1	0	1	1	0	0	2	0	0	0	0	0	0	**5**
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
11	0	1	1	0	0	0	0	0	0	1	0	0	0	0	**3**
12	2	0	0	1	1	0	0	0	0	0	0	0	0	0	**4**
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	**2**
14	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**2**
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
16	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**2**
Total	**6**	**7**	**4**	**14**	**9**	**1**	**8**	**8**	**2**	**2**	**9**	**2**	**1**	**1**	**74**
Abundance															
Average	0.4	0.4	0.3	0.9	0.6	0.1	0.5	0.5	0.1	0.1	0.6	0.1	0.1	0.1	4.6
Relative (%)	8.1	9.5	5.4	18.9	12.2	1.4	10.8	10.8	2.7	2.7	12.2	2.7	1.4	1.4	100
Species richness		**14**													
No of quadrats		**16**													

Appendix 4.3: Distribution of amphibian species by quadrats collected in Tsamba Forest between July 2001 and November 2002.																												
Quadrat Number	Bufo guttralis	Bufo maculatus	Breviceps mossambicus	Afrana angolensis	Ptychadena oxyrhynchus	Ptychadena anchietae	Ptychadena mossambica	Ptychadena mascareniensis	Phrynobatrachus natalensis	Arthroleptis stenodactylus	Schoutedenella xenodactyloides	**TOTAL**																
1	0	4	1	0	1	0	1	1	0	0	0	**8**																
2	0	9	0	0	0	0	0	0	0	0	0	**9**																
3	0	0	0	0	0	0	0	0	0	0	0	**0**																
4	0	0	0	2	3	1	0	3	3	4	2	**18**																
5	5	0	0	0	1	0	0	0	0	0	0	**6**																
6	0	0	0	0	3	2	1	4	0	0	0	**10**																
7	0	0	0	0	0	0	0	0	0	0	0	**0**																
8	0	0	0	1	0	0	0	0	0	1	1	**3**																
9	0	0	0	0	0	0	0	0	6	0	0	**6**																
10	0	0	0	0	0	0	0	0	0	0	0	**0**																
11	0	8	0	0	0	0	0	0	0	0	0	**8**																
12	1	0	0	1	0	0	0	0	0	2	1	**5**																
13	0	0	0	0	0	0	0	0	0	0	0	**0**																
14	1	0	0	0	0	0	0	0	0	0	0	**1**																
15	0	0	0	0	0	0	0	0	0	0	0	**0**																
16	0	0	0	0	1	0	0	0	0	0	0	**1**																
Total	**7**	**21**	**1**	**4**	**9**	**3**	**2**	**8**	**9**	**7**	**4**	**75**																
Abundance																												
Average	0.4	1.3	0.1	0.3	0.6	0.2	0.1	0.5	0.6	0.4	0.3	4.7																
Relative (%)	9.3	28.0	1.3	5.3	12.0	4.0	2.7	10.7	12.0	9.3	5.3	100																
Species richness		**11**																										
No of quadrats		**16**																										

Appendix 4.4: Distribution of reptilian species by quadrats collected in Mughese Forest between July 2001 and November 2002.

Quadrat Number	Mabuya striata	Mabuya varia	Proscelotes arnoldi	Hemidactylus platycephalus	Chamaeleo dilepis	Gerrhosaurus flavigularis	Tropidosaura montana	Varanus niloticus	Psammophis brevirostris	Philothamnus semivariegatus	Philothamnus haplogaster	Crotaphopeltis hatamboeia	Lamprophis fuliginosus	Dispholidus typus	Typhlops obtusus	Rhinotyphlops schlegelii	Naja melanoleuca	Dendroaspis polylepis	Causu rhombeatus	**TOTAL**
1	13	0	0	3	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	**20**
2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**3**
3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
4	4	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	**8**
5	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	**3**
6	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	**2**
7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**2**
8	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
11	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	**3**
12	1	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**
13	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
15	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
16	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**6**
Total	**24**	**9**	**8**	**3**	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**62**
Abundance																				
Average	1.5	0.6	0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.9
Relative (%)	38.7	14.5	12.9	4.8	4.8	1.6	1.6	1.6	1.6	3.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	100
Species richness		**19**																		
No of quadrats		**16**																		

Appendix 4.5: Distribution of reptilian species by quadrats collected in Ntchisi Forest between July 2001 and November 2002.

Quadrat Number	Mabuya striata	Mabuya varia	Mabuya margaritifer	Mabuya maculilabris	Agam atra	Agama aculeata	Acanthocercus atricollis	Hemidactylus mabouia	Lygodactylus bradfieldi	Chamaeleo dilepis	Gerrhosaurus flavigularis	Nucras holubi	Varanus niloticus	Psammophis mossambicus	Psammophis sibilans	Psammophis sub orientalis	Psammophylax tritaeniatus	Philothamnus naltlensis	Crotaphopeltis hatamboeia	Thelotornis capensis	Lamprophis fuliginosus	Bitis arietans	Causu rhombeatus	Python sebae	**TOTAL**
1	12	6	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	2	2	1	0	1	0	**27**
2	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**
3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**
5	0	3	3	0	0	0	0	1	0	2	2	1	1	0	0	1	0	1	0	0	0	1	0	0	**16**
6	0	3	3	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**10**
7	0	3	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
8	5	6	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	**14**
9	0	5	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	**12**
10	5	4	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**15**
11	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**7**
12	2	3	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	**9**
13	0	0	2	0	0	0	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**
14	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**5**
15	0	1	0	0	3	1	10	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**18**
16	2	0	0	0	0	1	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**
Total	**32**	**42**	**16**	**2**	**5**	**3**	**12**	**2**	**4**	**21**	**9**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**3**	**1**	**168**
Abundance																									
Average	2	2.6	1	0.1	0.3	0.2	0.75	0.1	0.3	1.3	0.6	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	
Relative (%)	19.0	25.0	9.5	1.2	3.0	1.8	7.1	1.2	2.4	12.5	5.4	1.8	0.6	0.6	0.6	1.2	0.6	0.6	1.2	1.2	0.6	0.6	1.8	0.6	
Species richness		**24**																							
No. of quadrats		**16**																							

Appendix 4.6: Distribution of reptilian species by quadrats collected in Tsamba Forest between July 2001 and November 2002.																										
Quadrat Number	Mabuya striata	Mabuya varia	Mabuya margaritifer	Mabuya bourengeri	Proscelotes arnoldi	Agam atra	Agama aculeata	Agama mossambica	Hemidactylus mabouia	Lygodactylus bradfieldi	Lygodactylus waterbergensis	Chamaeleo dilepis	Gerrhosaurus flavigularis	Nucras holubi	Varanus niloticus	Psammophis mossambicus	Psammophis sibilans	Psammophis sub orientalis	Psammophylax tritaeniatus	Philothamnus naltlensis	Crotaphopeltis hatamboeia	Thelotornis capensis	Lamprophis fuliginosus	Bitis arietans	Python sebae	**TOTAL**
1	8	5	0	0	0	23	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	1	1	0	1	**43**
2	3	14	12	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**33**
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
5	0	0	3	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	**11**
6	0	7	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**12**
7	4	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**6**
8	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**3**
9	0	2	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**9**
10	6	2	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**12**
11	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**3**
12	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**5**
13	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**3**
14	0	7	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**
15	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
16	1	3	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**8**
Total	**25**	**43**	**26**	**1**	**8**	**27**	**2**	**2**	**1**	**4**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**4**	**3**	**1**	**161**
Abundance																										
Average	1.6	2.7	1.6	0.1	0.5	1.7	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	10.1
Relative (%)	16	27	16	0.6	5	17	1.24	1.2	0.6	2.5	0.6	1.2	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	2.5	1.9	0.6	100
Species richness		**26**																								
No. of quadrats		**16**																								

Appendix 4.7

SOCIO-ECONOMIC IMPORTANCE OF HERPETOFAUNA

SEMI-STRUCTURED QUESTIONNAIRE

1. Study Area
   (a) Name of forest reserve……
   (b) Name of locality…….
   (c) Date of interview……

2. Personal Information
   (a) Name of respondent ……
   (b) Gender…….
   (c) Occupation……..
   (d) Religion……..……..
   (e) District…….
   (f) Traditional Authority……..
   (g) Village……..……
   (h) For how long have you been staying in this area?……..

3. Information on the Forest Reserve
   (a) Do you rely on this forest reserve in one-way or the other?
   …….
   (b) If the answer to the above question is yes, which natural resources do you get or harvest from the forest reserve?
   ……
   ……
   ……
   (c) In your own observation, is the forest changing in terms of its thickness if you compare its present state and how it was 5 or 10 years ago?
   ……
   (d) What do you think is causing the change?
   ……
   ……
   ……

4. Uses of Plant and Animal Resources

(i) Plant Resources

(a) Based on your knowledge, please supply information on the useful plant species found in the reserve:

Plants available in the forest	How often are they harvested	Part of plant used	Quantities collected	What is the use of the plant collected

(b) Are these resources readily available in the reserve?

……
……

(c) What other alternative energy sources do you use apart from firewood?

……
……
……

(ii) Animals Resources

(a) List down the animals you know that exist in this forest.

……
……
……

(b) Based on your knowledge, please supply information on the useful amphibian and reptilian species found in the:

Animals available in forest	How often they are exploited	Part of animal used	Quantities collected	What is it used for

(c) Are the animal resources mentioned in 4(ii) (b) readily available in the reserve?

……
……

(d) Are there any amphibian or reptilian species that were plentiful in the past but are hard to find nowadays? If yes, mention them.

……
……

(e) Explain why you think the animals mentioned in (d) above are scarce now than before.

……
……
……

(f) Do you keep domesticated animals?

……

(g) If yes, how do you feed them?

……
……
……

(5) Information on conservation of biodiversity including herpetofauna

(a) How accessible is the forest reserve?

……

(b) What are the initiatives currently being pursued by the communities/Forest Department to conserve the forest?

……
……

(c) If a snake or a frog came to your home, would you kill it or let it go? Explain why?

……
……

(d) Are there any beliefs that centre around the local herpetofauna that could help protect these animals or their habitats? If yes, what are they?

……
……
……

(e) Apart from the Forestry Department and the community are there any institutions, which are involved in management and conservation of the forest reserve? Mention them if any.

……
……

(f) Personally, what ideas do you have that you feel may help to conserve the forest?

……
……
……

THE END!

Appendix 4.8

SOCIO-ECONOMIC IMPORTANCE OF HERPETOFAUNA

INTERVIEW GUIDE FOR KEY INFORMANTS

1. Study Area
   (a) Name of forest reserve…….
   (b) Name of locality……..
   (c) Date of interview…….

2. Personal Information
   (a) Name of respondent. …….
   (b) Gender…….……
   (c) Occupation……..
   (d) Religion……..……..
   (e) District…….
   (f) Traditional Authority……
   (g) Village……..…….
   (h) For how long have you been staying in this area?……....

3. Information on the Forest Reserve
   (a) Does the forest reserve have any cultural value or is it associated with any traditional beliefs or sacred stories? If yes, what are they?
   ……..
   ……..
   (b) How important is the Forest Reserve to the daily lives of people around this area?
   ……..
   ……..
   ……..
   ……
   (c) Explain why you think many people rely on natural resources for their livelihood?
   ……..
   ……..
   (d) In your own observation, is the forest changing in terms of its thickness if you compare its present state and how it was 5 or 10 years ago?
   ……
   (e) What do you think is causing the change?
   ……
   ……
   (f) What other alternative energy sources do the people of this area use apart from firewood?
   ……
   ……
   ……

(g) Are there any beliefs that centre on the local herpetofauna that could help protect species and/or habitats? What are they?

……
……
……

(h) Are there any amphibian or reptilian species that were plentiful in the past but are hard to find nowadays? If yes, name them.

……
……
……

(i) Explain why you think the animals mentioned are very scarce these days.

……
……
……

(j) What is the general altitude of people in this are when they see a snake, lizard or frog? Do they kill the animal let it go?

……
……
……

(k) What is the general altitude of the people towards use of traditional medicine? Do many people visit traditional herbalists when they are sick?

……
……

(l) Are there any medicinal animals hunted from this forest? If yes, explain how these animals are utilized when preparing these medicines.

……
……

4. Information on Forest Reserve Conservation

(a) What is the level of participation like in conservation of natural resources in the forest from the local people?

……
……

(b) What are the initiatives currently being pursued by the communities/Forest Department to conserve the forest?

……..
……..

(c) Apart from the Forestry Department and the community are there any institutions involved in management and conservation of the forest reserve in this area? Mention them if any.

……
……

(d) Personally, what ideas do you have that you feel if implemented may help conserve the forest?

……
……
……
……

Appendix 4.9

SOCIO-ECONOMIC IMPORTANCE OF HERPETOFAUNA
A GROUP DISCUSSION GUIDE

1. Study Area
   (a) Name of forest reserve…….
   (b) Name of locality……..
   (c) Village……..…….....
   (d) Traditional Authority……
   (e) District……..
   (f) Gender for the discussion group……...
   (g) Date of interview……...

2. TOPICS FOR GROUP DISCUSSION

(a) Importance of your Forest Reserve to your daily life?
……
……
……
……

(b) Human use of amphibian and reptilian species found in the forest reserve:
……
……
……
……

(c) How does the community take part in biodiversity management in the forest reserve?
……
……
……
……

(d) What consequences may arise if you mismanage your forest reserve?
……
……
……
……

(e) How can the communities around help to conserve the forest?
……
……
……
……

THE END!