

West Kilombero Scarp Forest Reserve

Management and Summary Report

FRONTIER TANZANIA

2001

Udzungwa Mountains Biodiversity Survey

West Kilombero Scarp Forest Reserve

Management and Summary Report

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Matumizi Endelevu ya Misitu ya Asili (MEMA)

Since 1999, MEMA based in Iringa, have been administering the Udzungwa Mountains Forest Management and Biodiversity Conservation Project (UMFM) and the Natural Woodlands Management Project (NWMP), funded by Danish International Development Assistance (DANIDA).

The University of Dar es Salaam (UDSM)

The University of Dar es Salaam was established in July 1970 as a centre for learning and research in the arts and the physical, natural, earth, marine, medical and human sciences. The University is surveying and mapping the flora and fauna of Tanzania and is conducting research into the maintenance and improvement of the environment and the sustainable exploitation of Tanzania's natural resources.

The Society for Environmental Exploration (SEE)

The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

Frontier Tanzania (FT)

The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, of which one component is the Frontier Tanzania Forest Research Programme (FT FRP).

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Foreword

The Udzungwa forests are unique. They represent a major part of the Eastern Arc forests, which are one of the 25 global biodiversity hotspots. Collectively, these 25 areas cover 1.4% of the planet's land area, but account for about 44% of all vascular plant species and 35% of four vertebrate groups.

The Eastern Arc Mountains have the highest levels of species endemism per unit area of remaining intact natural vegetation worldwide.

The Udzungwa Mountains contain the major part of the closed forests found in the group of Eastern Arc forests that cover an area from the Taita Hills in Kenya to Makambako in Southern Tanzania. The total area of closed natural forest in the Tanzanian part of the Eastern Arc is 1451km² or approximately 0.2% of the total area of the country. In a Tanzanian context the areas are extremely important, both for their biodiversity and water catchment values (for example 34% of all Tanzanian mammal species are found in the Eastern Arc forests).

The Udzungwa Mountains have been legally protected with Forest Reserve status for many years due to their water catchment value. The water that drains from the mountains is of both local and national importance for domestic consumption, livestock, irrigated agriculture and hydroelectric power production.

The biodiversity values specific to the forests of Nyumbanitu/Ndundulu and New Dabaga/Ulangambi are described in the Udzungwa Mountains Biodiversity Survey Reports and represent the foundation for the development of the Udzungwa Forest Management Plans.

The Udzungwa Mountains Forest Management and Biodiversity Conservation Component of MEMA contracted the biodiversity surveys to Frontier Tanzania. MEMA is supporting the Forestry & Beekeeping Division and the Iringa District Council to develop and test models for Participatory Forest Management in the Udzungwa Mountains.

Participatory Forest Management is a new strategy that enhances the protection and sustainable utilisation of forests through the involvement of the communities neighbouring the forests. Communities living near the forests are hence able to monitor closely the activities in the forests while they at the same time often are the major users of the products that can be harvested in the forests. Indeed, the continued harvesting at planned and sustainable levels is a key to committed and responsible community involvement. Sometimes the term 'use-it-or-lose-it' is used to describe this strategy.

The central and local governments have accepted that community participation is the way forward. The Ministry and the local Council fully support the communities being active forest managers.

The great challenge now to all foresters, other professionals and local leaders involved in participatory forest management in the Udzungwas is to ensure that the communities are aware of the unique biodiversity values of their forests. That will hopefully lead to comprehensive, but locally manageable, joint forest management agreements between the

Forestry & Beekeeping Division, Iringa District Council and the communities surrounding the forests.

These reports are the result of the enduring effort by Frontier researchers, volunteers and villagers during almost two years of biodiversity surveys on the steep and wet slopes of the Udzungwa Mountains. The task has strained the human and material resources to their maximum capacity, so I am happy to see that the surveys are safely accomplished. I admire the spirit of the team and their ability to pursue the goal under challenging conditions. Their work is highly appreciated and the output constitutes a valuable and essential part of the framework needed to ensure that the unique Udzungwa forest ecosystems are maintained to the benefit of present and future generations of the Wazungwa people and all the rest of us.

Iringa, March 5th 2001

Henrik Lerdorf
Technical Advisor
MEMA

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Kathryn Doody
KM Howell
Eibleis Fanning

30th April 2001

3.0 Introduction

3.1 Frontier Tanzania

Frontier Tanzania (FT) is a collaborative project first formed in 1989 between the University of Dar es Salaam (UDSM) and the Society for Environmental Exploration (SEE). SEE is a non-profit making company limited by guarantee. Its principal activity is the promotion and organisation of practical research and conservation projects manned by volunteers that will assist national authorities in host countries to develop, maintain or improve the environment and promote the sustainable use of natural resources. UDSM is an institution of higher learning where training and research are conducted. It also provides consultancy to government institutions, parastatals and individuals. The resulting organisation from the collaboration between these two institutions is known as Frontier Tanzania.

Since 1989 the aims of the Frontier Tanzania Forest Research Programme (FT FRP) have been to provide baseline information on the biological values of strategically selected forests as a basis for management planning and long-term monitoring, as well as training Tanzanian personnel and overseas students in the use of biological inventory techniques. The FT FRP worked in the Tanzanian Coastal Forests between 1989 and 1994, then moved to the East Usambaras where baseline biodiversity surveys are still being undertaken.

3.2 Matumizi Endelevu ya Mimitu ya Asili (MEMA)

Since 1999, MEMA based in Iringa, has been administering two projects, the: Udzungwa Mountains Forest Management and Biodiversity Conservation Project (UMFM) and the Natural Woodlands Management Project (NWMP). It is the UMFM project funded by Danish International Development Assistance (DANIDA) that contracted Frontier Tanzania to undertake this survey.

This report is the culmination of work begun by FT in January 1999 working with the Udzungwa Mountains Joint Forest Management and Biodiversity Conservation Project (MEMA) funded by DANIDA, providing baseline biodiversity data. The biological data provided, together with separate MEMA socio-economic surveys will be used to draw up joint forest management plans.

3.3 Data Citation

Any publication that uses this data must acknowledge all collaborating parties (UDSM, FBD, MEMA, DANIDA, SEE and FT FRP). It should contain the following sentence:

“This publication uses material collected during the Udzungwa Mountains Biodiversity Surveys; a collaborative venture between the Society for Environmental Exploration and the University of Dar es Salaam (through the Frontier Tanzania Forest Research Programme), and the Udzungwa Mountains Forest Management and Biodiversity Conservation Component, MEMA, supported by the Danish Government through DANIDA.”

3.4 Survey Period and Personnel

The survey of West Kilombero Scarp Forest Reserve was conducted between July to December 1999, and July to September and November to December 2000.

The survey was conducted by Frontier Tanzania staff, volunteers and local people from Udekwa and Ifuwa villages.

3.5 How to Use This Report

3.5.1 UMBS Reports

This report is one of a series of seven completed by Frontier Tanzania researchers. The reports are the culmination of the two year long Udzungwa Mountains Biodiversity Survey.

The overall aim of the report series is to provide detailed information on the survey findings in the two target reserves, with emphasis on the importance of the forested areas for the conservation of biodiversity. In order to achieve this, a **Botanical and Forest Use Report** and a **Zoological Report** have been written for each reserve, which are broken down into sections tackling each of the survey methods in turn. Each section has been written to give the reader enough detail to understand the findings without extensive reference to other reports in the series. In an attempt to make each section understandable without reference to other reports there is some repetition between sections, this is due to the similar needs of most forest dependent taxa, and the inevitable overlap of some surveys.

To minimise extensive repetition between sections, all recommendations for management and monitoring of the forests arising from the surveys are discussed in more detail in this **Management and Summary Report** for each of the two reserves. Also within this report, the key findings from all surveys are summarised in the executive summary, which is also included in both the Botanical and Forest Use and Zoological Reports. The purpose of this report is to give a brief overview of the UMBS project for use by managers, MEMA and the Forestry and Beekeeping Division of Iringa.

Detailed explanation of the methods used can be found in a **Methods Manual**. This gives methods for all surveys plus a bibliography of texts from which the methods have been derived. This also lists the animal and plant identification guides that were used in the field.

3.5.2 Database

The other major output of UMBS is a Microsoft Excell database. All zoological data will also be added to the National Biodiversity Database at the Department of Zoology and Marine Biology, University of Dar es Salaam. The UMBS database will include all data collected from the surveys in NDUFR and WKSFR and will include details on taxonomic identification, habitat details, current location of all specimens, collection localities and dates.

The Frontier Tanzania team has made every effort to ensure that this database can be understood by anyone who should wish to use it. For information regarding this, contact MEMA at the address given at the front of this report.

Hard copies of all original data sheets are stored at Frontier Tanzania and MEMA.

Please contact MEMA for information regarding the data.

3.5.3 Reports in This Series

Frontier Tanzania (2001a). New Dabaga/Ulangambi Forest Reserve – Management and Summary Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-77 pp

Frontier Tanzania (2001b). West Kilombero Scarp Forest Reserve – Management and Summary Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-78 pp.

Frontier Tanzania (2001c). New Dabaga/Ulangambi Forest Reserve – Botanical and Forest Use Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-117 pp.

Frontier Tanzania (2001d). West Kilombero Scarp Forest Reserve – Botanical and Forest Use Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-145 pp.

Frontier Tanzania (2001e). New Dabaga/Ulangambi Forest Reserve – Zoological Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-160 pp.

Frontier Tanzania (2001f). West Kilombero Scarp Forest Reserve – Zoological Report. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.* 1-191 pp.

Frontier Tanzania (2001g). Methods Manual. *Report for the Udzungwa Mountains Forest Management and Biodiversity Conservation Project, MEMA, Iringa, Tanzania.*

4.0 Executive Summary - West Kilombero Scarp Forest Reserve

4.1 Introduction

The following report is one of six presenting the results of botanical, zoological and forest use surveys of West Kilombero Scarp Forest Reserve (WKSFR) and New Dabaga/Ulangambi Forest Reserve in Iringa region, south-central Tanzania. Fieldwork was carried out by Frontier Tanzania as part of the “Udzungwa Mountains Biodiversity Survey”. The aim of this was to collate and analyse information on wildlife and forest use and thus to determine the biodiversity and conservation priorities of WKSFR. The findings are intended for use by Danida’s MEMA project “Udzungwa Mountains Forest Management and Conservation” in the preparation of management plans.

WKSFR lies in a sparsely populated area 70km east of Iringa town. The habitat consists of moist evergreen forest, riverine woodland and wooded grassland. Within the Forest Reserve, surveys have primarily been carried out in the three evergreen forest fragments of Ndundulu, Nyumbanitu and Ukami. The total cover of these forests is 135km² between altitudes of 1,040-2,480m a.s.l. Wooded grassland and riverine habitats outside of the main forest fragments were also surveyed for comparison.

Fieldwork was divided into botanical and forest use surveys from July-December 1999 and zoological surveys from July-December 2000. The following summary provides information on all of these surveys, although the detailed findings of these are presented in separate reports (Frontier Tanzania, 2001d&f).

4.2 Forest Use

Natural Forest Resources

Transect surveys assessing human disturbance have determined that the level of extraction of natural resources from West Kilombero forests is low. Further casual observations and interviews conducted in Udekwa and Ifuwa villages revealed that most natural resources were taken from woodland and riverine sources outside the reserve. Hunting, honey collection, pole cutting and medicinal plant collection do, however, take place inside the Forest Reserve, predominantly near settlements and forest edge. Villagers expressed that medicinal plants are the most important resource from the Forest Reserve, as some of these cannot be replaced by a woodland resource.

The villages of Udekwa and Ifuwa are expanding and cultivated areas have appeared near the forest reserve boundary. Some villagers were worried about the increasingly longer distances they had to walk to collect firewood. Concern was also raised about a shortage of fertile land leading to clearance of woodland areas. This increasing demand for land results from both an increasing human population and the rapid degradation of cultivated areas.

The forest is also the scene for cultural events such as sacrifices for rain and celebrations of ancestors.

Bushfires

Charred ground and burnt plant remains were widespread in the wooded/scrubby grassland adjacent to the forest fragments. Reports from scientists and villagers further suggested that bushfires are often an annual occurrence in the area. These are started by human activities, which are mostly deliberate. Upon return to WKSFR in November 2000, the entire grassland area between Ndundulu and Nyumbanitu had been swept by fire, killing all herbaceous vegetation and even some trees.

Both the maintenance of savanna and the prevention of forest expansion are facilitated by persistent bushfires. This is further demonstrated by differences in vegetation from aerial photographs and systematic surveys at forest edge. Primarily, in areas of reduced fire, there is significantly more regenerating vegetation and even the appearance of forest tree species. Fire started from an unknown source has also reduced forest cover in the north of Ndundulu forest.

4.3 Botanical Survey

The botanical survey was based primarily around 20m×50m vegetation plots, in which all trees above 10cm diameter at breast height (dbh) were measured and identified. Regenerating trees and shrubs were sampled within 3m×3m plots in the centre of the larger plots. To supplement these, fertile specimens of opportunistically encountered plants were also collected.

From all surveys, the WKSFR forests are highly diverse, both in terms of species content and forest communities. This is demonstrated by comparison with the heavily disturbed New Dabaga/Ulangambi Forest Reserve. In WKSFR there are no super-dominant species such as in NDUFR and there is a comparatively low proportion of secondary tree species. There is also a threefold decrease in the mean number of regenerating trees in WKSFR, demonstrating the stable nature of much of the forest.

Trees above 10cm dbh from vegetation plots are tentatively identified from 44 families, 106 genera and 141 species. Of these, 16 species are found to be endemic to the Eastern Arc Mountains. The dominant tree species are *Cola* sp., *Cassipourea gummiflua*, *Bersama abyssinica*, *Syzygium guineense* and *Octolobus spectabilis*. None of these dominant trees are secondary species. An estimated 258 additional plant species including 13 endemics have also been collected opportunistically, giving a combined total of 399 species and 29 endemics. Identification of these is still however continuing.

Distinct tree communities were revealed. A *Cassipourea/Cola/Craterispermum* community was the dominant forest type at most altitudes. Additionally, a *Hagenia/Tecomaria* community dominated at high altitudes (>2000m), and at mid-altitudes (1850-2000m), a *Neoboutonia/Aphloia/Podocarpus* community was common. Two further undifferentiated forest types were also found.

The conservation importance of WKSFR is confirmed by the large regional variation. Importantly, this shows the biodiversity value of the reserve as a whole and there is no clear area that can justifiably be designated for sustainable extraction. Further comparison of the evergreen forest with plots in wooded grassland and mono-dominant riverine forest also reveals the far higher biodiversity of the evergreen forest. Therefore management initiatives should seek to preserve all forested areas.

4.4 Zoological Survey

The zoological survey was carried out using a combination of live trapping, timed searches, transect surveys and casual observations. Seven taxonomic groups were selected for detailed study (**Table 4.4A**).

Ten trapsites were sampled for eight days, each in different habitats within the evergreen forests of Nyumbanitu, Ndundulu and Ukami. These sites were selected using information gained about plant communities from the earlier vegetation surveys. The aim of this was to obtain a good impression of the biodiversity from the reserve as a whole. For comparison with the evergreen forest, four additional trapsites were positioned in other habitats outside of the main forest blocks. These were each sampled for four days.

A summary of the fauna recorded from WKSFR by this survey is presented in **Table 4.4A**. In total this list comprises 344 species identified by taxonomists and field biologists including Frontier Tanzania researchers. Taxonomic identification was however not available for all specimens at the time of writing. In addition to **Table 4.4A** there are species remaining to be identified from most taxa and thus species numbers are likely to increase. In particular, 155 shrew, 158 amphibian and thousands of invertebrate specimens still await identification.

Table 4.4A. Summary of animal species of conservation importance recorded from West Kilombero Scarp Forest Reserve. Sources of information for forest dependence and range restriction can be found in the relevant sections of the Zoological Report. Identification of several specimens from most taxa is still pending and thus these figures are likely to increase.

Taxonomic group	Total no. of species	Forest dependent	Restricted range***	IUCN conservation concern
Butterflies	102	47	23	0
Millipedes	38*	-	-	-
Molluscs	54*	-	-	-
Amphibians	20	9	11	9
Reptiles	19	9	9	0
Birds	151	43	22	9
Mammals	54	15	11	9**

* Identification of millipede and mollusc specimens was not available at the time of writing. Instead the number of "morpho-species" classified by Frontier Tanzania researchers are indicated.

** A further nine mammal species are of IUCN Lower Risk or Data Deficient.

*** Restricted Range = Tanzania, Northern Malawi

Most evident from the collections made is the high number of restricted range and forest dependent species (**Table 4.4A**). The forests of WKSFR therefore have massive importance for the conservation of animal biodiversity. This is most noticeable from comparisons made with New Dabaga/Ulangambi Forest Reserve (NDUFR) and other areas in the Eastern Arc and Africa. There are also numerous signs of animals that are sparse or even absent from NDUFR, especially amongst the larger mammals. In particular the rare Abbot's duiker and Udzungwa red colobus appear to have relatively healthy numbers in comparison to NDUFR. This is most likely to have resulted from the sparse human population in the area and the resulting low level of human disturbance.

There are however some highly threatened species whose distributions appear to be patchy within the reserve. The most apparent examples are seen amongst the birds and primates,

including the Amani sunbird, banded green sunbird, Usambara weaver and Sanje crested mangabey. The implications for management of this are given below.

4.5 Management Recommendations

Reducing Threats to Biodiversity

Priorities for management to conserve biodiversity are a vital part of this report. For this reason, suggestions for management and monitoring have been treated in separate sections to the biological surveys. It should however be considered that these are only suggestions and should not be undertaken without considerable discussion and additional research. Additional phases of the MEMA project have and will further investigate these and other issues to determine priorities for Joint Forest Management.

The impact of fires constitutes the biggest single obstacle in the efforts to sustain the biodiversity values within WKSFR. To conserve these values it is proposed that all annual bushfires are ceased. From surveys at forest edge, the cessation of fire is likely to result in increased regeneration of woody and forest species. By prevention of fires there is therefore excellent potential to connect the main forest fragments and therefore to establish a number of “corridors” for the dispersal of species. This may be facilitated by a mosaic of mono-dominant riverine forest that already exists within the expanse of wooded grassland. This will be most important for patchily distributed plants or animals.

Improvement of honey production in the villages could replace honey collection in the Forest Reserve. Further development of animal husbandry in the villages, including pigs, guinea pigs and chickens could also replace hunting. This would both reduce the ignition of fires in relation to these activities and would reduce the human presence in the areas of evergreen forest. To assist this, it is also necessary to re-mark the boundaries of the reserve.

Logging, pole cutting and other tree felling should be avoided within the reserve. These and other resources may instead be obtained from a woodland source outside of the reserve. With technical support and with large scale awareness raising, there is potential for a sustainably managed woodland. This could provide most resources obtained from within the forest although some resources are thought to be only available from a forest source, e.g. medicinal plants. Subject to further studies, access to the reserve with a permit and limited sustainable extractions of non-threatened and readily renewable evergreen forest species for medicinal purposes could be allowed, if closely monitored and properly administered.

Overall, the preservation of the reserve is of primary importance. Forest use should firstly be carefully monitored to ensure that extractions do not increase above the current low level. With the fast expansion of nearby villages and the planned development of a road to serve Udekwa village, this may however be difficult. The incorporation of the reserve into the adjacent Udzungwa Mountains National Park should also therefore be considered. Such a move has been suggested previously and would provide maximum legislation for the protection of the area. There is an overriding need however for the managing authorities of the Tanzania National Parks Authority (TANAPA) and MEMA to co-operate and to find a solution that will best conserve the rich wildlife communities of WKSFR whilst providing for the needs of the Udekwa and Ifuwa communities.

Income Generation

Initiatives should also be undertaken to improve current practices to limit the need for new agricultural land. This will serve to alleviate poverty whilst further directing activities away from the valuable forest habitat. Enhanced land use planning and development of sustainable use practices in the still extensive miombo woodland areas should also be implemented as a matter of high priority. Agriculture, bean growing, pig farming and tourism could be considered as ways for future increased cash income. These and other potential resources of income should be fully investigated by the MEMA project.

Eco-tourism is taking place on a small scale, but in the right hands the business could be taken further with limited implications for the forest biodiversity. However, mechanisms should be in place which secure a fair share to the villages.

It is important to take into consideration that it is the poorest representatives living around the Forest Reserve, which are most dependent on natural resources. So any restrictions imposed via the management plan are likely to have the greatest implications for these groups. All intended management initiatives have to be carefully planned and screened for maximum sustainability before implementation takes place. A strictly precautionary principle should be employed due to the unique internationally important biodiversity value of the forest reserve.

5.0 Aims

- **To conduct baseline forest and biodiversity surveys.**
Based on systematic surveys, field observations, and casual collections.
- **To collate and disseminate baseline biodiversity information.**
Through the production of reports.
- **To provide information on the biological value and use of the forests to assist in the development of Joint Forest Management plans.**
Based on systematic surveys of forest use/human impact, field observations of forest use/human impact, and Participatory Rural Appraisal technique. Management recommendations and monitoring schemes will be suggested, based on baseline forest/biodiversity data and forest use/ human impact data.

6.0 Study Area

6.1 The Eastern Arc Mountains

Thomas Lehmberg, Lars Dinesen

The Eastern Arc Mountains (**Figure 6A**) are defined as the broken mountain chain stretching from Taita Hills in south-eastern Kenya and extending down to the south-western part of Tanzania, with the Udzungwa Mountains being the last in the chain (Lovett & Wasser, 1993). Each mountain range is separated from the next by drier woodland and savanna vegetation, although they all share a common geological history which dates back to at least the Miocene (Griffiths, 1993). Evidence shows that each mountain range is a block-fault mountain, shaped by periods of repeated uplift and vertical movements followed by longer periods of stability and erosion (Griffiths, 1993). The high proportion of endemic forest-dwelling organisms in the Eastern Arc is ascribed to the long presence of a humid forest cover fostered by a seasonal, but highly predictable rainfall pattern (Lovett 1993). This precipitation arises from moisture evaporating from the Indian Ocean, being subsequently carried towards the East African coast and discharged (Lovett, 1990 & 1993).

The Udzungwa Mountains, the largest of the Eastern Arc Mountain blocks, comprise a number of highly fragmented forest patches of varying sizes and composition (**Figure 6B**). The Mwanihana forest on a southeast-facing escarpment is the easternmost, with a long altitudinal gradient of continuous forest cover, whereas the westernmost forest fragments are smaller and drier, mainly situated on the highland plateau. Extensive forest areas are still present further down the escarpment as well. The large Luhombero forest on the plateau, has the highest peak in the Udzungwas reaching 2576m and forest cover extending up to around 2400m. There is still some uncertainty about the total forest cover in the Udzungwas. Rodgers and Homewood (1982) estimate 450 km² of evergreen forest, whereas Dinesen *et al.* (2001) has an estimate of 1800 km², including secondary forest, bamboo and groundwater dependent forest. The large majority of forests are situated in Catchment Forest Reserves designated because of their recognised importance as water catchment areas both locally and nationally. The Udzungwa Mountains National Park gazetted in 1992 covers almost 2000 km² of the eastern part of the Udzungwas (**Figure 6B**) and encompasses the entire Mwanihana forest (formerly Mwanihana Forest Reserve), large parts of the Luhombero and Matundu forests as well as smaller fragments.

Whereas the Usambara and Uluguru Mountains have been the subject of biological studies for more than 70 years, it is only quite recently that the attention has been focused on the Udzungwa Mountains. During the last three decades, the Udzungwa Mountains have received ever-increasing interest from biologists due to the continued discovery of taxa new to science. The taxonomic groups having received most attention are primates and birds, whereas other larger mammals, spiders, plants, and frogs have been subject to few studies. Other groups have hardly been studied, and due to the very fragmented nature of the forests, basic distribution data is lacking for the majority of groups. For a review of biological studies see Lovett and Wasser (1993) and Dinesen *et al.* (2001).

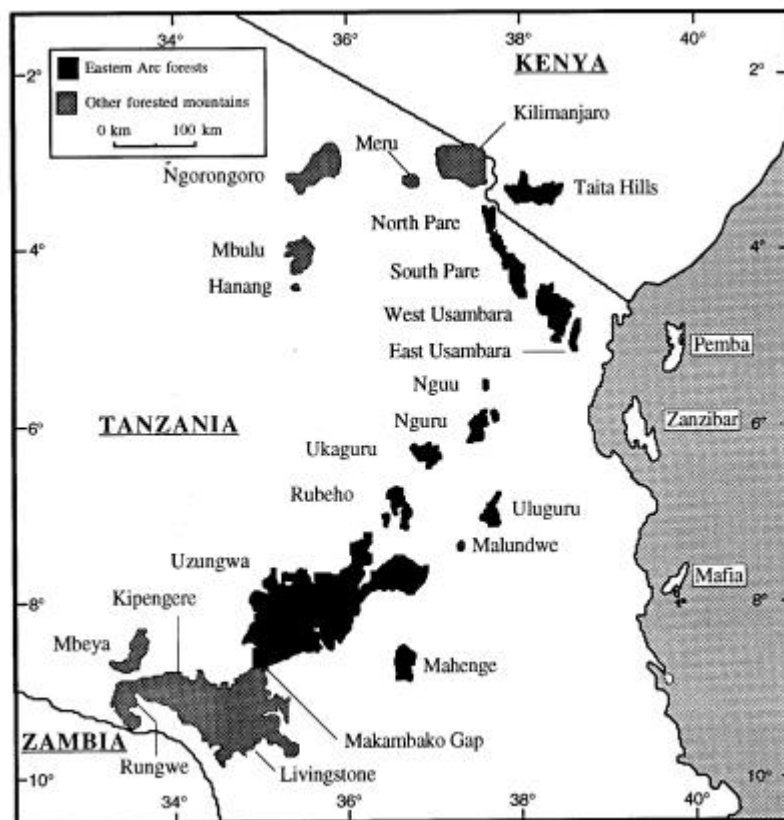


Figure 6A. Mountains of eastern Tanzania and southern Kenya that support moist forest. Eastern Arc Forests shown in black. From Lovett (1993).

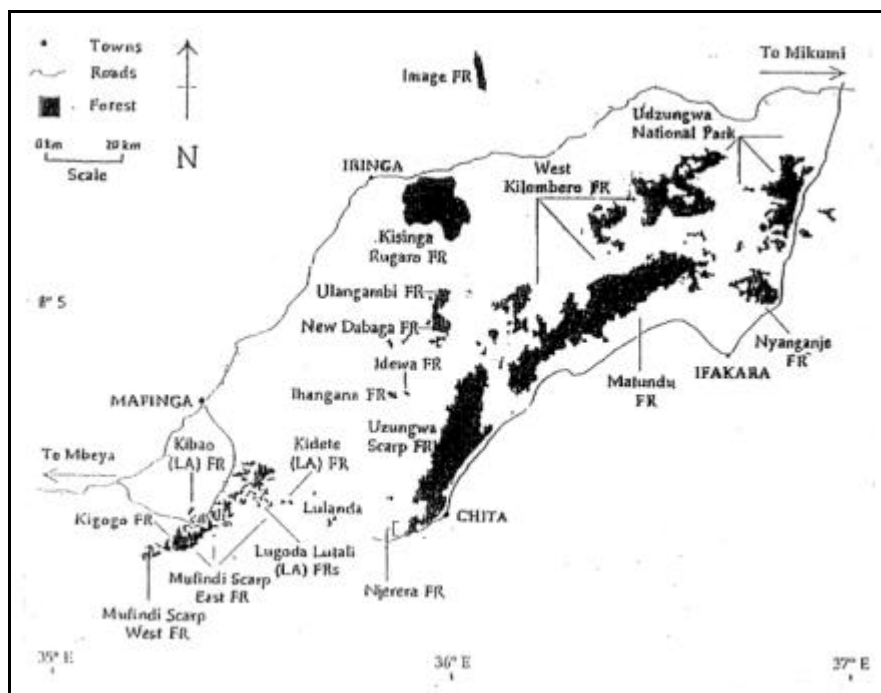


Figure 6B. Forest Reserves of the Udzungwa Mountains. From Lovett (1992).

6.2 Description of Reserve

6.2.1 General Description

- Name:** West Kilombero Scarp Forest Reserve
Iringa District, Iringa Region, Tanzania.
- Area:** 104,296 ha; 1043 km² Forested: 305 km² (Ndundulu, Nyumbanitu, & Ukami).
- Boundary**
- Length:** The boundary is not clearly marked.
- Status:** Catchment Forest Reserve. Gazetted in 1957. Originally comprised 195,253 ha, however, 91,000 ha given over to the formation of the Udzungwa Mountains National Park.
- Maps:** Ordnance Survey topographic maps 1:50,000 Series Y742 Sheets 216/2, 216/3, 216/4, 217/1, 217/2, 217/3, 217/4, 234/1, 234/3. Forest reserve boundary is not marked on Ordnance Survey Map. Aerial photographs available from the MEMA project for 1956, 1978 and 1999.

6.2.2 Location

Grid Reference: 36°05'E - 36°33'E; 7°38'S - 8°17'S

Elevation: 320 – 2576m a.s.l.

West Kilombero Scarp Forest Reserve is located 70km east of Iringa town. The area was accessed by a poor road from Ilula town, passing through Ifuwa village and terminating just south of Udekwa village (see **Figure 5.2A**). Udekwa is the nearest village to the study area. Due to the poor road, Udekwa is rather isolated. There is no bus service linking Udekwa to Iringa. However, trucks service Udekwa twice a week.

Aside from Udekwa and Ifuwa villages (west of the reserve), and Ikula village (north of the reserve) the area is remote and uninhabited. To the east, the reserve is bordered by the Udzungwa Mountains National Park and the Ruipa River, to the south is Matundu Forest Reserve (**Figure 6B**). The reserve's other borders are comprised of uninhabited miombo/acacia woodland and grassland.

For the purpose of this report, the name “West Kilombero Scarp Forest Reserve” or “WKSFR” is used to refer to the northern part of the reserve including the three montane forest fragments of Ndundulu, Nyumbanitu and Ukami and surrounding wooded grassland (see **Figure 5.2A**). The reserve actually extends south of this area, however this study does not cover the southern half. The area between forests is made up of grassland and miombo/acacia woodland on the slopes with riverine forest and marsh in the low-lying wet valleys.

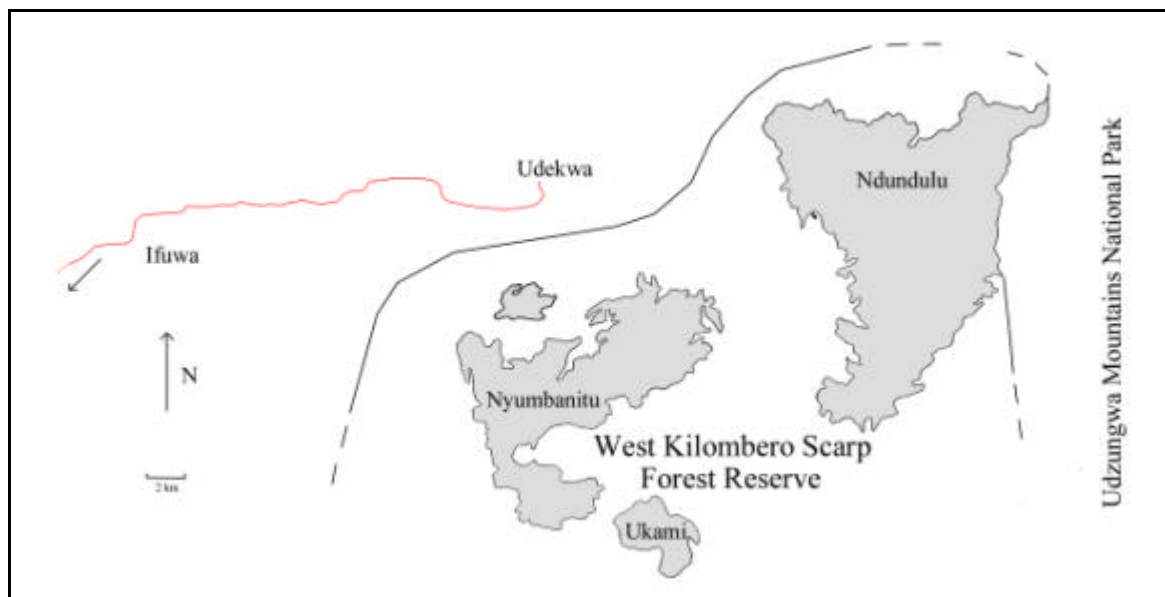


Figure 6.2A. Map of West Kilombero Scarp Forest Reserve including approximate location reserve boundary (dark solid/dashed line) and road (light line) from Udekwa to Iringa (through Ifuwa). The three main forest fragments are labelled: Ndundulu, Nyumbanitu, and Ukami.

6.2.3 Soils

Soils are brown sandy loams over crystalline gneiss.

6.2.4 Climate

Climate is that of oceanic rainfall with oceanic/continental temperatures. For the upland plateau areas the nearest rainfall station with comparable results is at the Brooke Bond Tea Estates to the south. Estimated rainfall is between 1500-2000 mm/yr. Estimated mean temperature is ~20°C max. (December), ~15°C min. (July). Dry season is between June and November.

For the lowland areas, the nearest rainfall station is at Lumemo. Estimated rainfall is 1350mm/yr with permanent riverine ground water. The mean temperature ranges between 27°C (max; December) and 19°C (min; July). The dry season is between June and October.

6.2.5 Vegetation

In upland areas, the vegetation is composed of moist and dry montane and upper montane forest with extensive areas of bamboo and upland grassland. In the drier lower-lying areas, forest is replaced by woodland/grassland.

Montane Forest: Typical trees include: *Cassipourea gummiflua*, *Maesa lanceolata*, *Neoboutonia macrocalyx*, and *Cola* sp..

Upper Montane Forest: Typical trees include: *Aphloia theiformis*, *Bersama abyssinica*, *Syzygium guineense*, *Hagenia abyssinica* and *Ocotea usambarensis*.

Riverine Forest: Within woodland/grassland usually dominated by *Syzygium cordatum* with varying amounts of *Bridelia micrantha*, *Faurea* sp. and *Rauvolia caffra*.

Woodland: In higher altitudes dominated by *Protea* sp., while in lower altitudes it is dominated by *Brachystegia* sp.

6.2.6 Catchment Value

The reserve includes a number of catchments due to its large area and its relatively high rainfall. A number of rivers flow south (e.g. Ruipa) into the Mgeta and Ruipa catchments which feed into the Kilombero valley (agricultural area). A number of rivers flow north into the Lukosi catchment which feeds into the Great Ruaha River and is the basis for the generation of electrical power at the Kidatu Hydro-electric Dam.

Frontier Tanzania Udzungwa Mountains Biodiversity Survey

West Kilombero Scarp Forest Reserve

7 Biodiversity and Forest Use Survey Summaries

7.0 Biodiversity and Forest Use Survey Summaries

7.1 Introduction

This section is a compilation of the summaries of each section in the botanical and zoological reports for West Kilombero Scarp Forest Reserve. For further information regarding the surveys aims, methods and results please refer to botanical or zoological report as appropriate (Frontier Tanzania, 2001c & Frontier Tanzania, 2001e).

7.2 Tree Communities and Diversity in West Kilombero Scarp Forest Reserve

(Section 7.2 in Frontier Tanzania, 2001d)

Andrew R. Marshall, Ioan Fazey, J. Elmer Topp-Jørgensen, Henry Brink

7.2.1 Summary and Recommendations

The following survey examines the mature tree species composition of two forest fragments (Ndundulu and Nyumbanitu) in the West Kilombero Scarp Forest Reserve. Trees over 10cm dbh were measured and identified within 50 systematically arranged 50m×20m sample plots. Ecological and topographical data were collected and subsequently used to explain the variation in tree composition.

Trees were tentatively identified from 44 families, 106 genera and 141 species. Of these, 16 species were found to be endemic to Tanzania. The dominant species were *Cola* sp., *Cassipourea gummiflua*, *Bersama abyssinica*, *Syzygium guineense* and *Octolobus spectabilis*.

Distinct plant communities were revealed. A *Cassipourea/Cola/Craterispermum* community was the dominant forest type at most altitudes. Additional communities included a high altitude (>1900m a.s.l. approximately) *Hagenia/Tecomaria* community, and a mid-altitude (around 1850-2000m a.s.l.) *Neoboutonia/Aphloia/Podocarpus* community. In addition, undifferentiated forest types were seen from lower altitudes in Nyumbanitu (<1650m a.s.l. approximately). Some outlying communities also occurred due to forest edge effects.

Altitude was the most significant determinant of tree composition. There were also distinct differences between the two forest fragments. Human impact is low, although logging and fires in the north of Ndundulu have had a negative effect.

Combined with studies on the fauna, this study confirms the extraordinary biodiversity values in WKSFR. The forests are highly diverse, both in terms of species and forest communities. Because the reserve as a whole is diverse, it is not therefore possible to determine areas of primary importance for conservation and thus management initiatives should seek to preserve and monitor all forested areas. Also noteworthy is the large number of species of low frequency and no single tree species is clearly dominant. This is further demonstrated by comparison with plots outside of the evergreen forest and with the more disturbed New Dabaga/Ulangambi Forest Reserve.

A final point worth note is the need for encouragement of species rich tree growth in the wooded grassland areas between the evergreen forest fragments. This may be accomplished by the prevention of bushfires (see section 8.4 and Frontier Tanzania, 2001b).

7.3 Tree Regeneration in West Kilombero Scarp Forest Reserve

(Section 7.3 in Frontier Tanzania, 2001d)

Andrew R. Marshall, Henry Brink, J. Elmer Topp-Jørgensen

7.3.1 Summary and Recommendations

3m×3m regeneration plots were established at 50 evergreen forest sites in West Kilombero Scarp Forest Reserve (WKSFR). All young trees and shrubs below 10cm DBH in each plot were then identified to determine the regenerating species content of the reserve.

Frequency and genera richness was compared with the heavily disturbed New Dabaga/Ulangambi Forest Reserve (NDUFR). Tests revealed a significantly lower number of regenerating trees in WKSFR. There was also a threefold decrease in the mean number of regenerating trees. No significant difference in genus richness was seen. This may have been due to a low sampling intensity and to small plot sizes.

A low number of secondary trees occurred in WKSFR. This, together with the generally low frequency of regenerating trees is thought to reflect the more stable nature of the forests in WKSFR. This is likely to be a result of lower human impact than in NDUFR. Some evidence of human presence was also noted in the north of Ndundulu along transect line 1. The effect of this was seen from significantly fewer regenerating canopy tree individuals and genera along this transect line in comparison with other transects. Conversely, understorey trees were however more numerous along transect line 1, thus reflecting the high rate of pioneer tree regeneration.

As a further comparison, three plots were set up outside of the reserve: two in wooded grassland and one in riverine woodland. These all had a low number of regenerating trees of few genera. This is interpreted as the result of the open and exposed nature of these habitats. Tolerant species predominate and thus diversity is low.

The suggested management priorities for forest regeneration are the strict prevention of future timber harvest and the careful control of fire.

7.4 Opportunistic Botanical Collections

(Section 7.4 in Frontier Tanzania, 2001d)

Henry Brink, Dominic Price, Andrew R. Marshall, J. Elmer Topp-Jørgensen, Kathryn Doody

7.4.1 Summary

395 fertile plant specimens were collected from West Kilombero Scarp Forest Reserve. To date, 388 specimens have been identified to family level, 381 to genus level, and 363 to species level. The collection comprises at least 87 families, 244 genera and 293 species. 20 species were identified as endemic to Tanzania, and 72 specimens as not previously recorded in the Udzungwas. Final verification and identification of the collection by Kaj Vollesen (Royal Botanical Gardens, Kew) is complete. 18 specimens still need verification.

7.5 Ethno-Ecological Survey

(Section 8.2 in Frontier Tanzania, 2001d)

J. Elmer Topp-Jørgensen, Henry Brink, Andrew R. Marshall, Abrahaman Mndeme

7.5.1 Summary and Recommendations

Ethno-ecological interviews were conducted in two villages neighbouring West Kilombero Scarp Forest Reserve. Using the Participatory Rural Appraisal technique, informal interviews were conducted with key informants including traditional healers and elder men recommended by the village chairman or secretary. Casual observations and aerial photographs were also used to record information regarding human uses of natural resources and land use patterns.

The disturbance level in terms of extractions of natural resources from West Kilombero Scarp Forest Reserve is very low. Casual observations supported interviewees who said that most natural resources were taken from woodland and riverine sources outside the reserve. Villagers said that prior to gazettement of the reserve, people lived inside what is now the forest reserve. After the establishment of the reserve, people were denied access to the forest resource and instead found replacements from the woodland or riverine areas outside the reserve. Here they find a supply of firewood, house-building materials, wood for furniture, tool handles, medicine, fruits, honey, kitchen utensils, thatched roofs, mats and ropes. With the implementation of appropriate management activities these resources hold potential for sustainable use in the future.

Casual observations however revealed that hunting, honey collection, pole cutting and medicinal plant collection take place inside the forest reserve, predominantly near settlements. Evidence of fire was also observed in the reserve (see section 8.4). To tackle this problem, introduction of modern beehives (where fire is not used in the collection of honey) within specified areas of WKSFR, could be allowed in the forest reserve.

Medicinal plant collections from the forest were said to be the most important resource extracted from the reserve as some medicinal plant species found here cannot be replaced by a woodland resource. Given the importance to local people of forest dwelling medicinal plants some form of controlled collection should be considered for inclusion into a joint forest management plan.

Villages are expanding and cultivated areas have appeared near the forest reserve boundary. Although it was generally agreed that natural resources were still sufficient near villages, some villagers raised concern about the increasingly longer distances they had to walk to collect firewood. Concern was also raised about a shortage of fertile land leading to destruction of new woodland areas. This increasing demand for land results from both an increasing human population and the rapid degradation of cultivated areas. It is suggested that initiatives are undertaken to improve the current land use practice to limit the need for new land for agricultural land.

The forest is also the scene for cultural events such as sacrifices for rain and celebrations of ancestors. It is suggested access certificates should be granted to medicinal plant extractors and issued for groups of villagers in the event of celebrations. It is however necessary to use a precautionary principle and review the system should it have a negative effect on forest quality.

7.6 Assessment of the Impact of Human Forest Use in West Kilombero Scarp Forest Reserve.

(Section 8.3 in Frontier Tanzania 2001d)

J. Elmer Topp-Jørgensen, Andrew R. Marshall and Henry Brink.

7.6.1 Summary

The disturbance survey was carried out along eight transects in West Kilombero Scarp Forest Reserve. All evidence of human activities was recorded within 5m of the transects with detailed focus on forest edge. Assessment was also made of the abundance and extraction level of poles and trees.

Observations for all disturbance categories revealed that the occurrence of human disturbance in West Kilombero Scarp Forest Reserve is very low. Logging has led to a more open canopy cover in the north-western part of Ndundulu. A prevailing herb, shrub and vine layer in these forest gaps has left this part of the forest more vulnerable to fires. Trees in this area at the forest edge were observed to have been killed by fire. Pole extraction shows a similar picture to logging, with all extraction observed on transect 1 Ndundulu, but unlike logging some recent cuts were observed. Observation of older cut poles might have accompanied logging activities, but all recent cuts are thought to be associated with honey collection or for certain hardwood species unobtainable from woodland areas.

The number of other disturbance categories is very low. The data however might indicate that most disturbance has occurred near the forest edge on transect 1 in Ndundulu and fire disturbance is more widespread than the other disturbance categories (see section 8.2 and section 8.4). It is however likely that the most accessible areas of forest near Udekwa and Ifuwa are subjected to extraction of natural resources. These areas include the north-western part of Ndundulu and the northern and north-western areas of Nyumbanitu. Further studies are needed to verify this.

7.7 Effect of Bushfire on Forest Expansion in West Kilombero Scarp Forest Reserve

(Section 8.4 in Frontier Tanzania, 2001d)

Andrew R. Marshall, Henry Brink, J. Elmer Topp-Jørgensen

7.7.1 Summary and Recommendations

Quadrats and transects were established dissecting the forest edge at nine sites in the West Kilombero Scarp Forest Reserve (WKSFR). Within these, all trees were identified and measured. Estimates of vegetation cover, tree canopy height and recordings of fire signs were also made.

Charred ground and plant remains were widespread in the wooded/bushed grassland adjacent to the forests. Reports from scientists and local people further suggested that large scale bushfires are often an annual occurrence in the area. Upon return to the area eight months after this fire survey fieldwork, a vast expanse of the grassland had been burnt, removing all herbaceous vegetation and even killing some trees.

The grassland fires in WKSFR are clearly started by human activities. Possibilities include spreading cultivation fires, honey collection fires and campfires. However, deliberate clearance by fire is also very likely. This may be to drive away dangerous animals, or most likely to assist hunting by improving visibility and encouraging the growth of pasture for large game animals.

The effect of the fires is apparent. Both the maintenance of savanna and the prevention of forest expansion are thought to be encouraged by persistent fire. This is seen from aerial photographs as well as statistically significant changes in vegetation. Fire has also decimated areas of forest in the north of Ndundulu forest. The cause of this is unknown.

It is concluded that the careless control of fires is by far the biggest threat to the WKSFR forests. Therefore, management practices should actively seek to prevent or control these activities.

7.8 The Small Mammal Fauna of West Kilombero Scarp Forest Reserve

(Section 7.2 in Frontier Tanzania, 2001f)

J. Elmer Topp-Jørgensen, Andrew R. Marshall and Henry Brink.

7.8.1 Summary

The small mammal fauna of West Kilombero Scarp Forest Reserve was surveyed between July and December 2000, using a combination of bucket pitfalls, Sherman traps and larger mesh traps. Ten trapsites were placed in the main forest block and four were positioned in non-evergreen forest habitats (miombo woodland, acacia woodland, mono-dominant riverine forest and grassland). Evergreen forest sites were trapped for eight days and other habitats for four days.

The term “small mammals” refers in this study to the members of the family Soricidae and the orders Macroscelidea and Rodentia. “Small rodents” refer to species of the family Rodentia caught in Sherman traps and bucket pitfalls (*Beamys hindei* and *Tatera* sp. being the largest species).

The list of small mammals species observed in WKSFR includes 16 species of rodents, at least four species of shrew (155 specimens await identification) and two species of elephant shrew. One casually observed species, Zanj elephant shrew (*Rhynchocyon petersi*) is listed as “Endangered” by IUCN, while *Crocidura monax* and *Beamys hindei* are listed as “Vulnerable”. Six of the specimens identified to date are forest dependent and five of these are restricted to forests in Tanzania, Kenya and Malawi.

Thirteen species of rodents were caught in Sherman traps and bucket pitfalls in the reserve as a whole. Nine rodent species were caught in evergreen forest areas and nine in other habitats, with *Graphiurus* sp., *Lemniscomys griselda* and *Rhabdomys pumilio* only recorded from the latter. Only one species occurred exclusively in evergreen forest, *B. hindei*.

The identification of *Dasymys incomptus* and *Mus minutoides/musculoides* (uncertainty about identification) from forested areas in WKSFR, combined with Frontier Tanzania surveys in New Dabaga/Ulangambi Forest Reserve and data from Stanley *et al.* (1998), increases the number of small rodent species known from forested areas in the Udzungwa Mountains to 16. This is the highest number recorded for an Eastern Arc forest, thus highlighting the great biodiversity value of this mountain region.

Two records were made of the servaline genet (*Genetta servalina lowei*), which according to Kingdon & Howell (1993) is known from only one individual collected in the Dabaga area in the 1930s. A slight morphological difference was also noted between four-toed elephant shrews (*Petrodromus tetradactylus*) caught in evergreen forest and miombo woodland, but taxonomic verification is needed to tell if the individuals belong to different sub-species.

The patchy distribution of some small mammal species suggests that the diversity of the small mammal fauna is closely linked with habitat heterogeneity. Therefore management should seek to preserve the mosaic of habitats found in West Kilombero Scarp Forest Reserve.

7.9 Bats of West Kilombero Scarp Forest Reserve

(Section 7.3 in Frontier Tanzania, 2001f)

Henry Brink, Andrew R. Marshall, J. Elmer Topp-Jørgensen

7.9.1 Summary

Bats of West Kilombero Scarp Forest Reserve (WKSFR) were sampled during the periods July to September, and November to December 2000. Sampling was carried out using mist nets. Bats encountered opportunistically (e.g. roosting) were also collected. A total of 122 hours were spent mist netting. Nineteen bats were caught, representing four families, at least six genera, and at least seven species. The sample size is, however, thought to be too small to comprise a representative species list of WKSFR.

Three factors were important when mist netting. Nets should be checked regularly (every 15 minutes or constantly watched). The siting of nets in well-used bat flyways and the arrangement of the nets in these flyways were also paramount to trapping success.

All bats identified to species level were forest dwelling. That is they are found in forests, but may also be found in other more open habitats. Although bats may forage widely for food, they require sheltered areas to roost. The forested areas of WKSFR offer a variety of potential roost sites, most notably the numerous hollow trees and caves. Fruit bats play an important role in the dispersal of seeds and the pollination of flowers, and hence are important for the diversity of the forest. It is thought that the maintenance of forested areas for roosting combined with a mosaic of other habitats for foraging should benefit bat diversity.

7.10 The Eastern Tree Hyrax (*Dendrohyrax validus*) in West Kilombero Scarp Forest Reserve

(Section 7.4 in Frontier Tanzania, 2001f)

J. Elmer Topp-Jørgensen, Henry Brink, Andrew R. Marshall.

7.10.1 Summary

The eastern tree hyrax (*Dendrohyrax validus*) was surveyed in West Kilombero Scarp Forest Reserve using the circular plot count method to count vocalizations. Results were gathered from 10 sites. Data was recorded from mid July to August and in November 2000.

D. validus is abundant within the forested areas of WKSFR. At sites where hyrax calls were recorded, the average number of individuals was estimated to be six individuals within the census radius of 50m. However, the uncertainty with which the census radius was estimated does not justify a density estimate. It should however be noted that the method holds great potential for assessing hyrax densities if distance estimates are precise or can be calibrated.

The *D. validus* distribution within the forest areas was somewhat affected by forest structure. In areas with broken canopy hyraxes were either absent or present at low numbers. The most likely explanation for this is a low number of possible shelter trees and a reduction in the number of arboreal pathways between trees. The latter means that in order to get from the tree in which the animal resides to neighbouring food trees, the hyrax may have to move along the ground where it is more vulnerable to predators.

Three distinct calls were defined in this study, Type A, B and C. The three calls seem to have different functions. The Type A call is used as an advertising call constantly reminding neighbouring individuals of its presence. The number of Type C calls increased significantly with increasing number of individuals and therefore is believed to express a higher level of aggression.

D. validus is highly dependent on forest for its survival. Management interventions should therefore focus on issues seeking to maintain the quality of the forested areas in West Kilombero Scarp Forest Reserve.

7.11 Large Mammals in West Kilombero Scarp Forest Reserve

(Section 7.5 in Frontier Tanzania, 2001f)

J. Elmer Topp-Jørgensen, Henry Brink and Andrew R. Marshall.

7.11.1 Summary and Recommendations

The “Fixed Area Search Method” (Eberhardt, 1978) and the “Line Intersect Method” (Eberhardt, 1978) were used to estimate the relative abundance of mammals at 7 sites in West Kilombero Scarp Forest Reserve from July to December 2000. A total of 7 km of transects were surveyed. In addition to this casual observations of large mammals and their spoor* were recorded for all habitat types within the reserve.

West Kilombero Scarp Forest Reserve is home to 28 species of large mammals. Seven of these species and subspecies are restricted to Tanzania. A total of nine species or subspecies are forest dependent including six of seven species or subspecies of restricted range. Furthermore, 11 of the 28 large mammals recorded from the reserve, are listed by IUCN as “Endangered”, “Vulnerable” or “Lower risk”. The presence of this unique diversity of large mammals can be accredited to the size of WKSFR and the mosaic of habitat types found in reserve, including grassland, woodland, and montane and sub-montane forest.

The reserve, with its many threatened species of large mammals, probably supports the richest large mammal fauna within the Eastern Arc Mountains. Comparison with the highly disturbed NDUFR shows that the large mammal populations have been reduced drastically as a result of hunting and habitat degradation. It is therefore essential that the managing authority aim to conserve the high biodiversity value in WKSFR, through cessation of fires, regulation of hunting and prevention of natural habitat destruction.

The study of spoor of large mammals showed a uniform distribution of smaller sized species compared to species of larger size. The results were not used to estimate densities of the seven surveyed species, but the data may act as a baseline for future monitoring of population trends if this is deemed necessary by the managing authority.

* *In this study the term “Spoor” refers to all signs produced by animals.*

7.12 Priorities for the Conservation of Monkeys in West Kilombero Scarp Forest Reserve Based on Comparison of Density and Socioecology with New Dabaga/Ulangambi Forest Reserve

(Section 7.6 in Frontier Tanzania, 2001f)

Andrew R. Marshall, Henry Brink, J. Elmer Topp-Jørgensen

7.12.1 Summary and Recommendations

Ten species of primate are known from the Udzungwa Mountains, making it one of the most important areas for primate conservation in East Africa. Amongst these are four forest dwelling monkey species, (Udzungwa red colobus, *Procolobus gordonorum*, Sanje crested mangabey, *Cercocebus galleritus sanjei*, Angolan black and white colobus, *Colobus angolensis palliatus* and Sykes' monkey, *Cercopithecus mitis* (subsp.)). The former two of these are of restricted range and of considerable conservation concern (IUCN vulnerable and endangered respectively).

There has been little previous study of Udzungwa primates in most forest fragments beyond details of presence/absence and not even that information is available for some forests. Previous limited surveys of West Kilombero Scarp Forest Reserve (WKSFR) have reported the presence of six monkey species including the four species of forest dwelling monkeys, which are the focus of this study.

Transect line survey and opportunistic encounters recorded the presence of black and white colobus, Sykes' monkey and the Udzungwa red colobus in most forested areas of the reserve. From 96h of transect line surveys in Ndundulu forest (the easternmost forest fragment of WKSFR), most visual records were of the black and white colobus, whereas Sykes' monkey vocalisations were heard most often. The Sanje mangabey was not recorded at any point during fieldwork, and thus its distribution within the reserve (known from Ndundulu forest only) is thought to be highly restricted.

By detailed comparison with New Dabaga/Ulangambi Forest Reserve (NDUFR), and with reference to previous studies in the Udzungwas and elsewhere, the potential effect of habitat quality is demonstrated and discussed. Primarily, there is a notably higher group density (measured as groups per kilometre transect) and group size in WKSFR than in NDUFR. This difference is apportioned to the generally low degradation of habitat in WKSFR. There are also a relatively high number of associations between different species in WKSFR, which may again have been affected by habitat degradation. Is it more likely however that the high abundance of predators in WKSFR benefits large aggregations of mixed species. Comparison between transect lines within the two reserves also appears to support these suggestions.

Observed changes in monkey ecology with habitat quality provide just one example of how human impacts on forested areas can affect wildlife. Such changes are indicative of monkey populations under environmental stress and thus the ecology of many taxa is likely to be under similar pressures. In WKSFR however, populations of the three observed species appear to be healthy. Habitat fragmentation from logging and bushfires may have affected the social group structure of monkeys in the north of Ndundulu forest, although group density remains high.

The importance of WKSFR to Udzungwa primate conservation cannot be stressed enough. It is one of only three known forests containing the Sanje mangabey (despite no records in this survey) and is a major stronghold for populations of the Udzungwa red colobus. There are two priorities for action:

- The preservation of the forested areas is vital. Forest use must be monitored closely by the MEMA project to ensure that the current low level of exploitation does not elevate. If forest use should begin to elevate, future inclusion of the reserve into the bounds of the adjacent Udzungwa Mountains National Park should also be considered to safeguard the long-term protection of the area.
- Also of concern is the isolated nature of the Nyumbanitu and Ukami forest fragments. Simple cessation of annual bushfires, which would allow re-colonisation by forest/woodland of the extensive grassland areas, may be sufficient to connect these fragments. Most importantly, such a connection could potentially open up the forests of Nyumbanitu and Ukami to the Sanje mangabey populations, which are currently limited in WKSFR to Ndundulu forest.

7.13 Bird Observations from West Kilombero Scarp Forest Reserve (Section 7.7 in Frontier Tanzania, 2001f)

Andrew R. Marshall, J. Elmer Topp-Jørgensen, Henry Brink

7.13.1 Summary and Recommendations

The Udzungwa Mountains contain more restricted range birds than any other area in Eastern Arc Mountain Range. The Udzungwa avifauna is therefore a key factor in demonstrating the conservation value of the area.

Between 1991 and 1995 a team of four Danish ornithologists spent 465h in West Kilombero Scarp Forest Reserve observing birds. This coupled with observations made by the Frontier Tanzania research team has allowed us to draw up a reasonably accurate list of species present.

A total of 151 species have been recorded, including one endemic to the Udzungwa Mountains and at least 16 near endemic forest dependent species. Many of these birds are also considered globally threatened, two of which are IUCN endangered: Amani sunbird, *Anthreptes pallidigaster* and Usambara weaver, *Ploceus nicolli*. Seven others are considered IUCN vulnerable: the Udzungwa forest partridge, *Xenoperdix udzungwensis*, dappled mountain-robin, *Modulatrix orostruthus*, Swynnerton's robin, *Swynnertonia swynnertoni*, Iringa ground robin, *Sheppardia lowei*, rufous-winged sunbird, *Nectarinia rufipennis*, banded green sunbird, *Anthreptes rubritorques*, and white-winged apalis, *Apalis chariessa*. These make West Kilombero Scarp Forest Reserve one of the most important centres for species of restricted range and conservation concern, both in the Eastern Arc Mountain chain and in Africa.

This is clearly an area of major importance for Eastern Arc birds, with both high avian diversity and many restricted range species. Each year, these birds draw a small number of visitors, whose enthusiasm and determination suggests that there is scope for tourism.

The forest reserve however remains fragmented and there do not appear to be any forest passages connecting the isolated fragments of Ukami, Nyumbanitu and Ndundulu. This is of particular concern for the forest dependent species that require strictly forested habitats to disperse. The establishment of forested corridors by active management or cessation of fires would significantly improve this situation.

An important consideration is that some threatened birds were observed only rarely within the reserve. The Amani sunbird, banded green sunbird and Usambara weaver were particularly scarce. These same species are also scarce in other fragments of the Udzungwas and thus it is important to conserve all known habitat of these species in the most effective way possible. This should involve close monitoring of forest use and co-operation between management authorities.

7.14 Assessment of Reptile Collections from West Kilombero Scarp Forest Reserve

(Section 7.8 in Frontier Tanzania, 2001f)

Andrew R. Marshall, J. Elmer Topp-Jørgensen, Henry Brink

7.14.1 Summary and Recommendations

Since short surveys in the 1950s, the herpetofauna of the Udzungwa Mountains has been much neglected. In recent years, three areas of Udzungwa forests have been surveyed although the reptilian inhabitants of several forests remain unstudied and undocumented. Much of the remainder of the Eastern Arc reptiles are also poorly known. In this respect, knowledge of East African reptiles lags behind other areas of the world. By contrast, the reptilian fauna of many countries (e.g. much of Asia, West Africa and America) has been inventoried and is currently undergoing detailed ecological study (Howell, 1993).

The reptiles of West Kilombero Scarp Forest Reserve were surveyed using a combination of bucket-pitfall traps and opportunistic collections. From this, reptiles from seven families were collected including 17 genera and 19 species. The reptile fauna varies considerably between different study sites. This coupled with the heterogeneity of habitats within the reserve, which may also influence faunal diversity, further demonstrates the important contribution to biodiversity of the reserve as a whole. In particular there are nine near endemic species.

The two forest trapsites at the lowest altitudes had the largest number of reptiles. This may be due to restrictions of cooler, high altitude climates on cold-blooded animals. This may also explain the relatively low frequency of reptile records from forest areas (only 19 individuals) compared to lowland Eastern Arc forests sampled using similar methods. Increased walks for opportunistic sampling may however have increased the number of records.

Despite the low number of records, three species are listed which do not appear to be previously recorded for the Udzungwas (*Bitis gabonica*, *Melanoseps uzungwensis* and *Lygodactylus angularis*). Such a high proportion of range extensions emphasises the importance of WKSFR for forest reptiles. Furthermore, three species previously defined as forest dependent were also found over 500m outside of forest habitats in fire-maintained wooded grassland. From both of these observations there is also a clear need for further study in the Udzungwas and equally important, the publication of findings.

Management priorities for reptiles are similar to those for other taxa. Namely, in addition to the preservation of diverse habitats, the forest dependent species may benefit from some means of dispersal. This can be achieved by the prevention of bushfires, which would encourage the formation of forested corridors to connect the Nyumbanitu, Ndundulu and Ukami forest fragments.

7.15 Amphibians of West Kilombero Scarp Forest Reserve

(Section 7.9 in Frontier Tanzania, 2001f)

Henry Brink, J. Elmer Topp-Jørgensen, Andrew R. Marshall

7.15.1 Summary and Recommendations

The amphibian fauna of West Kilombero Scarp Forest Reserve (WKSFR) was sampled using a combination of bucket pitfall trapping and opportunistic collections. Ten sites were sampled within evergreen forest (trapsite 1-10), and four trapsites were placed outside evergreen forest (trapsite A-D). Trapsites within the forest were sampled for eight days, while those outside were for four days. Amphibian communities of WKSFR were surveyed from July to September, and again in November 2000.

A total of 2088 amphibians were caught (includes 18 individuals caught opportunistically during 1999), of which 275 were retained for taxonomic purposes. Species identification is still preliminary. Within this amphibian collection, there are at least six families, ten genera and 14 species*. It is felt that this survey provides a representative sample of the terrestrial amphibian fauna of WKSFR. No amphibians endemic to the Udzungwa Mountains were recorded by this survey. All species listed as forest dependent are limited range species (six species), three of which are restricted to the forests of Eastern Tanzania. The presence of these limited range forest dependent species highlights the conservation importance of WKSFR.

Amphibian diversity varied between trapsites. Four factors were thought to be important in explaining this variation, namely, altitude, precipitation, distance to water and canopy cover. The proximity of water was shown to have a significant influence on the number of species recorded; more species were recorded near water.

Of note was the collection of one individual of the genus *Hoplophryne*, which represents the first record of this genus in the Udzungwas, thereby highlighting the incomplete nature of current knowledge.

The amphibian fauna of limited distribution tends to be forest dependent, and forested areas occupy a minute portion of the Tanzanian landscape (less than 3%) stressing the importance of conserving these forest fragments in Tanzania (as highlighted in Howell, 1993; Schiøtz, 1981). WKSFR possesses some of the largest tracts of primary forest within the Udzungwas and Tanzania, therefore efforts should be concentrated on maintaining and expanding these forested areas.

Just prior to completion of this report additional species determinations were available, this section uses preliminary findings as the basis of its analysis but more recent determinations show that within this amphibian collection, there are at least six families, 12 genera and 20 species. One of the species is endemic to the Udzungwa Mountains. There are a further 10 near endemic species, of which nine are forest dependent. Eight species have an IUCN criteria of vulnerable, while one species is near threatened. Three records are of particular interest:

- The record of *Arthroleptis xenodactylus* represents the first record of the species in the Udzungwa Mountains.
- The record of *Hoplophryne* represents the first record of the genus in the Udzungwa Mountains.
- A species currently being described (*Arthroleptides* sp. nov.) was recorded by this survey of WKSFR.

Up to date figures will be used in the executive summary and management sections.

* Number of species used in the Executive Summary and Management Sections based on Table 7.9F; Frontier Tanzania, 2001f.

7.16 Mollusc Diversity in West Kilombero Scarp Forest Reserve

(Section 7.10 in Frontier Tanzania, 2001f)

J. Elmer Topp-Jørgensen, Andrew R. Marshall, Henry Brink

7.16.1 Summary and Recommendations

The mollusc fauna of West Kilombero Scarp Forest Reserve (WKSFR) was sampled using a combination of plot surveys, direct timed searching and casual collections. Ten sites were sampled in evergreen forest; five in the Ndundulu forest area including an area dominated by bamboo, four in Nyumbanitu and one in Ukami. Four trapsites were in non-evergreen forest habitats including miombo and acacia woodland, grassland and riverine forest. For each site, collected molluscs have been counted and divided into morpho-species.

The mollusc fauna of forested areas in WKSFR is the second most species rich area within the Eastern Arc Mountains. With its 54 morpho-species (60 including non-evergreen forest habitats) the area is equivalent to some of the richest land-snail faunas recorded worldwide. The area has more than twice the number of species than its fellow Udzungwa site of New Dabaga/Ulangambi Forest Reserve (NDUFR). This reflects the presence of an undisturbed and very diverse forest habitat in WKSFR, covering a significant altitudinal span.

Rain had a significant effect on the results. Sites sampled after the onset of the rainy season were richer in species than sites sampled in the dry season. Molluscs are sensitive to desiccation and therefore prefer moist habitats. Where large fluctuations occur in the microclimate mollusc species may enter a dormant stage during dry periods. This is thought to have affected results, primarily for the miombo woodland site but also for drier habitats in evergreen forest.

In this study woodland areas tend to be as species rich as evergreen forest sites, although differing in species composition. During the dry season however, species can be difficult to locate in the woodland area as they bury deep into the ground or hide in cracks and crevices or on vegetation in order to escape desiccation. The grassland and riverine forest sites are considered to have a low number of species due to the uniform nature of the habitat. Compared to the woodland sites these sites have a more constant microclimate because they were found on waterlogged ground and thus are not expected to show similar fluctuations in the number of species and individuals collected.

The implication of changes in forest structure in relatively stable forest environments is likely to be more severe in tropical areas than in temperate regions, because of the high solar radiation which may cause desiccation. In temperate climate zones it has been shown that silvicultural management can have a considerable negative impact on molluscan faunas. Furthermore, the record of 36 morpho-species recorded only in forested areas and six from other habitats only. A management plan should therefore seek to maintain an altitudinal range of forest cover as well as preserve the diversity of habitats found in WKSFR.

7.17 Millipede Diversity and Distribution – West Kilombero Scarp Forest Reserve

(Section 7.11 in Frontier Tanzania, 2001f)

Andrew R. Marshall, Henry Brink, J. Elmer Topp-Jørgensen

7.17.1 Summary and Recommendations

Knowledge of millipedes (class Diplopoda) is extremely limited, especially in the montane forests of Tanzania. Notably, only about six of the eleven Tanzanian families are known in any detail and only one has been extensively documented. For this reason, most millipede collections made from Tanzania are likely to contain several undescribed species and even new genera. Hoffman (1993) estimates that only one in eight millipede species has been described.

Endemism in millipedes is extremely high and few species occur in more than one mountain range. The Udzungwa Mountain range has been surveyed by only one expedition, which concentrated on Mwanihana forest. This short study however found four endemic genera and eleven endemic species from the family Oxydesmidae (Hoffman, 1993). When compared to species endemism of this family in other Eastern Arc forests, this places the Udzungwas above all others. Much of the Udzungwas are however unexplored and given this high level of millipede endemism, there are clearly more discoveries to be made.

Millipedes from the previously unstudied populations of West Kilombero Scarp Forest Reserve (WKSFR) were sampled using a combination of quadrats and timed casual searches. From these, 4,941 millipedes were collected. Taxonomic verification was however unavailable at the time of report writing, so these were classified into thirty-eight morpho-species in order to investigate diversity.

Comparison with millipedes collected from New Dabaga/Ulangambi Forest Reserve (NDUFR) highlights the high level of endemism of forest millipedes. Most notably, only ten out of the thirty-eight morpho-species in WKSFR were also found in NDUFR. WKSFR also has an exceptionally high diversity of millipedes, including twelve morpho-species that were only found at one trap site.

The millipede fauna within the forest is also clearly more abundant and species rich than that outside. Notably, twenty-one out of the thirty-eight morpho-species (51.2%), were found only in the forest trapsites. Given the extremely low dispersal ability of millipedes beyond environmental boundaries, most of these “forest species” are likely to be restricted to and dependent on these forests for survival.

Differences in millipede diversity between and also within the two reserves are likely to be due to factors influencing desiccation. This is the primary limiting factor to millipede distribution (Hoffman, 1993). In particular, canopy fragmentation increases the exposure of the forest floor to drying out, and forest use should be monitored to ensure that harmful activities are not threatening this (see Frontier Tanzania, 2001b). The onset of rains in WKSFR highlighted this dependence on moisture, with a significant increase in species richness after the rains began.

7.18 Butterfly Diversity of West Kilombero Scarp Forest Reserve

(Section 7.12 in Frontier Tanzania, 2001f)

Henry Brink, Andrew R. Marshall, J. Elmer Topp-Jørgensen

7.18.1 Summary and Recommendations

The butterfly community of West Kilombero Scarp Forest Reserve (WKSFR) was sampled using a combination of butterfly traps, timed sweep netting, and casual collections. Ten sites were sampled within evergreen forest; five within Ndundulu forest block (trapsites 1-5), four within Nyumbanitu forest block (trapsites 6-9) and one in Ukami (trapsite 10). Four trapsites (trapsites A-D) were placed outside the evergreen forest; in miombo woodland, acacia woodland, riverine forest, and grassland. Butterflies were sampled from July to September and again in November to early December 2000.

A total of 672 butterflies were caught in WKSFR. The butterflies came from eight families, 52 genera and 102 species. One species was endemic (*Bicyclus uzungwensis uzungwensis*) to the Udzungwa Mountains, where it is confined to the high forests of WKSFR. At the subspecies level, a further three Udzungwa endemics were recorded. There are a further 19 near-endemic species or subspecies. These figures reflect the high biodiversity value of WKSFR.

Three factors were thought to be important in influencing butterfly diversity at the various trapsites. These were time of year, altitude and habitat heterogeneity. A significant positive correlation was noted between number of individuals caught and time of year; more individuals were caught at the end of the survey period than at the beginning. This suggests more butterflies would be recorded had sampling continued into the warmest and wettest months of the year (December to April). An increase in species and individuals was also noted with a decrease in altitude. Trapsite 9 in forest edge habitat near a river had the highest butterfly diversity, with 45 species and 122 individuals recorded.

47 species recorded by this survey were forest dependent, while 78% of limited range species were forest dependent. This highlights the importance of reserve's forested areas. The variety of habitats in WKSFR has led to the high diversity of butterflies recorded there. This stresses the importance of maintaining the mosaic of habitats found within the reserve.

7.19 A Field Study on the Conservation Status and Species Diversity of Galagos in the West Kilombero Scarp Forest Reserve, November - December 1999.

(Section 8.0 in Frontier Tanzania, 2001f)

Andrew Perkin (Nocturnal Primate Research Group, Oxford Brookes University, UK.)

7.19.1 Summary

Ten days field work (from 26/22 – 11/12/1999) were spent with the Frontier Tanzania field project team in the West Kilombero Scarp Forest Reserve, Udzungwa Mountains, Iringa Region. This galago survey is part of a larger study on the biogeography and conservation status of galagos in the Eastern Arc Mountains and Coastal forests of Tanzania. Two forests Nyumbanitu and Ukami, within the West Kilombero Scarp Forest Reserve were visited. Two species of galago were seen and heard. The first species is probably the mountain galago *Galagoides orinus*, which was seen and heard briefly in Nyumbanitu forest. The uncertainty in the identification is due a lack of sightings and calls heard. The second galago species recorded was the Matundu galago *Galagoides udzungwensis*, which was seen and heard in riverine woodland on the edge of Ukami forest. Further research is recommended to ascertain the identity of the galago occurring in Nyumbanitu forest.

Frontier Tanzania Udzungwa Mountains Biodiversity Survey

West Kilombero Scarp Forest Reserve

8 Input to Joint Forest Management

8.0 Input to Joint Forest Management (JFM)

J. Elmer Topp-Jørgensen, Andrew R. Marshall, Henry Brink

8.1 Introduction

The management recommendations presented here are based on the biodiversity survey carried out in the target area and are meant as an input to JFM plans under development by the MEMA project. These recommendations therefore only discuss issues to be addressed for the protection of biodiversity. These include proposed activities inside as well as outside the forest reserve, which combined with socio-economic studies, should form the basis for further discussion and research into the proposed components of JFM plans.

The Frontier Tanzania studies were designed as a biodiversity survey and therefore no recommendations are made of potential harvest levels for natural resources. Recommendations proposed here for sustainable use of natural and managed resources should therefore be investigated further before implementation in JFM plans. Other wider issues related to the suggested recommendations including land ownership in relation to activities outside the reserve, socio-economic studies to assess the natural resource needs in the participating communities and participation interest level among villagers are not discussed here. These issues should be addressed by other initiatives under the MEMA project.

8.2 Biodiversity Value of West Kilombero Scarp Forest Reserve and General Recommendations for Joint Forest Management

Forested areas of the Eastern Arc are widely recognised as centres of both botanical and faunal endemism. Together with the coastal forests of East Africa, the Eastern Arc is ranked among the 25 most important areas in the world for the conservation of biodiversity (Myers *et al.*, 2000). What makes these forests so exceptional is the high number of unique species found within a very limited area, and therefore their protection is paramount to the protection of globally important biodiversity. The Udzungwa Mountains contains the largest forested area within the Eastern Arc and is therefore important for the conservation of biodiversity.

West Kilombero Scarp Forest Reserve within the Udzungwa Mountains contains a unique flora and fauna with many forest dependent and restricted-range species (see **Table 8A**), and ranks among the most important areas for biodiversity in the Eastern Arc. It is the responsibility of the managing authority to ensure that all Joint Forest Management initiatives understand and respect the importance of the conservation of this diverse ecosystem. The remoteness of the forests and their combined considerable size, mean that extraction levels have been low, and the forest reserve still contains large tracts of fairly undisturbed forest. The availability of natural resources from the miombo woodland adjacent to the forest reserve is also an important part of the explanation for the low human impact levels found inside the forest.

Forest dependent species and species of restricted range are most vulnerable to destruction of forest habitat. The impact of any management activity on these species should therefore be evaluated before any implementation of Joint Forest Management plans. **Appendix 8A** presents a list of all species considered to be of priority for management, including forest

dependent species, endemic and near endemic species and species considered threatened by IUCN.

Table 8A. Summary of the number of species considered important for conservation in West Kilombero Scarp Forest Reserve. Sources of information for forest dependence and range restriction can be found in the relevant sections of the zoological report.

Taxonomic group	Total no. of species	Forest dependent	Restricted range***	IUCN conservation concern
Butterflies	102	47	23	0
Millipedes	38*	.	.	.
Molluscs	54*	.	.	.
Amphibians	20	9	11	
Reptiles	19	9	9	0
Birds	151	43	22	9
Mammals	54	15	11	9**

* Identification of millipede and mollusc specimens was not available at the time of writing. Instead the number of “morpho-species” classified by Frontier Tanzania researchers are indicated.

** A further nine mammal species are of IUCN Lower Risk or Data Deficient.

*** Restricted range refers to species found within the Eastern Arc Mountains, rest of Tanzania and northern Malawi.

General Management recommendations

WKSFR is comprised of a mosaic of habitat types, which support essentially different plant and animal communities. Any management initiative within the reserve should therefore be screened for maximum sustainability before it is implemented as it may have a detrimental effect on localised populations. It is therefore recommended that Joint Forest Management plans seek to prevent activities threatening the biodiversity and instead focus on sustainable use of resources in woodland areas outside the forest reserve.

Box 8A lists recommendations for the overall aims of Joint Forest Management. As a guiding principle, any management intervention should be carried out with to ensure the survival of native species and maintain evolutionary and ecological processes. At present, fires constitute the greatest concern for the effort to sustain the biodiversity value of WKSFR as it prevent forest expansion and prevent a natural formation of wooded corridors between forest fragments in the reserve. The threats from natural resource extractions from the forests are at present very limited and it is important that any logging, pole cutting and other tree felling are prevented in the forests. There is however some scope for sustainable extractions of non-threatened and readily renewable evergreen forest species for medicinal purposes. Identification of other resources from the protected area with a potential value to the local community should also be investigated and possibilities of sustainable extraction should be assessed. Careful planning is however needed in all management interventions to achieve the aim of conserving the biodiversity value of the forests.

Additionally, general access to the forest for cultural activities should be allowed with a locally issued permit. However, if any illegal activity is carried out due to open access, the system should be evaluated and further restrictions considered from case to case.

Management initiatives outside the reserve should seek to replace resources currently extracted from the forest and to generate additional income in the area. Improvement of

honey production and further development of animal husbandry (such as pigs, guinea pigs and chickens) outside the forest reserve could replace current honey collection and hunting of wildlife in the forest reserve, thereby reducing the ignition of fires in relation to these activities. Enhanced land-use planning and development of sustainable use practices in the still fairly extensive miombo woodland areas should be implemented as a matter of priority. If proper land-use planning is implemented in the miombo woodland zone and combined with development of enhanced agricultural practises and homegardens including fruit and timber trees, it is probably enough to meet the needs for local consumption. Increased production of beans and pigs, as well as eco-tourism, could be considered as means of boosting the income in adjacent communities.

The uniqueness of Eastern Arc forests and their importance for water catchment mean that a precautionary principle should be applied in every management action to be taken. This is based on the fact that little is known about sustainable levels of natural resource use and that management initiatives often are based on proposed assumptions influenced by a number of little known or unknown factors.

Most important for the participatory approach of JFM is the benefit of such efforts to the involved communities. The limited scope for sustainable natural resource extraction from the forest reserve means that it is unlikely that initiatives inside the forests alone can increase living standards markedly in villages surrounding the forest reserve. It is therefore important that the MEMA project identifies and develops incentives for the local communities to participate in the protection of the forest.

In the creation of the management plan, it is also important to take into consideration that it is often the poorest representatives of the population which are most dependent on natural resources provided by the nearby habitats. So any restrictions imposed via the management plan are likely to have most severe implications for them, and their incentives for participating in the protection of forests should therefore be taken into special consideration in the drawing up of the plans.

Input to Joint Forest Management plans are presented in the following sub-sections. It should here again be stressed that these management suggestions should be investigated in more detail by the managing authority before incorporation into the Joint Forest Management plans. The issues addressed include: fire prevention, marking of forest reserve boundary, access to reserve, medicinal plant extraction, wood extraction, income generating activities and Udzungwa Mountains National Park extension.

Box 8A. List of overall aims for management in WKSFR based on the biodiversity baseline survey.

1. **Conserve and protect the mosaic of habitat types and the biodiversity found herein.**
 2. **Ensure sustainable use practises for miombo woodland resources.**
 3. **To locate resources outside forest reserve that can replace current extractions.**
 4. **Increase efficiency of agricultural and silvicultural production through education of landowners.**
 5. **Awareness raising through village meetings and school education.**
 6. **Ensure access to the reserve for cultural events.**
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8.3 Discussion of Input to Joint Forest Management

8.3.1 Bush-Fires

The collected data show that annual dry season bushfires are evidently sweeping through West Kilombero Scarp Forest Reserve, shaping and influencing the vegetation to a large extent. This is considered the largest threat to the remaining forest patches. Grassland prevails on ridges between the forests and an abrupt transition between grassland and the forest fragments was observed in fire damaged areas. This clear line is similar to what was observed in forest edge areas influenced by fire. Consequently, it is assumed that the clear forest-grassland boundary is a result of repeated fires. This is a sign of that fires are preventing forest expansion and is distinct from the more gradual transition from forest to grassland in non-fire damaged areas.

Given the highly fragmented nature of Udzungwa forests, it is recommended that the establishment of habitat corridors between isolated patches is pursued. The expansion of existing forest patches for the creation of wooded corridors between the three largest forest fragments of Ndundulu, Nyumbanitu and Ukami should have high priority. They would in turn facilitate the dispersal of low-density forest species and thus ensure their continued existence. A larger unified forest habitat is crucial for the long term survival of low density plant and animal species. At present no observed links of narrow riverine forest strips seem to connect the major forest fragments. These riverine strips are mainly dominated by *Syzygium cordatum* with *Bridelia micrantha* interspersed. This narrow and monodominant habitat might aid the dispersal of some species, but it is unlikely that many others are able to move from one forest area to another. Fire is thought to prevent any tree regeneration along these often waterlogged forest strips. The prevention of annual fires would lead to increased tree regeneration expanding these riverine strips of forest, which eventually could form a forested corridor for dispersal between the major forest fragments in WKSFR.

Prevention of fire is a crucial issue in West Kilombero, which needs to be seriously addressed through management interventions. As the majority of fires are man made, large-scale awareness raising (including village meetings and teaching in schools) in combination with the enforcement of local rules and by-laws in the communities adjacent to the forest reserve should be implemented to prevent the hazardous fires from spreading. To reach any improvement towards a more controlled fire management plan, preventive measures should be developed in conjunction with the local communities, as this requires a gradual understanding to bring about any change in present practices.

8.3.2 Marking of Forest Reserve Boundary

Udekwa village has expanded towards the forest reserve and settlements are now very close to the reserve boundary. Recent (1999) aerial photographs indicate that cultivated land has been established inside the reserve, and it is therefore suggested that the forest reserve boundary should be clearly demarcated, in order for people to know when they are entering the forest reserve.

Planted trees should be used to demarcate boundaries. Boundary planting is not considered necessary where West Kilombero Scarp Forest reserve is bordering other protected areas (Udzungwa Mountains National Park and Matundu Forest Reserve), as there are no

settlements nearby. Consequently, it is primarily the northern and western boundaries, which should be demarcated.

Regular visits should be made to follow the development of the boundary trees, and decide if necessary actions should be taken to secure their growth.

8.3.3 Access to and Medicinal Plant Extraction from the Forest Reserve

Permission to enter the forest reserve should be considered on the condition that only activities agreed in the Joint Forest Management plan is carried out. The permits should be issued by the local authority to persons having a genuine interest in entering the forest, e.g. if agreements are made on the possibilities to collect specific medicinal plants. Additionally, both the people holding issued permits and the permit system as such should be evaluated for efficiency and adjusted accordingly on a regular basis. It is especially important that the local authority respects the contents of the Joint Forest Management plans and ensure that activities within the reserve complies to what is agreed here. If not the Forest Division should be considered as the permit issuing authority.

As long as the effects of the present level of extraction of medicinal plants from the forest reserve are not known, a cautious approach should be taken before any management steps are initiated. An assessment should be made of all utilised species and their suitability to sustainable extraction on the basis of abundance, renewability, rarity, ecological affinities and harvest method. Experts and local stakeholders should make the assessment. As some herb and liana species are often renewable and regenerate quickly, these are suitable for sustainable extraction. However, bark from certain tree species should be harvested in a way so that the individual tree is not killed and only on a small-scale. Subsequently, a list of species allowed for medicinal plant collection should be agreed upon, specifying where the extraction should take place and how much produce should be harvested. It is important that extractions are carried out for local consumption only to avoid unsustainable harvests, and alternative medicinal plant parts should be sought outside the forest.

Ideally, only certain certified persons who possess knowledge of medicinal plant uses (e.g. traditional healers) should carry out the medicinal plant collections. The poorest people in the community are often the ones benefiting most from this natural resource extraction, as they cannot afford medicine sold from dispensaries. Therefore, the possibility that other people could be allowed to collect medicinal plants for consumption in their own household should be considered.

Certified persons should be taught harvest methods, so ring barking and other non-sustainable extraction methods are avoided. The certified persons should keep a record of collected species and an estimate of the harvested amount. The lists should be checked annually by Forest Division staff, and annual walks through the forest with certified persons should be made to monitor the sustainability of the extractions.

8.3.4 Wood Extraction from Forest Reserve and Miombo Woodland

Timber and pole extractions have been carried out within the forest reserve, however, on a localised basis compared to other Udzungwa forests. It has mainly targeted camphor trees (*Ocotea usambarensis*), which have been extracted from areas closest to settlements. Settlements are however moving closer to the reserve and resource use in Miombo woodland within the reserve boundary was observed. Although woodland resources are still available, extractions of certain hardwood species from the forest are likely to increase in areas near settlements in the near future. Additionally, the pressure on the wood resources in the Miombo woodland outside the forest reserve and bordering the settlements is increasingly high, and the off-take is at present completely unsustainable. Land-use planning and a subsequent sound implementation is highly needed and should have high priority. The land-use zone should include buffer zones adjacent to the forest reserve.

In conclusion, before any implementation of tree plantations are made, a genuine land-use plan should be agreed upon from the outset. This is crucial in order to try to make the natural resource use outside the forest reserve sustainable, thereby relieving the pressure on the evergreen forest inside the forest reserve. This land-use plan should specifically address the issues of sustainable Miombo woodland utilisation, management of agricultural land, water management etc., as well as the possibility of setting aside land for homegardens, to provide the individual households with fruits, firewood, poles and even timber. Additionally, larger timber and pole plantations could be considered.

8.3.5 Income Generating Activities

Honey Production

At present, honey is being extracted from the evergreen forests inside the forest reserve and is highly favoured as a sweet and for medicinal purposes. Fire accompanies the collections and poses a threat to forest habitat. To avoid the damaging effects of this harvest, alternatives could be created closer to the settlements. Therefore, it is suggested that the harvests from the forests are stopped and replaced with a managed source from the woodland.

Villagers interested in honey production should receive technical assistance in the establishment and management of modern beehives in suitable areas, preferably outside the forest reserve, and closer to the settlements. As fire is not necessary to extract honey from modern beehives, it could be considered to allow beehives to be situated closer to the evergreen forest if villagers express a specific interest in obtaining honey derived from flowers in the evergreen forest, and thereby creating a marketing potential both in and outside the village.

Animal Husbandry

Some villagers mentioned bush meat as the most important resource from the forest reserve. Hunting is therefore carried out opportunistically inside the forest reserve using guns and snares. The preferred species is buffalo, but a number of species including birds, tree hyraxes, bushbuck, bush pig and elephant are hunted.

Chickens and to a lesser extent guinea pigs are kept for food in many households, but the production seems to be too small to satisfy the demand for meat in the villages. Therefore, initiatives to replace the bush meat extracted from the forest reserve with an alternative or enhanced production of the existing animal protein source should be considered (e.g.

increased production of pigs or domestication of cane rats which has shown to be successful in other countries). Technical assistance should be provided regarding a more efficient production and animal care, which would require regular visits, by a veterinary officer.

Eco-Tourism

The unique flora and fauna combined with the splendid views of evergreen forests in West Kilombero Scarp Forest Reserve could offer opportunities for eco-tourism. The diversity of the reserve could attract wilderness enthusiasts from all over the world to spot the endemic animal and plant species found in the reserve. At the moment the area receives few visitors a year, primarily people interested in birds. The area however poses a larger potential for tourism, and with the right set-up, more people could visit the area, thereby increasing the income to the local community. Any management steps towards eco-tourism should be carefully planned.

Facilities outside of the reserve near the forest edge could be developed to accommodate tourists, but once inside the forest all accommodation should be in tents. Suitable campsites should be located and prepared with toilet facilities upon the arrival of tourists. A route from Udekwa through the Udzungwa Mountain National Park to the Kilombero Valley has been investigated for its tourism suitability and remains one of the possibilities for tourism in the area.

If eco-tourism is deemed a feasible solution, based on a market analysis, guidelines for tourism activities should be developed to ensure that the habitats in the reserve are not damaged or threatened (e.g. from introduced species). Travel agents with approved skills in eco-tourism (as those trained by NOLS, National Outdoor Leadership School) should be permitted into the reserve, at the same time ensuring that maximum economic benefits are accrued to the local community, e.g. through employment.

A TANAPA (Tanzania National Parks authority) ranger post has been proposed in the area and may have a preventive effect on human impact in the reserve. It might also serve as an entry point for tourism activities.

Other Income Generating Activities

The natural resources suggested for extraction from the reserve and the income generating activities suggested above were identified during the Frontier Tanzania studies. Further investigation of socio-economic aspects and marketing analysis may reveal other possible resources suitable for sustainable extraction (e.g. oils, seeds, genetic material to improve resistance in commercial crops or hunting in areas outside the forest reserve).

8.3.6 Extension of Udzungwa Mountains National Park

It has previously been proposed to extend Udzungwa Mountains National Park to include areas in WKSFR (e.g. Dinesen & Lehmborg, 1996) and recently also Udzungwa Scarp Forest Reserve (Struhsaker, *pers. comm.*). This may have implications for Joint Forest Management due to overlapping interests of the MEMA project and TANAPA. The presence of TANAPA would provide the best protection of the forest reserve's biodiversity. Furthermore, it may provide job opportunities for some villagers and increase tourism (money) in the area. The presence of both MEMA and TANAPA in the area could therefore safeguard the area's unique environment and at the same time assure that resources from both within and outside of the forest reserve could be utilised in a sustainable manner. It is therefore strongly recommended that the managing authority investigate the possibility for such a joint collaboration. The

feasibility of this depends on numerous factors including Forest Policy (legislation), political will and not least the attitude of the villagers in affected communities. Importantly the sharing of responsibilities should be discussed among all involved parties and a collaborative work plan agreed upon.

8.3.7 Suggestions for Future Research Related to Joint Forest Management in and around West Kilombero Scarp Forest Reserve

- Investigation of which forest plants used for medicine can be replaced by a resource from outside of the reserve.
- Assessment of medicinal plant harvest potential from the forest that cannot be replaced by extractions from habitats outside the reserve.
- Investigation of possibilities and potential for sustainable hunting outside the reserve.
- Further studies on the impact of fire (e.g. impact on forest regeneration and the potential for natural establishment of corridors for dispersal).
- Investigating the possibility and feasibility of establishing buffer zone of indigenous tree species around the reserve.
- Develop a rapid appraisal technique to assess changes in forest quality.
- Development of sustainable miombo woodland management techniques and assessment of potential harvest levels.
- Marketing analysis of products harvested within and outside the reserve.

Furthermore, WKSFR offer excellent opportunities for studying plants and animals in some of the least disturbed habitats within the Eastern Arc Mountains.

Frontier Tanzania Udzungwa Mountains Biodiversity Survey

West Kilombero Scarp Forest Reserve

9 Recommendations for Monitoring

9.0 Recommendations for Monitoring of West Kilombero Scarp Forest Reserve

J. Elmer Topp-Jørgensen, Andrew R. Marshall, Henry Brink

9.1 Summary of Monitoring Recommendations

Implicit in the rationale for monitoring is recognition of potential for change. Monitoring creates an ongoing feedback that allows managing authorities to track the results of their actions. Incorporating the results from monitoring activities allows managers to remain flexible and adapt to uncertainty. Such an adaptive approach is considered to be vital for the successful implementation of a Joint Forest Management plan.

The strong influence of fire on West Kilombero Scarp Forest Reserve highlights the need for management intervention. In order to evaluate the effect of the management interventions regular monitoring is recommended. Primarily, monitoring activities should be initiated to measure forest regeneration.

Fire has a negative impact on tree regeneration outside closed canopy forests. Transitional zones between closed canopy forest and grassland are also destroyed and other wooded habitats and fire dependant species are favoured. Fixed-point photographs used in combination with aerial photographs, should together with casual walks be used to monitor the influence of fire.

The limited human impact on evergreen forests in WKSFR leaves no need for systematic assessment of resource extraction. Instead, walks along and inside the forest edge should be made to assess the threats to the quality of forest habitats. Limited extraction and production of some minor forest resources are suggested as an input to the management plan. It is however important that a precautionary principle is employed to secure sustainability. Therefore, medicinal plant extractions by certified collectors should also be monitored.

The Joint Forest Management plan also includes resource production and extraction initiatives in areas outside of the forest reserve. These efforts focus on sustainable use of miombo, for both timber and non-timber forest resources (including bush meat). Also, improvement of current agricultural practices should be sought and home gardens with resource production (e.g. fruit trees) should be encouraged around settlements. Again in all implementations of new land use practices a precautionary principle should be employed to secure that all extraction from natural habitats is carried out on a sustainable basis. Therefore monitoring of these activities are important for their successful implementation.

Involving monitoring of animal populations in evaluation of Joint Forest Management initiatives is not deemed essential for the MEMA project. It is often time consuming and requires experienced researchers. Furthermore, most of the forest dwelling, restricted range and threatened animal species found in WKSFR are not immediately threatened by the current level of human activities in the reserve. The majority of these are dependent on forest quality, which is better monitored in other ways.

9.2 Justification, Activities and Outputs of Suggested Monitoring Activities

9.2.1 Monitoring of Bush-Fires

Justification

The regular fires combined with logging have a negative impact on the extension of the forest area, and thereby indirectly on the forest biodiversity. In areas where logging and pole cutting have occurred the canopy is more open and a dense herb, shrub and climber layer persist. This dense ground cover increases the risk of fires spreading into forested habitat. Fires sweep through the grassland areas in the reserve regularly. Fire maintains areas of grassland, favours fire resistant species, destroys forest-grassland transitional zones and prevent formation of wooded corridors between the major forest fragments (see section 8.4).

Actions

Photos taken annually from defined fixed-points on the ground should serve as documentation and be used in information meetings with the villagers. This method should preferably be combined with aerial photographs (or satellite images) obtained on a regular basis, e.g. every 10th or 20th year depending on available funds. Extension of forest area of each forest fragment, and length and width of each forest corridor should be measured and compared with previous measurements.

Additionally, at the end of each dry season, monitoring should be carried out in the reserve. Walks should be made along the inhabited northern and western areas of the reserve and in the grassland area between Ndundulu and Nyumbanitu. A local informer knowledgeable of the area should accompany forest division staff on the fire observation walks, and a sketch map of the reserve should be used to record the occurrence of fire. Villagers should be informed of the activities and findings of the fire observation walks, and preventative actions should be developed in conjunction with the local communities.

Outputs

Aerial photos: The size of all forested areas (including evergreen, riverine and woodland forest as well as transitional zones) in the forest reserve and all forest fragments in the public areas is measured on the basis of aerial photographs. These measurements can then be compared with measurements from previous photographs.

Fixed-point photos: Fixed-point photographs of the forest reserve are compared to previously taken photos.

Casual walks: The number of fire signs and estimated extent are compared with previous recordings.

9.2.2 Monitoring of Forest Quality

Justification

The low level of disturbance in forests in the forest reserve makes systematic surveys an unnecessary action. The low rate of change that would occur in vegetation plots also makes monitoring unnecessary in the short run. If it is felt necessary to repeat the Large Tree Survey

(e.g. in disturbed plots), new surveys could be carried out. A period of 5-10 years between re-surveys of selected plots is recommended.

Actions

Areas most prone to human disturbances should be selected for casual observation walks. These areas should be visited every year by Forest Division staff accompanied by a local guide. Random walks could be made along the forest edge at each survey site including small trips made into the forest. These minor excursions should penetrate some hundred meters into the forest. The forest and grassland areas in the forest reserve should be examined using binoculars from three sites (fixed points) in each of the two major forest areas of Ndundulu and Nyumbanitu.

Villagers should be informed of the activities and the findings of the casual disturbance walks via yearly information meetings.

Outputs

Number and nature of human activities observed during casual walks and from fixed-points should be recorded. These data can be compared with previous observations.

9.2.3 Monitoring of Medicine Plant Collections

Justification

Medicinal plants are the only resource proposed practical for sustainable extraction from the forest reserve. Collections from trees and large shrubs seem not to totally damage the affected individuals and certain herbs; shrubs and climbers are believed to be readily renewable. However, it is important that the extractions are planned carefully and monitored closely to assess sustainability. Should the monitoring show that some extractions are not sustainable, collections of the particular species should be reduced or avoided.

Actions

The lists produced by the certified medicinal plant collectors should be checked and reviewed annually by Forest Division staff, and a plan for monitoring the extraction should be produced. The simplest possibility being yearly walks through the forest with certified persons informing on the availability of all species on the legal extraction list. Investigations should be carried out in areas designated for medicinal plant collections along the boundary where settlements are abundant and the extractions are occurring. Monitoring should continue as long as medicinal plant extractions are allowed.

Outputs

Certified collectors produce lists of species, record the harvested amount and approximate distance to source (in hours). Compared with previous recordings this may indicate population trends for harvested species.

9.2.4 Monitoring of Miombo Woodland and Plantations

Justification

Most wood resources are extracted from woodland areas surrounding the villages. Woodland is cleared every year to meet the demand for building materials, household materials, firewood and new fertile agricultural land. Settlements have moved closer to the forest reserve making this wood source more prone to extractions. To secure a future supply of

wood for the local community extension of miombo woodland and plantation growth should be monitored.

Actions

A) The extension of the miombo woodland should be established every third year by producing a rough land use sketch of a large specified area around the villages of Udekwa, Ifuwa and Ikula. These sketch maps could be compared with air photographs taken every 20th year.

B) Further, visits should be made annually to plantation sites to monitor the development of plantation tree growth. General notes on growth of plantation trees should be recorded using a sketch map of the area. If necessary Forest Division staff should develop and implement new management initiatives for areas where plantation tree growth is not optimal.

Outputs

Sketch maps and aerial photographs of the extent of miombo woodland and plantations will be made. Comparison with previously produced sketch maps will be used to monitor the effect of management implementations.

9.2.5 Monitoring of Honey Production and Animal Husbandry

Justification

As an alternative to collection of wild honey, beehives are suggested in buffer zones and other habitats outside the forest reserve. This would minimise the use of fire within the reserve boundary and create a safe zone for bees in the forest. Furthermore, wildlife is currently being exploited to supply the local community with animal protein. Alternative sources of meat should be sought, established through animal husbandry adjusted to the specific environmental conditions of the area. Monitoring of meat production activities should be carried out at regular intervals to secure a successful implementation of the programme.

Actions

A bee-keeping expert should visit beehives in the area annually to evaluate the progress, and people interested in beehives should have the possibility of seeking advice for their honey production efforts. People involved in the raising of animals should be visited at regular intervals by Forest Division staff and a veterinarian to monitor the health of the animals. Action plans for the animal raisers should be produced during visits. In the beginning, visits should be regular, but once judged appropriate the number of visits can be reduced.

Outputs

The total number of beehives, the number of hives inhabited by bees, and the honey production should be compared with previously recorded numbers to monitor the success of this management activity. The number of household animals should be recorded and compared with previous recordings to follow the development in animal husbandry.

9.2.6 Monitoring of Tourism

Justification

Tourism is suggested as an income generating activity, which could be undertaken in the forest reserve. To avoid incidents with negative effect for the natural habitats within the reserve, monitoring of tourism activities should be carried out.

Actions

The Forest Division should keep a record of all people granted with a tourist permit to enter the forest reserve. Furthermore, a system of monitoring the generation of income to the village government should be developed.

Outputs

The recorded number of tourists per year should be compared with previous recordings to monitor the development of this activity. Generation of income to the village government should be monitored by auditing of the accounts.

9.3 Summary of Monitoring Activities

Monitoring activity	Activities	Replication	Outputs	Man days (estimate)
Disturbance	Casual disturbance walks Fixed-point disturbance observation	Annually	Number of disturbance observations	3
Fire	Fixed-point photographs Aerial photographs Casual fire walks	Annually Every 20 th year Annually	Fixed-point and aerial photographs Number of fire observations	3
Medicinal plant collection	Visits to certified medicinal plant collectors Assessment of medicinal plant availability	Annually	Species lists with estimated amounts and approximate distance from household	2
Sustainable Miombo	Sketch map production of extent of Miombo and 'home gardens' Aerial photos	Annually Every 20 th year	Sketch map Aerial photographs	3
Honey production	Advice for beehive owners Visits to honey production sites	Annually Annually	Total number of beehives and number of inhabited hives	1.5
Animal husbandry	Advice for livestock raisers Visits to livestock raisers	As appropriate, later annually	Number of animals	2
Tourism	Keep a record of the number of visiting tourists Income estimate from tourism activities	Annually Annually	Number of visitors Estimate of income from tourism	0.5

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11.0 Appendices

Appendix 8A. Lists of animals considered important for conservation in West Kilombero Scarp Forest Reserve. Lists are presented for each taxonomic group and include forest dependent species, species of restricted range, species considered threatened by IUCN or CITES and species not currently described. Definitions of the presented categories can be found at the end of the tables, while the sources used for these categories can be found in the relevant sections.

Reptiles

Species	Ecological type	Conservation status	Endemism
ATRACTASPIDIDAE			
<i>Atractaspis aterrima</i>	F		NE
COLUBRIDAE			
<i>Natriciteres variegata sylvatica</i>	F		NE
<i>Buroma procterae</i>	F		NE
VIPERIDAE			
<i>Bitis gabonica</i>	F		.
GEKKONIDAE			
<i>Lygodactylus angularis</i>	O		NE
<i>Cnemaspis uzungwae</i>	F		NE
CHAMAELEONIDAE			
<i>Chamaeleo weneri</i>	F	II	NE
<i>Bradypodion</i> sp.	?	II	?
<i>Bradypodion oxyrhinum</i>	F	II	NE
SCINCIDAE			
<i>Leptosiaphos kilimensis</i>	F		NE
<i>Melanoseps uzungwensis</i>	F		NE

Amphibians

Species	Ecological type	Conservation status	Endemism
ARTHROLEPTIDAE			
<i>Arthroleptis affinis</i>	F	VU	NE
<i>Arthroleptis reichei</i>	F		NE
<i>Arthroleptis xenodactylus</i>	F	VU	NE
BUFONIDAE			
<i>Nectophrynoides viviparus</i>	F	VU	NE
HYPEROLIIDAE			
<i>Afrixalus morerei</i>	O	VU	E
<i>Hyperolius pictus</i>	O		NE
MICROHYLIDAE			
<i>Callulina kreffti</i>	F	VU	NE
<i>Probreviceps macrodactylus</i>	F	LR/nt	NE
<i>Hoplophryne</i> sp. cf. <i>ulugurensis</i>	F	VU	NE
RANIDAE			
<i>Arthroleptides martiensseni</i>	F	VU	NE
<i>Arthroleptides</i> sp. nov.			
SCOLECOMORPHIDAE			
<i>Scolecormorphus</i> sp. cf. <i>vittatus</i>	F	VU	NE

Appendix 8A continued Butterflies

Species	Ecological type	Conservation status	Endemism
ACRAEIDAE			
<i>Acraea alicia cf uzungwae</i>	×		(E)
<i>Acraea cf cepheus bergeriana</i>	F		(NE)
<i>Acraea igola</i>	F		
<i>Acraea ntebiae</i>	F		
<i>Acraea servona cf orientis</i>	F		
<i>Bematistes quadricolor itumbana</i>	×		(NE)
DANAIDAE			
<i>Amauris cf crawshayi crawshayi</i>	F		NE
<i>Amauris echeria serica</i>	F		
<i>Amauris cf ellioti junia</i>	F		
<i>Amauris niavius domicanus</i>	F		
HESPERIIDAE			
<i>Cf Celaenorrhinus bettoni</i>	F		
<i>Metisella decipiens cf decipiens</i>	×		(NE)
LYCAENIDAE			
<i>Cf Alaena picata picata</i>	F		(NE)
<i>Cf Anthene hobleyi</i>	F		
<i>Cf Anthene lasti</i>	F		
<i>Cf Liptena xanthostola</i>	F		
<i>Oboronia bueronica</i>	F		
<i>Tuxentius cf ertli</i>	F		NE
<i>Uranothauma cf delatorum</i>	F		
<i>Uranothauma cf heretsia virgo</i>	F		(NE)
NYMPHALIDAE			
<i>Antanartia dimorphica dimorphica</i>	F		
<i>Antanartia schaeneia dubia</i>	F		
<i>Bebearia cf cocalia</i>	F		
<i>Catuna cf sikorna</i>	F		NE
<i>Charaxes acuminatus cf acuminatus</i>	F		
<i>Charaxes candiope candiope</i>	F		
<i>Charaxes cf pollux pollux</i>	F		
<i>Charaxes cf xiphares brevicaudatus</i>	F		(NE)
<i>Eurytela hiarbas cf lita</i>	F		
<i>Euxanthe tiberius cf tiberius</i>	F		
<i>Issoria baumanni orientalis</i>	×		(NE)
<i>Nepis ochracea uluguru/uzungwa</i>	F		(NE)
<i>Precis tugela cf aurorina</i>	F		
<i>Pseudacraea dolomena cf usagara</i>	F		(NE)
<i>Salamis temora cf virescens</i>	F		(NE)
PAPILIONIDAE			
<i>Graphium polices</i>	F		
<i>Papilio cf bromius chrapkowskoides</i>	F		
<i>Papilio dardanus cf tibullus</i>	F		
<i>Papilio cf desmondi usambarensis</i>	F		(NE)
<i>Papilio echerioides</i>	F		
<i>Papilio ophidicephalus ophidicephalus</i>	F		
<i>Papilio pelodurus vesper</i>	F		NE
<i>Papilio phorcas cf nyikanus</i>	F		(NE)
PIERIDAE			
<i>Belenois margaritaceae intermedia</i>	F		(E)
<i>Eurema senegalensis</i>	F		
<i>Mylothris sagala cf sagala</i>	F		
<i>Mylothris cf yulei</i>	F		
SATYRIDAE			
<i>Aphysoneura pigmentaria uzungwae</i>	F		(NE)
<i>Bicyclus danckelmani</i>	F		NE
<i>Bicyclus simulacris</i>	F		NE
<i>Bicyclus uzungwensis uzungwensis</i>	F		E
<i>Neocoenyra heckmanni uzungwae</i>	O		(E)

Appendix 8A continued

Birds

Common name	Species	Ecological type	Conservation status	Endemism
FALCONIFORMES				
Mountain buzzard	<i>Buteo oreophilus</i>	F	II	
GALLIFORMES				
Udzungwa forest partridge	<i>Xenoperdix udzungwensis</i>	F	VU	NE
COLUMBIFORMES				
Olive pigeon	<i>Columba arquatrix</i>	F		
Lemon (or cinnamon) dove	<i>Aplopelia larvata</i>	F		
CUCULIFORMES				
Barred long-tailed cuckoo	<i>Cercococcyx montanus</i>	F		
TROGONIFORMES				
Bar-tailed trogon	<i>Apaloderma vittatum</i>	F		
PICIFORMES				
Moustached green tinkerbird	<i>Pogoniulus leucomystax</i>	F		
Olive woodpecker	<i>Dendropicops griseocephalus</i>	F		
PASSERIFORMES				
Green-throated (mountain) greenbul	<i>Andropadus chlorigula</i>	F		NE
Stripe-cheeked greenbul	<i>Andropadus milanjensis</i>	F		
Shelley's greenbul	<i>Andropadus masukuensis</i>	F		
Placid greenbul (=olive mountain greenbul)	<i>Phyllastrephus cabanisi placidus</i>	F		
African hill babbler	<i>Pseudoalcippe abyssinica</i>	F		
Olive-flanked robin-chat(=olive-flanked ground-robin)	<i>Cossypha anomala</i>	F		NE
Dappled mountain-robin	<i>Modulatrix orostruthus</i>	F	VU	NE
Spot-throat	<i>Modulatrix stictigula</i>	F		NE
Swynnerton's robin	<i>Swynnertonia swynnertonii</i>	F	VU	NE
White-starred robin	<i>Pogonocichla stellata</i>	F		
Iringa ground robin	<i>Sheppardia lowei</i>	F	VU	NE
Sharpe's akalat	<i>Sheppardia sharpei</i>	F		NE
(Northern) olive thrush	<i>Turdus olivaceus</i>	F		
Orange ground thrush	<i>Zoothera gurneyi</i>	F		
White-chested alethe	<i>Alethe fuelleborni</i>	F		NE
African dusky flycatcher	<i>Muscicapa adusta</i>	F		
Red-capped forest warbler	<i>Orthotomus metopias</i>	F		NE
Evergreen forest warbler	<i>Bradypterus lopezi</i>	F		
Yellow-throated woodland warbler	<i>Phylloscopus ruficapillus</i>	F		
Black-lored cisticola	<i>Cisticola nigriloris</i>	×		NE
Bar-throated apalis	<i>Apalis thoracica</i>	F		
Brown-headed apalis	<i>Apalis alticola</i>	F		
Chapin's apalis	<i>Apalis chapini</i>	F		NE
White-winged apalis	<i>Apalis chariessa</i>	F	VU	NE
White-tailed crested flycatcher	<i>Trochocercus albonotatus</i>	F		
Fülleborn's black boubou	<i>Laniarius fuelleborni</i>	F		NE
Grey cuckoo-shrike	<i>Coracina caesia</i>	F		
Kenrick's starling	<i>Poeyoptera kenricki</i>	F		NE
Waller's starling	<i>Onychognathus walleri</i>	F		
Amani sunbird	<i>Anthreptes pallidigaster</i>	×	EN	NE
Banded green sunbird	<i>Anthreptes rubritorques</i>	F	VU	NE
Eastern double-collared sunbird/ Moreau's sunbird	<i>Nectarinia mediocris/ moreaui</i>	F	LR	
Rufous-winged sunbird	<i>Nectarinia rufipennis</i>	F	VU	E
Usambara weaver	<i>Ploceus nicolli</i>	F	EN	NE
Red-faced crimsonwing	<i>Cryptospiza reichenovii</i>	F		
(Yellow-browed) streaky seed-eater	<i>Serinus striolatus whytii</i>	×		NE
Kipengere seedeater	<i>Serinus melanochrous</i>	F	LR	NE
Oriole finch	<i>Linurgus olivaceus</i>	F		

Appendix 8A continued

Mammals

Species	Common name	Forest dependency	IUCN status	Endemism
PRIMATES				
Colobidae	<i>Procolobus gordonorum</i>	F	VU	NE
	<i>Colobus angolensis palliatus</i>	F	DD	
Cercopithecidae	<i>Cercocebus galeritus sanjei</i>	F	(EN)	(E)
Galagonidae	<i>Galagoides zanzibaricus</i>	F	LR/nt	NE
	<i>Galagoides orinus</i>	F	DD	NE
INSECTIVORA				
Soricidae	<i>Myosorex kahaulei</i>	?		E
	<i>Crocidura hildegardeae</i>	F		
	<i>Crocidura monax</i>	?	VU	
MACROSCELIDEA				
Macroscelididae	<i>Rhynchocyon petersi</i>	F	EN	
RODENTIA				
Sciuridae	<i>Paraxerus lucifer lucifer</i>	F		
Cricetidae	<i>Beamys hindei</i>	F	VU	
Muridae	<i>Lophuromys flavopunctatus</i>	F		
	<i>Praomys delectorum</i>	F		
CARNIVORA				
Hyaenidae	<i>Crocuta crocuta</i>	×	LR/cd	
Viverridae	<i>Genetta servalina lowei</i>	×		(E)
	<i>Nandinia binotata arborea</i>	F		
Felidae	<i>Panthera leo</i>	O	VU	
HYRACOIDEA				
Procavidae	<i>Dendrohyrax validus</i>	×	VU	
PROBOSCIDEA				
Elephantidae	<i>Loxodonta africana</i>	×	EN	
ARTIODACTYLA				
Bovidae	<i>Syncerus caffer</i>	×	LR/cd	
	<i>Neotragus moschatus</i>	×	LR/cd	
	<i>Cephalophus harveyi</i>	F	LR/cd	
	<i>Cephalophus spadix</i>	F	VU	NE

Ecological type: F = Forest dependent, × = found in forests and also other habitats, O = normally regarded as a non-forest species.

Conservation status according to IUCN (Hilton-Taylor, 2000): VU = vulnerable; LR/cd = lower risk, conservation dependent; LR/nt = lower risk, near threatened; DD = data deficient; I = CITES appendix I; II = CITES appendix II.

Endemism: E = Endemic: occurs only within the Udzungwa Mountains; NE = near endemic, distribution limited to the Eastern Arc, Tanzania and Malawi.

Letters in brackets refer to subspecies.