BIOLOGICAL DIVERSITY IN MALAWI

BIOLOGICAL DIVERSITY IN MALAWI

Project title: Conservation and Development Opportunities from the Sustainable Use of Biological Resources in the Communal lands of Southern Africa (CODEOSUB)

Project number: European Community : Grant Reference No. B7-6200/00-17ENV/DEV

Sponsors: European Community through African Resources Trust, Zimbabwe

Implemented by: Wildlife and Environmental Society of Malawi
Private Bag 578
Limbe Malawi
Tel.:+265(0)1 643 502/428
Fax: +265(0)1 643 765
E-mail: wesm-hq@africa-online.net
Website: www.wildlifemalawi.org

Editor: Professor Cornell O. Dudley
University of Malawi
Chancellor College
Department of Biology
P. O. Box 280
Zomba, Malawi
Email: codsld@globemw.net

Printer: WESM-Environmental Publishing Unit,
Wildlife and Environmental Society of Malawi,
Private Bag 578
Limbe, Malawi.
Tel.:+265(0)1 643 502/428
Fax: +265(0)1 643 765
E-mail: wesm-hq@africa-online.net
Website: www.wildlifemalawi.org

First Published January 2005. ISBN 99908-31-03-3

CONTENTS

Acknowledgments 1

Acronyms 2

Executive Summary 3

1.0 General Introduction
Cornell Dudley and Jamestone Kamwendo 5

2.0 Flora and Vegetation
Jamestone Kamwendo 9

3.0 Mammals
Wilbert Chitaukali 15

4.0 Birds
Potiphar Kaliba 21

5.0 Reptiles and Amphibians
Lovemore Mazibuko 25

6.0 Fish
Moses Banda 31

7.0 Invertebrates
Cornell Dudley 37

8.0 Mushrooms
Gerald Meke and Eric Boa 43

9.0 Mulanje Mountain
David Nangoma 49

10.0 Biodiversity Conservation
Cornell Dudley 57

11.0 Names and Addresses of Contributors 63

ACKNOWLEDGEMENTS

The publication of the document was made possible with support from the 'Conservation and Development Opportunities from the Sustainable Use of Biological Resources in the communal lands of Southern Africa' project with financial support provided by the European Community through the Africa Resources Trust- Zimbabwe.

Acknowledgements are also extended to the authors of various chapters without which the document could not have been prepared. The authors are: Dr. Moses Banda, Wilbert Chitaukali, Cornell Dudley, Potiphar Kaliba, Jamestone Kamwendo, Lovemore Mazibuko, Gerald Meke, and David Nangoma. Sandy Dudley's proofreading of the document is much appreciated. Thanks to Daulos Mauambeta for the pictures on the cover page except the one on butterfly taken by Andrew Watson, WESM Calendar 2003.

ACRONYMS

CBNRMC	Community Based Natural Resource Management Committees
CITES	Convention on the International Trade in Endangered Species
CODEOSUB	Conservation and Development Opportunities from the Sustainable Use of Biological Resources in the Communal lands of Southern Africa
EAD	Environmental Affairs Department
DREA	Department of Research and Environmental Affairs
EDG	Environmental Development Group
ESCOM	Electricity Supply of Malawi
FRIM	Forestry Research Institute of Malawi
GAA	Global Amphibian Assessment
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IUCN	International Union for the Conservation of Nature
MMCT	Mulanje Mountain Conservation Trust
MMFR	Mulanje Mountain Forestry Reserve
NBSAP	National Biology Strategy and Action Plan
NEAP	National Environmental Action Plan
NGOs	Non Governmental Organisations
NHBG	National Herbarium and Botanic Gardens
ART-ZM	Africa Resources Trust - Zimbabwe
RDL	Red Data List
UNESCO	United Nations Education, Scientific and Cultural Organisation
VNRMC	Village Natural Resource Management Committees
WESM	Wildlife and Environmental Society of Malawi

EXECUTIVE SUMMARY

Biodiversity, the variety and variability among living organisms and the complexes in which they occur, has become one of the main conservation focal points over the last decade. Serious biodiversity losses have been recorded in all countries over this period with the largest declines occurring in tropical countries containing the greatest biodiversity.

Malawi, a small tropical country, has significant biodiversity as it sits at the crossroads of the East and Central African and Southern African floral and faunal subregions. It also has a very high human population, the majority rural and dependant on these biodiversity resources for their survival. As a consequence the conservation and sustainable use of biodiversity is of considerable importance.

In response, the Malawi Government has prepared a *National Biodiversity Strategy and Action Plan* in response to biodiversity loss. This loss was identified as one of the major environmental concerns noted by the *National Environmental Action Plan*. This demonstrated the country's adherence to its constitution and to the international *Convention on Biological Diversity* which it ratified in 1994.

Over the last three years the National Herbarium and Botanic Gardens (NHBG), with support of the GTZ, has made a contribution to this concern with an evaluation of the biodiversity of three of the country's forest reserves. More recently, the Wildlife and Environmental Society of Malawi initiated its own activity in this arena with the assistance of ART-ZM. One of the outputs is this publication. Although prepared by many of the authors of the NHBG study, this document attempts to look at the country's biodiversity from a broader perspective with the goal of creating awareness of the biodiversity of Malawi to a wider audience.

The publication contains ten chapters. The first chapter is a general introduction, both to the basic ideas of biodiversity and to Malawi as a country. It provides an overview of the complexities of defining biodiversity, emphasizing the species aspect and provides a short statement on biodiversity's value. Following this is a brief description of Malawi's geographic features, its protected areas and customary areas and the seriousness of the country's biodiversity losses.

The second chapter focuses on the flora and vegetation. The vegetation types are presented in very broad terms with some emphasis on the evergreen forest relics which are considered 'hot spots' of Malawi's biodiversity. This is followed by a quantitative description of the country's flora (6,000^{+} spp.). One hundred and fourteen endemic species are noted and concern is raised regarding the number of species (228 spp.), mostly endemics, that are officially classified as threatened. Also pointed out is the number of important tree species that are under threat but are not provided with official listing due to lack of official documentation. The chapter concludes with a number of potential mitigation measures either in place or being implemented.

Chapter three highlights Malawi's mammal diversity now numbering 190 species in 36 families and 12 orders. Of particular concern are the eight species listed on the IUCN's Red Data List. On a positive note, the black rhino, formally extinct in Malawi, has been successfully reintroduced. The author then presents an overview of the orders, with some comments regarding the distribution and conservation situation of important species. Finally, there is a short statement of the significance of mammals to Malawi and a concern of the widespread serious decline in most of Malawi's larger species.

Chapter four covers the birds, noting the country's very high diversity of species (650^{+} spp.). The author provides numbers and distribution information on eleven threatened and endangered species and lists the four endemic subspecies. This is followed by some suggested mitigation measures and comments on the importance of birds to the nation.

Reptiles and amphibians are discussed in chapter five. Malawi is home to 145 species of reptiles and 83 species of amphibians belonging to a total of thirty families. Endemic amphibians number six but no endemic reptiles are known. Amphibians are one of the most threatened vertebrate groups in the world with 37 species officially categorized as threatened in the Southern and Central Africa. Twelve of these occur in Malawi. The author follows with a list of eight reptiles which he considers threatened. The majority of these have extremely small ranges, most being found on Nyika Plateau and Mulanje Mountain. The author concludes with a review of the threats to reptile and amphibian conservation with general mitigation measures proposed.

One of the world's most impressive hot spots is Lake Malawi with its cichlid fish. Chapter six highlights this along with providing comments on all of the country's 14 fish families. Total species richness of fish is over 1,000 species or 14% of the total fresh water fish species in the world! The author provides some information regarding

the distribution of the fish fauna, its endemic species (~95%) and its eleven threatened species. Many of these are part of the commercial fisheries and the author discusses the reasons for this decline. He follows this with a discussion of the mitigation measures the country is putting in place to reverse this decline.

The author of chapter seven attempts to cover the widest biodiversity group of all-the invertebrates. He notes that invertebrates make up more than 73% of all organisms, most of which are small and unknown, yet important in numerous ways for the functioning of the world's ecosystems. Malawi is no exception with presently over 9,000 species recorded from numerous groups ranging from various types of worms, to mites, zooplankton, spiders and insects, the latter making up 90% of the total. The author concludes with a discussion of the serious shortcomings in Malawi's ability to deal and understand this diversity and proposes some possible solutions. Invertebrate conservation, endemism and social value are also discussed.

Fungi are poorly known in Malawi and probably number several thousand, mostly unknown species. However, one group, the mushrooms (~500 spp.), have a long history of use in Malawi and are well known to rural people principally due to their use as food. These are discussed in Chapter eight. Conservation, endemics and populations of mushrooms are difficult to evaluate at present and their safety relies on continued protection of the environments in which they grow-the woodlands and forests. The authors then follow this with a comprehensive list of species and their uses.

Chapter nine focuses on one of Malawi's hot spots of biodiversity-Mulanje Mountain. The author presents the case for the importance of the mountain to the country's biodiversity and the efforts to protect, develop and manage this for the people surrounding the mountain. Of great importance to the conservation and sustainable use of the mountain's biodiversity is the support given by the World Bank and the GEF to the trust fund administered by the Mulanje Mountain Conservation Trust (MMCT). The author concludes with a discussion of the work of the MMCT.

Chapter ten concludes with a discussion of the approaches to biodiversity conservation the species approach and the ecosystem approach. He concludes that both may be needed separately or together depending on the situation. In most cases in Malawi the ecosystem approach is most appropriate. Following this is a list in some detail of the threats to biodiversity with complimentary suggestions for mitigative actions to these threats and a plea for the various government, NGOs and private organizations to work together to conserve Malawi's biodiversity for future generations.

1.0 GENERAL INTRODUCTION

Professor Cornell Dudley
University of Malawi
Department of Biology
Chancellor College

Jamestone S. Kamwendo
National Herbarium and Botanic Gardens

1.1 Introduction

Over the last twenty years much of the interest in environmental problems has focused on biodiversity. Yet, the perceptions of the meaning of biodiversity are anything but uniform (Gaston 1996, Hammond 1995, Heywood & Baste 1995). This is not unusual for concepts that enter the legal, political, media and general public sectors. At times, its meaning is so broad as to run the risk of equating it to the whole of biology. There is a general acceptance in many communities world wide that biodiversity *per se* is a 'good thing', its loss a 'bad thing' and that it should be conserved. As a result, biodiversity is equated to 'nature' or 'nature conservation' in some quarters, a value concept rather than a more neutral scientific term (Bowman 1993 in Gaston 1996). Gaston considers the U.S. Congress Office of Technology Assessment definition of 1987 as the most widely used: "variety and variability among living organisms and ecological complexes in which they occur . .".

1.2 Levels of Biodiversity

Most investigators divide 'biodiversity' into three levels - genes, species (taxa) and ecosystems (or landscapes) (Bisby & Coddington 1995). Two more levels - populations and communities might be added. Bisby & Coddington point out that biodiversity can be measured at an ecological/functional level as well. Some authors have broadened the definition further by including interactions between human society and biodiversity, for example 'natural' resources or specific 'natural' products used directly by human communities (Zambezi Society 1998). I believe that social biologists tend to look at biodiversity in too broad and loosely defined terms. As with many biological concepts, biodiversity levels are rather abstract and fuzzy and emphasis in the literature has been primarily on entities (i.e. species) rather than on processes. These levels are to some degree artifacts of analysis and structural and functional relationships exist among them. Lower levels of 'biodiversity' generally depend upon the processes at higher levels and visa versa.

The recognition and characterization of biodiversity depends critically upon the work of three scientific disciplines - genetics, taxonomy and ecology (Bisby & Coddington 1995). While predictive methods are of value (indicator species, latitudinal gradients, "hot spot" mapping, etc.) there is no substitute for 'full' enumeration of biodiversity's characteristics. But to what degree can the concepts of biodiversity be quantified and, thus, subjected to some sort of rigorous empirical enquiry such as a comparison of decline, level or value of biodiversity? Probably genetic diversity is the most quantifiable level (i.e. the genes, the four base pairs of the genetic code) (Thorpe & Smartt 1995). However, for obvious practical reasons, such information is unlikely for most organisms.

The next most definable level is the species or its included populations. Species are 'counted' in two ways. "Species diversity" is a concept that includes not only the number of species in each community but also their population proportions as determined by various sampling techniques. A second measure of biodiversity is "species richness". At this level all species

are equally weighted and in practice this index is based on samples of larger organisms only, very much an incomplete inventory. This measure is the most common characteristic used in discussions of biodiversity (Heywood & Baste 1995, Bisby & Coddington 1995)

The third biodiversity level(s), ecosystems (landscape, habitats) is the most difficult to pin down. These are functional units in which the biological, physical and chemical components of the environment interact. Unfortunately, this definition could refer to a tiny rock pool, a forest or even the whole biosphere! Clearly ecosystems are part of a continuum. Landscapes are usually large expansive areas containing a complex matrix of environments (ecosystems) including those strongly influenced by humans. Habitats are normally on a smaller scale of analysis and are often defined in terms of vegetation or physical features (i.e. soil, hydrology). Yet they remain difficult to define precisely. Species can be considered to choose habitats, yet habitats are often defined by the species present. The term community is more restrictive referring to the biotic component of the ecosystem or habitat. In many cases this restriction refers to the botanical components.

It is the species that take part in ecosystem processes. Species conservation cannot be separated from that of the habitats in which they are found. Maintaining a functional ecosystem does not insure all species are conserved. Ecosystems can function with many missing species but are not likely to function as well. Yet, it is also true that all species are not equally significant to human welfare. Preserving all species is a philosophical point of view from a moral world perspective. Selecting certain species considered valuable to humans for conservation efforts is a very anthropomorphic view.

Our perspective is more compatible with the idea of maintaining ecosystem integrity rather than maintaining biodiversity *per se*. While individual species are important, we know so little about them that conservation strategies based on many individual species cannot be designed.

1.3 The Value of Biodiversity.

The value of biodiversity to human welfare has been the subject of much discussion, some of it quite heated and emotional (Perrings 1995, Swanson 1992, Blench 1998). There are many justifications for conserving biodiversity including five types of positive arguments: economic, indirect economic, ecological, aesthetic and ethical. Blench discusses each of these in detail and although positive in much of his analysis, considers important weaknesses in each. He considers "technological triumphalism" a significant obstacle to biodiversity conservation.[1] Many crucial technical questions remain unresolved and complex arguments with many uncertainties become oversimplified for absorption into policy documents.

1.4 The Malawi Setting

Malawi is a small country with a total land area of 119,140km^2 of which about 20% or 20,902km^2 is covered by the waters of Lakes Malawi, Chilwa, Malombe and Chiuta. Forest and woodland cover on the remaining 95,312km^2 has been reduced from 45% in 1975 to about 27% in the early 2000s (Malawi Government 2004). The topography is variable and ranges from 300m in the Lower Shire Valley to 3,000m a.s.l. on Mulanje Mountain. An extensive mid-altitude plateau occurs between 800-1,200m a. s. l. and has a number of isolated hills from

[1] "Technological triumphalism": whatever the biological [ecological?] backlash, human ingenuity will prevail and lead us on to ever greater material progress

1,500-1600m. The climate is continental with large seasonal variations in temperature and rainfall. The average rainfall is 1200mm per annum. The mean annual temperatures are between 14°C and 18°C. Maximum temperatures can be as high as 42°C in low-lying areas (Department of Meteorological Services 2002). Most soils in Malawi are leached. Brown & Young (1964) classified the Malawi soils into the following types: ferallitic soils, ferruginous tropical soils, ferrosols and lithosols. The vegetation types are comparable with the diversities of topography, geology, climate and soil types. Woodlands and forest occupy approximately 2.6 million hectares, 97% of which is mainly semi-deciduous *miombo* woodlands (Malawi Government 2004).

Forest reserves, national parks and wildlife reserves represent about 20% of the land area and constitute the majority of protected areas in Malawi. Other protected areas include botanic gardens, nature sanctuaries, shrines and graveyards (Kamwendo & Dudley 2004). According to Masamba (2000), there are over sixty-six forest reserves in Malawi (including plantation forests). There are five national parks, four wildlife reserves, three botanic gardens and three nature sanctuaries (Malawi Government 1998). These areas are rich in biodiversity and, where allowed, are environments of useful biological resources such as wild edible food (e.g., fruits, vegetables, mushrooms, tubers, caterpillars, bush meat and honey), medicine, fuel wood, timber, poles, construction materials, and art and craft materials (Kamwendo & Dudley 2004). Malawi also contains some of the Africa's most important wetland ecosystems. These include the shoreline plains of Lakes Malawi, Chiuta and Chilwa, a diversity of dambo ecosystems and the marshes of the Shire River system (Malawi Government 2004). These wetland resources constitute 20% of the country's territorial area and are also rich in flora and fauna.

Outside protected areas, most of the customary land is used for farming and collection of firewood. These activities have led to deforestation and its associated soil erosion, poor water retention, siltation and flooding (Kamwendo & Dudley 2004). High rates of deforestation, unsustainable harvest of biological resources, expansion of agriculture, urbanisation and introduction of alien invasive species in the country have significant negative impact on the flora and fauna. As a result, many species are today threatened with extinction (Msekandiana & Mlangeni 2002) and there is a severe shortage of fuel wood for domestic cooking, which in turn, imposes serious socio-economic problems on the development of the country (Kamwendo 2004). Therefore, a holistic approach must be taken in order to address these problems before the country loses its biodiversity heritage.

1.5 References Cited

Bisby, F. A. & J. Coddington (1995) 2.0 Introduction to the characterization of biodiversity, pp. 21-57. **In:** V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP 1,140pp.

Blench, R. (1998) Biodiversity conservation and its opponents. *ODI: National Resource Perspectives* 32:1-4.

Bowman, D. M. J. S. (1993) Biodiversity: much more than biological inventory. *Biodiv. Lett.* 18:163.

Brown, P. & Young, A. (1964). The physical environment of Central Malawi, with special reference to soils and agriculture. Government Printer, Zomba, Malawi.

Department of Meteorological Services (2002). *Annual Reports*. Blantyre, Malawi.

Gaston, K. J. (1996) 1.0 What is biodiversity?, pp. 1-9. **In:** K. J. Gaston (ed.) *Biodiversity of numbers and differences.* Blackwell Science, London, 396pp.

Hamond, P. M. (1995) 3.1 The current magnitude of biodiversity, pp. 113-138. **In:** V. H.

Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP 1,140pp.

Heywood, V. H. & I. Baste (1995) 1.0 Introduction, pp. 1-19. **In:** V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP 1,140pp.

Kamwendo, J. S. (2004). Flora and Vegetation, pp. 15-28. In: C. O. Dudley (ed.) *Management of Biodiversity in Protected Areas of Malawi, Final Report June 2004.* National Herbarium and Botanic Gardens, Zomba, Malawi.

Kamwendo, J. S. & Dudley, C. O. (2004). General Introduction, pp. 5-14. In: C. O. Dudley (ed.) *Management of Biodiversity in Protected Areas of Malawi, Final Report June 2004.* National Herbarium and Botanic Gardens, Zomba, Malawi.

Malawi Government (1998). *State of the Environment Report for Malawi 1998.* Department of Research and Environmental Affairs, Lilongwe, Malawi.

Malawi Government (2004). Biodiversity strategy and action plan for Malawi. Department of Research and Environmental Affairs, Lilongwe, Malawi.

Masamba, C. (2000). *Status of forest genetic resources conservation in Malawi.* A paper presented on the second National Workshop on Plant Genetic Resources Conservation and International Agreements related to Biodiversity, 15-19 May, 2000. Lilongwe, Malawi.

Msekandiana, G. C. & Mlangeni, E. (2002). Malawi, pp. 31-42. In: J. Golding (ed.) *Southern African Plant Red Data Lists.* Southern African Botanical Diversity Network Report No. 14, South Africa.

Perrings, C. (ed.) (1995) *12.0 The economic value of biodiversity*, pp 820-914. **In:** V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP 1,140pp.

Swanson, T. M. (ed.) (1992) 27.0 Biodiversity and economics, pp. 407-438. **In:** B. Goombridge (ed.) *Global diversity: Status of the earth's living resources.* Chapman & Hall, London, 585pp.

Thorpe, J. P. & J. Smartt (1995) 2.2 Genetic diversity as a component of biodiversity, pp. 57-88. **In:** V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP 1,140pp.

Zambezi Society (1998) *Zambezi basin initiative for biodiversity and conservation (ZBI) project concept document.* Biodiversity Foundation for Africa, Bulawayo, Zimbabwe, typescript, 21pp.

2.0 FLORA AND VEGETATION

Jamestone S. Kamwendo
National Herbarium and Botanic Gardens

3.1 Introduction

Malawi has a very varied physiography. Soils vary extensively due to topography and its interactions with climate and geology (Kamwendo 2004). These variations in relief, steep habitat gradients in a heterogeneous environment, are reflected in the floristic and vegetation diversity of the country (Msekandiana & Mlangeni 2002). Much of the early ideas regarding this diversity can be found in Brown & Young (1964), Chapman (1966), Chapman & White (1970), Jackson (1954, 1972), Steel (1965), Stobbs (1970) and Young & Brown (1962). Shaxson (1976) reviewed these contributions and produced a map of the major biotic communities of Malawi. His system included seven major terrestrial vegetation communities with twelve sub-communities. Green (1983) closely followed this system. He divided the biotic communities into several subclasses based on altitude, rainfall and soils. The subclasses include closed canopy woodland of wetter uplands (tall *Brachystegia* spp.), open canopy woodlands (*Brachystegia/Julbernardia/Isoberlinia* spp.), open woodlands of hills and scarps (*Brachystegia* spp.) and the Savannah woodland. These woodland communities are predominantly deciduous to semi-deciduous. In the most recent analysis of the evergreen forest communities (White, *et al.* 2001), four aspects are recognised: montane, sub-montane, mid-altitude and lowland forests. Evergreen forests also occur as fringing or riverine forests along banks of rivers and streams throughout the woodland areas. Dowsett-Lemaire (1989) lists 52 evergreen forests in the country, their size and location. Their total cover amounts to no more than 28.4 km^2 or 0.03% of Malawi's land cover and they are scattered throughout the highlands from the Misuku Hills in the north to the Malawi Hills in the south with sizes varying between 5-5,000ha and altitudes of 500-2,300m. These relics and fragments probably constitute Malawi's core biodiversity hot spots. More recently, Dowsett-Lemaire (2004) has provided an analysis of the drier woodlands and deciduous forest thickets of the protected areas in the Lower Shire Valley.

3.2 Types of Species and Quantity

Malawi's flora totals about approximately 6,000 described species (Malawi Government 2004). This number includes the Angiosperms (Dicotyledons) (over 4,000 spp.) and the Gymnosperms (Monocotyledons) (1,440 spp.), both groups also known as the higher flowering plants. Of these, 400 species are orchids (La Croix *et al.* 1991). Plants that do not bear flowers and reproduce by means of spores such as Ferns and their allies (Pteridophytes) and Cryptogams (referred to as lower plants) number about 219 and 168 species respectively. Our knowledge of the Cryptogams is extremely meagre. Only 66 algal species, mostly belonging to Chlorophyta, have been documented.

3.3 Distribution of the Species

Large areas of Malawi are covered with *miombo* woodlands (*Brachystegia, Julbernardia* and *Isoberlinia* spp.). The species in these genera occur in wetter upland areas, plateaus, hills and scarps, and also plain areas. Small areas of relatively fertile ferruginous soils support Savannah woodland (*Combretum, Acacia, Colophospermum* [mopane] and *Bauhinia* spp.). Evergreen forest species, including species of the genera *Entandrophragma*, *Pouteria*, and *Chrysophyllum* are found in the Afromontane forests which occur on highland and plateau areas (over 1,900m a.s.l.) (Kamwendo 2004). The floristic composition of Mulanje Mountain comprises mostly *Widdringtonia* forest, thicket, shrub and grassland while that of Nyika

Plateau comprises a diversity of relic evergreen forest patches scattered across widespread grasslands. Most of the endemic plant species (e.g., *Widdringtonia whytei*) occur on Mount Mulanje in the south and the Nyika Plateau in the north (Msekandiana & Mlangeni 2002). A few other endemic species occur in other parts of the country, again mainly in the highlands. Where protected, banks of rivers and larger streams are covered with rich riparian forest where the genera *Khaya, Newtonia, Terminalia* are prominent (Dudley 1994). Wetland and dambo areas are covered with water logged grasses such as *Pennisetum, Phragmites* and *Cyperus* (MULULU). *Typha*, *Papyrus*, *Phragmites* and *Vossia* dominate a diverse marsh vegetation along the shore of Lake Malawi and the banks of the Shire River (Blackmore, *et al.* 1988).

3.4 Endemic Species

Endemic plant species are those species that are restricted (confined) to a certain region/country or part of a region (Holmes 1979). In Malawi, there are 114 plant species (50% of the total species on the National Red Data List), which are endemic (Msekandiana & Mlangeni 2002). A further 31 species are near-endemic in that they are distributed in adjacent areas of neighbouring countries; Zambia, Mozambique and Tanzania. The most important endemic species of socio-economic importance are: *Aloe cameronii* (Eng: Krantz Aloe; Ch:[2] CHINTHEMBWE; Y: CHISOKHWE), *Widdringtonia whytei* (Eng: Mulanje Cedar; Ch: MKUNGUZA; Y: MUKUNGUSA), *Protea caffra* (Eng: Common Sugarbush; Ch: CHISEWA; Y: CHINJISI), *Zanthoxylum (=Fagara) deremense* (Eng: Knobwood; Ch: MCHODZI, MLUNGUCHULU; Nk: MKURUNGU), *Ixora scheffleri* (Y: MSISISTI), Dissotis *johnistoniana* (Ch: CHIUSO; Y: MCHIRU), *Erica nyassana* (Eng: Tree Heath); *Rawsonia burtt-davyi* (Eng: Forest Peach; Ch: MZOZOLA; Y; MSOSOSLA), *Morinda asteroscepa, Indigofera hilaris* (Eng: Indigo) and many other species as mentioned in the Southern African Plant Red Data lists (Msekandiana & Mlangeni 2002).

3.5 Threatened Species

Threatened species are those species whose future survival in nature hangs in balance because they are in danger of becoming extinct or are endangered due to human activities (World Conservation Monitoring Centre 1990). According to Msekandiana & Mlangeni (2002), a total of 248 species are on the National Red Data List (RDL). This number comprises both threatened and endemic species. About 52% (128 species) is regarded as threatened (*Critically endangered, Endangered or Vulnerable*)[3]. The families with the highest representation on the RDL include Orchidaceae (51), Asteraceae (22), Aloaceae (18) and Rubiaceae (18). The following are some of the examples of threatened species which have socio-economic importance to communities: *Juniperus procera* (Eng: Pencil Cedar; Ch: MLANJE; To: CHANGALUMWE), *Afzelia quanzensis* (Eng: Pod Mahogany; Ch: MSAMBAMAFUMU; MNGONGOMWA; Y: MNGONGOMWA; Tu: MKONGWE, MTONTHO), *Prunus africana* (Eng: Red Stinkwood), *Pterocarpus angolensis* (Eng: Wild Teak; Ch: MLOMBWA; NK: MTUMBATI; Y: MTUMBALI), *Milicia excelsa* (Eng: Eroco Tree), *Ficus ottoniifolia* (Eng: Fig; Ch: NKHUYU; Y: MSUKAMBIZA; Tu: MUKUYU), *Morus mesozygia* (Eng: Mulberry; Ch: MAPULESI, KANJERENJA), *Burttdavya nyasica* (Ch: MBVULE), *Tricalysia coriacea* (Eng: Common Coffee; Ch: MGOBOLA, NADOLA), *Cola mossambicensis* (Eng: Coshwood; Ch: MKOPE, KATOLE, CHILOLE, CHINYANGA, MPIMBINYOLO; Y: MUSARA), *Ozoroa reticulate* (Eng: Currant Resin Tree; Ch: MBAVE, NAMASIRA; Tu: UNTUKAMBAKO; Y; MBEWE), *Aloe* spp. (Eng: Aloe; Ch: CHINTHEMBWE; Y: CHISOKHWE, LICHONGWE) *Croton megalobotrys* (Eng: Large Fever-berry; Ch: MFUMPU, MTUTU, MUKO; Y: MTUTU (MUKO)), *Warburgia salutaris*, and many other species as indicated in the Southern African Plant Red Data List (Msekandiana &

[2]Vernacular name key: Ch = Chichewa, L = Lomwe, Nk = Nkhonde, To = Tonga, Tu = Tumbuka, Y = Yao and Eng. = English
[3]Red Data Lists-Lists of threatened plant or animal species featured in particular books. The conservation Status of each species is assessed using IUCN (The International Union for the Conservation of Nature) Categories Criteria.

Mlangeni 2002).

Widdringtonia whytei (Eng: Mountain Cypress; Ch: MKUNGUZA L: MPONGO), *Khaya anthotheca* (Eng: Red Mahogany; Ch; M'BAWA, MUWAWA), *Colophospermum mopane* (Eng: Mopane) *Combretum imberbe* (Leadwood; Ch: MSIMBITI, MNANGALI; Y: MKOLONGONJO, MUKOTAMA) and *Dalbergia melanoxylon* (Eng: Zebrawood; Ch: PHINGO, L: MPHINGWE; Tu: KASALASALA) are not included on the National Red Data List due to lack of information relating to their trade, rate of utilisation and regeneration statistics. However, these species are heavily used as timber, for charcoal production, fuel wood, and for making carvings. As such, these species are also disappearing rapidly and hence need to be monitored in order to protect these species from becoming extinct. Table 2.1 summarizes the numbers of endemic and threatened plant species of Malawi.

Table 2.1: Number of plant species, endemism and their conservation status in Malawi

IUCN Category	Number of plant species
Total species in Malawi	6,000[+]
Listed on the RDL	248
Endemic	114
Possibly endemic	8
Near-endemic	31
Possibly near-endemic	1
Extinct (EX)	5
Critically endangered (CR)	25
Endangered (EN)	14
Vulnerable (VU)	89
Lower-Risk near threatened (LR-nt)	24
Lower-Risk least concern (LR-lc)	27

Source: Msekandiana & Mlangeni (2002).

The major threats to the plant species in Malawi are habitat loss through urban expansion; clearing of vegetation for agricultural production; forestry exploitation through the removal of certain woody species for timber and poles; introduction of alien invasive plant species; fire, afforestation and unsustainable harvest of other plant species for medicinal purposes (e.g. *Warburgia salutaris, Prunus africana*) (Msekandiana & Mlangeni 2002).

3.5 Mitigation Measures Towards Threatened Species

Recognising the importance of plant diversity in the socio-economic development of the country, for many decades the Government of Malawi has had established various policies, legislation, strategies and programmes to curtail loss and extinction of the threatened and endemic plant species (Msekandiana & Mlangeni 2002). This has led to the establishment of the Department of Forestry, the National Herbarium and Botanic Gardens of Malawi (NHBG) and other organisations which aim at protecting all indigenous plant species including threatened, rare and endemic species. The Department of Forestry has established many forest reserves in the country which aim to protect vital indigenous plant genetic diversity and also to protect threatened and endemic plant species from exploitation. Further, the Government of Malawi has recently established a plant Gene Bank at the Forestry Research Institute of Malawi (FRIM) which aims at collecting and preserving germ plasma (e.g. seeds) of indigenous plant species with potential for cultivation. The germ plasmas are germinated at

the nursery and the seedlings are transplanted in areas where such species once occurred but have significantly declined in abundance. This helps to reduce the extinction of the threatened and endemic plant species in the country (Malawi Government 1994). The NHBG embarked on a rescue programme of threatened, rare and endemic plant species by collecting seeds and seedlings from the wild, and the seeds are multiplied in a screen house. The seedlings raised are taken back to communities living in the areas where the seeds were collected in order to be planted. This ensures continuity and the survival of the threatened, rare and endemic species. This programme promotes conservation and the threat to genetic diversity is reduced.

Further, the National Environmental Action Plan (NEAP) clearly spells out the strategies and action plans needed to conserve, sustainable use and manage the country's plant resources. Through the mandate of the Department of Research and Environmental Affairs (DREA), the Government attempts to ensure that all sectoral policies are harmonised. It also has produced an Environmental Management Bill that is aimed at providing a legal framework for regulating the conservation and management of all the natural, biological and environmental concerns in the country. The Bill spells out that the biological diversity should be determined as far as possible, in terms of threatened species, and that strategies should be devised for the better protection and conservation of rare and endemic species of flora and fauna. The Bill also states that rescued species should be re-introduced into their natural habitats (Msekandiana & Mlangeni 2002).

3.6 Conclusion

Malawi is a developing country and as such industrialisation and urbanisation are on the increase. It is, therefore, anticipated that more and more plant species will be threatened in the near future and it is evident that some of the already threatened species may become extinct. This scenario merits the monitoring of threatened, rare and endemic plant species to prevent local, regional and global extinctions since it is known that these species play an important role in the socio-economic development of Malawi.

3.7. References Cited

Blackmore, S., Dudley, C. O. & Osborne, P. L. (1988). An annotated check-list of the aquatic macrophytes of the Shire River, Malawi with special reference to potential aquatic weeds. *Kirkia* 13(1):125-142.

Brown, P. & Young, A. (1964). *The physical environment of Central Malawi with special reference to soils and agriculture*. Government Printer, Zomba, Malawi.

Chapman, J. D. (1966). The conservation of vegetation and its individual species in Malawi. *Acta Phytogeogr. Secu.* 54:215-224.

Chapman, J. D. & White, F. (1970). *The evergreen forests of Malawi.* Commonwealth Forestry Institute, University of Oxford, London.

Dowsett-Lemaire (1989). Ecological and biogeographical aspects of forest bird communities in Malawi. *Scopus* 13:1-80.

Dowsett-Lemaire (2004). The vegetation of the Lower Shire Valley Reserves, Majete, Lengwe and Mwabvi, Malawi. *Nyala* 22:9-22.

Dudley, C. O. (1994). The flora of Liwonde National Park, Malawi. In: J. H. Seyani & A. C. Chikuni (eds.) *Proc. XIIIth Pleanary Meeting AETFAT, Malawi*, 2: 1485-1509.

Green, J. W. (1983). *The national atlas of Malawi.* Department of Surveys, Blantyre, Malawi.

Holmes, S. (1979). *Henderson's dictionary of biological terms*. Windsor, U.K.

Jackson, G. (1954). Preliminary ecological survey of Nyasaland. *Proceedings of the 2nd Inter African Soils Conference, Leopoldville,* pp. 679-690.

Jackson, G. (1972). Vegetation, pp. 154-158 In: S. Agnew & M. Stubbs (eds.) *Malawi in*

maps. University of London Press.
Kamwendo, J. S. (2004). Flora and Vegetation, pp.15-28. In: C. O. Dudley (ed.) *Management of Biodiversity in Protected Areas of Malawi, Final Report June 2004*. National Herbarium and Botanic Gardens, Zomba, Malawi.
Kamwendo, J. S. & Dudley, C. O. (2004). General Introduction, pp. 5-14. In: C. O. Dudley (ed.) *Management of Biodiversity in Protected Areas of Malawi, Final Report June 2004*. National Herbarium and Botanic Gardens, Zomba, Malawi.
La Croix I. F., La Croix, E. A. S. & La Croix, T. M. (1991). Orchids of Malawi: *The epiphytic and terrestrial orchids from South and East Central Africa*. A. A Balkema Publishers, Brookfield, Vermont.
Malawi Government (1994). *National Environmental Action Plan, Vol. I.* Department of Research and Environmental Affairs, Lilongwe, Malawi.
Malawi Government (1995). *Malawi Biodiversity Country Study Project Proposal.* Department of Research and Environmental Affairs, Lilongwe, Malawi.
Malawi Government (2004). *Biodiversity strategy and action plan for Malawi*. Department of Research and Environmental Affairs, Lilongwe, Malawi.
Msekandiana, G. C. & Mlangeni, E. (2002). Malawi, pp.31-42. In: J. Golding (ed.) *Southern African Plant Red Data Lists.* Southern African Botanical Diversity Network Report No. 14, South Africa.
Shaxson, T. F. (1976). A map of the distribution of major biotic communities in Malawi. *Society of Malawi Journal* 31(1):36-48 map.
Steel, B. (1965). *Ecology-vegetation map.* Ministry of Natural Resources, Department of Agriculture Annual Report 1962/63. Government Printer, Zomba, Malawi.
Stobbs, A. R. (1970). *Southern Malawi map 10, Vegetation 1:1,000,000.* Department of Surveys, Blantyre, Malawi.
White, F., Dowsett-Lemaire, F. & Chapman, J. D. (2001). *The evergreen forest flora of Malawi.* Royal Botanic Gardens, Kew, London.
World Conservation Monitoring Centre (1990). Biodiversity and its *importance*. IUCN, Gland, Switzerland and Cambridge Printers. UK.
Young, A. & Brown, P. (1962). *The physical environment of Northern Nyasaland, with special reference to soils and agriculture*. Government Printer, Zomba, Malawi.

3.0 MAMMALS

W.N. Chitaukali Lecturer in Vertebrate Zoology
University of Malawi
Biology Department
Chancellor College

3.1 Introduction

Currently in Malawi we have 12 orders, 36 families 114 genera and 190 species of mammals (Ansell & Dowsett 1988, Chitaukali 2002). Of these, eight (4.1%) are threatened, a rise from seven (3.6%) in 1996 (Baillie & Groombridge (IUCN) 1996, Hilton-Taylor (IUCN) 2000). So far, no endemic mammals have been recorded for Malawi. According to the IUCN 2000 report, Malawi has eight threatened mammal species: one critically endangered, two endangered and five vulnerable (Table 3.1).

Table 3.1: Threatened mammal species of Malawi (IUCN 2000).

Scientific Name	Degree of Threat*	English Name	Vernacular Name	Current localities
Diceros bicornis	CR	Black Rhinoceros	Chipembere	Liwonde NP
Loxodonto africana	EN	African Elephant	Njobvu	Nyika NP, Kasunu NP Vwaza WR, Nkhotakota WR, Liwonde NP, Namizim FR, Thuma FR
Lycaon pictus	EN	Wild Dog	Mimbulu	Vwaza, Kasungu NP, NKK WR, Mwabvi WR
Rhynchocyon cirnei	VU	Checkered Sengi	Sakhwi	Widespread in forest habits
Acinonyx jubatus	VU	Cheetah		Nyika NP, Kasungu NP
Panthera leo	VU	Lion	Mkango	Liwonde NP, Kasungu NP, Nkhota-kota WR, Vwaza WR
Paraxerus palliatus	VU	Red Bush Squirrel		Mulanje, Liwonde NP, Lower Shire, Ntchisi mt. S. Viphya
Lutra amculicollis	VU	Spotted-Necked Otter		Shire river, L. Chilwa, Nkhotakota

*Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) based on the 2000 IUCN Red List of Threatened Animals National Park (NP) Game Reserve (GR), Wildlife Reserve (WR).

Overall there has been a general decline in the number of large mammals throughout Malawi. The Government and a number of local and international conservation organizations are putting every effort in trying to rescue the threatened species and improve the status of all large mammals species in the country. Recently efforts have been made to reintroduce some mammals to areas where they used to occur. These species include Black Rhino (*Diceros bicornis*), Zebra (*Equus burchellii*), Hartebeest (*Sigmoceros lichtensteinii*), Eland (*Taurotragus oryx*), Roan Antelope (*Hippotragus equinus*) and Buffalo (*Syncerus caffer*) reintroduced to Liwonde National Park (Chafota *et al.* 2002) and the Black Rhino being reintroduced to Majete Wildlife Reserve.

3.2 Species Accounts

Most of the mammals in Malawi are terrestrial (living on land), but we also have some, which are semi-aquatic (living in/near water) and some, like the bats, arboreal (living in trees). The twelve major groups (orders) of mammals in Malawi occupy almost all the habitats available.

Order Insectivora: This group includes the shrews and hedgehogs. Under the Insectivora there are two families, Soricidae (the shrews, nine species) and Erinaceidae (hedgehogs, one species). The shrews and hedgehogs are entirely terrestrial and are mainly found in the higher altitudes in Malawi. They feed principally on insects and other small invertebrates.

Order Chiroptera: This group is divided into two, the fruit bats (suborder Megachiroptera) and the insect-eating bats (suborder Microchiroptera). The fruit bats are included in only one family, the Pteropodidae, which is further divided into five genera and seven species. Of interest is the recently recorded and rarely collected fruit bat, *Plerotes anchietae,* which was first recorded in Malawi in 1997 in Nyika National Park. The insect-eating bats are divided into seven genera and 48 species. Almost all the bats are nocturnal and they are found across the country. However, some species are known by a single specimen.

Order Primates: The Primates are divided into two families, the Lorisidae (galagos) and the Cercopithecidae (monkeys and baboons). The Lorisidae are further divided into three genera and three species and the Cercopithecidae into two genera and three species. The Lorisidae are arboreal and nocturnal (active during the day). They occur throughout Malawi in woodlands and forests. The Cercopithecidae are diurnal (active during the day), social and highly intelligent occurring both as arboreal and terrestrial dwellers.

Order Carnivora: In Malawi this order comprises six families, 24 genera and 27 species. They cover a wide range of habitats across the country. The Canidae comprise the wild dogs and jackals. Wild Dogs (*Lycaon pictus*), locally known as *mimbulu*, are mainly diurnal and terrestrial, inhabiting the woodlands and grasslands. Their presence has been greatly reduced to a few protected areas where they exist in small numbers. This species is currently classified as endangered. Wild Dogs have been recorded in Vwaza Marsh Wildlife Reserve, Kasungu National Park, Nkhotakota Wildlife Reserve, Mwabvi Wildlife Reserve and also on Nyika Plateau. Side-striped Jackals (*Canis adustus*) mainly occupy woodlands and open country and are widespread throughout the country.

The Mustelidae family (Otters, Weasels, Zorilla and Honey Badger) includes five genera and five species. One species, *Lutra maculicollis* (Spotted-necked Otter), is considered vulnerable. The otters are nocturnal and amphibious living in rivers, streams and swamps. They occur throughout the country. Honey Badgers (*Mellivora capensis*) are terrestrial and occur in most areas of the country and at most of the altitudes. Zorillas (polecats) occur in

woodlands and grasslands throughout most of the country.

Viverridae include the palm civets and genets which are represented by three genera and three species. They mainly inhabit montane forests. Currently they occur in the south and northern parts of Malawi.

Herpestidae (mongooses) are represented by nine genera each with only one species. Most of these live in woodlands and grasslands. Of the nine species, the Slender Mongoose (*Galerella sanguinea*) and the Banded Mongoose (*Mungos mungo*) are widely distributed throughout the country. The rest are somewhat more limited in their distribution.

In Malawi we only have one species of Hyaenidae (Hyenas), the Spotted Hyena *(Crocuta crocuta*). Hyenas are mainly nocturnal and are widely distributed throughout the country.

Of the Felidae (cats), two species of this family, the cheetah (*Acinonyx jubatus)* and the lion (*Panthera leo*) are rated as vulnerable in the IUCN 2000 listing of threatened species. Current records indicate that Cheetah are found in Nyika and Kasungu National Parks. Lions are found in Kasungu National Park and also in Nkhotakota and Vwaza Wildlife Reserves. The other members in the family i.e. *Felis caracal* (Caracal), *Felis serval* (Serval Cat) and the *Felis lybica* (Wild Cat) are widely distributed throughout the country.

Order Proboscidae: The African Elephant (*Loxodonta africana*) is the only member of this order in Malawi and it falls under the family Elephantidae. According to IUCN 2000 ratings, elephants are classed in the endangered category. They are found in Liwonde, Nyika, and Kasungu National Parks and Nkhotakota and Vwaza Wildlife Reserves. They also occur in a number of forest reserves such as Mangochi, Tuma and Perilongwe. They used to occur in most forest areas in Malawi but now their populations are confined to Malawi's protected areas.

Order Perissodactyla: The order Perissodactyla (odd-toed ungulates) includes two families, Rhinocerotidae, (Rhinos) and Equidae (zebras). The Black Rhinoceros is critically endangered worldwide (IUCN 2000). In Malawi, this species became extinct in 1990 but reintroduced in Liwonde National Park in 1993 (Chafota *et al.* 2002). Rhino prefer woodlands and thickets and on marginally more open country. Burchell's Zebra was previously found throughout the country, but today zebras are confined to a few protected areas, more especially in Nyika, Kasungu and Liwonde National Parks.

Order Hyracoidea: They are represented by one family, Procaviidae (hyraxes and dassies). There are two genera and three species, the Rock Hyrax (*Procavia capensis*) and the Dassies, *Heterohyrax brucei* and *Dendrohyrax arboreus*. They prefer rocky hills and are diurnal except for the Tree Dassie, *D. arboreus*, which prefers thickets, woodlands and is nocturnal. They are fairly distributed throughout the country.

Order Tubulidentata: This order is represented by only one species, the Ant Bear, *Orycteropus afer.* Ant bears are associated with termite mounds in woodlands and open country. They are uncommon but widely distributed throughout the country.

Order Artiodactyla: The Artiodactyla (even-toed ungulates) are represented by three families, the Suidae (pigs), Hippopotamidae (hippopotamus), and the Bovidae (buffalo and antelopes). The Suidae are represented by the Wart Hog (*Phacochoerus aethiopicus*) and the

Bush Pig (*Potamochoerus porcus*). The Bush Pigs and Wart Hogs occur throughout the country in grasslands, woodlands, montane forests, thickets and swamps. The Hippos occur in the major rivers, especially the Shire River and along the shores of Lake Malawi. The lake shore populations have been greatly reduced in the last several years.[4]

Family Bovidae includes the buffalo and all the antelopes, represented by 15 genera and 20 species. Members of this large family are wide spread throughout the country. However, most species are confined to the protected areas (national parks and wildlife reserves). The Suni (*Neotragus moschatus*) and the Nyala (*Tragelaphus angasii*), originally confined to the Lower Shire Valley, may now be found further north in Liwonde National park and Kuti Game Ranch respectively.

Order Pholidota: Only one species of Pangolin exists. Pangolins prefer living in woodland and grassland and are always associated with the presence of termites. They are fairly distributed in the Southern Region of Malawi.

Order Rodentia: This very large order is divided into seven families, 31 genera and 52 species. Rodents occur throughout the country and their habitat range from terrestrial (most species) to subterranean (the mole rats: *Heliophobius argenteocinereus* and *Cryptomys hottentotus*). The African Flying Squirrel, *Anomalurus derbianus*, is only known from single record from Mughese Forest Reserve in Misuku Hills in the northern most end of Malawi. *Aethomys namaquensis* is only known from Mulanje and the Doormouse, *Graphiurus platyops*, is only known from Blantyre.

Order Lagomorpha: Two genera under the family Leporidae (Hares and Rabbits) exist in Malawi: *Lepus saxatilis* (Hare) and *Pronolagus rupestris* (Red Rock Hare). They are common and widely distributed mainly inhabiting woodlands and scrub areas.

Order Macroscelidea: (Elephant-shrews). Three species occur throughout the country, mainly inhabiting thickets, forests. One species of elephant shrews, *Rhynchocyon cirnei* (Checkered Elephant Shrew) is categorized as being vulnerable under the IUCN categorization of 2000.

3.3 Relevance of Mammals to the Nation

Mammals, both large and small, are very important to the nation. Large mammals play an important role in the tourism industry. They attract foreign visitors who bring foreign exchange to the country. Small mammals, more especially rodents, are very important in food security. They attack cereal and other crops in the field and in storage (granaries etc). A greater portion of our food is lost to rodents year after year. However, rodents also provide an important source of bush meat along with some of the smaller antelope species that have managed to co-exist with people in customary land. Bats also play a significant role in pollination of fruits and translocation of seeds from one locality to another. On the other hand, they are also responsible for food destruction, especially fruits in our gardens.

[4]Although Giraffe (*Giraffa camelopardalis*: Giraffidae) have never been known to exist historically in Malawi one did come across the border from Zambia about 25 years ago. It was killed immediately. Malawi habitat is very suitable for this species and a few years ago it was introduced into a private game ranch in the Lower Shire Valley where they thrived. They now also have been introduced in Kuti Game Ranch in the Central Region.

3.4 References Cited

Ansell, W,F.H and R.J. Dowsett (1988): *Checklist and atlas of the mammals of Malawi.* Trendrine Press, Zenor, Cornwall.

Baillie, J. & Groombridge, B. (1996). *IUCN Red List of threatened animals* (Also known as the "1996 IUCN Red Data Book"). IUCN - The World Conservation Union. Gland, Switzerland.

Chafota, J., Dudley, C. and Labuschagne, R. (2002). *Ecological and institutional evaluation, and development of guidelines for future management of black rhinos in Liwonde National Park, Malawi.* Ecological Evaluation and Development of Guidelines for Future Management of Black Rhinos at Liwonde NP., Malawi Semester 4 task 1.2-4.1. SADC Regional Programme for Rhino Conservation

Chitaukali, W.N. (2002). *Small mammals of Nyika Plateau.* MSc Thesis, Knightsbridge University, England, UK.

Hilton-Taylor, C. (2000). *IUCN Red List of threatened species.* IUCN - The World Conservation Union, Gland, Switzerland.

4.0 BIRDS

Potiphar M. Kaliba, Senior Ornithologist
Museums of Malawi

4.1 Introduction

The total list of birds for Malawi contains approximately 650 species. Of these, 107 are non-breeding migrants or vagrants, leaving more than 490 species which breed in the country. Under current taxonomy, Malawi has no endemic bird species, but it does have four endemic subspecies which may eventually be treated at species level. The country is also home to a number of near endemics with ranges that include either southern Tanzania or northwestern Mozambique.

Malawi is important ornithologically as a cross-roads between eastern and southern Africa. Many East African species reach their southern limits in northern Malawi, while many others typical of southern Africa reach their northern limits in the southern half of the country. This unique position makes Malawi very important to studies of the biogeographical history of the whole continent of Africa. Malawi has eleven species of birds that are listed as endangered, threatened and vulnerable (BirdLife International 2004), as well as several additional species of particular concern (Dowsett-Lemaire, Dowsett & Dyer 2001).

4.2 Species of Conservation Concern, Their Numbers and Distribution

Wattled Crane (*Bugeranus carunculatus*) has a broad distribution in Africa, but a total population estimated at only 7500 individuals in 1985 (Collar & Stuart 1985). At that time, the breeding population on the Nyika Plateau was in the range of 30-40 pairs. Studies by Kaliba & Nhlane (2003) had 11 individuals occurring in Nyika. Recent field work (2004) in the non-breeding season produced only one individual and, while some of the population may wander away from the plateau when not breeding, it is probable that the Malawi population has declined even further. Little is known about whether the Malawi birds disperse to places like the Kafue Flats in Zambia, or what effect the current fire regime at Nyika has on their nesting success.

Thyolo Alethe (*Alethe choloensis*) is restricted to evergreen highland forest patches in southern Malawi adjacent to Mozambique. Its largest population is on Mulanje Mountain, with smaller numbers formerly on Thyolo Mountain, and even smaller numbers on scattered mountains in the south. The species is dependent on forest habitat so it is doubtful if any remain in Thyolo Forest as that forest reserve has been almost entirely cleared by agricultural encroachers. Virtually nothing is known of its status in Mozambique. Its global population is estimated to be between 2,500 to 5,000 birds (BirdLife International 2004).

Denham's Bustard (*Neotis denhami*), with a range that includes much of the grasslands of west, central and southern Africa, occurs only in northern Malawi where it is now thought to be restricted to the Nyika Plateau. There, it is often seen in recently burned patches of grassland, foraging on the remains of insects and vertebrates charred by the fires.

Spotted Ground Thrush (*Zoothera guttata*) is scattered around East Africa. Some of these birds are migratory and the details of their movements are still unknown. In Malawi, this bird has a range very much overlapping that of the Thyolo Alethe, but it is even more rare. Its global

population is within the range of 1,000 to 2,499 birds (BirdLife International 2004).

Blue Swallow (*Hirundo atrocaerulea*) is a species that has become uncommon to rare in a number of its southeastern African breeding sites with a global population of 4,000 birds. In Malawi, it is known to breed in the montane grasslands of Nyika Plateau as well as on Mount Mulanje Forest Reserve. However, there are also some historic records from Kirk Mountain Range (Benson 1942, Dowsett-Lemaire, in prep). Its population in Malawi is estimated to be 300400 pairs with one of the largest remaining populations in Nyika, thus an important stronghold for the species.

Lappet-faced Vulture (*Torgos tracheliotus*) is the least common of all the vulture species in Malawi and restricted to certain national parks only (Newman, Johnston-Stewart & Medland 1992). Its population is about 8,500 birds worldwide.

Madagascar Pond-heron (*Ardeola idae*) is a migrant species with a large wintering (non-breeding) range in Central Africa including Malawi and East Africa. Its breeding area is mostly within Madagascar. Its population size is within the range of 2,000 to 6,000 birds (BirdLife International 2004).

White-winged Apalis (*Apalis chariessa*). One of the subspecies of this particular species occurs in nine sites in southern Malawi and also on Chiperone Mountain in Mozambique. It ranges in elevation from 500m to 1500m and above. One hundred pairs were recorded in 1983 (BirdLife International 2004).

Lesser Kestrel (*Falco naumanni*) is a vagrant and does not breed in Malawi. Wintering areas are found in Malawi and other countries in central and southern Africa. The primary breeding areas for this species are found in North Africa, Europe, Asia and the Middle East. Population size is within the range of 50,000 to 60,000 birds (BirdLife International 2004).

East Coast Akalat (*Sheppardia gunningi*) has four subspecies in northern Malawi, south-east Kenya, eastern Tanzania and Mozambique. It inhabits mid-altitude humid forests, moist forests and also has been recorded in secondary forests in Malawi. Population size is within the range of 10,000 to 19,999 birds (BirdLife International 2004).

Yellowthroated Apalis (*Apalis flavigularis*) has its distribution restricted to Mulanje, Zomba and Malosa Mountains (BirdLife International 2004). It has been predicted to occur on Mount Chiperone, Mozambique. However, there are no records indicating its presence there. Its population size is within the range of 2,500 to 9,999 birds.

Basra Reed-warbler (*Acrocephalus griseldis*), a wetland (marsh) species, breeds in the Mesopotamian marshes and winters in Malawi and other east and southern African countries. Its population size is within the range of 2,500 to 9,999 birds (BirdLife International, 2004).

4.3 Endemic Subspecies

The endemic subspecies, Crawshay's Red-winged Francolin (*Francolinus levaillantii crawshayi*), Whyte's Greater Double-collared Sunbird (*Nectarinia afra whytei*), Nyika Baglafecht Weaver (*Ploceus baglafecht nyikae*), Nyika Rufous-naped Lark (*Mirafra africana nyikae*) are only found in northern Malawi in Nyika National Park. Their habitat is mostly grassland, which is found on the high plateau.

4.4 Threatened Species

Wattled Crane (*Bugeranus carunculatus*), Thyolo Alethe (*Alethe choloensis*), Spotted Ground Thrush (*Zoothera guttata*), Blue Swallow (*Hirundo atrocaerulea*), Basra Reed-warbler (*Acrocephalus griseldis*), Yellowthroated Apalis (*Apalis flavigularis*), Madagascar Pond-heron (*Ardeola idae*) are listed as threatened.

4.5 Mitigation Measures

Research: The ecology for most threatened bird species which are resident and migrants is not well known. Research activities to document the distribution, current conservation status and threats must be carried out to ascertain their status. The implementation of this research could be guided by the international action plans that have been developed for other species like the Blue Swallow and the Spotted Ground Thrush by the Africa Species Working Group.

Burning regime guidelines: Most threatened bird species inhabit national parks, wildlife reserves and forest reserves because of the presence of natural vegetation. Burning is done with the intention to have new grass for herbivorous animals especially in national parks and wildlife reserves. However, this protocol does not take into account the breeding cycles of threatened birds, and hence has potential impacts on nests and unfledged chicks. Therefore, it is important to develop guidelines for all important bird areas. It is also vital to give professional training in fire management to all personnel involved in burning.

Civic education and community participation: This would improve the awareness of the local communities living in and around important bird areas on the importance of safeguarding bird species/communities. This will improve the protection of birds and help to keep illegal hunting and burning under control.

Control of invasive (alien) plant species: These plants alter microhabitats and could have no foliage value for resident species thus affecting foraging behaviour. Therefore, these plants need to be controlled to improve the status of bird species.

International co-operation: Need to develop strategies for joint conservation efforts with other adjacent countries whose borders fall within the threatened bird species distributions.

Infrastructure development: The construction of roads and buildings for ecotourism in all important bird areas as well as power lines should have a thorough Environmental Impact Assessment made.

4.6 Relevance to the Nation

The presence or absence of certain bird species can be indicators of environmental degradation. The type and health of habitat available will determine which species are found. Assessing this is important and must be understood in order to come up with necessary mitigating measures. Birds promote tourism by attracting birders, both local and international. Birds are seasonal indicators. In villages people associate the beginning of migration or calls for certain bird species with the beginning of the rainy season. This notifies them to finish preparing their gardens before the onset of the first rains, hence improving household food security. Birds are eaten by people as source for protein in their diet. Bird feathers are used for preparation of Traditional Regalia, thus birds are also important in preserving our cultural history.

4.7 References Cited

Benson, C.W. (1942). Additional notes on Nyasaland Birds. *Ibis* 6(2):197 224, 6(3):229 337.

BirdLife International (2004). Species Fact sheet: *Alethe choloensis, Zoothera guttata, Hirundo atrocaerulea, Acrocephalus griseldis, Apalis flavigularis, Ardeola idea, Apalis chariessa, Falco naumanni, Sheppardia gunningi, Torgos tracheliotus.* Downloaded from http://www.birdlife.org on10/5/2004.

Collar, N.J. & Stuart, S.N. (1985). *Threatened birds of Africa and related islands.* ICBP/IUCN Red Data Book, Cambridge U.K.

Dowsett-Lemaire, F. & Dowsett, R. (in prep). *Birds of Malawi.*

Dowsett-Lemaire, F., Dowsett, R. J. & Dyer, M. (2001). Malawi, pp. 539-555. In: L. D. C. Fishpool & Evans, M. I. (eds.) *Important bird areas in Africa and associated islands; priority sites for conservation.* Birdlife Conservation Series No. 11, Birdlife International, Pisces Publication.

Kaliba, P.M. & Nhlane, M.E.D. (2003). *The Status of Wattled Cranes and other water birds in Malawi.* ICF, Wisconsin, Baraboo.

Newman, K., Johnston-Stewart N. & Medland, B. (1992). *Birds of Malawi, a supplement to Newman's Birds of Southern Africa.* Southern Book Publishers (Pty) Ltd, South Africa.

5.0 REPTILES AND AMPHIBIANS

Lovemore C.J. Mazibuko, Curator of Herpetology
Museums of Malawi

5.1. Introduction

Malawi, though small, supports a significant diversity of amphibians and reptiles (herpetofauna). According to published sources, there are 228 species in Malawi consisting of 83 amphibians and 145 reptiles (Stewart & Wilson 1966, Stewart 1967, 1968, Stevens 1974, Morgan 1979 & 1981, Branch 1998, Channing 2001). The amphibians now known from Malawi belong to 11 families and 24 genera (Table 5.1). The largest number of species is found in the families of Hyperoliidae (28 species), Ranidae (24 species) and Bufonidae (9 species). Endemic species are six with two species occurring exclusively on Mulanje Mountain with the remaining four on Nyika Plateau, Mulanje and Zomba Mountains as well as Rumphi District. The total number of genera restricted to Malawi is six. Most endemic species are found in high altitudinal areas of Nyika Plateau, Zomba and Mulanje Mountains.

Table 5.1: Number of genera and species of amphibians currently known from Malawi.

Family	Genera	Species
Arthroleptidae	2	5
Bufonidae	2	9
Caeciliidae	1	1
Hemisotidae	1	1
Hyperoliidae	4	28
Petropedetidae	1	8
Microhylidae	2	3
Pipidae	1	2
Ranidae	8	24
Rhacophoridae	1	1
Scolecomorphidae	1	1
Total	**24**	**83**

The reptiles recorded from Malawi belong to 19 families and 72 genera (Table 5.2). The fauna is particularly rich in snakes of the family Colubridae (43 species), lizards of the families Scincidae (20 species) and Geckonidae (16 species). There are eight endemic species with six species restricted to Mulanje Mountain while the remaining two species occur in Nyika Plateau, Misuku Hills and Ntchisi Forest. As with amphibians, the highest level of endemicity generally occurs at high altitudes.

5.2. Threatened Amphibian Species

IUCN's Global Amphibian Assessment (GAA) for Africa in 2002 implemented a project to determine the status of amphibians of Africa. This was achieved through a consensus built through a process of scientific assessment. The assessment showed that 37 amphibian species from Central and Southern Africa are currently threatened. Out of these, 12 species are

Table 5.2: Number of genera and species of reptiles currently known from Malawi.

Family	Genera	Species
Crocodylidae	1	1
Pelomedusidae	2	3
Testudinidae	2	2
Trionychidae	1	1
Agamidae	2	8
Amphisbaenidae	3	3
Chamaeleonidae	2	7
Cordylidae	3	6
Geckonidae	4	16
Gerrhosauridae	1	4
Lacertidae	5	8
Scincidae	8	20
Varanidae	2	2
Boidae	1	1
Colubridae	24	43
Elapidae	3	7
Leptotyphlopidae	1	4
Typhlopidae	2	2
Viperidae	5	7
Total	**72**	**145**

reported from Malawi. Table 5.3 shows names of threatened and endemic amphibian species of Malawi.

5.3. Threatened Reptile Species

Unlike amphibians, no effort has been made to determine the conservation status of reptiles in Central and Southern Africa, let alone Malawi. However, the author has made his own assessment to determine the conservation status of reptiles of Malawi. Out of the 145 species known to occur in Malawi, eight have been classified as threatened. These species have been classified as threatened in view of their limited extent of occurrence of probably less than 20,000km^2, severely fragmented distribution as well as quality and extent of their habitats which are probably declining. Table 5.4 shows my proposed assignments for reptilian species of Malawi believed to be threatened.

5.4 Threats to the Herpetofauna of Malawi

Threats to herpetofauna of Malawi have been previously reported by Mfune & Mhango (1998) and Mazibuko (2004). The major threats to herpetofauna of Malawi are summarized below:

Habitat loss/degradation: Poor land management practices threaten the herpetofauna of Malawi as they destroy the habitats in which herpetofauna live. These practices include shifting cultivation, overgrazing and burning, cutting of trees for the production of timber, hunting and unsustainable collection of fruits and edible insects, mushrooms and medicinal plants among others.

Table 5.3: Names of threatened and endemic amphibian species of Malawi.

Common Name	Scientific Name	Family	Endemicity	IUCN GAA Status
France's Squeaker	*Arthroleptis francei*	Arthroleptidae	Endemic	Endangered
Reiche's Squeaker	*Arthroleptis reichei*	Arthroleptidae	Not endemic	Near threatened
Nyika Dwarf Toad	*Bufo nyikae*	Bufonidae	Endemic	Endangered
Variable Reed Frog	*Hyperolius pictus*	Hyperoliidae	Not endemic	Vulnerable
Spiny Throated Reed Frog	*Hyperolius spinigularis*	Hyperoliidae	Not endemic	Near threatened
Stewart's Puddle Frog	*Phrynobatrachus stewartae*	Petropedetidae	Endemic	Data Deficient
Ukinga Puddle Frog	*Phrynobatrachus ukingensis*	Petropedetidae	Not endemic	Vulnerable
Johnston's River Frog	*Afrana johnstoni*	Ranidae	Endemic	Endangered
Mongrel Frog	*Nothophryne broadleyi*	Ranidae	Endemic	Endangered
Broadley's Ridged Frog	*Ptychadena broadleyi*	Ranidae	Endemic	Endangered
Kirk's Caecilian	*Scolecomorphus kirkii*	Ranidae	Not endemic	Vulnerable

Table 5.4: Proposed reptilian species from Malawi those are believed to be threatened.

Common Name	Scientific Name	Family
Nile crocodile	*Crocodylus niloticus*	Crocodylidae
Mulanje Dwarf Chameleon	*Chamaeleo mlanjensis*	Chamaeleonidae
Nyika Dwarf Chameleon	*Chamaeleo goetzei nyikae*	Chamaeleonidae
Pitless Pigmy Chameleon	*Rhampholeon nchisiensis*	Chamaeleonidae
Dwarf Gecko	*Lygodactylus bonsi*	Geckonidae
Dwarf Gecko	*Lygodactylus rex*	Geckonidae
Legless Skink	*Melanoseps ater*	Scincidae
Arnold's (Mulanje) Skink	*Proscelotes mlanjensis*	Scincidae
Cross-barred Tree Snake	*Dipsadoboa flavida flavida*	Colubridae

Direct exploitation: Factors such as collection and wanton killing of herpetofauna can be considered under this threat category. Local exploitation of reptiles includes the trade in skin of the Nile crocodile, (Crocodylus niloticus). Other herpetofauna such as Leopard Tortoise (Geochelone pardalis), Nile Monitor (Varanus niloticus), African Python (Python sebae), Mozambique's Rain Frog (Breviceps mossambicus), Flap-necked Chameleon (Chamaeleo dilepis), Puff Adder (*Bitis arietans*), Cape File Snake (*Mahelya capensis*) and

the Stripped Skink (*Mabuya striata*) allegedly possess medicinal qualities. Thousands of these species are annually removed from the wild for this purpose (Mazibuko 2004). Snakes are generally killed mostly because of the misconception that all snakes are poisonous. In addition, there are records of snakes, frogs and lizard mortalities due to road kills. These incidences are high in those roads running through and adjacent to forests. In addition to that, some species are killed due to certain religious/cultural beliefs and myths.

Pollution: The application of insecticides and chemical fertilizers adversely affects insects populations, an important food source for most of the amphibians and reptiles (Mazibuko 2004). Such chemicals may also prove fatal to the amphibians themselves as their skin is moist and absorbent.

Invasive alien species: This is a growing problem to herpetofauna. Domestic/feral cats and dogs destroy many species of reptiles and amphibians, especially in home gardens. For instance, Dwarf Gecko (*Lygodactylus bradfieldi*) is regularly preyed upon by domestic/feral cats. Invasive alien carnivorous fish such as the Trout (*Oncorhynchus* spp.), which are numerous on Mulanje and Nyika Plateaux, are known to attack amphibians (De Silva 1996).

5.5. Mitigation Measures Towards Threatened Species

In view of the serious challenges faced by herpetofauna particularly the threatened species, a number of measures have been put in place by Government to reverse the situation. The Government of Malawi promulgated a Wildlife Act for protecting wildlife in general. This includes inclusion of certain herpetofaunal species such as crocodiles under CITES. The Wildlife Act among other things prohibits any trade and export in crocodiles or their products unless permission is sought from relevant government institutions. Although crocodiles are protected by law, there is general laxity in the application of this law by relevant government institutions such that violation is on the increase. In view of this, there is need to reinforce this legislation to protect populations of these species in Malawi.

The Government has established protected areas to protect animals, selected plants and water catchment areas. This has helped quite a lot in preserving the country's natural heritage. However, Government should take into account the richness of faunas found in different areas and the level of endemicity when establishing protected areas in future.

Awareness programmes have also been undertaken by relevant government institutions and other non-governmental organizations such as the Wildlife and Environmental Society of Malawi (WESM) to educate the general public on the need to conserve our forest reserves and national parks which act as home to most animals. These institutions are also promoting sustainable use of wildlife species that bring benefits to the local people. Other forms of sustainable use include the use of herpetofauna such as pythons and monitor lizards in sanctuaries for enhancing ecotourism.

The Herpetology Section of the Museums of Malawi is making sustained efforts to inventory the herpetofauna of Malawi. Long-term studies on ecology and population monitoring are currently underway and will be ongoing in order to gather data on the fauna and identify conservation requirements of each threatened species.

The Government of Malawi established the National Research Council of Malawi in 1974 in order to promote and co-ordinate all research activities at national level and ensure that any research project proposed for execution on Malawi's genetic materials does not lead to loss of biological diversity.

5.6 Conclusion

The reasonably high endemicity of herpetofauna on Mulanje Mountain and Nyika Plateau make these two specialized habitats important herpetofaunal hotspots in Malawi. Unfortunately, the rapid decline in habitat and its quality in these two areas may result in the decline of some herpetofaunal species particularly the endemic ones. Ultimately, the success of conservation of biodiversity, including herpetofauna, in Malawi will largely depend on educating the people on the dangers of environmental degradation. Without conservation work which encourages the full participation of local people to implement and maintain conservation plans in their areas, there are few hopeful prospects for the protection of herpetofauna and other wildlife species in Malawi.

5.7 References Cited

Branch, B. (1998). *Field guide to snakes and other reptiles of Southern Africa.* Struik Publishers (PTY) Ltd.

Channing, A. (2001). *Amphibians of Central and Southern Africa.* Protea Bookhouse Pretoria.

De Silva, A. (1996). *The herpetofauna of Sri Lanka: A brief review.* Published by the author, 100pp.

Department of Meteorological Services (2001). *Annuals reports.* Blantyre, Malawi.

Mazibuko, L.C.J. (2004). Reptiles and amphibians, pp.43-55. In: C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens of Malawi, Zomba, Malawi.

Mfune, J.K.E. & Mhango, C.R.G. (1998). Amphibians, reptiles and mammals of Lake Chilwa, pp. 109-120. In: Zegeren, K. van & Munyenyembe, M. P. (eds.) *The Lake Chilwa environment: a report of the 1996 Ramsar site study.* Department of Biology, Chancellor College, Zomba, Malawi, 162pp.

Morgan, D.R. (1979). Notes on a herpetofauna collecting trip to Malawi, Central Africa. *Herptile* 4(3): 24-28.

Morgan, D.R. (1981). *Report on a second collecting trip to Malawi, Central Africa.* Lynnwood Ridge, Pretoria 0081. S. Africa.

Stevens, R.A. (1974). An annotated checklist of the amphibians and reptiles known to occur in South-Eastern Malawi. *Arnoldia Rhod.* 6 (30): 1-22.

Stewart, M.M. (1967). *Amphibians of Malawi.* State university of New York Press.

Stewart, M.M. (1968). A collection of reptiles from Northern Malawi, Africa. *Jour. Herp. Assoc. Afric.* 1968(2): 22 29.

Stewart, M.M. & Wilson, V. J. (1966). Herpetofauna of the Nyika Plateau (Malawi and Zambia). *Ann. Natal Mus.* 18: 287 313.

6.0 FISH

Dr Moses Banda
Fisheries Research Unit

6.1. Introduction

The fishes of Malawi are one of the most remarkably diverse and abundant faunal groups in the world. The numbers of genera and species known to occur in this country are 81 and in excess of 1,000, respectively. The fish species number represents about 15% of the global total of freshwater species and approximately 4% of the world's fishes. The number of species and genera in the lake continues to increase with new discoveries and taxonomic revisions that alter nomenclature and phylogenetic groupings (Eccles & Trewavas 1989, Konings 1990, Turner 1996, Ribbink 2001). Lake Malawi alone contains over 800 fish species, which is more than any other lake in the world and its fishes represent an evolutionary and biological spectacle of global importance.

6.2. Type of Species and Quantity

The fish species found in Malawi belong to 14 families and the *Cichlidae*, occurring in rivers and lakes, dominate in terms of species richness, diversity and numerical abundance (Table 6.1). There are 70 non-cichlid species in 13 families occurring in both rivers and lakes. Of these, 50 species belong to 11 families living in the lake. The principal characteristics of the 14 families are briefly described below:

Protopteridae: The common name for this family is lungfish, which is represented by one genus and four species in Africa. Only one of these species, *Protopterus annectens brieni*, is found in Malawi.

Anguillidae: This family is represented by one genus (*Anguilla*) and one sub-species (*Anguilla bengalensis labiata* (MKUNGA, Mottled Eel) occurs in the country (Skelton 1993).

Mormyridae: The family includes 18 genera and at least 2,000 species in Africa (Skelton 1993), but only six genera and seven species of this family are found in this country. The seven species are *Hippopotamyrus discorhynchus* (MPHUTA), *Marcusenius livingstonii* (MPHUTA, NTHACHE, Lake Malawi Bulldog), *Marcusenius macrolepidotus macrolepidotus* (MPHUTA, NTHACHE, Bulldog), *Mormyrops anguilloides* (NYANDA, NJOLO, NKUPE), *Mormyrus longirostris* (MPANDA, SAMWAMOWA), *Petrocephalus catostoma catostoma* (MPHUTA, NTHACHE) and *Pollimyrus castelnaui* (MPHUTA, NTHACHE, Dwarf Stonebasher).

Salmoidae: The introduced Rainbow Trout, *Onchorhynchus mykiss*, is the only fish species belonging to this family found in the country.

Characidae: The family characidae is represenred by 18 genera and over 100 species in Africa, but only two genera and two species of this family occur in the country (Skelton 1993). The genus *Brycinus* has 30 species in Africa, but only *Brycinus imberi* (NKHALALA) is found in here. *Hemigrammopetersius barnardi* (NKHALALA) is the second species that is found in this country.

Cyprinidae: This family has 24 genera and more than 475 species occurring in Africa (Skelton 1993), but only five genera and 26 species represented are found in Malawi. The

Table 6.1: The riverine (living in rivers R) and lacustrine (living in lakes L) fishes in Malawi and their percentage endemicity (adopted from Ribbink 2001).

Family	Habitat	Genera		Species	Endemic %
		Total	Endemic		
Protopteridae	R	1	0	1	0
Anguillidae	R&L	1	0	1	0
Mormyridae	R&L	6	0	7	0
Salmonidae	R	1	0	1	0
Characidae	R&L	2	0	2	0
Cyprinidae	R&L	5	1	26	35
Bagridae	R&L	1	0	1	100
Amphilidae	R	1	0	6	40
Clariidae	R&L	2	1	17	71
Mochokidae	R&L	2	0	3	33
Cyprinodontidae	R&L	1	0	1	0
Aplocheilidae	R	1	0	2	50
Mastacembelidae	R&L	1	0	2	100
Cichlidae	R&L	56	51	750	99.5

genus *Barbus* is represented by about 300 species in Africa, 18 species occur in this country. *Barbus paludinosus* (MATEMBA, Straight Fin Barb), *B. eurystomus* (KADYAKOLO, NKHUYU, Long-barbelled Lake Malawi Yellowfish), *B. litamba* (TAMBA, MATAMBA) and *B. johnstonii* (NGUMBO, CHIMWE, Short-barbelled Lake Malawi Yellowfish) are the common species of this genus. The other common cyprinids species belong to other genera and include *Engraulicypris sardella* (USIPA, Lake Sardine), *Labeo cylindricus* (NINGWE, MBUNUNU, Redeye Labeo), *L. mesops* (NCHILA), *Opsaridium microcephalus* (SANJIKA) and *O. microlepis* (MPASA, Lake Salmon). USIPA, MATEMBA, MPASA and SANJIKA are the economically important species.

Bagridae: This family is widely distributed in Africa, but represented by one genus and one species, *Bagrus meridionalis* (KAMPANGO) in Malawi and is a very popular food.

Amphillidae: The Amphiliidae with nine genera and about 60 species, are small catfish (catlets) that are widely distributed in Africa and usually associate with running water (Skelton 1993). Two genera, *Amphilius* and *Leptoglanus* and six species of this catfish family are recognized in Malawi. *Amphilius uranoscopus, A. natalensis* and *Leptoglansis rotundiceps* are the three species described while the other three are not yet described.

Clariidae: Twelve genera and 74 species belong to this family and occur in Africa, of which two genera (*Clarias* and *Bathyclarias)* and 17 species are found in this country. The genus *Clarias* has five species namely *C. gariepinus* (MLAMBA, Sharptooth Catfish), *C. liocephalus* (SUTE, Blunt-tooth Catfish), *C. ngamensis* (SUTE, CHIKANO, Blunt-tooth Catfish), *C. stappersii* (Blotched Catfish) and *C. theodorae* (KOBO, Snake Catfish). *B. gigas* (NKANDA), *B. nyasensis* (SAPUWA), *B. atribrachus (*KAPHYOTHA), *B. euryodon* (PWEFU), *B. filicibarbis*, *B. foveolatus* (CHIMWAMAPUMBA), *B. longibarbis* (KABWIRI), *B. rotundifrons* (NKOMO) and *B. Worthingtoni* (NKOPORA) (Banda 2000).

Mochokidae: This is the largest catfish family in Africa with ten genera and more than 170

species (Skelton 1993), but only two genera (*Chiloglanis* and *Synodontis)* are recorded from this country. The genus *Chiloglanis* has 34 species and only three, *Chiloglanis neumanni* (NKHOLOKOLO, Prickleback Suckermouth) and two undescribed species occur in the country (Tweddle 1996). The genus *Synodontis* has over 100 species but only one species, *S. njassae* (NKHOLOKOLO, NJEKAYEKA, Lake Malawi Squeaker), is found in Malawi.

Cyprinodontidae: This family comprises nine genera, of which, *Aplocheilichthys* is prominent with 44 species. *Aplocheilichthys johnstoni* (Slender Topminnow) is the only species described here though several more may exist.

Aplocheilidae: Two genera occur in Africa, with the genus *Nothobranchius* being represented by at least 30 species. Two species, *Nothobranchius kirki* and one undescribed species are found here.

Mastacembelidae: This family, commonly known as Spiny Eel, is represented by two genera and about 43 species in Africa. The genus *Aethiomastacembelus* has 19 species with only one, *A. shiranus* found in this country.

Cichlidae: The family Cichlidae dominates in terms of species and diversity. It comprises two groups: the tilapiines of which there are seven species and the haplochromines, with more 800 species. The tilapiines comprise the two genera *Oreochromis* (CHAMBO, FWILIRI) and *Tilapia* (CHILUNGUNI). The haplochromine cichlids, represented by 39 genera and of great economic importance, are the small, brightly coloured cichlids, collectively known as MBUNA cichlids (ten genera with more than 200 species), *Rhamphochromis* (MCHENI with eleven species), *Diplotaxodon* (NDUNDUMA with nine species), *Lethrinops* (CHISAWASAWA or KAMBUZI with more than 35 species) and *Otopharynx* and spotted species (KAMBUZI with 26 species), *Copadichromis* (UTAKA with nine species) and *Buccochromis* (MBABA with four species) (Turner 1996).

6.3. Distribution

All the families in the lake have riverine representatives, but not all riverine families have representatives in the lake (Table 6.1). Protopteridae, Anguillidae, Mormyridae, Characidae, Cyprinidae, Bagridae, Clarridae, Mochokidae, Cyprinodontidae, Mastacembelidae and Cichlidae are the families that occur in both rivers and lakes and the rest only in rivers. However, although Cyprinidae, Clariidae and Cichlidae families occur in both river and lakes some species within the families are confined either to rivers or lakes. Of the 18 cyprinid fish species, ten are confined to rivers, one (USIPA) to the lake and the rest appear in both rivers and lakes. All the species of the genus *Bathyclarias* (Clariidae) are found only in Lake Malawi and two of the five *Clarias* species in rivers only. The tilapiines are widely distributed, found in both rivers and lakes, while all haplochromines except *Astatotilapia calliptera* and *Serranochromis robustus* are found in lakes. *Astatotilapia calliptera* and *Serranochromis robustus* occur in both rivers and lakes.

6.4. Endemic Species

The percentage endemicity of genera and species are shown in Table 6.1. Almost all the Malawian cichlid species are endemic to the lake and therefore have restricted distributions. The Ciclidae is the only family that has produced many species flocks in the country. Endemic species are also found in families of Clariidae, Cyprinidae, Bagridae, Mochiokidae, Amphilidae, Aplocheilidae and Mastacemblidae. The clariids and cyprinids are the second

group with high endemic species. All the species of the genus *Bathyclarias* within the clariids are endemic to Lake Malawi and is the only non-cichlid fish group that forms species flocks. The cyprinids have nine species that are endemic out of the 26 found here. The rest of the families have species that are not endemic to Malawi.

6.5. Threatened species

Buccochromis spectabilis (MBABA), *Corematodus taenatius*, *Cytocara moori, Docimodus johnstonii*, *Labeo mesops* (NCHILA), *Opsaridium microlepis* (MPASA), *Opsaridium microcephalum* (SANJIKA), *Oreochromis shiranus chirwae* (MAKUMBA), *Oreochromis lidole* (CHAMBO), *Oreochromis karonge* (CHAMBO) and *Oreochromis squamipinnis* (CHAMBO) are the eleven fish species classified as endangered in Malawian waters, based on the IUCN rules of classification. The anadromous cyprinid species, which used to be the most abundant species in the 1950's, in particular NCHILA, have almost disappeared because of loss of spawning habitats along the rivers due to siltation and overexploitation at the river mouths. The CHAMBO, the most important economic fish species, has declined markedly from a record high of over 9,400 tonnes in 1985 to a low level of about 1,400 tonnes by 1999 due to unsustainable exploitation practices. In early 1982 CHAMBO contributed 49% of the annual total fish landings for Lake Malawi but by 1999 it only contributed 7% to the total catch. Unsustainable agricultural practices in catchment areas and deforestation are the causative factors for siltation while overexploitation is attributed to high human population growth.

6.6. Commercial Fisheries

Cichlids (non MBUNA cichlids), cyprinids (USIPA and MATEMBA) and catfish (KAMPANGO, MLAMBA and BOMBE) are the three major commercial fish categories accounting for 61%, 26% and 12% of landed fish, respectively. Malawian fisheries have experienced considerable decline in the 1990s after a relative stability in the preceding years. The catches have declined from an average of 60,000 tonnes in the period of 1976-1990 to 49,000 tonnes in 1991-2001. This decline is mainly attributed to habitat degradation and overfishing caused by ever increasing number of gears and fishermen, the common use of illegal gears and overcapitalisation. In the last decade, the number of fishermen, fishing gears and fishing crafts has increased by 27%, 124% and 30%, respectively.

6.7. Mitigation Measures Towards Threatened Species

The Government of Malawi, recognizing the importance of biological diversity in the socio-economic development of the country and realizing the severe ongoing environmental degradation, has put in place various policies, legislation, strategies and programmes to curtail the destruction of biological resources. The National Biodiversity Strategy and Action Plan (NBSAP, Malawi Government (2004)) was prepared as a response to biodiversity loss identified as one of the major environmental concerns in the National Environmental Action Plan (NEAP, Malawi Government (2002)). The Department of Fisheries has identified eleven fish species as endangered, which awaits declaration and registration with the IUCN Red Data Book as part of the action of NBSAP. The department is also in process of formulating and implementing strategic plans such as the Chambo Restoration Strategic Plan (Malawi Government 2004) to regulate overfishing. Lake Malawi National Park the first fresh water underwater national park in Africa was established in 1980 and designated as a UNESCO World Heritage Site in 1994 as part of conservation strategy for the threatened fish biodiversity of the Nankumba Peninsula.

6.8. Relevance to the Nation

The fisheries sector has a key role to play in poverty reduction through the provision of rural employment and, more importantly, through its contribution to household food security. The

fisheries sector provides employment opportunities to over 200,000 people and supports about 14% of Malawi's lakeshore communities through fishing, fish processing, fish marketing, fishing gear construction, boat building and other ancillary activities. It provides a major source of protein supply, estimated at approximately 70% of animal protein and 40% of the total protein intake for the majority of the rural poor. Much of the fish is consumed in rural areas and thus contributes to the nutritional needs of some of the poorest people in the country, as it is easily accessible, available in times of drought and within the purchasing power of the majority of the population. Fish, therefore, guarantees a nutritionally balanced diet to a population suffering from high levels of malnutrition. Fish contributes 4% to the GNP. While the potential importance of fish in meeting food security and nutritional needs is apparent, so are the inevitable pressures that are exerted on these resources as Malawi's human population continues to increase.

6.9 References cited:

Banda, M.C. (2000). *The biology and ecology of the catfishes of the genera* Bathyclarias *and* Bagrus *in lake Malawi.* PhD Thesis, University of Zimbabwe.

Eccles, D.H. & Trewavas, E. (1989). *Malawian cichlid fishes: a classification of some haplochromine genera.* Lake Fish Movies, Herten, Germany.

Konings, A. (1990). *Cichlids and all the other fishes of Lake Malawi.* TFH, Neptune City, USA.

Malawi Government (2002). *National Environmental Action Plan.* (draft) Department of Research and Environmental Affairs, Lilongwe, Malawi, 219pp.

Malawi Government (2004a). *National Biodiversity Strategy and Action Plan* (draft). Department of Research and Environmental Affairs, Lilongwe, Malawi, 98pp.

Malawi Government (2004b). *Chambo Restoration Strategic Plan* (draft). Department of Fisheries, Lilongwe, Malawi.

Ribbink, A. (2001). *Lake Malawi/Niassa/Nyasa ecoregion: biophysical reconnaissance.* World Wildlife Fund Southern African Regional Programme Office, Harare, Zimbabwe.

Skelton, P.H. (1993). *A complete guide to the freshwater fishes of Southern Africa.* Southern Book Publishers (Pty) Ltd, Halfway House, South Africa.

Turner, G.F. (1996). *Offshore cichlids of Lake Malawi.* Cichlid Press, Germany.

Tweddle, D. (1996). *Fish survey of Nkhota kota Wildlife Reserve.* JLB Smith Institute of Ichthyology Investigational Report (Grahamstown) 53:1-79.

7.0 INVERTEBRATES

Professor Cornell Dudley
University of Malawi
Department of Biology
Chancellor College

7.1 Introduction

Biodiversity of invertebrates worldwide is vast and almost unimaginable. The present estimate of numbers of described species is more than 1.3 million (Minelli 1993). Not only is this diversity overwhelming at species level, but it includes a continuum of organisms from the simplest sponges (Porifera) and jelly fish (Cnidaria), through various worm phyla (Platyhelminthes, Nematoda and Annelida), to the molluscs (snails, clams) and finally the dominant group of organisms, the arthropods (insects, spiders, etc.). Present knowledge considers this the tip of the iceberg. Numbers of species of insects alone could be anywhere from five million (Stork & Gaston 1990) to thirty million (Erwin 1982)! Mites and roundworms may contribute an additional 500,000 to one million species each to this total (Hammond 1992). The estimated number of species of higher plants (300,000) and vertebrates (mammals through fish) (50,000) pales in comparison (Fig. 7.1).

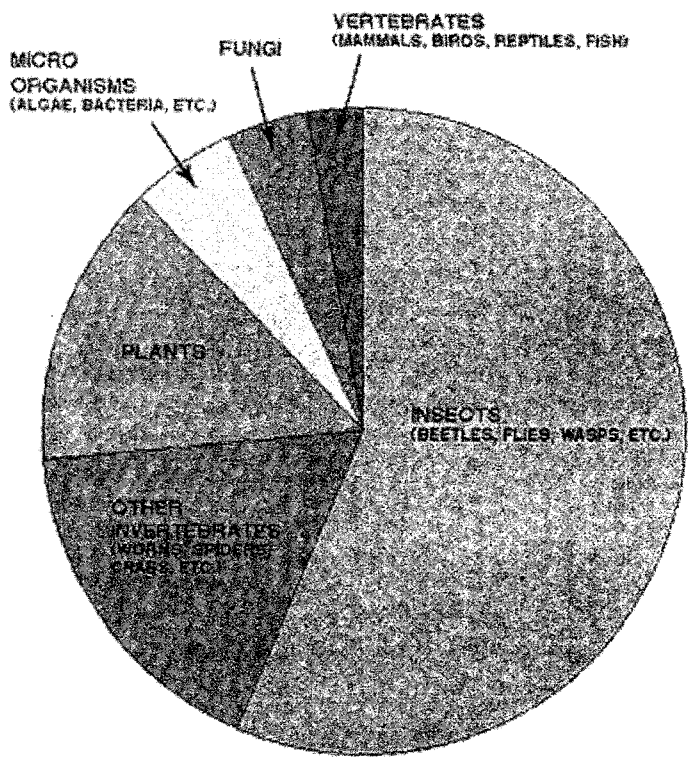

Fig. 7.1. Major groups of organisms: described species as proportions of the global total. Note that 73.6% of all organisms are invertebrates (pastel and light cyan blue).

While the actual number is greatly debated (Stork 1988, 1996; Hodkinson & Casson 1991, May 1990, and others), few specialists believe the total will be less than 8 million, enough species to keep taxonomists and natural historians busy for many generations to come, that is provided we are able to stabilize the impact of humanity upon the earth and provide more support for systematics development. Perhaps an unthinking person might feel that what we do not know we have lost will not hurt us. A more practical person would worry about loss of potentially useful information in the cause of humanity. A philosopher would call the loss of

the biodiversity of life an intellectual tragedy for the world.

7.2 Malawi's Invertebrate Biodiversity

How many species is Malawi likely to contain? Dudley (1996a, b) estimated that the country might have well over 100,000 species of insects. As insects make up approximately 85% of all invertebrates, this could mean that Malawi provides a home for nearly 118,000 species of invertebrates. These estimates were based on comparisons of the proportions of well documented groups and national faunas with those poorly known. There are serious potential flaws in the assumptions underlying these calculations, a principal one being that the proportions among compared groups remain relatively constant the world over.

Sheer numbers of species means only a tiny percentage can be studied in the detail needed. Population estimates have always been an imprecise and difficult job with invertebrates. Their distributions tend to be very patchy, while flushes of activity (e.g. emergence of adults, nuptial flights, etc.) are sporadic and often short-lived. Full geographic distributions are seldom known for any species and those of adults and immature stages of the same species may not match.

Nevertheless, no matter what the actual number of Malawi's invertebrate species is, it is several orders of magnitude bigger than the list of 9,197 species presently listed on Malawi's inventory (Table 7.1.) (Dudley 1997 and unpublished data). The data in Table 7.1 suggests that our information on Malawi's invertebrate biodiversity is rather uneven with better than expected knowledge of insects but much poorer that expected on flatworms, earthworms and leeches and spiders, mites and ticks. However, when one looks in a similar fashion within these groups (e.g. insects) a similar uneven pattern occurs.

Considering that there are probably less than a dozen invertebrate zoologists in Malawi, none of whom are taxonomists, the present information of the country's invertebrate biodiversity is unlikely to improve. In practice, it is often impossible even to recognize the numbers of species present in a given sample without having a specialist's knowledge of that particular group.

Table 1. A comparison of the numbers of species of invertebrates known for the world and Malawi for various groups. Numbers are rounded off to the nearest whole number and only include terrestrial and fresh water species. The expected number is what one might expect if our knowledge of all Malawi's invertebrate groups were at a similar level.

Phyla/Class (group)	World	Malawi	
		Recorded	Expected
Porifera (sponges)	150	2	1
Cnidaria (jellyfish)	100	3	1
Platyhelminthes (flatworms)	7,500	21	66
Nematoda (round worms)	13,000	112	116
Annelida (earthworms, leeches, etc.)	6,200	8	55
Mollusca (snails, clams, shellfish, etc.)	25,000	180	221
Other small soft bodied groups (threadworms, rotifers, etc.)	3,620	31	32
Arachnida (spiders, mites, ticks, scorpions, etc.)	73,000	360	646
Crustacea (crabs, zooplankton, schrimp, etc.)	18,000	158	159
Hexapoda (insects and their close relatives)	879,280	8,286	7784
Other arthropod groups (millipedes, centipedes, etc.)	13,160	36	116
Total Invertebrates	**1,039,010**	**9,197**	**9,197**

7.3 Malawi's Capacity in Understanding its Invertebrate Biodiversity

Information on invertebrate biodiversity is obtained from three sources; collections, scientific literature and specialist personnel, none of which is sufficient in the country.

The local invertebrate collections are poor and in taxonomic disarray (Dudley 1981). Collections, other than of insects, are almost non-existent. The best represented group, the insects, are better collected but remain a poor source of information on insect biodiversity. The collections are widely scattered, most are poorly curated, in declining condition and without the guidance of a professional taxonomist. There are no regular collection and identification activities. Species names on the specimens in local collections were mostly identified more than 30 years ago and undoubtedly include many incorrect and redundant names. Only a strong exchange policy and vigorous technical cooperation with outside taxonomic experts over some extended time can correct this problem

The number and types of literature relating to invertebrates is almost as diverse as its subject matter. In the last 25 years about 8,680 species of new insects are described annually (Erwin 1996)! Among some of these publications will be records and descriptions of new species from Malawi. How does one search this type of published diversity? In Malawi, the biodiversity literature on invertebrates is scattered throughout the country. This literature is very outdated and limited and is housed in various research institutions, none of which carries out invertebrate biodiversity work. Currently, no biological institution has any invertebrate systematic or biodiversity journals under subscription

Malawi has never had a resident invertebrate biodiversity expert (taxonomist), either local or foreign, and currently there is no professional invertebrate biodiversity specialist in the country. Traditionally, biodiversity work on Malawi invertebrates has been done either externally by European or South African museum- based taxonomists or (rarely) by foreign applied nematologists or entomologists in the course of agricultural project implementation in Malawi.

7.4 Invertebrate Biodiversity Conservation

It is not surprising then, that little is known regarding conservation status or endemism of most species. However, where a few popular taxa of invertebrates (e.g. molluscs, dragonflies, saturniid and sphinx moths, butterflies, scarab beetles) have been collected over many years in many places by many collectors, some idea of the conservation and endemism status can sometimes be ascertained. The same is true of a few important families with many pest species (e.g. mosquitoes, cutworm moths, grasshoppers). For other groups such as mites, spiders, nematodes, and flatworms, there simply is no information. Almost nothing is known of the distribution and threatened status of most organisms (Stork 1996). At a global scale, it can be said that nothing is known of the distribution of 86% of species, 7% are known just from one locality, only 7% are known from more than one locality, and the threat of extinction is known for less than 0.5%!

We are a very long way from this type of information for the great majority of Malawi's species of invertebrates.[5] What needs to be done in the meantime is to maintain the integrity of the relative undisturbed ecosystems in protected areas (Dudley 1996b, Mawdsley & Stork 1995). It is here that I can make some rather definite statements about conserving species. Nyika

[5]Presently, the 1996 IUCN Red List of Threatened Animals lists only eight species of invertebrates from Malawi. These are snails from Lake Malawi listed as vulnerable (*Bulinus nyassanus*) or endangered (*Bellamya ecclesi, B. jeffreysi, B. robertsoni, Lanistes nasutus, L. nyassanus, L. solidus*, and *Bulinus succcinoides* (Baillie & Groombridge 1987).

National Park, Viphya Plateau, Mughese Forest Reserve (in the north), Kasungu National Park and Ntchisi Forest Reserve (in the centre) and Liwonde National Park, Zomba Plateau and Mulanje Forest Reserve (in the south) all have made major contributions to new species of invertebrates (principally insects). They are also home to many of the other species known from Malawi. Isolated, ecologically intact and variable, forested and intensively collected are some of the characteristics why these areas are important. If the elephants of Kasungu and Liwonde are lost, all arthropods intimately associated with their dung (hundreds of species) are lost. If the evergreen forests of Nyika or Mulanje are lost, 10,000s of species will become extinct whether we know what they were or not. Then there is Lake Malawi, home to so many species of endemic fish. Are their crustacean and worm parasites also endemic? These ecosystems must be preserved if substantial portions of Malawi's invertebrates are to survive.

While protected areas are important in conserving a full range of invertebrate species, customary land contributes its share and this should not be overlooked. Traditional cultivation does not clean an area of all competing plants. Indigenous trees and shrubs and coppiced woody plants are generally left at the edges of cultivation or rejuvenate after fallow. How much of the invertebrate biodiversity is retained of the original woodland (i.e. Brachystegia, mopane woodlands) is not known, but it may be substantial. Modern 'clean' forming or greatly reduced fallow rotation time would reduce the remaining fauna considerably. Invertebrate species, particularly certain groups of insects, can be useful as indicators of environmental change. Comparable biodiversity data from 'natural', managed and traditional agricultural lands are very few (Holloway & Stork 1991).

7.5 Social Importance

Invertebrates, such as free-living nematodes, earthworms, soil mites and beetles, play a major beneficial role in the ecosystems by maintaining soil structure and fertility. In addition, parasitic nematodes and cestodes and numerous species of wasps, predaceous beetles, mites, and flies control or regulate populations of pests and thereby contribute to increased agricultural production. Insects as principal pollinators of most crops (fruit, vegetables and most flowers) also contribute to agricultural production. Crustaceans and insects are significant contributors to aquatic food chains within Lake Malawi and maintain the lake's natural productivity.

Invertebrates are also important producers of such products as lac, wax, silk, honey, pearls and valuable biochemicals. In addition, termites, insect larvae, locusts, grasshoppers and molluscs are a source of protein to most Malawians.

On the other hand, invertebrates also have a negative impact on human society and on its economy. The majority of human, crop and livestock pest and disease vectors, for example, are invertebrates. Invertebrates also can produce toxins and act as reservoirs and sinks for some persistent toxic compounds resulting in their accumulation in food chains. Consequently, it is vital that we can identify and understand them accurately.

The above presentation of the importance of invertebrates to human welfare is general. One could record species under all the above categories for most countries of temperate and tropical latitudes. Malawi, as a tropical country of Africa with a high diversity of invertebrate species, also has a large number of species in both the 'good' and the 'bad' groups. What it does not have is a great deal of information regarding these species.

7.6 Conclusion

The invertebrate biodiversity of Malawi is substantial and, because of its great variation in habitats, perhaps greater than would be expected for such a small country. But, as is true for

most developing countries in the tropical world, most of it is unknown. Malawians utilize many invertebrates for food. Yet, there is no list of these species available. Such a list is well beyond the scope of this investigation but it should be documented. How do traditional and modern farming methods affect *in situ* invertebrate diversity? How do these areas compare with intact ecosystems? What system is best? What are the major losses? We do not know. What are the losses to the ecosystem once plantations of bluegum or pine are established? What native invertebrates are intimately associated with important endangered trees such as Mulanje Cedar? How important are crustacea to the fish food chain of the lake and how important are their parasites to fish production? We do not have a listing of the vectors of livestock and human diseases nor a list of all parasitic worms of importance to human and livestock health. We do not really have a comprehensive list of the major and minor pests of important crops. What are the species of invertebrates (both 'good', 'bad' and 'neutral' species) introduced into this country over the last 50 years? We do not know. What we do not know is many magnitudes more than what we do know!

A beginning to finding answers to all these questions, including the big one, "What is Malawi's invertebrate biodiversity?", would be to create an institution whose mandate is to create a national centre for the assemblage, growth, curation and classification of a comprehensive collection of invertebrates of Malawi. Unless such an institution is established I see little hope in answering any of the questions posed above in any real professional and holistic manner. Current collection resources, both identified material and the present available literature, will continue to decline in numbers, condition, value and, thus, in usefulness.

7.7 References Cited

Baillie, J. & B. Groombridge (eds.) (1996) *IUCN red list of threatened animals.* IUCN Species Survival Commission, 368pp.

Dudley, C. O. (1981). The status of insect identification services and insect collection resources in Malawi. *Insect Sci. Application* 1(4):447-449.

Dudley, C. O. (1996a) How many insect species does Malawi have? *Nyala* 19:13-17.

Dudley, C. O. (1996b) The invertebrates of the Lake Chilwa Basin. In: K. van Zegeren & M. P. Munyenyembe Ieds.). *The Lake Chilwa environment. A report of the 1996 Ramsar Site Study.* Department of Biology, Chancellor College, Zomba, pp72-90.

Dudley, C. O. (1997) *An inventory and bibliography of the invertebrate biodiversity of Malawi, Volume one.* Consultant report for Malawi Biodiversity Country study: Indigenous animals (Invertebrates). Department of Environmental Affairs, Lilongwe, 16pp.

Dudley, C. O. & Phiri, G. (2004) *A revised proposal to establish a national insect collection and identification service in Malawi.* Museums of Malawi, Blantyre, 14 pp typescript.

Erwin, T. L. (1982) Tropical forests: their richness in Coleoptera and other arthropod species. *Coleopt. Bull.* 36.74-75.

Gaston, K. J. (1996) 1.0 What is biodiversity?, pp1-9. **In:** K. J. Gaston (ed.) *Biodiversity of numbers and differences.* Blackwell Science, London, 396pp.

Hammond, P. (1992) Species inventory, pp 17-39. In: B. Groombridge (ed.) *Global biodiversity: status of the earth's lining resources.* Chapman and Hall, London, 585 pp.

Hodkinson, I. D. & Casson, D. (1991) A lesser predilection for bugs: Hemiptera (Insecta) diversity in tropical forests. *Biol. J. Linn. Soc.* 43:101-109.

Holloway, J. D. & Stork, N. E. (1991) The dimensions of biodiversity: the use of invertebrates as indicators of human impact, pp 37-62. In: D. L. Hawksworth (ed.) *The biodiversity of microorganisms and invertebrates: its role in sustainable agriculture.* CAB International, London.

Mawdsley, N. M. & Stork, N. E. (1995) Species extinctions in insects. ecological and biogeographical considerations, pp 322-369. In: R. Harrington & N. E. Stork (eds.) *Insects in a changing environment*. Academic Press, London.

May, R. M. (1990) How many species? *Phil. Trans. R. Soc. Lond. B.* 330:293-304.

Minelli, A. (1993) *Biological systematics: the state of the art*. Chapman & Hall, London, 387 pp.

Stork, N. E. (1988) Insect diversity: facts, fiction and speculation. *Biol. J. Linn. Soc.* 35:321-337.

Stork, N. E. (1996) Measuring global biodiversity and its decline. In: M. L. Reak-Kudla, D. E. Wilson & E. 0. Wilson (eds.) *Biodiversity II. Understanding and protecting our biological resources*. Joseph Henry Press, Washington, D. C., pp 41-68.

Stork, N. E. & Gaston, K. G. (1990) Counting species one by one. *New Scientist* 1729:43-47.

8.0 MUSHROOMS

Gerald Meke
Forest Research Institute of Malawi

Eric Boa
CABI Biosciences

8.1 Introduction

Fungi are a distinct yet varied group of organisms now classified in their own kingdom. Where once they were described uniformly as 'plants without chlorophyll', today their true origins are recognized to be highly diverse and more closely related to animals (Margulis & Schwartz 2000). They cannot produce their own food and rely on a variety of mechanisms from using dead organic material (saprobes) to attacking living organisms (pathogens) to survive. Many, if not most, are microscopic, invisible to the naked eye. Others form large fruiting bodies commonly referred to as mushrooms.

There are over 71,000 known species of fungi (Hawksworth 1992). However, Hawksworth (1991) conservatively estimates that the total will reach at least 1.5 million species. The largest and most easily seen species belong to two groups, known scientifically as the Basidiomycota and the Ascomycota. The basidiomycetes includes about 30,000 of species worldwide and contains almost all the edible mushroom species found in Malawi, many of which are used as food. Although mushroom is the common term used to refer to this species, many do not have a typical stalk and cap and also lack the gills. We prefer the more general term of 'wild edible fungi'.

There are also nearly 33,000 species of ascomycete but few are eaten in Malawi. The most valuable types are the truffles and in particular tuber species. Truffles develop below the soil level and are best found using animals trained to detect their powerful aroma. Species in this group will not be discussed here and our report will emphasise the mushroom producing basidomycetes.

8.2 Role of Mushrooms

In Malawi mushrooms play various roles in the ecosystem as well as directly sustain the livelihoods of people. A very small number of edible species also cause plant diseases, of which *Armillaria mellea,* a serious pine plantation disease, is perhaps the best known example occurring in Malawi. Other mushroom species cause decay of wood though few are edible. The vast majority of mushrooms can be eaten, though only selected species are especially tasty. There are a very small number of toxic species which, if eaten, can cause major damage to people. Others are simply poisonous when raw but this property is shared with many common food crops, for example cassava. The highly poisonous, *Amanita phalloides*, can be confused with similar edible species in the same genus. The limited number of poisonings which do occur are commonly associated with children or adults with declining awareness of local knowledge.

Mushrooms play a very important ecological role of nutrient recycling by decaying dead materials. Mushrooms are also extensively used for food. In Malawi this is the most obvious role in the rainy season. Many species of mushrooms are collected in woodlands and termite mounds for home consumption or for sale. Over 70 species are collected for food in Malawi.

Table 8.2 (at the end of this chapter) lists some of the known edible mushroom species in Malawi.

8.3 Biodiversity

The biodiversity of fungi in Malawi is not well known. There are over 500 records of fruit body producing fungi and several records of non-fruit body producing fungi (Malawi Government 2004). Unlike plants and animals, the study of fungi in Malawi has been concentrated on disease-causing fungi of Malawi's major corps such as maize, rice, cassava and cotton for the purposes of control. The early white settlers who associated mushrooms with death did not do any extensive collection and identification. Most extensive wild fungi collections were done in the late 1970s and again between 1979 and 1981 by the late Solomon Chipompha a plant pathologist (1985) and more recently by Brian Morris (1987, 1990), a British antholopopogist. Another extensive collection was made by Paul Kirk, Eric Boa and Gerald Meke between 1999 and 2000. Since then there have been several collections targeted at edible mushroom species (Boa 2003, Meke 2004, Meke *et al.* 2003).

8.4 Endemism and Threat to Biodiversity

Different vegetation types are associated with different mushroom species in Malawi. Open areas with termite hills or with a lot of termite activity are associated with a special species of mushrooms called *Termitomyces* species. While miombo woodlands are associated with a wide variety of mushroom species some of which form a special symbiotic relationship called mycorrhiza like most *Amanita* species. Some are saprophytic, like *Auricularia* species, and while others are parasitic, like *Armillaria* species. However, there has not been any deliberate effort to specifically study distribution of different mushroom species in Malawi. Most of the studies conducted so far have been targeted at specific areas, in which case, documentation of species in these particular areas does not mean that they are endemic to these areas.

The only statement that can be said in terms of threat to biodiversity of mushrooms species is that general deforestation will lead to disappearance of mushroom species that form special mycorrhizal relationship with trees or those that are obligate parasites. Opening of timber plantations in miombo woodlands has undoubtedly resulted in decline of 'native' mushroom species yet there have also been introductions of new species, some with a high commercial value. *Boletus edulis* and *Suillus granulatus* are both edible and particularly the former is a highly prized mushroom in Europe.

8.5 Mushroom Populations

The population levels of different mushroom species have not been well studied in Malawi. However some effort has been made to quantify the productivity of some edible mushroom species for the purposes of management (Table 8.1). In areas where the Forest Department would like to issue a collection permit to a company they may need productivity to cost the concession of the particular area. The productivity data that has been collected so far shows that mushroom productivity is very erratic. Productivity changes from area to area and from season to season. The amount of mushrooms that is produced does not necessarily relate to the population density of that particular species in that particular area but rather the availability of right conditions for it to produce fruiting bodies. The number of species of fruiting bodies produced in an area does not necessarily represent the total diversity of mushrooms in that area, it only represents species that had the right conditions to fruit. In other words, we are saying that there are many species of fruiting fungi that are present in the soil which may not fruit in most years.

Table 8.1: Mushroom productivity measured in Liwonde Forest Reserve in 2002.

Mushroom taxa	Mean kg ha^{-1}
Amanita loosii	0.972
Amanita mafingensis	0.82
Cantharellus cibarius	4.616
Cantharellus congolensis	2.24
Cantharellus longisporus	19.722
Clavaria albiramea	10.344
Cymatoderma dendriticum	4.65
Inocybe sp.	2.224
Russula atropurpurea	4.198
Russula schizoderma	9.49
Russula sp. (LIWUWULA)	0.62
Russula sp. (DODOLIDO)	4.08
Termitomyces sp.	0.12

8.6 Status of Mushroom Collections

Mushroom collections in Malawi are either deposited at the National Herbarium and Botanic Gardens or the Forestry Research Institute of Malawi. As is common with most natural history collections the largest number of specimens can be found in European museums in United Kingdom, France and Belgium.

8.7 Conservation Efforts

There are no specific efforts to conserve particular mushroom species in Malawi. The general drive has been total conservation of areas marked as forest reserves, national parks or game reserves. Even within the conservation areas, mushrooms are not protected as people are allowed to collect for food and sale. Mushrooms have been likened to fruits on a tree. If you collect the fruits, the tree will not be affected. The only danger is the method of collection where you have large numbers of people trampling, thereby compacting the soil, or digging and racking the soil, thereby disturbing the mycelium.The lack of mycologists in the country has limited the study of mushrooms. Consequently, it has not been possible to establish their conservation status to the same level as that for plant species.

8.8 References Cited

Boa, E. (2003). *Miombo edible fungi.* Final Technical Report, CABI BioSciences.

Chipompha, S. (1985). *Some mushrooms of Malawi.* Association for the Advancement of Science of Malawi, duplicated, 11p

Hawksworth, D. K. (1991). The fungal dimension of biodiversity: magnitude, significance and conservation. *Mycological Research* 95:641-645.

Hawksworth, D. K. (1992). 6. Microorganisms, pp. 47-54. In: B. Groombridge (ed.) *Global biodiversity, status of the earth's living resources.* Chapman Hall, London.

Malawi Government (2004). Department of Research and Environmental Affairs, Lilongwe, Malawi.

Margulis, L. & Schwartz, K. V. (2000). *Five kingdoms: An illustrated guide to the phyla of life on earth,* third edition. Freeman and Company, New York, 520pp.

Meke, G. 2004. Mushrooms, pp 87-93. In: C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

Meke, G, Chapama, H., Mawdesley, K., & Wong, J. (2003). Using local knowledge as a basis for stratification of inventory sites: wild mushroom inventory in Liwonde Forest Reserve, Malawi. In: J. Wong, J., Ndeckere-Ziangha & Pouakouyou, D. (eds.) *Summary of six case study reports as a contribution to development of practical techniques to assess non-wood forest product resources.*

Morris, B. (1987). *Common mushrooms of Malawi.* Fungiflora, Olso, Norway, 103pp.

Morris, B. (1990). An annotated check-list of the macrofungi of Malawi. *Kirkia* 13(2):323-364.

Rammeloo, J. & Walleyn, R. (1993). *The edible fungi of Africa South of the Sahara. A literature Survey.* Spripta Bot, Belgica, 5:1-62.

Table 8.2: List of edible mushroom species recorded in Malawi

Order	Species	Local names	Growing habitat and general remarks
Agaricaceae	*Agaricus bingensis*	Chifwifwi	Collected from Zomba Plateau. Found on decaying litter and around termite mounds
Agaricaceae	*Agaricus bisporus*		The cultivated species
Agaricaceae	*Agaricus campestris.*	Utale, nakasachi, nkolakola, kalisachi	Common field mushroom
Agaricaceae	*Agaricus croceolutescens*		Wide spread in Malawi. Edible in Mulanje
Agaricaceae	*Agaricus* sp JW571	Msolo wa nkhwali	
Agaricaceae	*Macrolepiota dolichaula* (This species is often confused with *Chlorophyllum molybdites)*	Nkhotwe, namandaderengwa, utenga, ndelema, tambala, katelela	Common in grasslands between November and January.
Agaricaceae	*Macrolepiota procera*	Njovu	Common in open grassland and woodland
Agaricaceae	*Micropsalliota brunneosperma*	nyozwe, ujonjo	Common in *Brachystegia* woodland. Recorded in Blantyre.
Amanitaceae	*Amanita annulatovaginata*	nakajongolo, kamchizgombo	Malosa Mountain, Zomba, but common in *Brachystegia* woodland
Agaricaceae	*Amanita bacata*	Degadega, Bongololo	Mulanje and Zomba associated With *Uapaca* and *Brachystegia* woodland
Amanitaceae	*Amanita bingensis*	nakajongolo, msongolo wa nkhali, utenga, tambala, ndelema, katelela.	Common in the Shire Highlands, *Brachystegia* woodland
Amanitaceae	*Amanita calopus*	kachitosi	Thyolo, common in *Brachystegia* woodland. Considered edible
Amanitaceae	*Amanita* cf *robusta*		Not listed edible by Morris (1990a) Listed edible by Rammeloo *et al.* 1993. Collected In Mzuzu.
Amanitaceae	*Amanita elegans*	Bongololo, nakatosi, Katalesya	Zomba, grow in *Brachystegia* woodland
Amanitaceae	*Amanita flammeola*	Pezupezu	*Brachystegia* woodland
Amanitaceae	*Amanita fulva*	pezupezu	Mzuzu, associated with evergreen forest
Amanitaceae	*Amanita goossensiae*	nakajeti	Malosa in Zomba, Considered Edible.
Amanitaceae	*Amanita hemibapha*	Katele, kalongonda, katsobola, dzanje, ndezu, kambalame, utenga, ndelema, tambala, katelela	Common in *Brachystegia* woodland Chongoni in Dedza, Common in *Uapaca-Brachystegia* woodland
Amanitaceae	*Amanita loosii (zambiana)*	utenga, sandji, tambala, ndelema, katelela	*Brachystegia* woodland. Zomba and Machinga
Amanitaceae	*Amanita rhodophylla*	ndelema, utenga, tambala, katelela, ndelema	Common in *Brachystegia* Woodland
Amanitaceae	*Amanita rubescens*	ndodzi	Savanna woodland Lilongwe, Dzalanyama
Amanitaceae	*Amanita vaginata*	Ndezu, bongololo, nakasuku, nakatelesya, Utenga	
Amanitaceae	*Termitomyces aurantiacus*	chanjira upya	Common in open woodlands near paths. Zomba
Amanitaceae	*Termitomyces clypeatus*	Nyozwe, uzuma, utothi, ujonjo, nakasuguli, manda, chikumbakumba, nakasowu, chanjira upya, kanchombo	All species in this genus are edible and they occur around active anthills
Amanitaceae	*Termitomyces eurrhizus*	kasale, nthando, kachofu, nakateresya, utembo, uwumbu, mazumbikira, ntoromwe, namatokhu, kanchombo, kamubvi, tholomwe, utale, bambomuluzu	Occurs singly or in clumps in grass on or next to an anthill. Common throughout Malawi
Amanitaceae	*Termitomyces* letestui	utali	Chimaliro, Kasungu
Amanitaceae	*Termitomyces microcarpus*	kamubvi, manda, kalumwe, ujonjo, nyozwe, namaturwa, namarokokho, mlyayuni	Grow in clumps over large areas, especially where termites have been active as at anthills.

Amanitaceae	*Termitomyces robusta*	kasale, nthando, kachofu, nakateresya, utembo, uwumbu, mazumbikira, ntoromwe, namatokhu, kanchombo, kamubvi, tholomwe, utale	
Amanitaceae	*Termitomyces schimperi*	ndiwo, nyozwe wa mkulu, usinda wa mkulu, namowe manandadarengwa, mazumbikira, nakasowo, toromwe, ujonjo, lilangwi	*Brachystegia* woodland. Zomba and Mulanje.
Amanitaceae	*Termitomyces* sp Jw602	kanchombo, kachofu	
Amanitaceae	*Termitomyces striatus*	kasale, kaufa, nakateresya, chanjira upya	Common in *Acacia-Brachystegia* woodland. Ncheu
Amanitaceae	*Termitomyces titanicus*	utale, bambomuluza, katsokomole	May occur in Malawi.
Auriculariaceae	*Auricularia auricula*	matwe, makutukulu, khutulanjobvu	Possibly found all over Malawi. Mulanje on dead wood in evergreen forest.
Boletaceae	*Pulveroboletus aberrans*	Mpafa yafulu, mphamfa, mphafa	Zomba, Grows singly in *Brachystegia* woodland.
Boletaceae	*Suillus granulatus*	mphafa, kapasa, mphafa yafulu, mphamfa	Mycorrhizal fungi, common in *Uapaca* woodland.
Boletaceae	*Suillus luteus*	gundamsuku, niphimbiri	Mycorrhizal fungi, common in pine plantations.
Cantharellaceae	*Cantharellus cibarius*	Manyame, chipatwe cho yera, mnofu wa nkhuku, nakachipande, gundasuku	Common in *Brachystegia* woodlands throughout Malawi.
Cantharellaceae	*Cantharellus densifolius*	Ngundasuku woyera	Found in *Brachystegia* woodland And in plantations of pine and *Eucalyptus*
Cantharellaceae	*Cantharellus longiporus*	Ngundasuku, nakasuku, kumelo kwa nang'omba, kungulo kwetiti, mnofu wa nkhuku, umera wadendera	
Cantharellaceae	*Cantharellus tenuis*	msogolo wa nkhwali, kasanjala, kanjala	Common in *Brachystegia* woodland. Recorded from Mzuzu, Mzimba.
Cantharellaceae	*Cantharellus congolensis*	Nakambuzi, makunguta, masutwe ya fipa, chipatwe chakuda	Common in *Uapaca-Brachystegia* woodlands. Recorded from Mzuzu, Mzimba.
Clavariaceae	*Clavaria albiramea*	kabvisaza, kasanza, masanjala, nakasachi, kalisachi, nakambi	Common in woodlands
Coprinaceae	*Coprinus disseminatus*		Found on leaf litter. Collected in Zomba. Normally cooks away to almost nothing.
Coprinaceae	*Coprinus disseminatus* (Chipompa, 1985, reported this species as *C. Africanus)*		Found on litter or stumps of deciduous trees. Recorded in Zomba
Coprinaceae	*Psathyrella atroumbonata*	Ujonjo, nyozwe, chamasala, ujonjo	Associated mainly with leaf litter forest debris in woodlands. Recorded in Zomba.
Coprinaceae	*Psathyrella candolleana*	Nakasukali, nakasuguli, kanchombo, nyozwe, ujonjo	Found in clusters around tree stumps and litter. Recorded in Blantyre.
Cortinariaceae	*Inocybe* sp.	Ulundi	*Brachystegia* woodland. Recorded in Zomba. Most members in Europe are poisonous.
Gyrodontaceae	*Gyroporus castaneus*	Kasanga	Common in *Uapaca-Brachystcgia* woodland.
Gyrodontaceae	*Gyroporus luteopurpurens*	Kamchikuni	Lilongwe, *Uapaca-Brachystegia* woodland
Gyrodontaceae	*Phaeogyroporus portentosus*	Mpafa ya fulu	Associated with *Uapaca* woodland. Recorded from Lilongwe.
Gyrodontaceae	*Phaeogyroporus (Phlebopus) colossus*	Ngoma wa nyani, mpafa yafulu, mphamfa, mphafa	Mulanje, common in *Brachystegia* woodland
Gyrodontaceae	*Phaeogyroporus colossus*	ngoma wanyani, mpafa yafulu, mphamfa, mphafa	Usually found in forest debris. Recorded from Mulanje.

Lentinaceae	*Lentinus cladopus*	nakatasi, kamsempha, chintsempha,	Common in *Brachystegia* woodlands
Lycoperdaceae	*Calvatia utriformis*		Erroneously quoted edible from Morris (1990a) by Rammeloo *et al.* (1993). But it is not edible in Malawi.
Pluteaceae	*Volvariella volvacea*		Found in a garden in Mzuzu, Mzimba. Said to be edible in East Africa.
Podoscyphaceae	*Cymatoderma dendriticum*	Nakakanyama, kanyama, masanjala, kalisachi, nakasachi, makunguta, magunguguli	Found growing on stumps and dead wood lying on the ground in *Brachystegia* woodlands.
Podoscyphaceae	*Stereopsis hiscens*	kanjedza	Dedza, Growing on old stumps in *Brachystegia* woodland
Russulaceae	*Lactarius gymnocarpus*	Kungulo kwetiti, kamsuku, nkwichi	Common in Zomba
Russulaceae	*Lactarius kabansa*	longolwe	Chimaliro
Russulaceae	*Lactarius* sp BM131	ngundasuku, nakasuku	
Russulaceae	*Lactarius* sp JW563	Kambwalo, kamphande	
Russulaceae	*Lacterius vellereus*		
Russulaceae	*Lactarius* sp Jw581	Nyame, ching'ambe, kadyam'lero	
Russulaceae	*Russula atropurpurea*	Chipindi, kafidi, namichombo	Common in *Brachystegia* woodland
Russulaceae	*Russula cyanoxantha*	Terenyawofira	Mulanje and Zomba, Savannah woodland
Russulaceae	*Russula delica*	Kamanthova, utenga, ndelema, tambula, katelela	Lilongwe (Bunda), associated with *Uapaca-Brachystegia* woodland.
Russulaceae	*Russula lepida*	kafidi, mkodzo wa galu	*Uapaca-Brachystegia woodland.* Recorded from Zomba.
Russulaceae	*Russula ochroleuca*	terenya woyera, terenya wa chikasi, Nakupeya	Mulanje, noted in *Brachystegia* woodland
Russulaceae	*Russula schizoderma*	usinda, chipindi, yiti, usinda, mkadzadzulo, lilangwi	Widespread in *Brachystegia* woodland. Recorded in Zomba.
Russulaceae	*Russula* sp JW578	lilangwi, Yiti, usinda, mkadzadzulo,	
Russulaceae	*Russula* sp JW593,580	namaloba	
Schizophyllaceae	*Schizophyllum commune*	Kalisachi, nakasachi	Mulanje, grows on dead wood in *Brachystegia* woodland
Strobilomycetaceae	*Afroboletus luteolus*		Wide spread in Malawi. Possibly edible. Recorded from Zomba.
Strobilomycetaceae	Strobilomyces costatispura	Mpando wa fisi, fisi	
Tricholomataceae	*Armillaria mellea*		A parasite on plantation crops.
Tricholomataceae	*Collybia dryophila*	Mangunguli	Introduced. Found in Zomba and Mulanje associated with pines in high altitudes
Tricholomataceae	*Collybia* sp Jw662	Kwasanga	
Tricholomataceae	*Lepista caffrorum*		Edible in South africa. Common under mbawa trees (*Khaya anthotheca*)
Tricholomataceae	*Mycena* sp. Jw697	Chamasala, ujonjo, nyozwe	Zomba, Found on forest litter in evergreen forest
Tricholomataceae	*Oudemansiella radicata*	Chidwali	Introduced in Malawi, found in Zomba and Mulanje in grasses at the edge of rainforest
Tricholomataceae	*Tricholoma lobayense*	Utothi	Grow in tufts at base of tree trunks
Tricholomataceae	*Xerulina lachnocephala*	nkalanganji	Mulanje, grows on dead wood in evergreen forests.
Xerocomaceae	*Xerocomus soyeri*	Gundamsuku, amape, mpafa yafulu	Common in *Uapaca* woodlands.
Xerocomaceae	*Xerocumus pallidoporus*	ngunda ngulube	Zomba Malosa mountain and Domasi, Lilongwe Bunda. Associated with *Uapaca-Brachystegia* woodland.

Source: Boa 2002

9.0 BIODIVERSITY OF MULANJE MOUNTAIN

David A.N. Nangoma, Biodiversity Programme Officer
Mulanje Mountain Conservation Trust (MMCT)

9.1 Introduction

The more conventional definition of Biological Diversity, (hereafter known as 'Biodiversity') focuses on the variety of living organisms and the relationship with the environments in which they occur. In simple terms, it refers to the number of different organisms (plants and animals of any form), their relative abundance, and the interaction with their habitats. This diversity is organized from various levels, such as chemical structures that are the molecular basis of heredity (genes) to complete ecosystems. The term therefore encompasses different genes, species, ecosystems and their relative abundance (National Research Council, USA 1992).

There are eight ecological zones in Malawi (Cumming 1999 in Government of Malawi 2002a) with vegetation classified into at least 19 distinct communities (Kachule & Tchale 1999). In the case of Mulanje District, with a total area of 3,450km^2, its biodiversity can be largely associated with the Mulanje Mountain Forest Reserve (MMFR), which has Malawi's highest levels of terrestrial biodiversity. The rest of Mulanje District is highly populated (approx 185 people/km^2), leaving a few relicts of indigenous *Brachystegia* woodlands, lowland evergreen forests, and a number of riverine systems incorporating unclassified biodiversity richness. Forest cover only accounts for 12% of the total land area (Government of Malawi, 2002b).

The vegetation of Mulanje has been described, following species composition, at varying altitudes with combined effects of local variations in soil, climate and human influence. In total, nine vegetation types can be identified (Dowsett-Lemaire 1989a,b). These include the lowland grassland vegetation below 700m comprising dambos and marshes; the *Brachystegia* (miombo) woodlands and lowland semi-evergreen forests both lying at 700 900m; the medium altitude evergreen forests at 900 1,600m; the montane evergreen cedar forests; the sub-montane evergreen forests and the grasslands and secondary scrub vegetation lying at 1,600 2,400m; and an ericaceous belt lying over 2,400 3,000m above sea level. Within these vegetation bands exist a vast array of plant and animal life and life forms that constitute the biodiversity of Mulanje District.

9.2 Relevance of Mulanje Biodiversity to the Nation

The importance of Mulanje flora and fauna cannot be over-emphasized. From the local perspective, it provides the basic livelihoods for the majority of communities living around the mountain. They fetch food and fodder, fibre, medicinal plants, as well as construction material. To the hunting communities, it is a source of protein and also income. It provides virtually everything that nature can provide to humankind.

On the national scale, the flora and fauna constitute the basis for much conservation work. It not only provides an economic base through tourism and direct harvest of plant and animal material, but also puts Malawi on the regional and international map in terms of its biodiversity uniqueness in this Afro-montane region. From a scientific point of view Mulanje biodiversity provides a representation of characteristic taxa that relates to the phytogeography of the Africa region south of the Cameroon Mountains. Therefore the Mulanje taxa constitute a phytogeographical mixture of the north and south compositions increasing the need for its conservation.

In addition, Mulanje Mountain Forest Reserve is a designated Global Biosphere Reserve under the Man and the Biosphere Programme of UNESCO. Hopefully it will also soon be designated a World Heritage Site. This recognition is on the basis of the uniqueness of the mountain's biodiversity and this is highly significant to Malawi as a nation.

9.3 Endemic and Threatened Species

Dudley (1999) defines "endemic" species as indigenous and restricted to a particular geographical location whereas "near endemic" species refer to a species, again, of a very restricted location (i.e. a mountain). Nevertheless, endemic and near endemic species, are generally rare, have restricted distribution, and are found in environments under pressure. They are therefore biologically valuable and the focus of conservation attention. Mulanje is known to contain a considerable number of endemic and near endemic species (and subspecies) that are mostly threatened.

9.4 Type of Species and Quantity:

Flora: It is estimated there are 1,303 naturally occurring and naturalized taxa comprising 138 families of gymnosperms and angiosperms from a total of 622 genera recorded for Mount Mulanje alone. Out of these, 69 taxa are categorized as endemic and a further 25 taxa as having very restricted ranges (near endemics) and 13 taxa with slightly wider but disjunct distributions (Strugnell 2002).

Recent work has shown that up to five endemic tree species are found on Mulanje (on the Massif). The list includes *Widdringtonia whytei, Pyrostria chapmanii, Vepris elegantissima, Podocarpus latifiouse, Encephalartos gratus* and *Buxus nyasica* but excludes *Rawsonia burtt-davyi* which is no longer considered endemic to Mulanje due to recent taxonomic revisions.

The majority of endemics in Mulanje are herbs, grasses, and small woody plants (Strugnell 2002) although it should be mentioned that it is very likely there are a lot more potential endemic species that are not as yet identified. The lower plant taxa, Pteridophytes (ferns) and Bryophytes (liverworts), are particularly poorly known in this respect. To-date, just slightly over 110 species of the fern flora is known.

Two tree species require special management attention. These are *Widdringtonia whytei* and *Punus africana.* The latter is restricted to montane forests of Madagascar and Africa and is seriously threatened by the trade in its bark, extracts of which are used worldwide to treat prostate conditions. On the massif, *P. africana* grows at relatively low altitudes (560m1,250m) and, therefore, is vulnerable to exploitation. With respect to *W. whytei,* a total area of 845.3 ha. On the mountain has been estimated as currently occupied by cedar clusters. Stocking levels vary from place to place, ranging from 41136 stems/ha (Makungwa 2004, Fig. 9.1).

Fauna: The larger animal species in the two Districts of Phalombe and Mulanje are principally confined to the Mulanje Mountain Forest Reserve, although some can be found in the few forest remnants and forest patches and aquatic habitats that surround Mulanje Mountain, hence the importance of the fauna populations of the MMFR which are under a great deal of pressure from hunting and trapping (Environmental Development Group (EDG) 2000).

Vertebrates: Ansell *et.al.* (1988) provides a total of 66 mammal species known to occur (or to

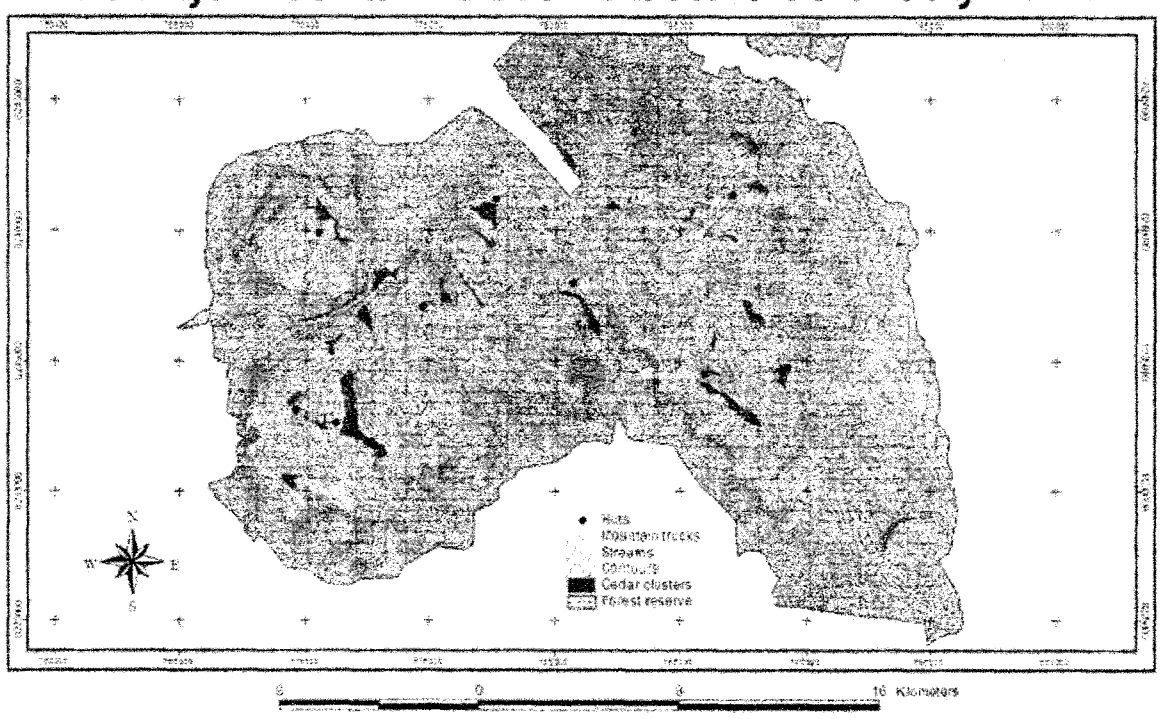

Fig. 9.1: A map showing Mulanje Cedar distribution, Mount Mulanje Forest Reserve, Malawi.

have occurred) on Mulanje, a few of which are either rare or merely isolated. These include the Leaf-nosed Bat (*Eptesicus flavescens*), a rare and very isolated species, the Four Striped Mouse (*Rhabdomys pumilio*), a rare and isolated species and another type of mouse *Aethomys namaquensis,* again an isolated species. Recent studies conducted on the mountain have potential to reveal new records, especially of the small mammals.

An estimated 300 bird species are known to inhabit the woodlands and forests of Mulanje Mountain. Twenty-two out of fifty-six endemic species to the Afro-montane Archipelago of the Usambara-Mulanje System breed on Mulanje. The following bird species should have special mention: the Stripe-cheeked Bulbul, *Andropadus m. milanjensis* (near endemic); the Olive Flanked Robin, *Cossypha a. anomala* (near endemic, very isolated); the Natal Thrush, *Tardus fischeri belcheri* (near endemic, rare); the Black Headed Apalis, *Apalis melanocephala fuliginosa* (near endemic); the Bar-throated Apalis *A. thoracica flaviguluris* (near endemic, rare and very isolated); the White Winged Apalis, *A. chariessa* (rare, very isolated); the Olive Bush Shrike *Malaconotus olivaceus* (near endemic and rare) (Johnstone-Stewart 1984, Dowsett-Lemaire 1989a,b, Dowsett-Lemaire, Dowsett & Dyer 2001).

There are 25 species of lizards, 31 snakes and 33 frog species known to occur on the mountain above 900m (Broadley 2001). Several of these have changed their taxonomic status but known endemics include the Mulanje Dwarf Gecko, *Lygodactylos bernardi bonsi;* the King Dwarf Gecko, *Lygodactylus rex*; the Mulanje Slender Skink, *Proscelotes mlanjensis*; the Mulanje Flat Lizard, *Platysaurus mitchelli*; the Mulanje Rock Skink, *Trachylepis mlanjensis*;

the Black Limbless Skink, *Melanoceps ater*; the Mulanje Striped Skink, *Mabuya gruetzneri mlanjensis*; the Variable Skink, *Mabuya varia* and the Mulanje Small-limbed Skink, *Scalotes arnoldi mlanjensis.*

The Mulanje Dwarf Stump-tailed Chameleon, *Rhampholeon platyceps*, is common on undergrowth in the cedar forests and grasslands on the summit. It is endemic to Mulanje Massfi. The Mulanje Forest Chameleon, Chamaeleo mlanjensis, is another endemic (Broadley 2001)

Only one sub-species of snake, out of a total of 34 species (the Mulanje Cross-barred Tree Snake, *Dipsadoboa flavida flavida*) is endemic to Mulanje. In addition, the following frog species are endemic to the massif: *Rana johnstoni,* and *Arthrolepis francei;* and two endemic sub-species *Nothophryne broadleyi* and *Hyperolius spiningularis* (Broadley 2001).

Mulanje fish fauna consists of seven species recorded above Zoa Falls on the upper Ruo River. Their conservation status is not yet quite certain. All seven listed include *Amphilius natalensis, Barbus choloensis, B. eutaenia, B. lieomaculatus,* one *Barbus* species, which is not yet described (probably endemic to Mulanje), *Hippopotamyrus ansorgii* and *Varicorhinus nelspruitensis* (Tweddle 1985).

Invertebrates: There are estimated to be between 25,00030,000 invertebrate species occurring on Mulanje Mountain (Dudley 1999).

The present data base contains over 700 species of invertebrates (Dudley on file). This includes 56 species of spiders (Arachnida mostly spiders) and 640 species of insects. This number could perhaps be doubled with a careful search of the published literature and, of course, it contains few records of the many other higher invertebrate taxa (e.g. Mollusca - snails, slugs, millipeds) that certainly exist on the mountain. There are about 280 beetle species on this list of which seven are endemic or near endemic at the species or sub-species level. Of the 61 scarab or dung beetles recorded, most are forest edge and woodland species save for two of the district's endemics which penetrate the evergreen forests. One of these, *Gyronotus mulanjensis,* is of particular importance as it belongs to a group with an ancient ancestry, being flightless relicts that are probably forest specialists and classified as Vulnerable (Davis *et al.* 1999).

Available records indicate that 233 species of butterflies (44% of Malawi's total) are found in and around Mulanje Mountain Forest Reserve. Out of these, eight species are endemic, three are near endemics and three are endemic sub-species. The endemics include *Papilio occidua, Charaxes martini martini, C. margaretae, Cymothoe melanjae, Alaena picata intrupta, Baliochila nyasae, B.* woodi and *Axiocerses bamptoni.* The three near endemics include *Charaxes acuminatus mlanji, Alaena lambomi* and *Lepidochrysops neavei.*

Mulanje Mountain Forest Reserve is home to sixty-five species of dragonflies (Odonata). Only eight species dominate on the high plateau. Among them are two relict species of conservation concern: the only endemic *Oreocnemis phoenix* (monotypic genus) and the restricted-range species *Chlorolestes elegan,* (Dijkstra 2003).

About sixty (60) species of terrestrial snails (10 identified) and ten slugs (none identified) have been found on Mulanje Mountain and the lower slopes. Out of the known snails, eight species are believed to be endemic to Mulanje (EDG, 2000).

9.5 Threats to Biological Diversity of Mulanje Mountain

Mulanje district is ranked high in terms of human population density (185 people/km^2) and high rates of poverty. Unsustainable harvesting of forest products forms, in part, the livelihood bases for a significant proportion of the population living near reserve boundaries. Deforestation and encroachment in most of the customary lands as well as protected areas particularly the MMFR has resulted into loss of plants and animal life. Illegal poaching, especially within the MMFR continues to reduce the populations of mammal species as is also the case with uncontrolled bush/forest fires. Invasive alien species (largely due to human introductions) are also a big concern. The above-named anthropological actions have resulted in the destruction of important ecosystems and habitats with consequent results of reducing biodiversity in Mulanje District.

9.6 Mitigation Measures Towards Threatened Species

In his concluding statements of a *Technical Review and Evaluation of the Biodiversity of the Mulanje Massif Ecosystem*, from which this section draws, Dudley (1999) explores various mitigation measures towards the conservation of biodiversity, especially in the light of human pressures on the ecosystems. He recognizes a number of interactions that should be considered and balanced carefully in the face of ecological, technological, industrial, economic and socio-cultural advancements. These considerations, when summed up, form the basis for which the Mulanje Mountain Forest Reserve and its biodiversity is being managed and protected. Conservation efforts on the ground carried out through collaboration between the Mulanje Mountain Conservation Trust and the Malawi Government through the Forestry Department and other stakeholders aim to involve general management principles which include the preservation of biodiversity as part of a functioning, although not necessarily pristine, ecosystem - regarded as *in situ* conservation. Following these principles are the non-biological components which the stakeholders take into consideration in their mitigation efforts.

An important consideration is zoning which involves segregating management objectives and uses that may be incompatible (i.e. timber production vs. research plots); inventory which involves research techniques including surveying, sorting, cataloguing, quantifying and mapping of populations, species or habitats and then the synthesis of this information for analysis purposes (Stork & Samways 1995); monitoring and evaluation and adaptive management through the use of inventories, monitoring and evaluation, will reduce uncertainty and improve resource management over time (Miller & Johnson 1995). It accepts change as a basic reality and looks to plan with, around and through change. Social and biological change is inevitable. Management interventions are made in an experimental manner so that the outcome of an intervention can be used to reduce the uncertainty about the system. Monitoring before, during and after intervention enables detection of the results of intervention and is a learning experience.

9.7 Conclusion

Malawi is signatory to a variety of World Conventions for the protection of nature and the environment. Amongst these important obligations Malawi has undertaken to comply with is the conservation and protection of biodiversity. At the national level, Mulanje Mountain Forest Reserve ranks the highest terrestrial biodiversity rich area followed by the Nyika Plateau. Internationally, it is an important biodiversity area (Global Biosphere Reserve). In spite of these recognitions, the management of the reserve is not without setbacks. The MMFR is situated in one of the highly populated areas in the country characterized by high levels of poverty.

From the above perspectives, the protection and management of the reserve calls for pragmatic approaches which should involve both scientific approaches as much as possible (which should at the same time be simple to follow and repeatable over a long period of time), and stakeholders' involvement,0 particularly the communities whose livelihoods are derived from the reserve. Furthermore, for a sustainable management of this biodiversity, a deliberate approach to incorporate participatory resource monitoring and evaluation is considered appropriate.

9.8 References Cited

Ansell, W. F. H. and Dowsett, R. J. (1988). *Mammals of Malawi: an annotated check list and atlas*. Tendine press, Zenor, Cornwall.

Broadley, D. G. (2001). An Annotated check list of the herpetofauna of Mulanje Mountain. *Nyala* 21:29-36.

Davis, A. L. V., Scholtz, C. H. & Harrison, J du G. (1999). New and threatened Afrotropical dung beetle taxa in the Gondwanaland tribe Canthonini (Coleoptera: Scarabaeidae: Scarabaeinae). *African Entomology* 7(1):77-84

Dijkstra, Klaas-Douwe B. (2003). Dragonflies (Odonata) of Mulanje Mountain, Malawi. *Nyala* 22:3-8.

Dowsett-Lemaire, F. (1988). The forest vegetation of Mt. Mulanje (Malawi): A floristic and chorological study along an attitudinal gradient (650-1950m). *Bull. Jard. Bot. Nat. Belg.* 58(1/2):77-107.

Dowsett-Lemaire, F. (1989a) Vegetation and birds of evergreen forests of southern Malawi, with special reference to mid-altitude forests. *Nyala* 14(1):29-37.

Dowsett-Lemaire, F. (1989b) Ecological and biogeographical aspects of forest bird communities in Malawi. *Scopus* 13:1-80.

Dowsett-Lemaire, F., Dowsett, R. J. & Dyer, M. (2001). Malawi, pp. 539-555. In: L. D. C. Fishpool & Evans, M. I. (eds.) *Important bird areas in Africa and associated islands; priority sites for conservation.* Birdlife Conservation Series No. 11, Birdlife International, Pisces Publication.

Dudley, C. (1999). *A technical review and evaluation of the biodiversity of the Mulanje Massif ecosystem (with proposals for its conservation and management).* Consultancy prepared for the Mount Mulanje Conservation Trust, Department of Biology, Chancellor College, Zomba, Malawi

Environmental Development Group (2000). *Mulanje Mountain and Michesi Forest Reserves, Malawi five year management plan, 2001 to 2005,* Report of file in MMCT Office, Mulanje, Malawi.

Johnson-Stewart, N. G. B. (1984) Evergreen forest birds in the southern third of Malawi. *Nyala* 10(2):99-119.

Kachule, R.N. & Tchale, H (1999). Review of environmental policy and legislation, review of environmental planning, review of natural resources management by government and the private sector. Published by ??

Makungwa, D.S. (2004). *Inventory results of Mulanje Cedar resources on Mulanje Mountain.* Report of file in office of MMCT, Mulanje, Malawi.

Malawi Government (2002a). *State of the environment report 2002, Second Edition.* Department of Research and Environmental Affairs, Lilongwe, Malawi.

Malawi Government (2002b). *District state of the environment report.* Mulanje District Assembly, Mulanje, Malawi.

Miller, K. & Johnson, N. (1995) 13.1 A framework for managing biodiversity, pp923-932. **In:** V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP,

CUP, 1140pp.
National Research Council US (1992). *Conserving biodiversity, A research agenda for development agencies.* National Academy Press, Washington D.C.
Stork, N. E. & Samways, M. J. (1995) Inventorying and monitoring, pp453-543. In: V. H. Heywood & R. T. Wilson (eds.) *Global Biodiversity Assessment.* UNEP, CUP, 1140pp.
Strugnell, A. M. (2002). Endemics of Mount Mulanje: the endemic spermatophytes of Mt. Mulanje, Malawi. *Systematics and Geography of Plants* 72: 11-26.
Tweedle, D. (1985). The importance of the national parks, game reserves, and forest reserves of Malawi to fish conservation and fisheries management. *Nyala* 11(1):5-11.

10.0 CONSERVING BIODIVERSITY

Professor Cornell Dudley
University of Malawi
Department of Biology
Chancellor College

10.1 Introduction

It is clear, that many of the biodiversity resources that occur in and around Malawi's protected areas are under threat through unsustainable exploitation by both urban and rural communities within the country. Of particular concern are the problems associated with protected areas. The difficult question is what the strategy should be and what actions should be taken by Government and the wider society to counter this trend.

Two basic approaches may be taken the species-based approach or the ecosystem-based approach. Both have their adherents and historical successes. However, both have serious practical problems in implementation. Species-based plans require detailed knowledge of particular species and, one might say, a fine-grained approach to conservation and management. Where reference is to large, threatened, "flagship" or ecosystem "keystone" species (i.e. elephant, rhino, Mulanje Cedar, Chambo) this strategy might be appropriate. Where conservation concern is for hundreds of species, mostly unknown in all their important characteristics (even their names!), such an approach will not succeed. Even with the needed information, society would not have the capacity to put in place the hundreds of management plans and finely balance the intricate matrix of the multitude of ecological factors. Nevertheless, this approach puts resources where conservation problems are most urgent.

The ecosystem approach is a systems-based action that looks at "the forest rather than the trees". The assumption is that if the ecosystem (forest, lake, etc.) remains intact, its numerous parts (species) will continue to thrive with their own checks and balances (Dudley 1996). This method does not require detailed knowledge of all species. It is also clear that such a strategy has its weaknesses, not only in the similar lack of information and capacity to undertake such plans, but in seeing what appears to be the success of the "big picture", failures at the species level may be obscured. As E. O. Wilson (1987) says, "It is the little things [insects, phytoplankton, zooplankton, mircoorganisms] that run the world". These are precisely the organisms that we know the least about. What is fundamental is that the maintenance of species diversity, at whatever level - particularly in preventing extinctions - is pivotal to conserving biodiversity.

Human influences, economic values and measures for conservation of biodiversity and sustainable use of its components are thoroughly discussed by McNeely *et al* (1995), Perrings (1995) and Miller *et al.* (1995) in the UNEP "Bible" *Global Biodiversity Assessment* (Heywood & Watson 1995).

10.2 Proposed Strategies and Actions

Proposed strategies and actions for the conservation of the considerable diversity of the natural resources of Malawi must be compatible with these factors. Therefore, both approaches should be incorporated. Where exceptional species-specific resources are involved, resources that are of principal importance economically and culturally to the rural community and among which serious population declines have been observed, a species approach may be undertaken. Such species might include stinkbugs (*Nezara robusta*) and processionary caterpillars (*Anaphe panda*) (Meke 2004), tubers (*Dioscorea odoratissima*) and timber species (*Khaya*

anthotheca and *Pericopsis angolensis*) (Kamwendo 2004) or fish (*Opsaridium microlepis* [MPASA]) (Banda this publication). Where general, non-specific resources or broad classes of resources are considered, only an ecosystem approach should be considered. Examples of such resources might be fuel wood, charcoal and meat or medicinal plants and craft materials or perhaps the cyprinid fish stocks.

Given the limited knowledge of natural resources as well as the limited capacity in Malawi, the majority of conservation efforts will have to continue to focus on the protection of the integrity of the national parks, forest reserves, wildlife reserves and major aquatic ecosystems (e.g. Lake Malawi and Lake Chilwa), yet provide "windows" for the continued sustainable use of an important, if limited, range of their biodiversity resources.

10.3 Threats to Biodiversity

Within the present document, authors have highlighted the threats and presented a very general outline of strategies and actions to counter the current negative trends within particular biodiversity taxa. Most fall under the "big picture" approach. Even within the animal taxa, several authors tend to focus on the environment rather than the specific species within their concerns. While this is understandable, it may not be sufficient to provide the needed supporting conservation inputs to insure the sustainability of these species-specific resources.

Table 10.1, modified from an earlier study of the biodiversity of three forest reserves by many of the same authors of the chapters in this document (Dudley 2004), provides a simple listing of the major factors identified as threats to the biodiversity of terrestrial ecosystems, problems that are really a microcosm of the problems facing most protected areas in this rural, agriculturally based and densely populated country. Aquatic ecosystems have their own set of threats, again many

related to unsustainable activities of people on land. This 'simple' list clearly shows the overwhelming complexity and range of the problems biodiversity conservation faces. The threats to both terrestrial and aquatic biodiversity are highlighted in the *National Biodiversity Strategy and Action Plan* (Malawi Government 2004).

10.4 Recommendations

Likewise, Table 10.2 shows the range of actions society might take to address the threats listed in Table 10.1. As before, none is simple, straightforward or quick acting. In particular, many of the threats are culturally based and, thus, difficult to change in the short or medium term. While unthreatening in the historical past, the increased intensities of these activities due to greater numbers of people and more widespread commercial forces on an ever declining natural resource base now become a serious threat. Again, the NBSAP proposes five objectives and 17 activities for addressing the threats for each of the terrestrial and aquatic systems.

Modifying of society's behaviour through education, training and provision of alternate jobs and incomes, improving Government's management of natural resources and increasing biodiversity knowledge through expanded field research programmes so as to understand what needs to be done and how, is no little problem for the future.

Proposed players in these activities include the usual parties of Government Departments (i.e. FRIM, DAR, EAD), parastatals (i.e. university colleges and NHBG, ESCOM), NGOs (i.e. WESM) and the communities themselves through organizations such as VNRMCs and CBNRMCs, and Traditional Authorities. Actions include regularly planned and well-

Table 10.1 Human activities and social conditions and, where uncontrolled or unmodified, some of their resultant threats to the terrestrial biodiversity resources of Malawi.

Activity	Resultant ecosystem modifications and threats
Deforestation-timber extraction, charcoal, fuel wood	Forest canopies modified allowing alien and grass species to invade, increasing fuel loads and the possibility of fire within the forests; loss of biodiversity, increased soil erosion and runoff, etc.
Bush fires	Biodiversity losses through killing of soil and ground layer vertebrates and invertebrates, loss of reproductive structures of plants and eventual death of larger trees, negative soil structure and nutrient modifications, etc.
Livestock grazing and browsing	Trampling of herbaceous species, soil structure and litter layers disturbed, ground level woody vegetation structure modified, biodiversity losses, etc.
Non-woody resource extraction including medicinal and food plants, mushrooms, vertebrates and invertebrates	Biodiversity losses where destructive methodologies are traditionally used, misinformation of assumed dangers and benefits (i.e. snakes, lizards and frogs), etc.
Invasive species such as *Pinus patula*, bracken fern and feral cats and dogs	Modification of ecosystem characteristics, competing with indigenous species, etc.
Cultivation	Establishing private gardens in forests clears land and opens it up to soil erosion and fertility loss, biodiversity and important cultural and economic resource losses maximized, etc.
Decline in indigenous knowledge	Loss of community knowledge with respect to evaluation, identification, collection and preparation techniques of a wide range of biodiversity resources, loss of traditional cultural practices in conservation, sickness and loss of life (i.e. mushrooms), etc.
Poor or lack of professional management capacity and sufficient Government support for conservation activities and traditional social and cultural structures	Misunderstanding of rules of resource extraction from protected areas, unwillingness to cooperate with Government or outside bodies in natural resource management, loss of empowerment of TAs to control community activities in biodiversity harvesting, etc.
Lack of economic information, infrastructure and market development	Difficulty of resource costing, development of income generating activities hampered, long term resource incentives hard to promote, etc.

organised meetings between these players where knowledge is exchanged and practical and technical training conducted where needed. Training and material assistance in seed propagation, nursery management and reforestation techniques and production of fuel saving strategies such as briquette production and improved cooking stoves including solar energy possibilities are suggested. Other areas of like importance are formation of wildlife clubs where conservation education reaches the younger members of the community, promoting awareness of the potential and actual dangers of alien species, bush fires, and overgrazing and education of both communities and forestry field personnel on the new forestry policy and act, including its enforcement.

Table 10.2 Proposed actions which are needed to reduce or minimize threats to terrestrial biodiversity resources of Malawi.

Action	Result
Increase the effectiveness of community social structures such as VNRMCs, CBNRMCs and TAs and promote co-management operations of selected biodiversity elements between the natural resource department and the adjacent communities.	Promotes cooperation and harmony among the users and managers of biodiversity resources so a to reduce misunderstandings and improve the conservation and ultimately the use of various natural resources.
Conduct public awareness campaigns and provide training in practical conservation and management activities such as efficient family cookers, reforestation and woodlots, agro-forestry practices, more efficient use of cultivated plants, etc.	Provides the users of biodiversity resources with the capacity to use them efficiently and wisely and to extend their values within their communities and in their day-to-day lives and to ensure such resources for future generations.
Lobby for greater Government investment and resources in biodiversity conservation and management within the forest ecosystems and with rural communities on adjacent customary land.	Enables protected areas to be professionally managed with the honesty and intensity that they deserve and to provide improved alternative sources of natural resources from customary land.
Promote improved economic infrastructure and correct marketing of biodiversity products.	Increases income generation from harvested biodiversity resources so as to provide an incentive for their conservation and sustainable management.
Conduct community sensitization meetings on the dangers of poor cultivation techniques, destructive biodiversity harvesting activities, and the threat of alien invasive species.	Reduces destructive and poor agricultural practices on both customary land and within the forest reserves so as to improve the harvest of important natural resources, limits threat of invasive species and reduces unwanted mortality on various biodiversity taxa.
Establish effective bush fire control measures and train community members in the importance of fire control and its techniques.	Promotes the use of fire as an ecological tool rather than a destructive force in the management of undesired vegetation, reduces manages the use of fires by hunters so as to minimize fires negative influence on bio-diversity.
Establish and enforce grazing patterns and limits to public access of livestock within the forest and wildlife reserves.	Improves soil structure and fertility and enhances herbaceous cover within forests so as to reduce soil erosion and runoff, thus, improving water sources within the forests and the biodiversity carrying capacity of this forest strata.
Promote continued research and education in the area of biodiversity within these and similar protected areas, establish a updatable data base for all inventories biodiversity taxa, investigate other neglected taxa, etc.	Formalizes the information on biodiversity so as to make it available for future investigations and use and provides a database to which important biodiversity knowledge can be added.

Several authors in the earlier biodiversity paper (Dudley 2004) stressed that the community organisations (i.e. VNRMCs) and the TAs need to be strengthened in their ability to enforce environmental by-laws. Further studies were suggested to carefully quantify the subsistence requirements of the local people from the reserves, the impact of market forces on their livelihoods and evaluation of possible conflicts. Such studies might include an investigation into traditional resource rights, ownership, access, control and possible benefit sharing. Other important areas noted for study were the cultural elements of biodiversity use, particularly with respect to the ecological and economic characteristics of harvest techniques. Clearly there is a continued necessity of investigations by scientists into the richness, dynamics and management requirements for the conservation of Malawi's biodiversity resources.

10.5 References Cited

Dudley, C. (1996) How many species does Malawi have? *Nyala* 19:13-16.

Dudley, C. O. (2004). *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

Government of Malawi (2004). *National biodiversity strategy and action plan.* Department of Research and Environmental Affairs, Lilongwe, Malawi.

Heywood, V. H. & Watson, R. T. (eds.) (1995) Global biodiversity assessment. UNDP and UCP, 1,140pp.

Kamwendo, J. (2004). Flora and vegetation, pp. 15-28. : C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

McNeeley, J.A, Gadgil, M., Leveque, L., Padoch, C. & Redford, K. (1995) Human influences on biodiversity, pp. 711-822. In: V. A. Heywood & R. T. Watson (eds.). *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Meke, G. (2004). Insects and people, pp.57-85. In: : C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

Miller, K., Allegretti, M. H., Johnson, N. & Johonson, B. (1995) Measures for conservation of biodiversity and sustainable use of its components, pp. 915-1061. In: V. A. Heywood & R. T. Watson (eds.). *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Perrings, C. (1995) Economic values of biodiversity, pp. 823-914. In: V. A. Heywood & R. T. Watson (eds.) *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Wilson, E. O. (1987) The little things that run the world. *Conservation Biology* 1(4):344-346.

10.5 References Cited

Dudley, C. (1996) How many species does Malawi have? *Nyala* 19:13-16.

Dudley, C. O. (2004). *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

Government of Malawi (2004). *National biodiversity strategy and action plan.* Department of Research and Environmental Affairs, Lilongwe, Malawi.

Heywood, V. H. & Watson, R. T. (eds.) (1995) Global biodiversity assessment. UNDP and UCP, 1,140pp.

Kamwendo, J. (2004). Flora and vegetation, pp. 15-28. : C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

McNeeley, J.A, Gadgil, M., Leveque, L., Padoch, C. & Redford, K. (1995) Human influences on biodiversity, pp. 711-822. In: V. A. Heywood & R. T. Watson (eds.). *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Meke, G. (2004). Insects and people, pp.57-85. In: : C.O. Dudley (ed.) *A Report on management of biodiversity in protected areas of Malawi.* PN 93.2208.2-03.208 and PN 00.2047.9-002.13, National Herbarium and Botanic Gardens, Zomba, Malawi.

Miller, K., Allegretti, M. H., Johnson, N. & Johonson, B. (1995) Measures for conservation of biodiversity and sustainable use of its components, pp. 915-1061. In: V. A. Heywood & R. T. Watson (eds.). *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Perrings, C. (1995) Economic values of biodiversity, pp. 823-914. In: V. A. Heywood & R. T. Watson (eds.) *Global biodiversity assessment.* UNDP and UCP, 1,140pp.

Wilson, E. O. (1987) The little things that run the world. *Conservation Biology* 1(4):344-346.

11.0 NAMES AND CONTACT ADDRESSES FOR CONTRIBUTORS

Dr Moses Banda
Chief Fisheries Research Officer
Fisheries Research Unit
P.O.Box 27
Monkey-Bay
Tel: 01 587 360
Cell: 08 305 824
Email: mafri@sdnp.org.mw

Wilbert N. Chitaukali
Biology Department
Chancellor College
P.O.Box 280
ZOMBA
Tel: 01 526 346 ex 208 / Cell: 08 338 735

Professor Cornell Dudley
University of Malawi
Department of Biology
Challor College
P.O. Box 280
Zomba, Malawi
Email: colds@globemw.net

Potiphar M. Kaliba
Senior Curator of Ornithology
Museums of Malawi
P.O.Box 30360
BLANTYRE 3
Tel: 01 675 909 / Cell: 08 836 336
Email: pmkaliba@yahoo.com

Jamestone Kamwendo
Assistant Scientific Officer
National Herbarium and Botanical Gardens
P.O.Box 528
ZOMBA
Tel: 01 525 388/145/118 / Cell: 08 877 064
Email: jkamwendo3@yahoo.co.uk

Lovemore C.J. Mazibuko
Curator of Herpetology
Museums of Malawi
P.O.Box 30360
BLANTYRE 3
Tel: 01 671 857 / Cell: 08 898 077
Email: museum@malawi.net or love_mazi@clcom.net

Gerald Meke &
Principal Forestry Research Officer
Forestry Research Institute of Malawi
P.O.Box 270
ZOMBA
Tel: 01 524 866 / Cell: 09 911 503
Email: gmeke@frim.org.mw

Eric Boa
CABI Biosciences
Bakeham lane, Edham,
Surrey, Tw 20 9TY, UK
Email: e.boa@cabi.org

David Nangoma
Programme officer
Biodiversity Conservation,
Research and Monitoring
Mulanje Mountain Conservation Trust
P.O.Box .139,
Mulanje.
Tel: 01 466 179/828 / Cell: 08 892 133
Email: david@mountmulanje.org.mw