

TECHNICAL PAPER 39

Mtai Forest Reserve

A biodiversity survey

**Nike Doggart,
Michael Dilger, Raymond Kilenga
and Eibleis Fanning
1999**

East Usambara Conservation Area Management Programme

Technical Paper 39

Mtai Forest Reserve

A biodiversity survey

**Nike Doggart, Michael S. Dilger, Raymond Kilenga and Eibleis
Fanning**

**Ministry of Natural Resources and Tourism,
Tanzania
Forestry and Beekeeping Division**

**Department of International
Development Co-operation, Finland
Finnish Forest and Park Service**

**Frontier-Tanzania
University of Dar es Salaam
Society for Environmental Exploration**

Tanga 1999

© Metsähallitus - Forest and Park Service

Cover painting: Jaffary Aussi (1995)

ISSN 1236-620X

ISBN 9987-646-02-6

East Usambara Conservation Area Management Programme (EUCAMP)

The East Usambara rain forests are one of the most valuable areas for biodiversity conservation in Africa. Several plant and animal species are found only in the East Usambara Mountains. The rain forests secure the water supply of 200,000 people and the local people in the mountains depend on these forests. The East Usambara Conservation Area Management Programme has established the Amani Nature Reserve and aims at protecting water sources; establishing and protecting Forest Reserves; sustaining villager's benefits from the forest; and rehabilitating the Amani Botanical Garden. The programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

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 Forest Research Programme (FT FRP)

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 the Frontier Tanzania Forest Research Programme (FT FRP). Since July 1994, the FT FRP has been working in the forests of the East Usambara mountains in collaboration with the East Usambara Conservation Area Management Programme (EUCAMP). This survey of selected forests collects baseline biodiversity data and assists the EUCAMP in the management of the East Usambara forests.

For more information:

Forestry and Beekeeping Division
P.O. Box 426, Dar es Salaam, Tanzania
Tel: 255-51-111 061/2/3/4
Fax: 255-51-114 659
TLX 41853 misitu tz
E-mail: misitu@twiga.com

Department for Development Co-operation
Ministry for Foreign Affairs
Katajanokanlaituri 3
FIN-00160 Helsinki, Finland
Tel 358-9-134 161
Fax 358-9-1341 6293

East Usambara Conservation Area
Management Programme
P.O. Box 5869, Tanga, Tanzania
Tel: 255-53-43453, 46907, 43820
Fax: 255-53-43820
E-mail: usambara@twiga.com
Internet: www.usambara.com

Finnish Forest and Park Service
P.O. Box 94, FIN-01301 Vantaa, Finland
Tel: 358-9-857 841
Fax: 358-9-8578 4401
E-mail: knowhow@metsa.fi

Dept of Zoology / Dept of Botany
University of Dar es Salaam
P.O. Box 35064, Dar es Salaam, Tanzania
Tel: 255-51-410462
E-mail: zoology@udsm.ac.tz

Society for Environmental Exploration
77 Leonard Street, London, UK
Tel: +44 20 76 13 24 22
Fax: +44 20 76 13 29 92
E-mail: enquiries@frontierprojects.ac.uk

TABLE OF CONTENTS

TABLE OF CONTENTS	1
LIST OF TABLES	3
LIST OF FIGURES	4
EXECUTIVE SUMMARY	5
FOREWORD.....	6
ACKNOWLEDGEMENTS	7
1.0 INTRODUCTION	8
1.1 THE EAST USAMBARA MOUNTAINS AND FOREST DIVERSITY	8
1.2 REPORT STRUCTURE	9
1.3 MAPS	11
1.4 DATA AND MONITORING	11
1.5 SURVEY PERIOD AND PERSONNEL	11
2.0 AIMS OF THE SURVEY	12
3.0 DESCRIPTION OF THE FOREST	13
3.1 GENERAL DESCRIPTION	13
3.1.1 Description	13
3.1.2 Location	13
3.1.3 Land use	13
3.1.4 History and Status	14
4.0 VEGETATION	17
4.1 INTRODUCTION	17
4.2 METHODS	17
4.2.1 Forest composition	17
4.3 RESULTS	20
4.3.1 Quantitative vegetation analysis	20
4.3.2 Disturbance	42
4.4 DISCUSSION	49
4.4.1 Species richness	49
4.4.2 Species Accumulation Rates	49
4.4.3 Ecological Type	49
4.4.4 Habitat	49
4.4.5 Endemic Status	50
4.4.6 Range Extensions	50
4.4.7 Regeneration	50
4.4.8 Disturbance	51
5.0 FAUNA.....	56
5.1 INTRODUCTION	56
5.2 METHODS	56
5.2.1 Mammals	56
5.2.2 Birds	57
5.2.3 Reptiles	57
5.2.4 Amphibians	57
5.2.5 Invertebrates	58
5.3 TRAPPING SITES AND SAMPLING INTENSITY	59
5.4 RESULTS	61

5.4.1	<i>Mammals</i>	61
5.4.2	<i>Birds</i>	70
5.4.3	<i>Reptiles</i>	74
5.4.4	<i>Amphibians</i>	80
5.4.5	<i>Invertebrates</i>	85
5.5	DISCUSSION	88
6.5.1	<i>Species richness and abundance</i>	88
5.5.2	<i>Ecological type</i>	90
5.5.3	<i>Endemic Status</i>	90
5.5.4	<i>CITES</i>	91
5.5.5	<i>IUCN Status</i>	91
6.0	CONCLUSION	93
7.0	REFERENCES	95

LIST OF TABLES

Table 1. Summary of biodiversity of taxa surveyed.	5
Table 2. Forest area in the East Usambaras (based on Johansson and Sandy 1996).	9
Table 3. Land use distribution (Johansson & Sandy, 1996).	14
Table 4. Checklist of trees and shrubs	20
Table 5. Species recorded in the regeneration layers but not as trees greater than 10 cm dbh.	26
Table 6. Summary of opportunistic botanical records.	27
Table 7. Tree and shrub species found outside their previously recorded range in the East Usambara Mountains.	28
Table 8. Summary of ecological type for tree and shrub species (based on Table 4).	30
Table 9. Summary of the habitat for tree and shrub species (based on Table 4).	30
Table 10. Submontane species occurring in lowland areas and the lowest altitudes where they were recorded.	31
Table 11. Summary of endemic status for tree and shrub species.	31
Table 12. The abundance of selected timber species.	31
Table 13. Disturbance transect results for pole counts in the west of Mtai.	42
Table 14. Disturbance transect results for pole counts in the east of Mtai.	43
Table 15. Disturbance transect results for timber counts in the west of Mtai.	45
Table 16. Disturbance transect results for timber counts in the east of Mtai.	46
Table 17. Frequency of selected human disturbances recorded in the forest in vegetation plots and along disturbance transects.	48
Table 18. Summary descriptions of trapping sites.	59
Table 19. Sampling intensity by trap night (number of nights x number of traps).*	59
Table 20. Summary of small mammals (non-bats).	61
Table 21. Abundance of duiker, bushbuck and hyrax dung.	63
Table 22. Summary of dung survey.	63
Table 23. Summary of mammal observations.	65
Table 24. Ranges of near endemic mammal species recorded.	66
Table 25. Summary of bats for Mtai East.	67
Table 26. Summary of birds.	70
Table 27. Ranges of near-endemic bird species recorded (Zimmerman, 1996).	73
Table 28. Summary of reptiles	74
Table 29. Summary of reptile observations.	76
Table 30. Range of endemic and near-endemic reptile species recorded (Howell, 1993).	77
Table 31. Summary of amphibians.	80
Table 32. Ranges of endemic and near-endemic amphibian species recorded (Howell 1993).	82
Table 33. Summary of butterflies.	85
Table 34. Summary of molluscs.	87
Table 35. Summary of faunal families and species.	88
Table 36. Summary of capture locations of faunal species.	88
Table 37. Summary of ecological type of faunal species.	90
Table 38. Summary of endemic status of faunal species.	90

LIST OF FIGURES

Figure 1. The location of Mtai Forest Reserve in relation to other East Usambara forests.	15
Figure 2. Topographical map.	16
Figure 3. Location of vegetation plots and disturbance transects.	19
Figure 4. Species accumulation rates of trees and shrubs (10 cm dbh and larger) by vegetation plot.	30
Figure 5. Distribution of forest dependent tree and shrub individuals.	32
Figure 6. Distribution of forest dependent tree and shrub species.	33
Figure 7. Distribution of non-forest tree and shrub individuals.	34
Figure 8. Distribution of non-forest tree and shrub species.	35
Figure 9. Distribution of submontane tree and shrub individuals.	36
Figure 10. Distribution of submontane tree and shrub species.	37
Figure 11. Distribution of endemic tree and shrub individuals.	38
Figure 12. Distribution of endemic tree and shrub species.	39
Figure 13. Distribution of near-endemic tree and shrub individuals.	40
Figure 14. Distribution of near-endemic tree and shrub species.	41
Figure 15. Cut and naturally fallen poles recorded per hectare by transect in the west of Mtai.	42
Figure 16. Cut and naturally fallen poles recorded per hectare by transect in the east of Mtai.	43
Figure 17. Distribution of pole cutting in the reserve.	44
Figure 18. Cut and naturally fallen timber recorded per hectare by transect in the west of Mtai.	45
Figure 19. Cut and naturally fallen timbers recorded per hectare by transect in the east of Mtai.	46
Figure 20. Distribution of timber cutting in the reserve.	47
Figure 21. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.	52
Figure 22. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and endemic.	53
Figure 23. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.	54
Figure 24. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.	55
Figure 25. Location of trapping sites.	60
Figure 26. Distribution of forest dependent mammal species.	68
Figure 27. Distribution of near-endemic mammal species.	69
Figure 28. Distribution of forest dependent reptile species.	78
Figure 29. Distribution of endemic and near-endemic reptile species.	79
Figure 30. Distribution of forest dependent amphibian species.	83
Figure 31. Distribution of near-endemic and endemic amphibian species.	84
Figure 32. Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent and endemic or near-endemic.	92

EXECUTIVE SUMMARY

Mtai Forest Reserve, in the East Usambara Mountains of north-east Tanzania was gazetted in 1913. It is situated in Muheza District, Tanga Region. The reserve now covers 3107 ha although 6107 ha was originally gazetted in 1913. The forest extends between 180 - 1016 m asl, encompassing lowland and submontane forest.

As part of the East Usambara Catchment Forest Project (from 1999 East Usambara Conservation Area Management Programme, EUCAMP) Frontier-Tanzania conducted a biological survey of Mtai Forest Reserve between July - September 1996 and between January - March 1997 for a total of 130 research-days. The survey covered systematically all parts of the reserve with a sampling intensity of 0.25% for the vegetation survey and eight zoological trapping sites. This report provides an inventory of the trees, shrubs, mammals, reptiles, amphibians, birds, butterflies and molluscs recorded during the survey. The report also describes patterns of human disturbance within the reserve.

Table 1. Summary of biodiversity of taxa surveyed.

Taxon:	Total no. of species	% forest dependent	No. of non-forest species	No. of endemics	No. of near-endemics	No. of forest dependent endemics and near-endemics
Trees, shrubs and herbs	271	34	18	7	62	33
Mammals	31	29	6	0	2	1
Birds*	94	20	32	0	2	2
Reptiles	34	47	1	2	9	11
Amphibians	27	52	1	1	10	11
Butterflies	55	42	0	0	6	5
Molluscs	33	N/A	N/A	5	1	N/A
Total	457		58	11	84	50

* This does not represent an inventory. This information is limited to the species observed casually.

Mtai Forest Reserve is one of the largest remaining forest blocks in the East Usambaras. In terms of conservation it is significant as habitat for a number of endemic and threatened species and, in some areas, as an example of pristine lowland and submontane Eastern Arc forest. Seven plants were recorded which are endemic to the Usambara Mountains including *Cola usambarensis*, *Rinorea scheffleri* and *Saintpaulia grotei* which are found only in the East Usambaras.

In terms of fauna, the reserve is home to one critically endangered, four endangered and 20 vulnerable species according to IUCN categories. This includes the recently described snake *Prosymna semifasciata* and the endemic chameleon *Chamaeleo spinosus*. Mtai has an exceptionally high diversity of amphibians and reptiles.

Pole and timber cutting is occurring throughout the reserve. The highest intensity of pole and timber cutting are on the western edge of the reserve. High rates were also recorded close to the villages of Hemsambia and Maramba. Fire has caused the most intense damage to the forest mainly at the forest edge. Trapping is also widespread.

The information collected will be used for management planning by the EUCAMP. The survey results are also available as a baseline for monitoring. The data is stored on a Microsoft Access database and is available on the Internet at the address: www.usambara.com

FOREWORD

The East Usambara forests in north-eastern Tanzania are part of the Eastern Arc mountains. More than one hundred years of biological interest and research have shown that these forests have a unique diversity of flora and fauna, and an exceptionally high degree of endemism. They have gained global recognition as being part of a Biodiversity Hotspot (Conservation International), an Endemic Bird Area (BirdLife), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). Since 1990, the East Usambara Conservation Area Management Programme (EUCAMP) (formerly known as the East Usambara Catchment Forest Project (EUCFP)) has worked in the East Usambara Mountains with the mission to protect these natural forests. The project is implemented by the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism (MNRT) with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service.

Although a considerable amount of biological information exists from the East Usambaras much of this is restricted to the Amani area and systematic surveys are few. In order to get more comprehensive information on the forests, biodiversity surveys were initiated and contracted in July 1995. The surveys are conducted by Frontier Tanzania, a joint venture between the University of Dar es Salaam and the Society for Environmental Exploration, together with EUCAMP. The aim of the surveys is to provide systematic baseline information on the biological values of different forests as a basis for management planning and long-term monitoring, as well as training forestry staff in the use of biological inventory techniques. They will also help setting of priorities in the conservation of this valuable area.

The surveys have been carried out over ten-week field phases. The programme involves short-term expatriate volunteer research assistants, permanent EUCAMP, Frontier-Tanzania, University of Dar es Salaam, and Tanzania Forestry Research Institute staff, as well as an international network of taxonomists and other experts. The surveys have become progressively more systematic and quantitative, and have already resulted in the discovery of several previously unknown taxa. This will further raise awareness of the unique conservation values of the East Usambaras. EUCAMP has also commissioned the development of a biodiversity database, a work which also contributed the maps to these reports. All data collected during the surveys is entered in this database, which is linked to the national biodiversity database.

The reports are the result of the work of many people – too many to be listed here. We would like to thank all of them for their invaluable effort. We hope that the surveys will make yet another contribution to the long historic chain of efforts to study and understand these unique forests. Perhaps even more than that we hope that this information will contribute to a better management and conservation of the East Usambaras so that the beauty of the area will continue to amaze coming generations and that the light in the tunnel will become the bright future.

Evarast Nashanda
Project Manager

Veli Pohjonen
Chief Technical Adviser

ACKNOWLEDGEMENTS

This report is the culmination of the advice, co-operation, hard work and expertise of many people. In particular we would like to thank the following people:

MANAGEMENT

FRONTIER-TANZANIA

Managing Director of SEE: Eibleis Fanning
 Director of Research: Leigh Stubblefield
 UDSM Co-ordinators: Professor K. M. Howell
 Dr M. H. Muruke

EUCAMP:

Chief Technical Advisor: Dr S. Johansson (until 1998) and Dr V. Pohjonen (from 1999)
 Project Manager: Mr Katigula (until 1997, now deceased) and Mr E. Nashanda (from 1998)

FIELD RESEARCH

FRONTIER-TANZANIA

Research Assistants: John Brockbank, Rose Chance, Ben Cornish, Maureen Eaton, Susan Fuller, Tanya Green, Rachel Hirst, Rhoda Holmes, Sonya Hudson, Liana Joseph, Deborah Mackenzie, Anna Marriott, Andrew Nicholson, Asa Nyberg, Omi Parikh, Clare Patten, Steve Pyer, Clare Quinn, Hanna Siurua, Rhiwena Slack, Liadan Stevens, Robert Tolhurst, Jack Trevelyan, Kate Westmacott and Emily Woods.

Project Co-ordinator: Pamela Cunneyworth
 Research Co-ordinator: Michael S. Dilger and Nike Doggart
 Assistant Research Co-ordinator: Nicholas Beale
 Camp Co-ordinators: Christopher White
 Field Assistants: Hassani Abadi, Abdallah Maingo and Zahara Rashidi.

EUCAMP: Raymond R. Kilenga, Albert Ntemi, Rashidi Shughuli, Frank Mahenge, Juma Ntogoela, Raymond M. E. K. Muna, Victor Mgonde and Mussa Jackson.

TECHNICAL SUPPORT

We would also like to thank the following technical staff:

UDSM: Professor K. M. Howell, Department of Zoology and Marine Biology.
 Frank Mbago, Curator of the Herbarium, Department of Botany and Microbiology.
 Bernard Mponda, Technician, Department of Botany and Microbiology.

TAFORI: Ahmed Mndolwa, Botanist.

We are also grateful to all of the taxonomists listed in Appendix II for providing us with the identifications of the zoological specimens.

REPORT WRITING

Frontier-Tanzania

Author: Nike Doggart
 Editorial Comments: Veli Pohjonen, Chief Technical Adviser, East Usambara Conservation Area Management Programme; Prof. K. M. Howell, University of Dar es Salaam; Neil Burgess, Birdlife Denmark; Alan Rodgers, UNDP and Damon Stanwell-Smith, SEE.

1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains support ancient and unique forests rich in endemic species (Hamilton, 1989). Their old age, isolation and role as condensers of the moisture from the Indian Ocean make them an important conservation resource. The mountains are situated in north-east Tanzania within 40 km of the coastal town of Tanga between 4°48'-5°13'S and 38°32'-38°48'E. These mountains form part of a chain known as the Eastern Arc that stretches down the coast of East Africa from southern Kenya to southern Tanzania. This is a chain of isolated mountains composed of Precambrian rock exposed by block faulting and slow uprising (Griffiths, 1993). Being adjacent to the Indian Ocean, considerable orographic rainfall occurs in this area. The rainfall distribution is bi-modal, peaking between March and May and between September and December. The dry seasons are from June to August and January to March. However precipitation occurs in all months. Rainfall is greatest at higher altitudes and in the south-east of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes. Because of the topographical and climatic interactions, the west-facing slopes of the mountains are drier compared to the east-facing slopes.

Research in the East Usambara Mountains began in the late 1890s with substantial botanical collections being undertaken. Later, in 1928, surveys were undertaken on amphibians and by the 1930s detailed ornithological work had begun. Since these early studies biological research in the mountains has steadily increased. Recently, work in the area has also included an attempt to understand the drainage and catchment value of the mountain's forests (Bruen, 1989; Litterick, 1989).

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers & Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa, if not the most important (Tye, 1994). Currently, at least 3450 species of vascular plants have been recorded in the Usambaras of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991a).

The forests of the East Usambaras are not only important for their biodiversity, they also play an important role in maintaining the hydrological cycle which feeds the Sigi River. The Sigi River is a vital water source for the local communities as well as supplying water for the large coastal town of Tanga. Deforestation in the area will lead to increased soil erosion particularly from the steeper slopes. Soil erosion is liable to result in more irregular run off and in a deterioration in water quality due to siltation.

The latest survey of the East Usambaras, showed that approximately 45,137 ha of the East Usambaras remain as natural forest (Johansson and Sandy, 1996). This can be divided into two types: submontane forest and lowland forest. Altitude is the factor differentiating these two forest types (Hamilton, 1989), with submontane forest

generally occurring above 850m. The area recorded as forest in the East Usambaras according to these categories is described in Table 2.

Table 2. Forest area in the East Usambaras (based on Johansson and Sandy 1996).

Forest type	Area	% of area
Lowland forest	29497.4	62.9
Submontane forest	12916.6	30.6
Forest plantation	2723.6	6.5
TOTAL	45137.6	

The mammals of the East Usambaras show limited endemism (Kingdon and Howell 1993). However, there are several species of special interest. These include: the restricted Zanj elephant shrew, *Rhynchocyon petersi*, which is common in the Usambaras (Collar & Stuart, 1987) yet listed as globally 'Endangered' by IUCN due to a decline in habitat extent and quality; Eastern tree hyrax, *Dendrohyrax validus*, listed as 'Vulnerable' by IUCN (1996) and the Lesser Pouched Rat, *Beamys hindei* which is considered 'Vulnerable by IUCN (1996).

There are at least 11 species of reptiles and amphibians endemic to the East and West Usambaras (Howell, 1993). The East Usambara Biodiversity Surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwamgumi Forest Reserve (Broadley, 1995) and an undescribed species of *Stephopaedes* sp. has been recorded by the surveys in Mtai and Kwamgumi Forest Reserves.

The forest avifauna of the East Usambaras has a high diversity with at least 110 species (Stuart, 1989). Six species occurring in the lowland forests are considered 'Vulnerable' to global extinction: Sokoke Scops Owl, *Otus ireneae*; the endemic Usambara Eagle Owl, *Bubo vosseleri*; Swynnerton's Robin, *Swynnertonia swynnertonii*; East Coast Akalat, *Sheppardia gunningi*; Amani Sunbird, *Anthreptes pallidigaster* and the Banded Green Sunbird, *Anthreptes rubritorques* (IUCN, 1996).

The East Usambaras are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for several million years. The Usambaras harbour many species that have been geographically separated from their closest relatives for long periods. They also serve as a refuge for formerly widespread flora and fauna that have become extinct over much of their former area (Iversen, 1991a).

These forests have been under continuous exploitative human pressure for at least 2,000 years (Schmidt, 1989). Until recently, especially before the past 50 years, (Kikula, 1989), this pressure was sustainable. However, the growing human population in the area is leading to increased pressure on the remaining natural forest, and represents the main threat to their survival.

1.2 Report structure

This report provides a floral and faunal inventory of Mtai Forest Reserve. Each species is described in terms of its ecological requirements and its endemic status.

Ecological requirements are defined in terms of:

- **Forest dependent species (F):** Species dependent on primary forest only. It does not include forest edge or secondary forest species;
- **Forest non-dependent species (f):** Forest dwelling but not dependent on primary forest: species occurring in primary forest as defined above as well as other vegetation types. It should be emphasised that many of these species are still dependent on a forest habitat albeit forest edge or disturbed forest. Most species in this category will still be adversely affected by forest destruction.
- **Non-forest species (O):** These are species that do not normally occur in primary or secondary forest or forest edge.

Levels of endemism are defined in terms of:

- **Endemic (E):** Occurring only in the Usambara Mountains;
- **Near-endemic (N):** Species with ranges restricted to the Eastern Arc Mountains and / or the East African lowland forests;
- **Widespread (W):** Species with ranges extending beyond the Eastern Arc and East African lowland forests.

The typical habitat association of plant species is categorised as either:

- **Lowland (L):** Species occurring at altitudes of <850 m.
- **Submontane (S):** Species occurring at altitudes of >850 m.

This refers to the habitat in which they are typically found in East Africa rather than to where they have been recorded in the reserve.

These three criteria are used to analyse the uniqueness of the biodiversity of the reserve and its vulnerability to disturbance.

The categories are based on information from various sources. For plants the ecological type and endemic status are primarily based on Iversen (1991a). Forest dependent species refers to those species listed as being exclusively associated with Iversen's categories 1a (wet evergreen forest), 1b (dry evergreen forest) and / or 1c (riverine forest). Forest dwelling also includes other habitats.

The habitat type is based on Hamilton (1989). For those species not listed by Iversen or Hamilton, the information is taken from the Flora of Tropical East Africa.

For the animals, the following references were used (in order of priority):

Mammals:	Kingdon (1997), Kingdon (1989) and Kingdon (1974)
Birds:	Zimmerman et al. (1996)
Reptiles:	Howell (1993) and Broadley and Howell (1991).
Amphibians:	Howell (1993)
Butterflies:	Kielland (1990) and Larsen (1996)

The IUCN conservation status is cited for those animals listed in the 1996 IUCN red data books. However many Tanzanian species are not included in the 1996 IUCN red data book as insufficient data was available at the time of its publication. The IUCN status listed for the amphibians and reptiles is based on the National Biodiversity

Database. The status of these species is undergoing national and international evaluation.

1.3 Maps

The distribution of species within the reserve is presented as a series of maps. These are thematic maps where the size of each spot is directly proportional to the value which they represent. In those plots where no spot is shown, the relevant taxa was not surveyed.

1.4 Data and monitoring

Data are stored in a Microsoft Access database currently stored at the East Usambara Conservation Area Management Programme, Frontier-Tanzania and at the University of Dar es Salaam. It will shortly be available on the Internet. Zoological data is also stored on the National Biodiversity Database at the University of Dar es Salaam. This is also a Microsoft Access database. The data are geographically referenced and so can be used as a baseline for biodiversity monitoring.

1.5 Survey period and personnel

The survey of Mtai Forest Reserve was conducted between July and September 1996 and between January and March 1997 for a total of 130 research-days. The survey was conducted by Frontier-Tanzania staff, Catchment Forest Officers, volunteers and local people from Maramba and Semdoe.

2.0 AIMS OF THE SURVEY

The specific aims of the survey as outlined in the Terms of Reference between the Frontier Tanzania Forest Research Programme (FT FRP) and the East Usambara Conservation Area Management Programme are:

- to conduct biological baseline surveys in selected gazetted forests and in forests which are proposed for gazettelement;
- to provide information on the biological value and importance of these forests in order to assist in the development of management plans and practices for these forests;
- to develop a system for monitoring aspects of forest biodiversity, both on a general as well as a forest-specific level.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of selected forests reserves in the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample between 0.25% and 0.5% in area of each Forest Reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, fire, animal trapping and other illegal activities along the vegetation transects;
- to use standardised and repeatable methods to record biodiversity values of the forest in terms of small mammal, reptile, amphibian and selected invertebrate species;
- to collect opportunistic data on all other groups of vertebrates and invertebrates. Species lists resulting from this will be compared against standard appraisals of species rarity and other values in order to assess the overall biodiversity values of each forest.

By using standardised and repeatable methods these surveys provide an assessment of the biodiversity value of the forests, enabling their importance to be determined and their biodiversity value to be monitored in future.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

3.1.1 Description

Name:	Mtai Forest Reserve Muheza District, Tanga Region, Tanzania.
Area:	3107ha; 31km ² ; 11.1 sq. miles;
Status:	Central Area Forest Reserve Gazetted 1913 (6107 ha); 1928; 1965; 1999 Gazettement Notice 306 (1967) Gazettement Notice 25 (1968) Gazettement Notice 286 (3107 ha) (1999)
Maps:	Ordnance Survey topographic maps 1:50 000 Series Y742 Sheet 110/3 'Hemagoma' of 1988 and Sheet 110/4 'Gombero' of 1989 Forest Division map: Jb 206

3.1.2 Location

Grid reference: 38°44'E - 38°48'E, 4°51'S - 4°54'S.

Elevation: 180 - 1016m above sea level (asl)

Mtai Forest Reserve is situated at the head of the Muzi River valley at the northern end of the East Usambara Mountains (Figure 1). The reserve includes two ridges, one lying on a north-south axis, and the other lying on a north-east to south-west axis. The Muzi River runs between these two ridges and drains into the Sigi River which is the main source of water for Tanga. The Muzi flows throughout the year, in addition there are many ephemeral streams within the reserve.

3.1.3 Land use

There are two major types of forest in the reserve, these are lowland forest and submontane forest (Hamilton, 1989a). The most recent survey of the area, was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results are summarised in Table 3 below and indicate that the majority of Mtai Forest Reserve can be classified as 'dense lowland forest'. Lowland forest has been classified as occurring up to 850m asl; above this is submontane forest (Hamilton, 1989a). Farmland surrounds the Forest Reserve on all sides with a 50m buffer zone existing along some of the border.

Table 3. Land use distribution (Johansson & Sandy, 1996).

Forest Class	Area (ha)	Percent (%)
Submontane forest	308.7	10.3
Lowland forest	2649.8	88.8
Peasant cultivation	22.0	0.7
Barren land	4.5	0.2
Total for the reserve	2985.0	100.0

3.1.4 History and Status

There has been human pressure on the East Usambara Mountains for at least 2000 years. In the 19th Century it appears that populations were markedly lower in the East Usambaras relative to the West Usambaras with much of the area remaining forested. In Mtai during the 19th Century there was an important trading post at Bwitu on the northern slopes (Hamilton, 1989b). In 1893, following the German proclamation of Tanganyika as a German colony, a mission station, Neu Bethel, was established at Mtai (Iversen 1991b). Under colonial rule Mtai was one of the six forests in the Usambaras to be gazetted by the Germans in 1913. Initial gazettelement was for an area of 6070ha. The size of the reserve was reduced in 1965 to 1567 ha and subsequently increased in 1999 to 3107ha. Nonetheless it would appear that since 1913 the forest area under protection has been halved suggesting that farming has encroached significantly on the forest.

Pitsawing and mechanised logging have been carried out intensively in Mtai, particularly on the eastern slopes close to Maramba. In the 1980s Sikh Saw Mills, a nationally owned subsidiary of the Tanzanian Wood Industry Corporation was taking timber from the lower slopes of Mtai. In 1987 logging was terminated in response to international pressure. Subsequently, 1540 ha of neighbouring lowland rain forests have been incorporated into the reserve by EUCAMP in 1999. Cardamom was cultivated in some areas of the reserve.

A soil survey of Mtai FR was conducted in 1995 (Shaka et al. 1996).

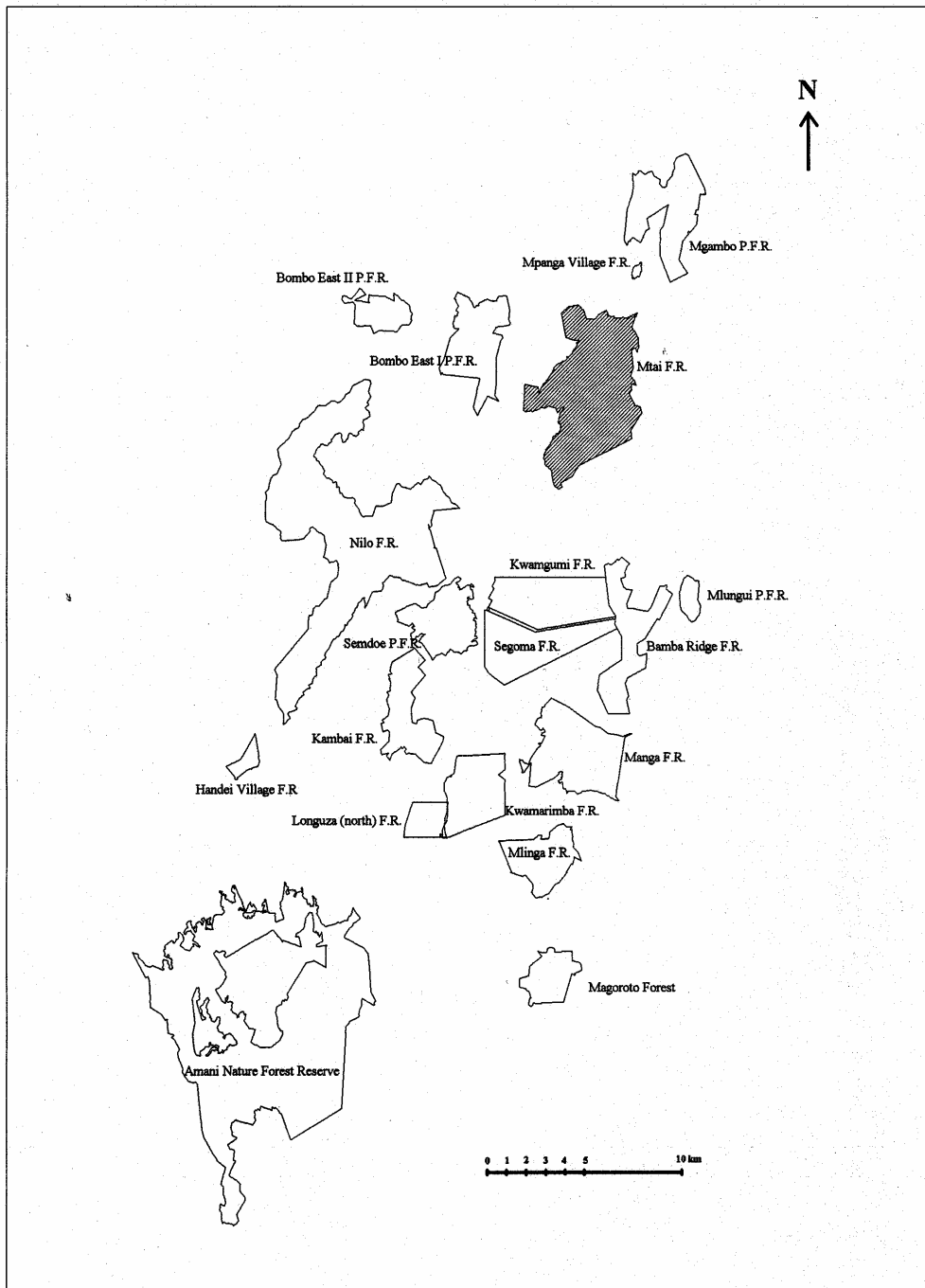


Figure 1. The location of Mtai Forest Reserve in relation to other East Usambara forests.

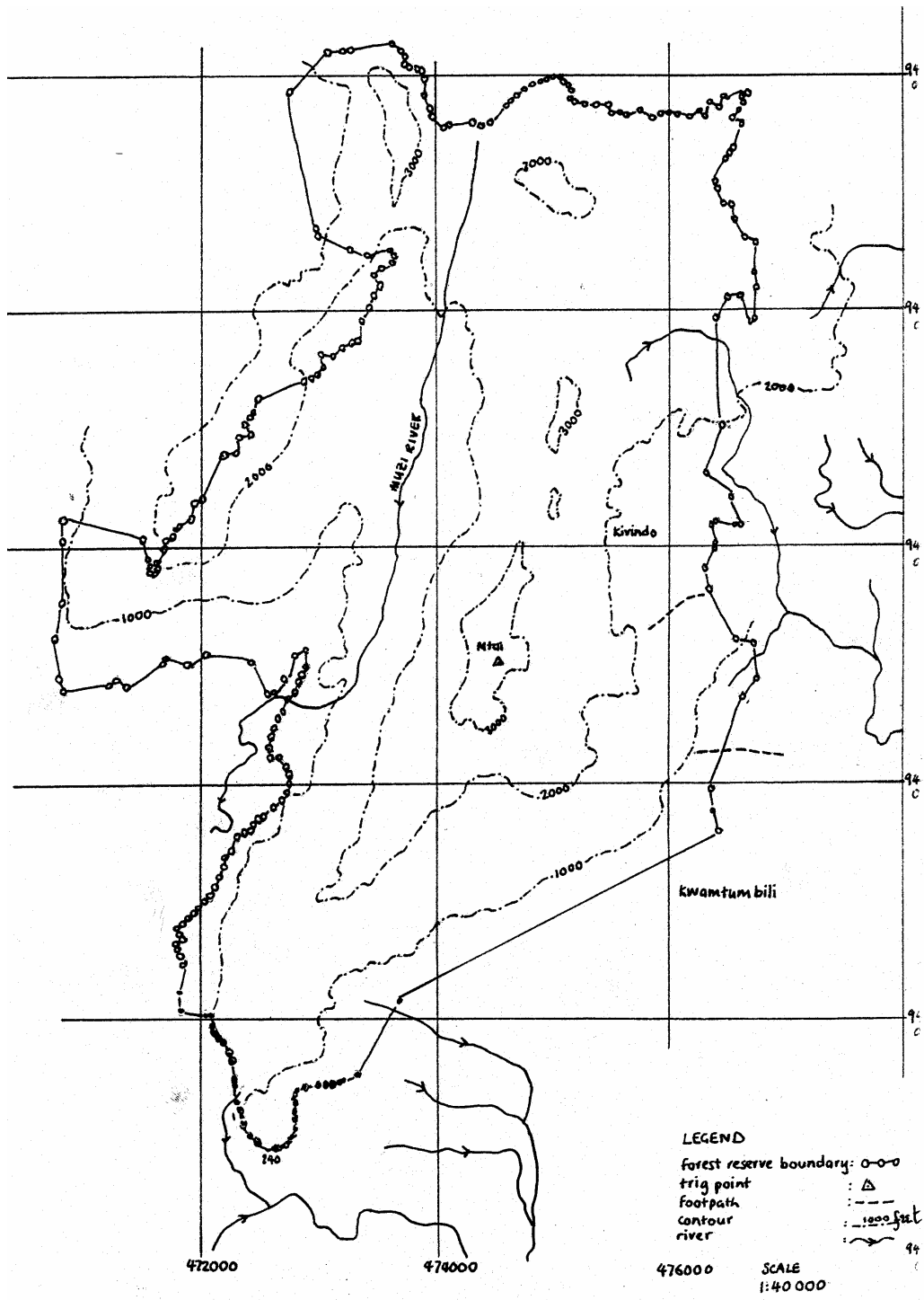


Figure 2. Topographical map.

4.0 VEGETATION

4.1 Introduction

A survey of the major vegetation types within the Forest Reserve was undertaken to quantify the extent and distribution of forest types and their species composition. Simple, quantitative and repeatable methods were employed and the results are comparable with other forest surveys undertaken by the Frontier-Tanzania Forest Research Programme (FT FRP). Human disturbance within the forest was also documented. Data collected by this survey have been entered onto the EUCAMP database in Tanga.

4.2 Methods

The forest block is divided into a grid, marked in the field by tagged transects. All methods are based on this grid system and are detailed in the FT FRP methodologies report (SEE, 1998). A brief description is presented below.

Mtai Forest Reserve was surveyed for 130 research-days during two separate phases due to its large size. The survey methods employed were going through a period of development at this time and so slightly different methods were employed on the eastern side compared to the west. The main difference between the methods used is that in the east the grid system is 450 m x 450 m whereas in the west the grid system is 450 m x 900 m. The location of vegetation plots and disturbance transects is illustrated in Figure 3.

4.2.1 Forest composition

Three methods were used to analyse forest composition: (1) quantitative vegetation analysis (2) opportunistic observations and (3) disturbance transects.

4.2.1.1 Quantitative vegetation analysis

In the east a 450 m x 450 m grid system was constructed throughout the forest identified by east - west transects marked with boundary tape. One 50 m x 20 m sample plot was recorded in each grid square, giving an approximate sampling intensity of 0.5%.

In the west and north-east of Mtai a 450 m x 900 m grid system was used. As in the east, one 50 m x 20 m plot was recorded in the south-east corner of each grid rectangle. This system gives a less intensive sampling intensity of 0.25%. Within the sample plot, every tree with a dbh (diameter at breast height) of 10 cm and over was recorded, marked and identified. Botanists from the Tanzanian Forestry Research Institute (TAFORI) and from the University of Dar es Salaam (UDSM) provided the field identification of plant species (Appendix 2).

The regeneration layer was recorded within 3 m x 3 m plots at the centre of each vegetation plot. All plants with a dbh below 10 cm were recorded in these plots, including herbs.

4.2.1.2 Opportunistic observations

Other botanical records were made on an opportunistic basis throughout the survey. Botanical specimens are held at the TAFORI Herbarium in Lushoto.

4.2.1.3 Disturbance transects

Disturbance transects provide an estimate of the intensity of tree cutting, hunting, fire and other human disturbances in a forest block. In the east the disturbance transects were based on the 450 m x 450 m grid squares. Each transect running east-west was sampled from the boundary. Every cut or naturally fallen self-standing tree and sapling (i.e. not lianas or creepers) above 5 cm dbh was measured within an area 5 m either side of each transect line. Each plant was recorded under one of two categories: cut or naturally fallen. The dbh of each tree, whether cut or naturally fallen, was recorded. These have then been categorised as either a pole (5 - 15 cm dbh) or as a timber (>15 cm dbh).

A comparable system was employed in the west of the reserve. Here the disturbance transects were based on the 450 m x 900 m grid. Every self-standing tree and sapling (i.e. not lianas or creepers) above 5 cm dbh was measured within an area 5 m either side of each transect line. The information was recorded by 50 m section along the transect. Each plant was recorded under one of three categories: live, cut or naturally fallen. Within these categories a distinction is made between poles and timbers. Poles are classified as having a dbh between 5 and 15 cm and a minimum of 2 m long relatively straight trunk. Timber is classified as having a dbh > 15 cm with a minimum 3 m long relatively straight trunk. These divisions are based on differences in use. Data are presented as a total and as an average per hectare.

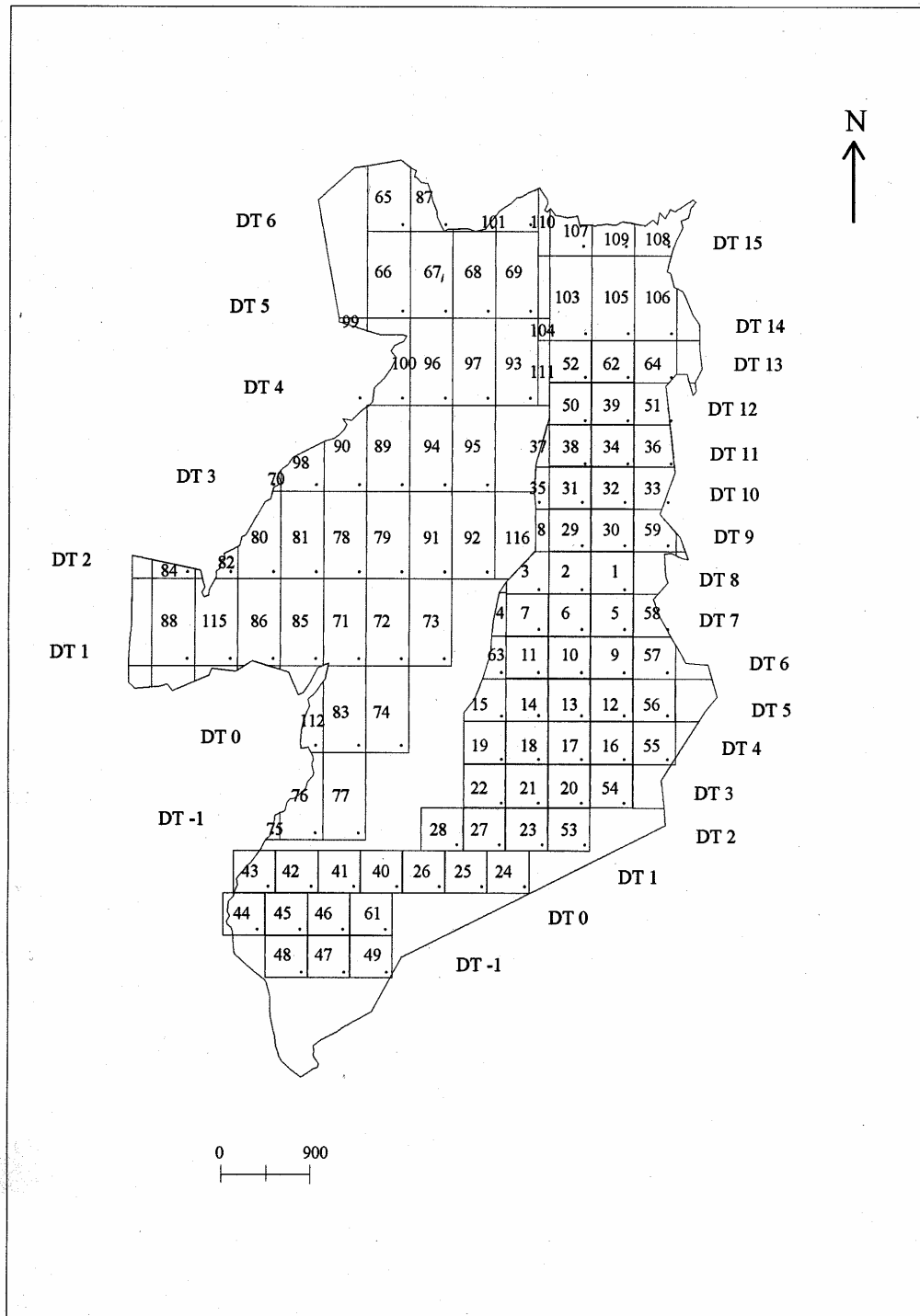


Figure 3. Location of vegetation plots and disturbance transects.

4.3 Results

4.3.1 Quantitative vegetation analysis

Table 4 presents a checklist of the tree and shrub species recorded in the 20 m x 50 m vegetation plots. Species are described, where adequate information exists, in terms of their ecological type, their habitat and their endemic status. Species marked with an asterisk have been recorded in the regeneration layer. Nomenclature follows Iversen (1991a) and the Flora of Tropical East Africa.

Table 4. Checklist of trees and shrubs

Species	Ecological type	Habitat	Endemic status
ACANTHACEAE			
* <i>Whitfieldia elongata</i>	f		W
ALANGIACEAE			
<i>Alangium chinense</i>	f	S	W
ANACARDIACEAE			
<i>Lannea alata</i>	f	L&S	W
<i>Lannea welwitschii</i>	F	L	N
<i>Rhus natalensis</i>	f	L&S	W
<i>Sclerocarya birrea</i> ¹	O	L&S	W
* <i>Sorindeia madagascariensis</i>	f	S & L	N
ANNONACEAE			
<i>Annona senegalensis</i>	f	S&L	W
* <i>Enantia kummeriae</i>	F	S	N
<i>Greenwayodendron suaveolens</i>	F	S	E (E&W)
* <i>Mkilua fragrans</i>	F	S	N
<i>Polyceratocarpus scheffleri</i>	F	S	N
<i>Sphaerocoryne gracilis</i>	f	L	N
<i>Uvariadendron sp.</i>			
<i>Xylopia aethiopica</i>	f	S&L	W
APOCYNACEAE			
* <i>Funtumia africana</i>	F	L&S	W
<i>Hunteria zeylanica</i>	f	L	W
<i>Mascarenhasia arborescens</i>	F	L	W
<i>Pleiocarpa pycnantha</i>	F	L&S	W
<i>Rauvolfia mombasiana</i>	f	L	N
<i>Tabernaemontana holtzii</i> ¹		L	
* <i>Tabernaemontana pachysiphon</i>	F	S	W
* <i>Tabernaemontana ventricosa</i>	F	L	W
ARALIACEAE			
<i>Cussonia spicata</i>	f	S	W
<i>Cussonia zimmermannii</i>	f	L	N
BIGNONIACEAE			
<i>Fernandoa magnifica</i>	f	L	N
* <i>Markhamia lutea</i>	f	L&S	W
<i>Markhamia obtusifolia</i>	O		W
<i>Markhamia usambarensis</i>		Unconfirmed taxon.	
<i>Stereospermum kunthianum</i>	f	L&S	W
BOMBACACEAE			
* <i>Bombax rhodognaphalon</i>	f	L	N

Table 4. Cont.

Species	Ecological type	Habitat	Endemic status
BORAGINACEAE			
<i>Cordia ovalis</i>	F	L&S	W
<i>Ehretia bakeri</i>	f	L&S	W
BURSERACEAE			
<i>Commiphora eminii</i>	f	L&S	N
CARICACEAE			
<i>Cylicomorpha parviflora</i>	f	S & L	N
CECROPIACEAE			
* <i>Myrianthus holstii</i>	f	S	W
CELASTRACEAE			
<i>Hippocratea sp.</i>			
<i>Maytenus heterophylla</i>	f	L&S	W
<i>Maytenus undata</i>	f	S	W
<i>Salacia lehmbachii</i>	F	L&S	W
CHRYSOBALANACEAE			
<i>Maranthes goetzeniana</i>	f	S	N
COMBRETACEAE			
<i>Combretum schumannii</i>	f	L	N
<i>Pteleopsis myrtifolia</i>	f	L	W
* <i>Terminalia sambesiaca</i>	f	L	W
COMPOSITAE			
<i>Vernonia pteropoda</i>	f	S	W
CYATHEACEAE			
<i>Cyathea manniana</i>	f	S	W
DICHAPETALACEAE			
<i>Dichapetalum ruhlandii</i>	f	L&S	W
DRACAENACEAE			
<i>Dracaena afromontana</i>	F	S	
<i>Dracaena usambarensis</i>	f	L	W
EBENACEAE			
<i>Diospyros abyssinica</i>	f	S	W
<i>Diospyros mespiliformis</i>	f	L	W
* <i>Diospyros natalensis</i>	f	L	W
<i>Diospyros occulta</i>	F	L&S	N
<i>Diospyros squarosa</i> ¹	f	L	W
EUPHORBIACEAE			
* <i>Alchornea hirtella</i>	f	S	W
<i>Bridelia cathartica</i>	f	L&S	W
* <i>Bridelia micrantha</i>	f	L&S	W
<i>Croton macrostachyus</i>	f	L&S	W
<i>Croton sylvaticus</i>	f	L	W
<i>Drypetes natalensis</i>	f	L	W
* <i>Drypetes usambarica</i>	f	S	N
* <i>Macaranga capensis</i>	F	L&S	W
<i>Macaranga kilimandscharica</i>	f	L&S	W
<i>Margaritaria discoidea</i>	f	S	W
<i>Phyllanthus leucanthus</i>	f	S&L	W
<i>Phyllanthus valliifolius</i> ¹			
<i>Ricinodendron heudelotii</i>	f	L	W
<i>Sapium ellipticum</i>	f	L&S	W
<i>Suregada zanzibariense</i>	f	L&S	W
FLACOURTIACEAE			
<i>Flacourtia indica</i>	f	L&S	W

Table 4. Cont.

Species	Ecological type	Habitat	Endemic status
FLACOURTIACEAE (cont.)			
<i>Homalium longistylum</i>	F	L	W
* <i>Ludia mauritiana</i>	f	L&S	W
* <i>Rawsonia lucida</i>	F	S	W
GUTTIFERAE			
* <i>Allanblackia stuhlmannii</i>	F	S	N
* <i>Harungana madagascariensis</i>	F	S	W
<i>Symphonia globulifera</i>	f	S	W
HERNANDIACEAE			
<i>Gyrocarpus americanus</i>	f	L	W
ICACINACEAE			
* <i>Alsodeiopsis schumannii</i>	F	S	N
LECYTHIDACEAE			
<i>Barringtonia racemosa</i>	f	L	W
LEGUMINOSAE- CAESALPINIOIDEAE			
<i>Afzelia quanzensis</i>	f	L	W
<i>Cassia angolensis</i>	F	S	W
<i>Cynometra engleri</i>	F	L	N
<i>Cynometra sp.</i>			
* <i>Cynometra webberi</i>	f	L	N
<i>Dialium holtzii</i>	f	L	N
* <i>Englerodendron usambarense</i>	F	S	E(E&W)
<i>Erythrophleum suaveolens</i>	F	L	W
* <i>Isoberlinia scheffleri</i>	F	S&L	N
<i>Julbernardia globiflora</i> ¹	O	S&L	W
* <i>Julbernardia magnistipulata</i>	f	L	N
* <i>Scorodophloeus fischeri</i>	f	L	N
LEGUMINOSAE-MIMOSOIDEAE			
<i>Albizia adianthifolia</i>	f	L&S	W
<i>Albizia glaberrima</i>	f	L	W
* <i>Albizia gummifera</i>	f	S&L	W
<i>Albizia petersiana</i>	f	L&S	W
<i>Albizia zimmermannii</i>	f	L	W
* <i>Newtonia buchananii</i>	F	S	W
<i>Newtonia paucijuga</i>	F	L	N
<i>Parkia filicoidea</i>	F	L&S	W
<i>Xylia africana</i> ¹	O	L	W
LEGUMINOSAE-PAPILIONOIDEAE			
* <i>Angylocalyx braunii</i>	F	L	N
* <i>Craibia brevicaudata</i>	f	L	N
<i>Craibia brownii</i>	F	S	W
<i>Dalbergia boehmii</i>	f	L	W
<i>Dalbergia nitidula</i> ¹	O	L&S	W
<i>Erythrina abyssinica</i>	f	L&S	W
<i>Lonchocarpus bussei</i>	O	L&S	W
<i>Lonchocarpus capassa</i> ¹	O	L&S	W
<i>Millettia stuhlmannii</i> ¹	O	L&S	W
* <i>Millettia usaramensis</i>	f	L&S	W
<i>Pterocarpus mildbraedii</i>	F	L	N
<i>Pterocarpus tinctorius</i> race ' <i>stolzii</i> '	F	S&L	W
<i>Schefflerodendron usambarense</i>	F	S	W

Table 4. Cont.

Species	Ecological type	Habitat	Endemic status
LOGANIACEAE			
<i>Anthocleista grandiflora</i>	f	S	W
MELIACEAE			
<i>Entandrophragma excelsum</i>	F	S	W
* <i>Khaya anthotheca</i> ¹	F	L&S	W
<i>Trichilia dregeana</i>	f	S & L	W
<i>Trichilia emetica</i>	f	L	W
MORACEAE			
* <i>Antiaris toxicaria</i>	f	L&S	W
<i>Antiaris toxicaria</i> ssp. <i>welwitschii</i> var. <i>usambarensis</i>	f	L&S	W
<i>Artocarpus heterophyllus</i>	Introduced species		W
* <i>Dorstenia kameruniana</i>	f	L	W
<i>Ficus cyathistipula</i>	f	L	W
<i>Ficus exasperata</i>	f	L&S	W
<i>Ficus lutea</i>	f	L	W
<i>Ficus scassellatii</i>	f	S	W
<i>Ficus sur</i>	f	L & S	W
<i>Ficus sycomorus</i> ¹	f	L	W
* <i>Ficus vallis-choudae</i>	f	L	W
* <i>Mesogyne insignis</i>	F	S	N
* <i>Milicia excelsa</i>	f	L&S	W
<i>Treulia africana</i>	F	S&L	W
<i>Trilepisium madagascariensis</i>	f	L & S	W
MYRISTICACEAE			
* <i>Cephalosphaera usambarensis</i>	F	S	N
MYRTACEAE			
* <i>Syzygium guineense</i>	F	S	W
OCHNACEAE			
* <i>Ochna macrocalyx</i>	f		W
OLACAECEAE			
<i>Strombosia scheffleri</i>	F	S	W
OLEACEAE			
<i>Chionanthus nilotica</i>	F	S&L	W
PANDANACEAE			
* <i>Pandanus rabaiensis</i>	O	L&S	W
RHAMNACEAE			
<i>Maesopsis eminii</i>	F	S&L	W
<i>Ziziphus mucronata</i>	O	L	W
<i>Ziziphus pubescens</i>	f	L	W
RUBIACEAE			
<i>Aorantho penduliflora</i>	F	L&S	N
<i>Breonadia salicina</i>	F	L&S	W
<i>Coffea robusta</i> ¹	O	L&S	W
<i>Cremaspora triflora</i>	f	S	N
<i>Hallea rubrostipulata</i>	f	S	W
<i>Heinsenia diervilleoides</i>	f	S	W
<i>Oxyanthus pyriformis</i>	f	S	N
* <i>Oxyanthus speciosus</i>	F	S	W
<i>Pauridiantha paucinervis</i> ssp. <i>holstii</i>	F	S	W
<i>Polysphaeria macrantha</i>	F	S	N
<i>Psydrax parviflora</i> ssp. <i>rubrocostata</i>	F	S	W
* <i>Rothmannia manganjae</i>	F	L&S	W

Table 4. Cont.

Species	Ecological type	Habitat	Endemic status
RUBIACEAE (Cont.)			
<i>Rothmannia urcelliformis</i>	F	L	W
<i>Rytigynia flavida</i>	F	S	N
<i>Rytigynia longicaudata</i>	F	S	E(E&W)
* <i>Tarenna pavettoides</i>	F	L&S	W
* <i>Tricalysia anomala</i>	F	S	N
<i>Tricalysia pallens</i>	f	S	W
<i>Tricalysia sp.</i>			
RUTACEAE			
* <i>Teclea amaniensis</i>	f	L&S	N
<i>Teclea nobilis</i>	f	S	W
<i>Zanthoxylum gillettii</i>	F	S	W
<i>Zanthoxylum usambarensis</i>	F	S	W
SAPINDACEAE			
<i>Allophylus abyssinicus</i>	F	S	W
<i>Allophylus melliodorus</i>	f		N
<i>Allophylus stachyanthus</i>	F	L	N
<i>Allophylus zimmermannianus</i>	F	L	N
* <i>Blighia unijugata</i>	F	L&S	W
<i>Chytranthus obliquinervis</i>	f	L	N
<i>Deinbollia kilimandscharica</i>	f	S	W
<i>Haplocoelum inoploeum</i> ¹	f	L	
* <i>Lecaniodiscus fraxinifolius</i>	F	L	W
<i>Placodiscus amaniensis</i>	F		N
* <i>Zanha golungensis</i>	F	L&S	W
SAPOTACEAE			
* <i>Afrosersalicia cerasifera</i>	f	S & L	W
<i>Aningeria adolfi-friedericii</i>	F	S	N
* <i>Bequaertiodendron natalense</i>	f	L&S	W
* <i>Chrysophyllum gorungosanum</i>	F	S	W
<i>Chrysophyllum sp.</i>			
* <i>Malacantha alnifolia</i>	f	L&S	W
* <i>Manilkara obovata</i>	f	S	W
<i>Manilkara sulcata</i>	f	L	W
<i>Mimusops kummel</i>	f	L	W
<i>Mimusops sp.</i>			
<i>Pachystela msolo</i>	F	L&S	W
* <i>Vincentella passargei</i>	f	L	W
SIMAROUBACEAE			
<i>Odyndea zimmermannii</i>	F	S	N
STERCULIACEAE			
<i>Cola clavata</i> ¹	F	L	W
* <i>Cola greenwayi</i>	F	S	W
<i>Cola microcarpa</i>	F	S	N
* <i>Cola scheffleri</i>	F	L	N
<i>Cola sp.</i>			
* <i>Cola usambarensis</i>	F	S	E(EU)
<i>Dombeya rotundifolia</i> ¹	O	S	W
<i>Dombeya shupangae</i>	f		W
<i>Dombeya sp.</i>			
<i>Dombeya taylorii</i>	O		N
* <i>Leptonychia usambarensis</i>	F	L&S	N
* <i>Melhanian velutina</i>	O	L&S	W

**Nesogordonia holtzii'*

L&S

N

Table 4. Cont.

Species	Ecological type	Habitat	Endemic status
STERCULIACEAE (Cont.)			
<i>Pterygota mildbraedii</i> ¹			
<i>Sterculia appendiculata</i>	F	L	W
TILIACEAE			
<i>Grewia bicolor</i>	O	L&S	W
<i>Grewia goetzeana</i>	f	L	N
<i>Grewia microcarpa</i>	f	L&S	W
ULMACEAE			
* <i>Celtis africana</i>	F	L	W
<i>Celtis durandii</i> ¹	F	L	W
<i>Celtis mildbraedii</i>	F	L&S	W
<i>Celtis wightii</i>	f	S	W
<i>Celtis zenkeri</i>	F	L&S	W
* <i>Trema orientalis</i>	f	L&S	W
VERBENACEAE			
<i>Premna chrysoclada</i>	O	L	N
<i>Premna schliebenii</i>	O	L	N
VIOLACEAE			
<i>Rinorea ferruginea</i>	F	S	W
<i>Rinorea scheffleri</i>	F	L	E(EU)

¹ Species which do not appear in Iversen (1991a). Summary information is based on Ruffo *et al.* (1989), Lovett (1993) or the *Flora of Tropical East Africa*.

² Information is based on Ruffo *et al.* (1989).

KEY TO ABBREVIATIONS FOR TABLE 4

Ecological type (based on Iversen, 1991a):

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes of <850 m;
- S - Submontane: Species occurring at altitudes of >850 m.

In the case where species occur in both lowland and submontane habitats, the most common habitat will be listed first and only this habitat will be counted in the summary statistics. If a species is common in forest gaps, rather than in the forest proper, this will also be noted.

Endemic status: (based on Iversen, 1991a):

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowlands between Somalia and Mozambique.
- W - Widespread distribution.

EU - Range limited to the East Usambaras ; WU - Range limited to the West Usambaras

? Insufficient data

Regeneration layer

Species recorded in the regeneration layer are marked with an asterisk e.g. **Trema orientalis*.

Table 5. Species recorded in the regeneration layers but not as trees greater than 10 cm dbh.

Species	Ecological type	Habitat	Endemic status
RUTACEAE			
<i>Teclea simplicifolia</i>	f	S	W
ULMACEAE			
<i>Celtis gomphophylla</i>	F	L	W

Table 6. Summary of opportunistic botanical records.

Species	Ecological type	Habitat	Endemic status
Pteridophyta			
ASPIDIACEAE			
<i>Dryopteris</i> sp.			
<i>Tectaria gemmifera</i>	f		W
ASPLENIACEAE			
<i>Asplenium</i> sp.			
CYATHACEAE			
<i>Cyathea manniana</i>	f		W
DENNSTAEDTIACEAE			
<i>Blotiella stipitata</i>	F		N
MARATTIACEAE			
<i>Marattia fraxinea</i>	f		W
THELYPTERIDACEAE			
<i>Cyclosorus</i> sp.			
Gymnospermae			
ZAMIACEAE			
<i>Encephalartos hildebrandtii</i>	f	L	N
Angiospermae			
ACANTHACEAE			
<i>Justicia</i> sp.			
ANNONACEAE			
<i>Uvaria acuminata</i>	f	L	W
APOCYNACEAE			
<i>Saba</i> sp.			
ARACEAE			
<i>Culcasia orientalis</i>	F	L	N
<i>Culcasia</i> sp.			
ASPARAGACEAE			
<i>Asparagus falcatus</i>	f		W
COMPOSITAE			
<i>Vernonia usambarensis</i>	f		N
CONNARACEAE			
<i>Agelaea heterophylla</i>	F	S	W
COSTACEAE			
<i>Costus</i> sp.			
CYPERACEAE			
<i>Cyperus distans</i>	f		W
DRACAENACEAE			
<i>Dracaena deremensis</i>	f		W
<i>Dracaena steudneri</i>	f		W
EUPHORBIACEAE			
<i>Erythrococca usambarica</i>	F	L&S	W
FLACOURTIACEAE			
<i>Grandidiera</i> sp.			
<i>Trimeria grandiflora</i>	f	L&S	W
GESNERIACEAE			
<i>Saintpaulia grotei</i>	f		E (EU)
<i>Saintpaulia magungensis</i>	f		E (EU & WU)
<i>Saintpaulia tongwensis</i>	f		N

Table 6. Cont.

Species	Ecological type	Habitat	Endemic status
GRAMINEAE			
<i>Olyra latifolia</i>	F	L&S	W
GUTTIFERAE			
<i>Garcinia volkensii</i>	F	L&S	W
ICACINACEAE			
<i>Leptaulus</i> sp			
MARANTACEAE			
<i>Marantochloa</i> sp.			
MELASTOMATACEAE			
<i>Calvoa orientalis</i>	F	S	W
<i>Clidemia</i> sp.			
MELIACEAE			
<i>Trichilia emetica</i>	f	L&S	W
MYRSINACEAE			
<i>Rapanea melanophloeos</i>	f		W
PALMAE			
<i>Phoenix reclinata</i>	f	L&S	W
PIPERACEAE			
<i>Piper capensis</i>	f	L&S	W
<i>Piper umbellatum</i>	f	L&S	W
RANUNCULACEAE			
<i>Clematis simensis</i>	f	S	W
RUBIACEAE			
<i>Chassalia parvifolia</i>	F	L&S	W
<i>Pavetta amaniensis</i>	f		N
<i>Pavetta</i> sp			
<i>Tricalysia acidophylla</i>	f	L	N
RUTACEAE			
<i>Toddalia asiatica</i>	f	L&S	W
SMILACACEAE			
<i>Smilax anceps</i>	f	L&S	W
THYMELAEACEAE			
<i>Peddia fischeri</i>	f	S	W
<i>Dicranolepis usambarica</i>	F	L&S	N
VERBENACEAE			
<i>Lantana camara</i>	f	L&S	W
<i>Vitex amaniensis</i>	f	S	N

In 1986 - 1987 a botanical survey was conducted in the East Usambaras (Ruffo et al. 1989). 47 species recorded in Mtai by the current survey were not recorded by Ruffo et al. in Mtai although they were recorded elsewhere in the Usambaras. These are listed in Table 7.

Table 7. Tree and shrub species found outside their previously recorded range in the East Usambara Mountains.

Species	Location as previously recorded
<i>Alsodeiopsis schumannii</i>	Bulwa, Kwamkoro FR, Kwamsambia / Kihuhwi FRs, Kilanga
<i>Breonadia salicina</i>	Amani
<i>Bridelia micrantha</i>	Bulwa, Kwamkoro FR and Kwamsambia / Kihuhwi FR.
<i>Celtis zenkeri</i>	Bulwa, Kwamsambia / Kihuhwi FRs, Lutindi FR, Longuza FR
<i>Cola greenwayi</i>	Kwamkoro FR, Lutindi FR
<i>Cola usambarense</i>	Kwamkoro FR, Amani area, Kwamsambia / Kihuhwi,

Table 7. Cont.

Species	Location as previously recorded
<i>Combretum schumannii</i>	Kwamsambia / Kihuhwi FRs, Kilanga, Lutindi FR, Longuza FR, Marimba FR, Kwamgumi / Segoma
<i>Craibia brevicaudata</i>	Kwamsambia / Kihuhwi FR, Longuza FR
<i>Cussonia spicata</i>	Lutindi FR Mlinga
<i>Cyathea manniana</i>	Kwamkoro FR, Kwamsambia / Kihuhwi FR and Lutindi FR.
<i>Cynometra engleri</i>	Bulwa, Kwamkoro FR, Kilanga, Lutindi FR, Longuza FR, Kwamgumi FR
<i>Cynometra webberi</i>	Marimba FR
<i>Dalbergia boehmii</i>	Longuza FR, Segoma FR
<i>Diospyros abyssinica</i>	Bulwa, Kwamkoro FR and known only from south end of main range
<i>Diospyros mespiliformis</i>	Amani area, Kwamgumi / Segoma FRs
<i>Drypetes natalensis</i>	Longuza FR, Churwa area
<i>Englerodendron usambarense</i>	Kwamkoro FR and restricted to south end of main range
<i>Fernandoa magnifica</i>	Kwamsambia / Kihuhwi FRs, Marimba FR, Kwamgumi / Segoma
<i>Ficus cyathistipula</i>	Lutindi FR
<i>Ficus lutea</i>	Bulwa, Lutindi FR, Longuza FR
<i>Ficus scassellatii</i>	Lutindi FR, Longuza FR, Mlinga
<i>Ficus sur</i>	Bulwa, Kwamkoro FR, Kwamsambia / Kihuhwi FRs, Kilanga, Lutindi FR
<i>Ficus vallis-choudae</i>	Kwamsambia / Kihuhwi FR, Mlinga
<i>Greenwayodendron suaveolens</i>	Bulwa, Kwamkoro FR, Amani area, Kwamsambia / Kihuhwi, Lutindi FR
<i>Gyrocarpus americanus</i>	Longuza FR, Kwamgumi / Segoma FRs
<i>Hallea rubrostipulata</i>	Amani-Sigi FR
<i>Harungana madagascariensis</i>	Bulwa, Kwamkoro FR, Kwamsambia / Kihuhwi FR, Lutindi FR, Kilanga FR, Longuza FR, Mlinga
<i>Heinsenia diervilleoides</i>	Kwamkoro FR, Lutindi FR, Kizara / Kizerui
<i>Julbernardia magnistipulata</i>	Kwamkoro FR, Amani area Kwamsambia / Kihuhwi FR and Longuza FR
<i>Malacantha alnifolia</i>	Kwamsambia / Kihuhwi FR, Lutindi FR, Longuza FR, Kwamgumi / Segoma,
<i>Manilkara obovata</i>	Kwamkoro FR
<i>Manilkara sulcata</i>	Lutindi FR, Longuza FR
<i>Maranthes goetzeniana</i>	Bulwa, Amani area, Kwamsambia, Lutindi FR
<i>Maytenus undata</i>	Lutindi FR, Kilanga FR, Kisara /Kizerui and restricted to north end of main range.
<i>Mimusops kummel</i>	Kwamgumi FR
<i>Newtonia buchananii</i>	Kwamsambia / Kihuhwi FR, Lutindi FR
<i>Oxyanthus speciosus</i>	Amani-Sigi FR, Kwamkoro, Kwamsambia / Kihuhwi, Longuza FR, Mlinga.
<i>Pauridiantha paucinervis ssp. holstii</i>	Monga / Ndora, Lutindi FR, Longuza FR
<i>Polyceratocarpus scheffleri</i>	Kwamkoro FR
<i>Pterocarpus mildbraedii</i>	Kwamsambia / Kihuhwi FR, Longuza FR, Kwamgumi / Segoma FRs
<i>Pterocarpus tinctorius race 'stolzii'</i>	Amani - Sigi FR, Kwamkoro FR, Kwamsambia / Kihuhwi FRs, Lutindi FR
<i>Rothmannia urcelliformis</i>	Kwamgumi FR
<i>Symphonia globulifera</i>	Kizara, Kizerui
<i>Teclea nobilis</i>	Kwamkoro FR, Kwamsambia / Kihuhwi FRs, Lutindi, Kwamgumi FR
<i>Trema orientalis</i>	Bulwa, Kwamsambia / Kihuhwi FRs, Lutindi FR, Mlinga
<i>Trichilia dregeana</i>	Kwamkoro FR, Amani area, Kwamsambia / Kihuhwi FRs, Lutindi FR, Kwamgumi FR
<i>Zanthoxylum usambarense</i>	Kwamkoro FR, Lutindi FR, Churwa area

¹ Information is based on Ruffo *et al.* (1989).

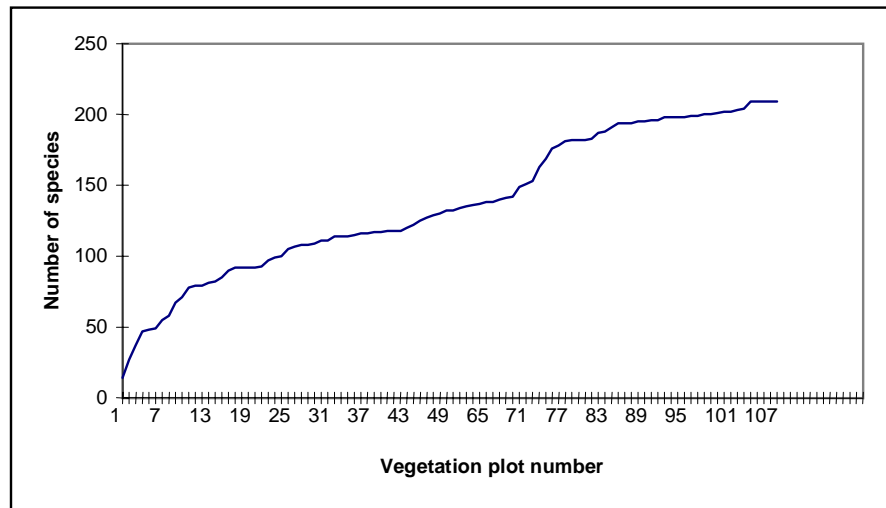


Figure 4. Species accumulation rates of trees and shrubs (10 cm dbh and larger) by vegetation plot.

Ecological type (refer to Figures 5, 6, 7, 8,):

Table 8. Summary of ecological type for tree and shrub species (based on Table 4).

Ecological type	Number of species	% of total species
(F) Forest Dependent Species	81	36
(f) Forest Non- Dependent Species	105	47
(O) Non-Forest Species	18	8
Unknown	19	9
Total:	223	100

Habitat (refer to Figures 9 and 10):

Table 9. Summary of the habitat for tree and shrub species (based on Table 4).

Habitat	Number of species	% of total species
(L) Lowland Forest Species	123	55
(S) Submontane Forest Species	76	34
(U) Unknown	24	11
Total:	223	100

Table 10. Submontane species occurring in lowland areas and the lowest altitudes where they were recorded.

Species	Altitude (metres)
<i>Craibia brownii</i>	270
<i>Dombeya rotundifolia</i>	380
<i>Myrianthus holstii</i>	690
<i>Rytignia longicaudata</i>	780
<i>Tricalysia anomala</i>	280
<i>Tricalysia pallens</i>	280

Endemic status (refer to Figures 11,12,13,14):

Table 11. Summary of endemic status for tree and shrub species.

Endemic status	Number of species	% of total species
(E) Endemic	5 (1-EU & 3 EU&WU)	2 (1-EU & 1 EU&WU)
(N) Near Endemic	54	24
(W) Widespread	146	65
Unknown	19	9
Total:	223	100

EU - endemic to the East Usambaras; WU - endemic to the West Usambaras

Timber species

Although Mtai was excluded from logging concessions in the 1980s, illegal commercial logging occurred. Table 12 lists the most commonly extracted trees (Ruffo et al. 1989) to give an indication of the remaining populations of these species.

Table 12. The abundance of selected timber species.

Species	Number of plots in which present	% of plots in which present	Total individuals	% of all stems
	n= 99			
<i>Cephalosphaera usambarensis</i>	21	22	63	3.2
<i>Khaya anthotheca</i>	9	9	13	0.7
<i>Milicia excelsa</i>	12	12	27	1.4
<i>Newtonia buchananii</i>	5	5	6	0.3
<i>Ocotea usambarensis</i>	0	0	0	0.0

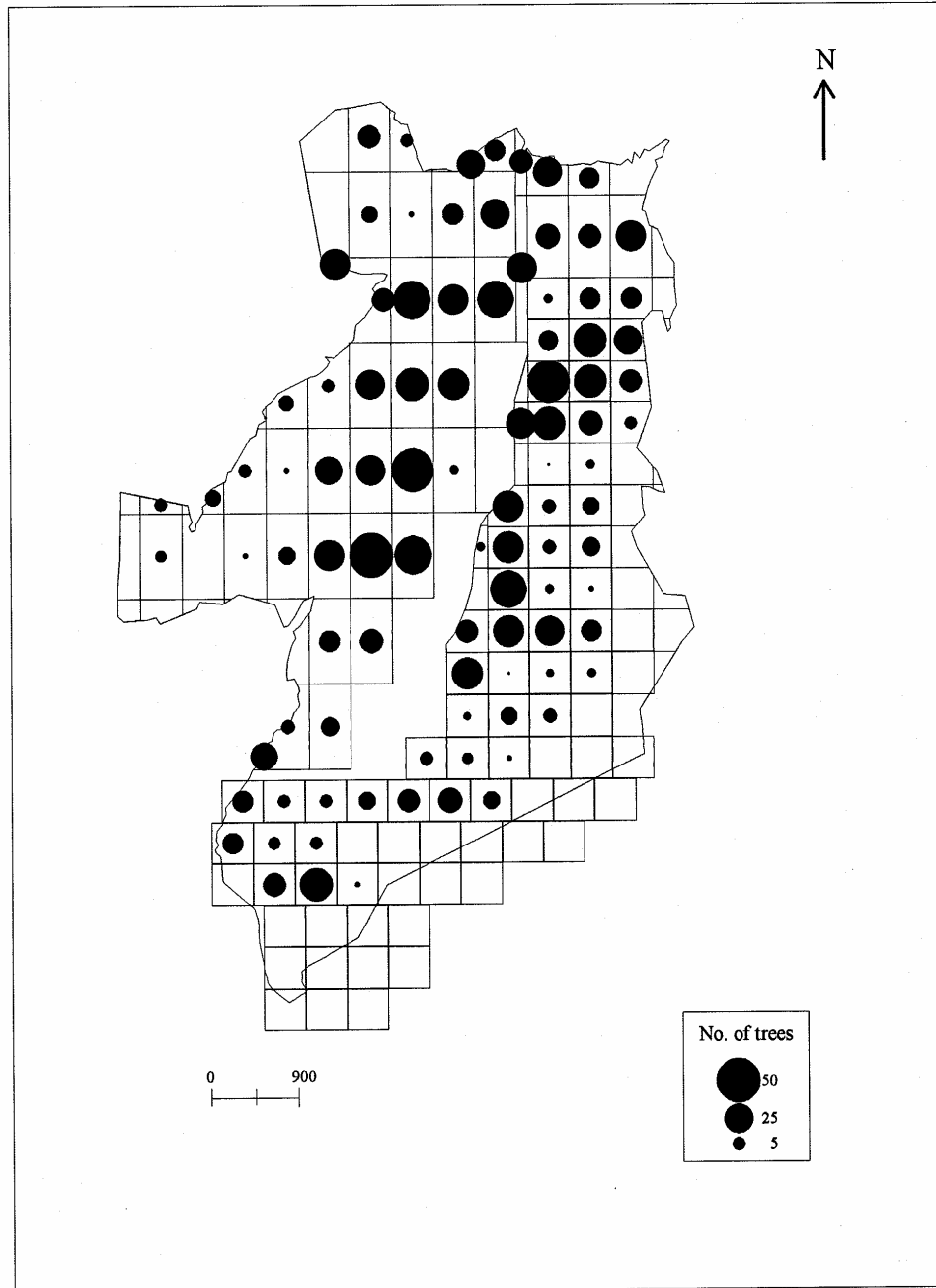


Figure 5. Distribution of forest dependent tree and shrub individuals.

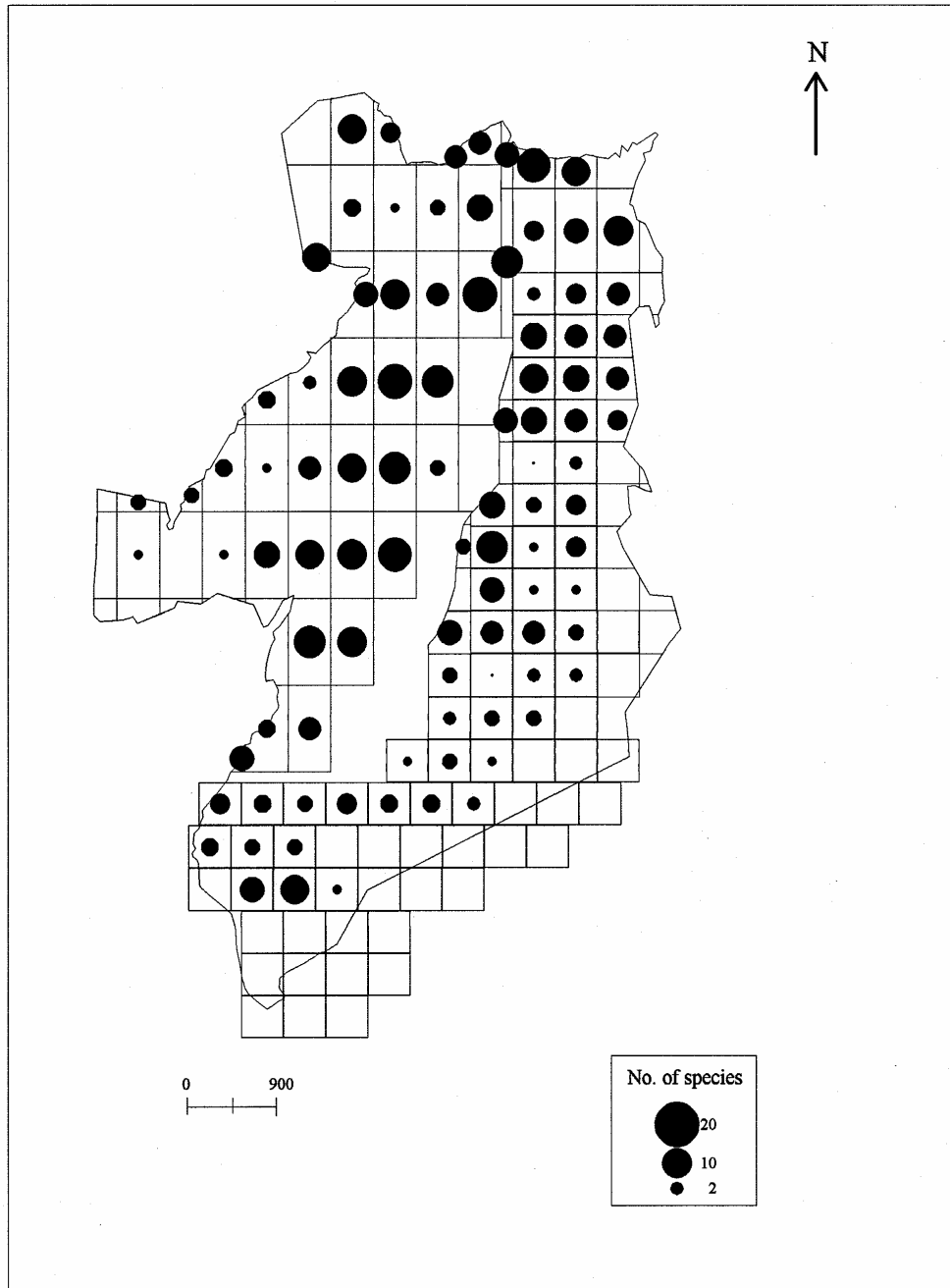


Figure 6. Distribution of forest dependent tree and shrub species.

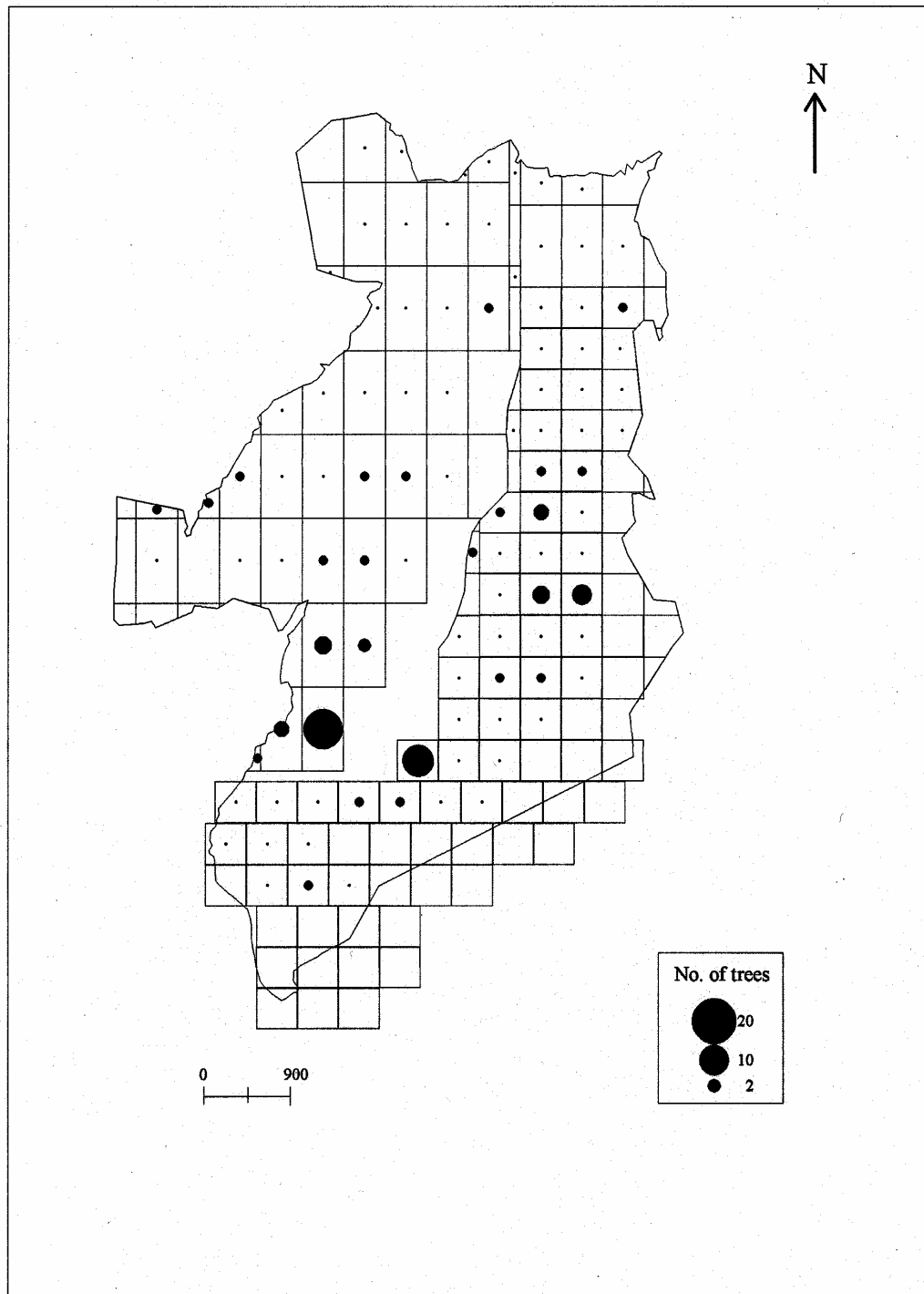


Figure 7. Distribution of non-forest tree and shrub individuals.

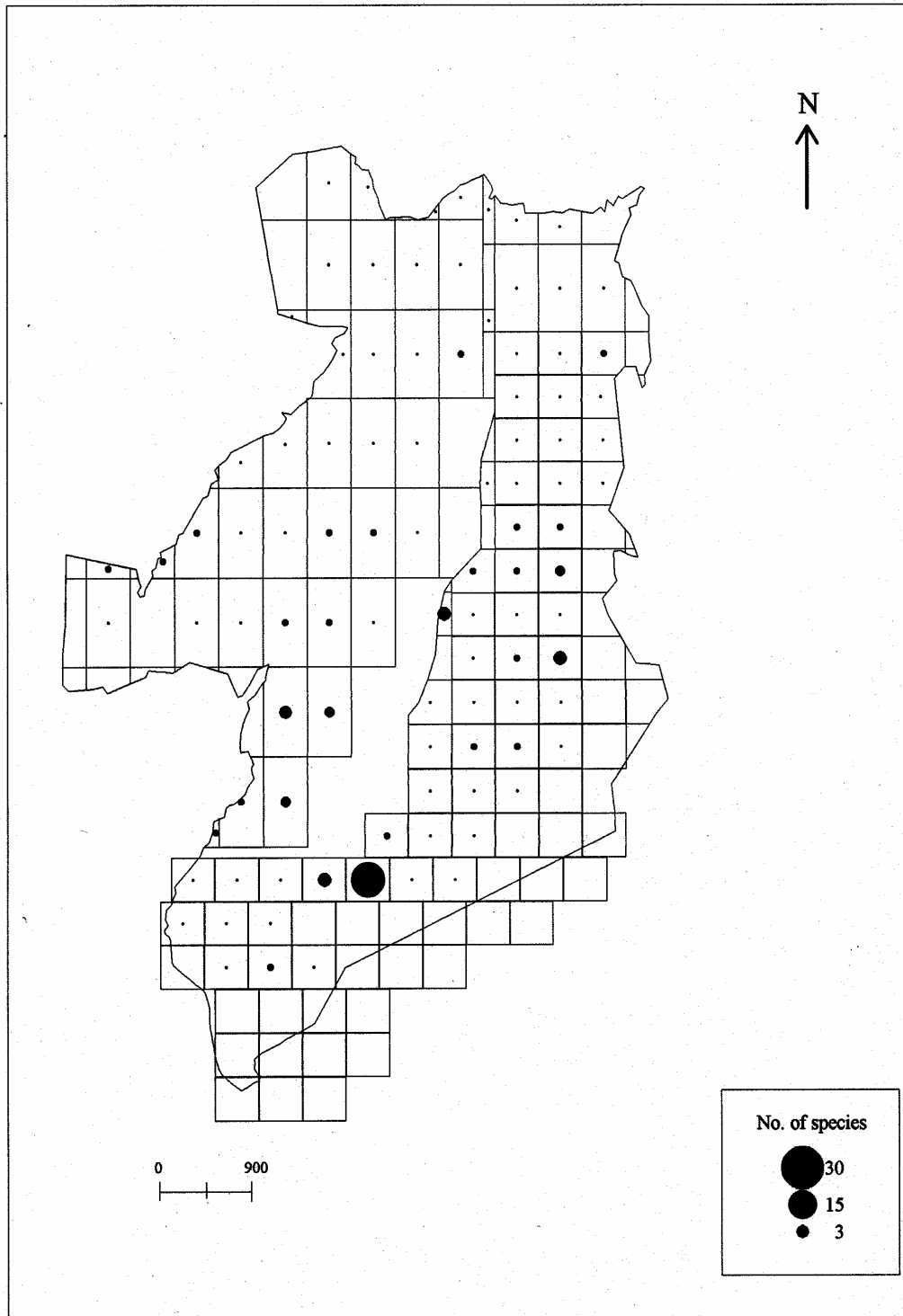


Figure 8. Distribution of non-forest tree and shrub species.

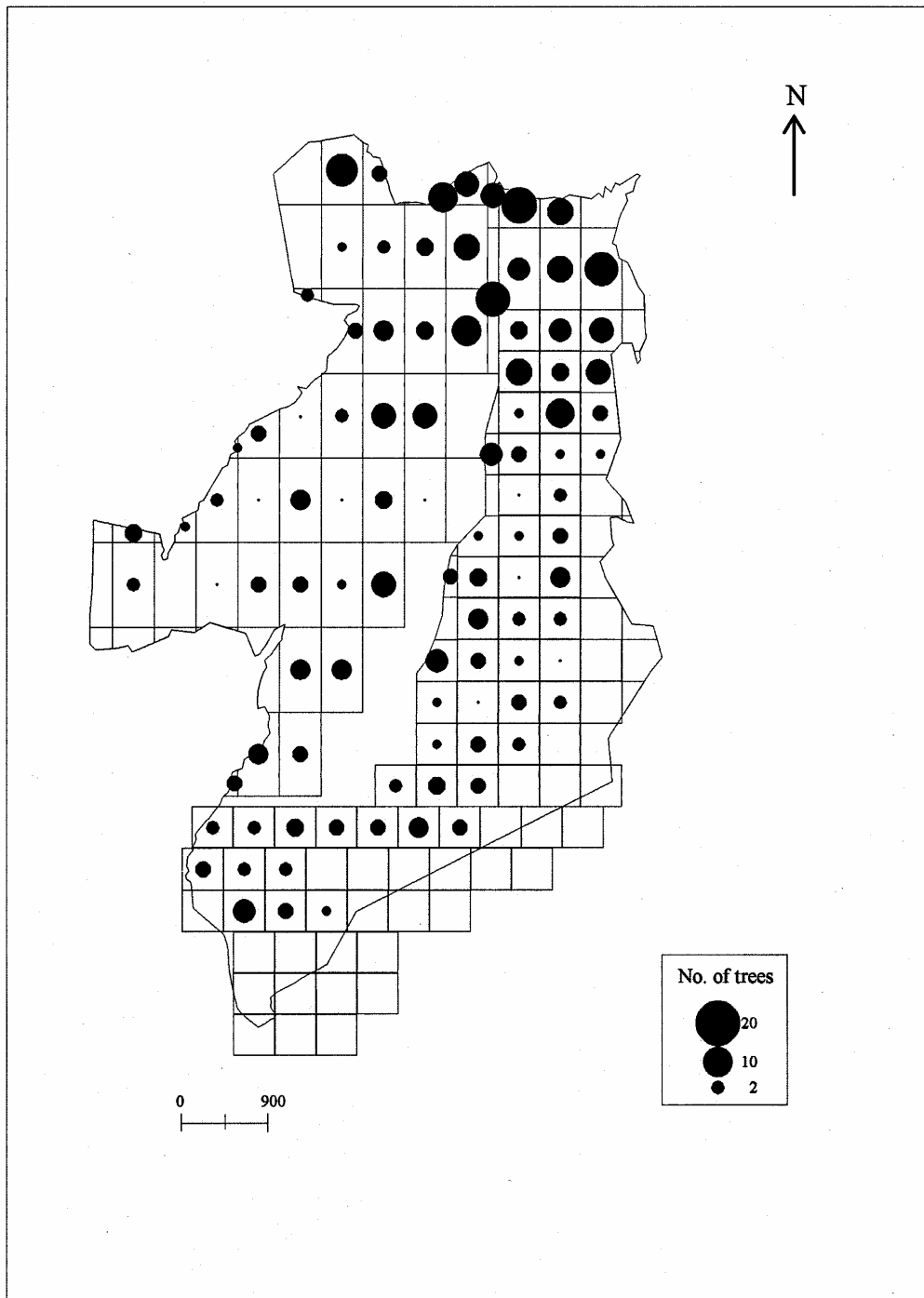


Figure 9. Distribution of submontane tree and shrub individuals.

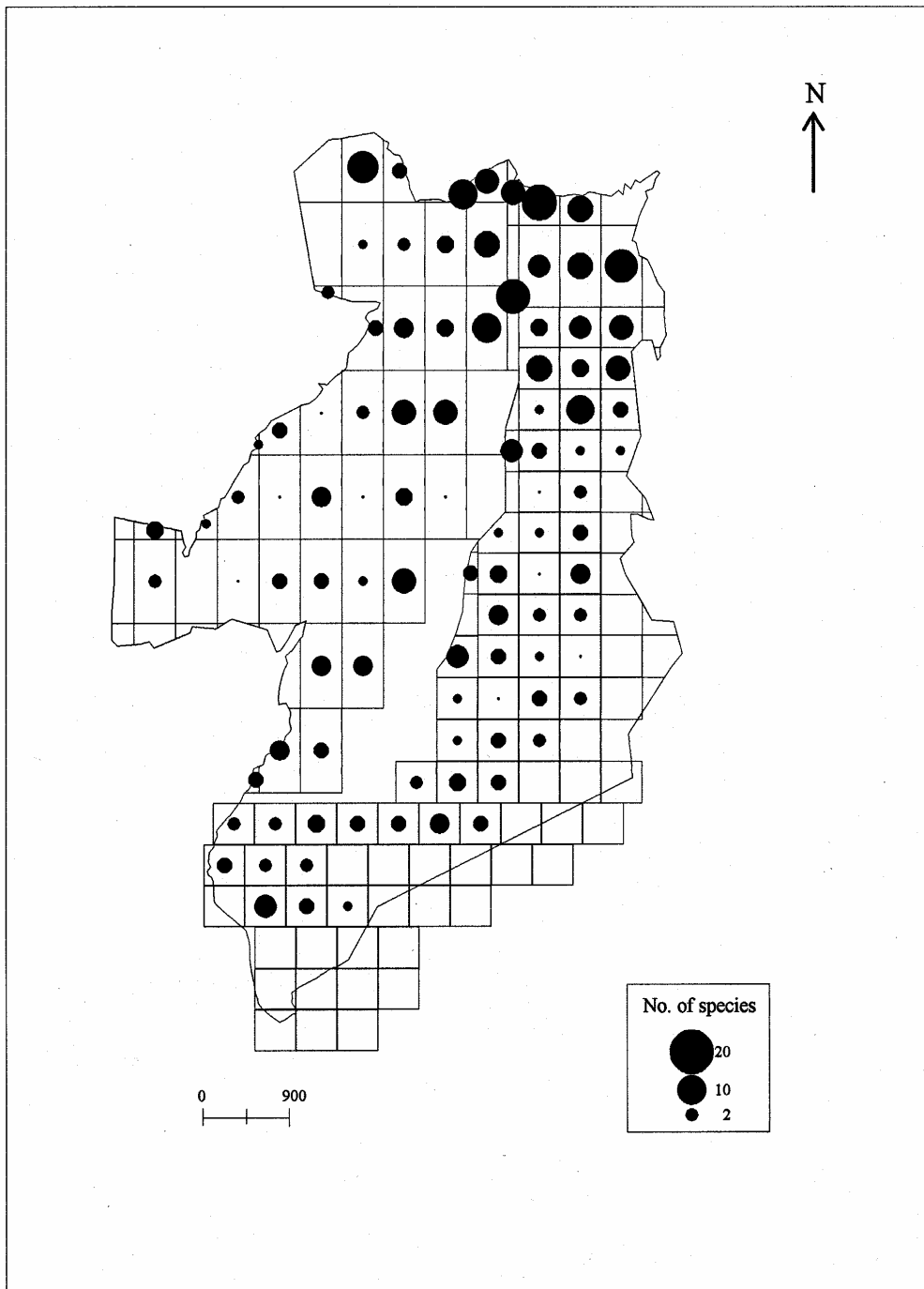


Figure 10. Distribution of submontane tree and shrub species.

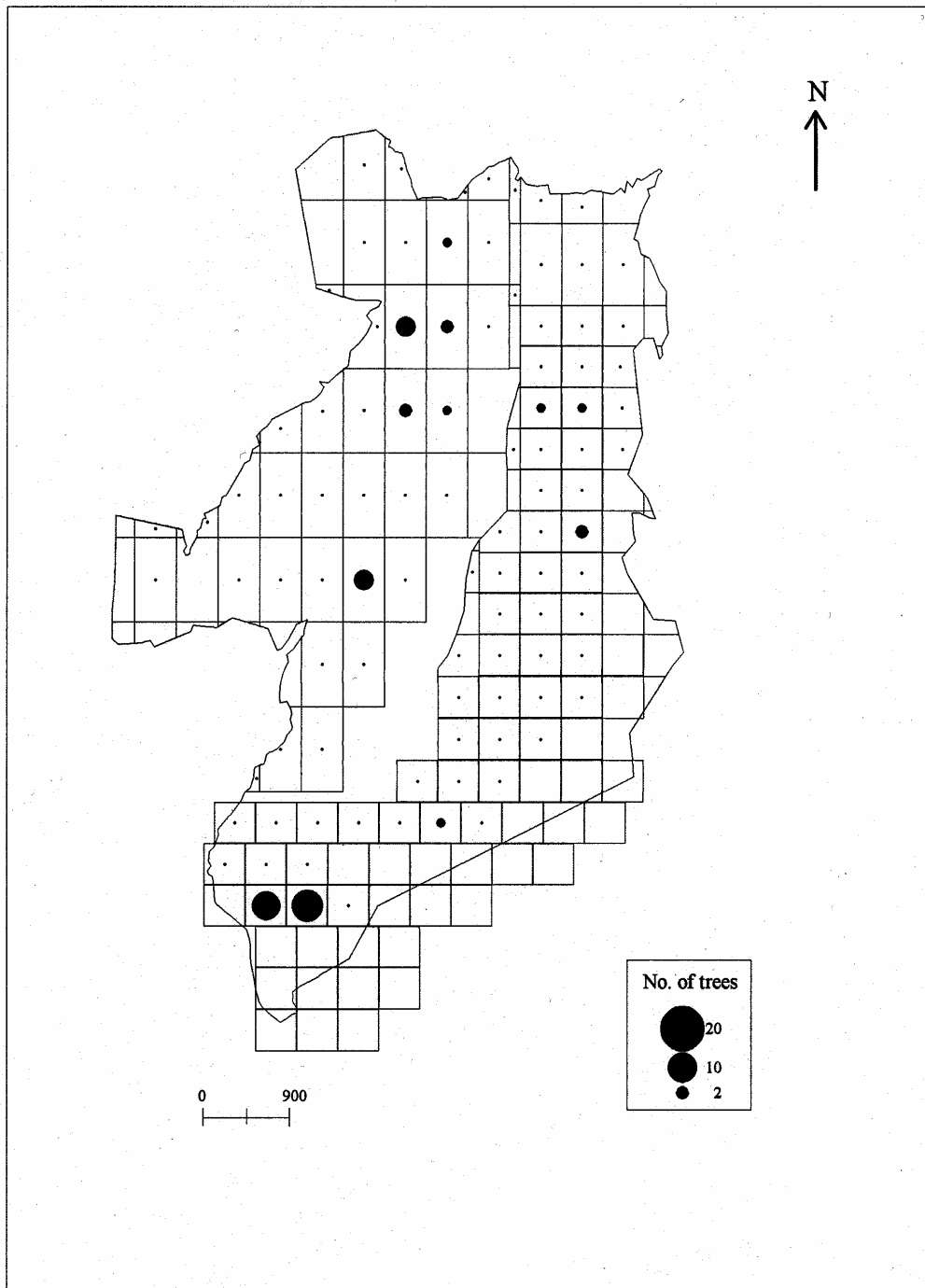


Figure 11. Distribution of endemic tree and shrub individuals.

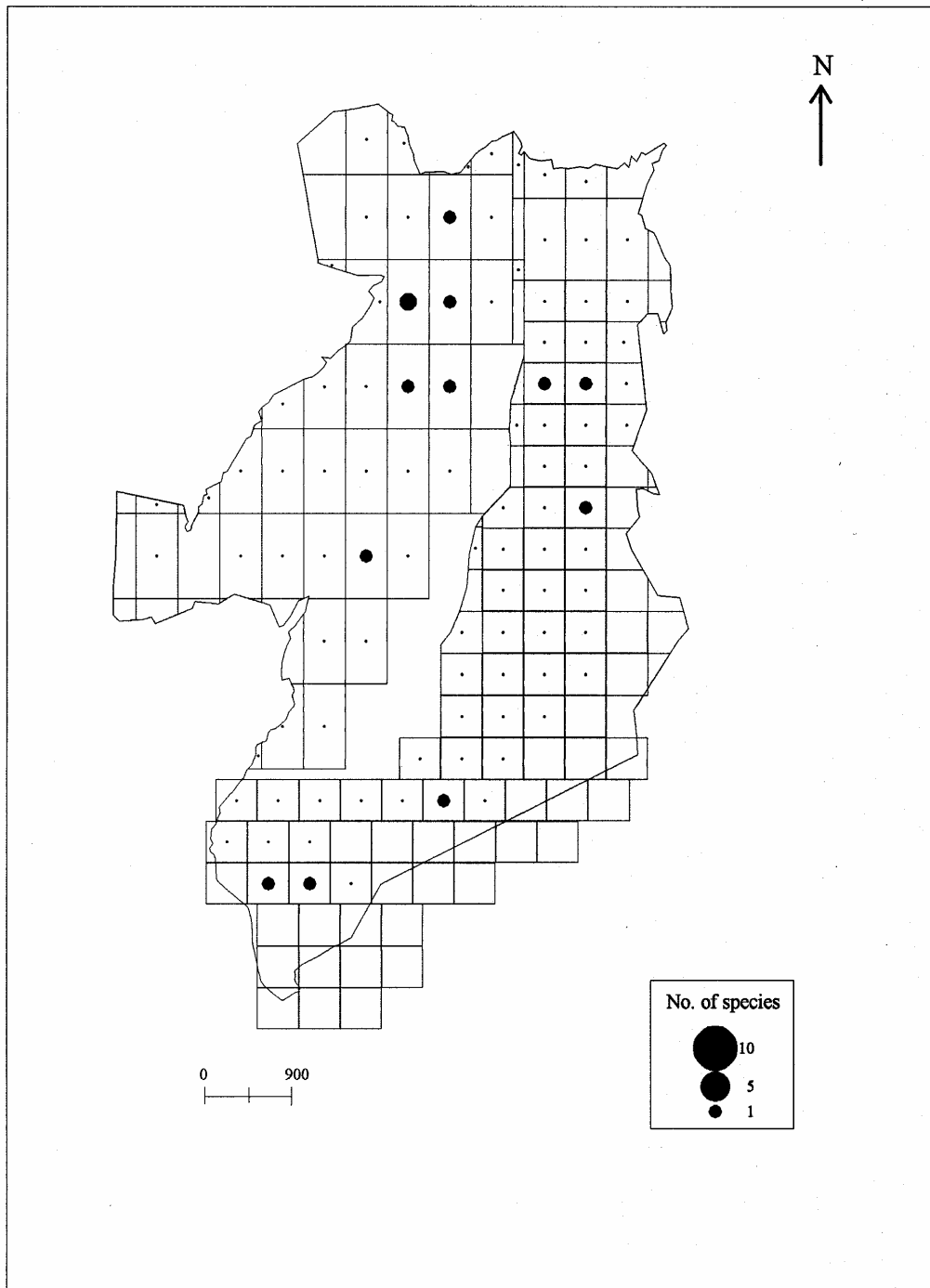


Figure 12. Distribution of endemic tree and shrub species.

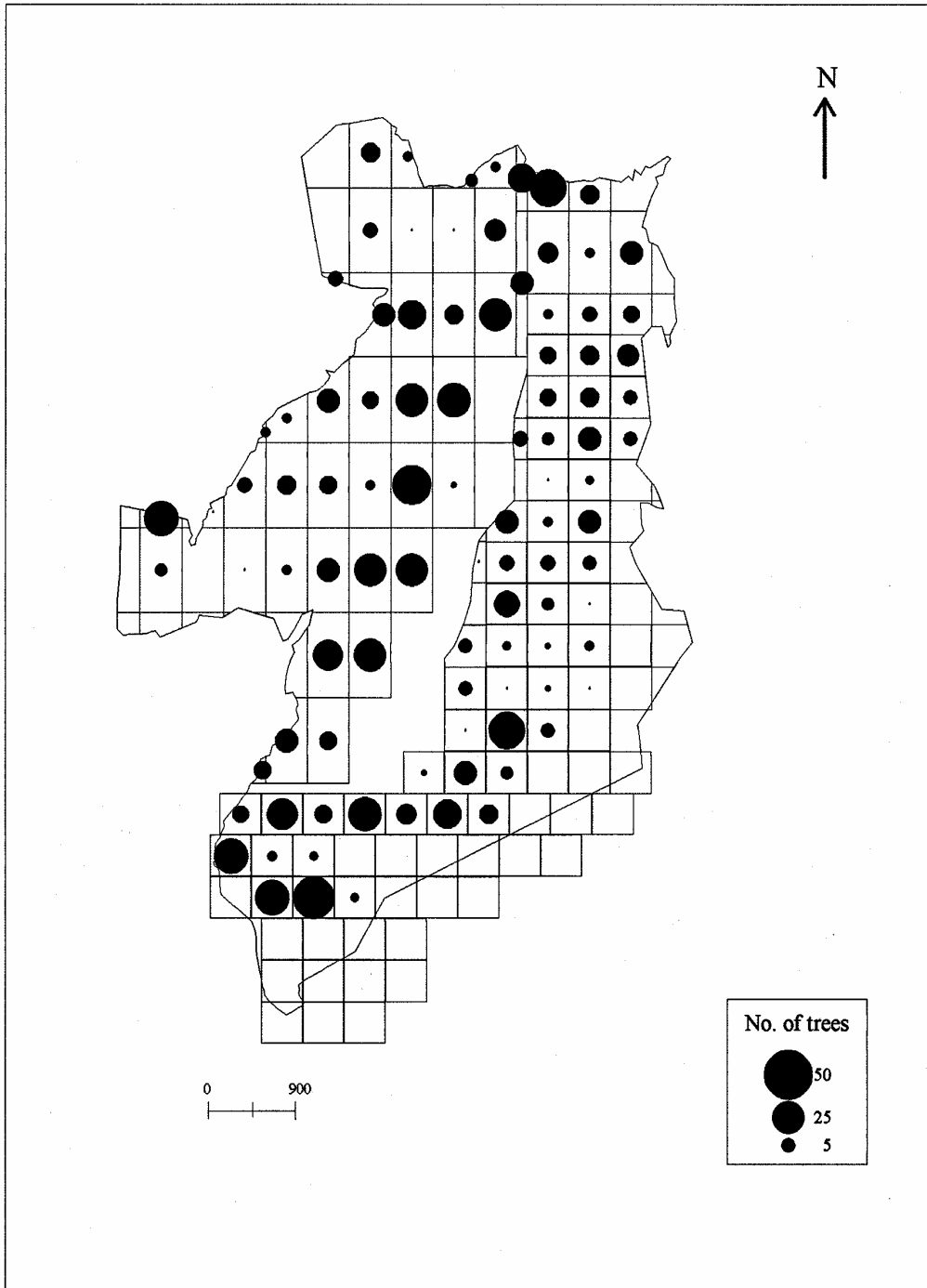


Figure 13. Distribution of near-endemic tree and shrub individuals.

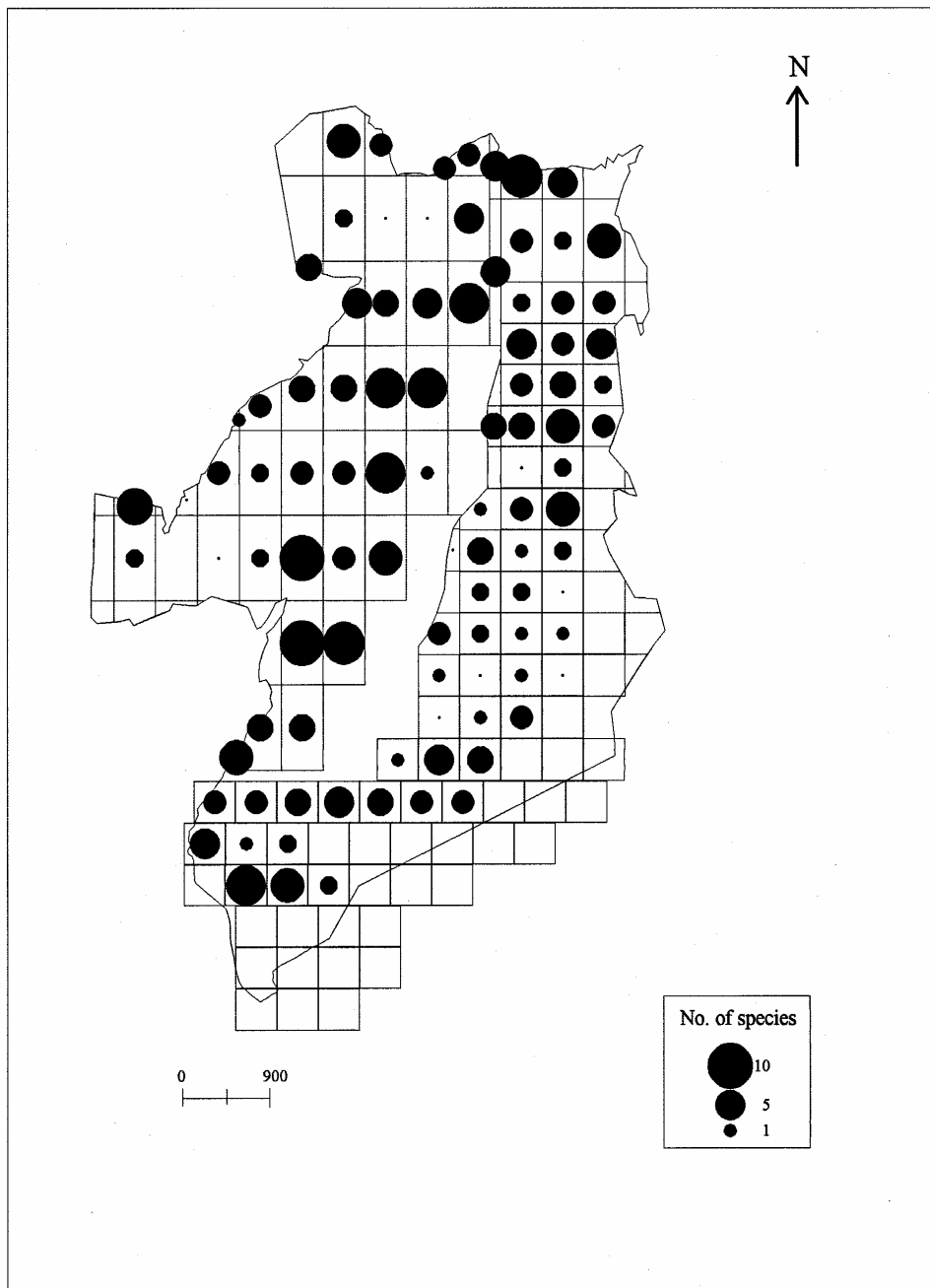


Figure 14. Distribution of near-endemic tree and shrub species.

4.3.2 Disturbance

Disturbance from pole and timber cutting was recorded along 17 transects in the East of Mtai and along eight transects in the West. The results are summarised in Tables 13 and 14 for poles and Tables 15 and 16 for timber. The term pole refers to all stems 5 - 15 cm dbh, the term timber refers to all stems > 15 cm dbh. Other disturbances were also recorded systematically and are listed in Table 15.

Table 13. Disturbance transect results for pole counts in the west of Mtai.

Transect number	Length of transect (m)	Total poles recorded	Live poles	Naturally fallen poles	Average fallen poles per ha	Cut poles	Average cut poles per ha	Percentage of poles cut
-1	1150	847	709	65	57	73	63	9
0	850	952	732	74	87	146	172	15
1	2900	1720	1335	116	40	269	93	16
2	3250	1826	1729	79	24	18	60	1
3	2550	1207	1056	57	22	94	37	8
4	2100	1148	1041	46	22	61	29	5
5	1650	568	520	13	8	35	21	6
6	1700	891	651	15	9	225	132	25

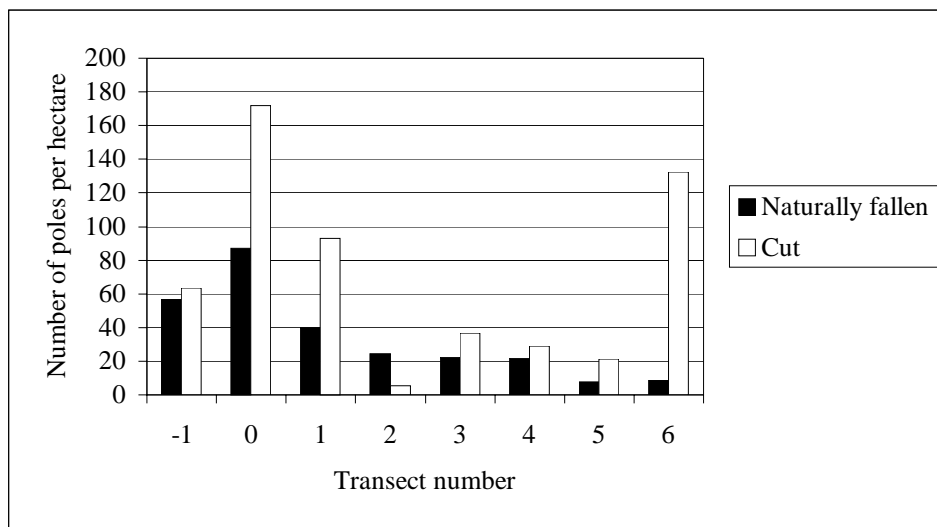
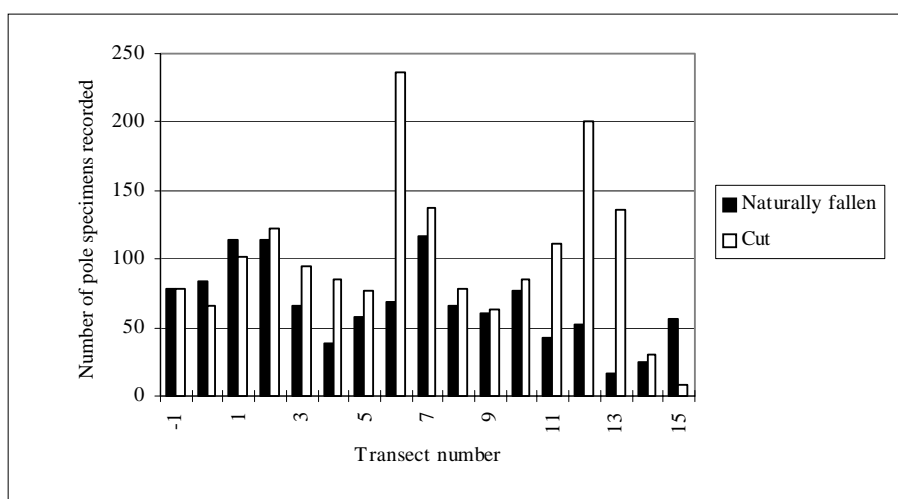


Figure 15. Cut and naturally fallen poles recorded per hectare by transect in the west of Mtai.

Table 14. Disturbance transect results for pole counts in the east of Mtai.

Transect number	Length of transect (m)	Total poles recorded	Live poles	Naturally fallen poles	Average fallen poles per hectare	Cut poles	Average cut poles per hectare	Percentage of poles cut
-1	1120	175	n/a	88	79	87	78	n/a
0	1550	232	n/a	103	66	129	83	n/a
1	2770	597	n/a	281	101	316	114	n/a
2	1500	353	n/a	183	122	170	113	n/a
3	1300	209	n/a	124	95	85	65	n/a
4	1600	198	n/a	137	86	61	38	n/a
5	1650	224	n/a	128	78	96	58	n/a
6	1350	411	n/a	319	236	92	68	n/a
7	1790	453	n/a	245	137	208	116	n/a
8	1500	216	n/a	118	79	98	65	n/a
9	668	82	n/a	42	63	40	60	n/a
10	1450	236	n/a	124	86	112	77	n/a
11	1450	223	n/a	162	112	61	42	n/a
12	950	240	n/a	191	201	49	52	n/a
13	1280	195	n/a	174	136	21	16	n/a
14	1450	684	604	44	30	36	25	5
15	1350	558	471	11	8	76	56	14

n/a: this data is not available as live poles were not recorded during the first survey in the east of Mtai.

**Figure 16.** Cut and naturally fallen poles recorded per hectare by transect in the east of Mtai.

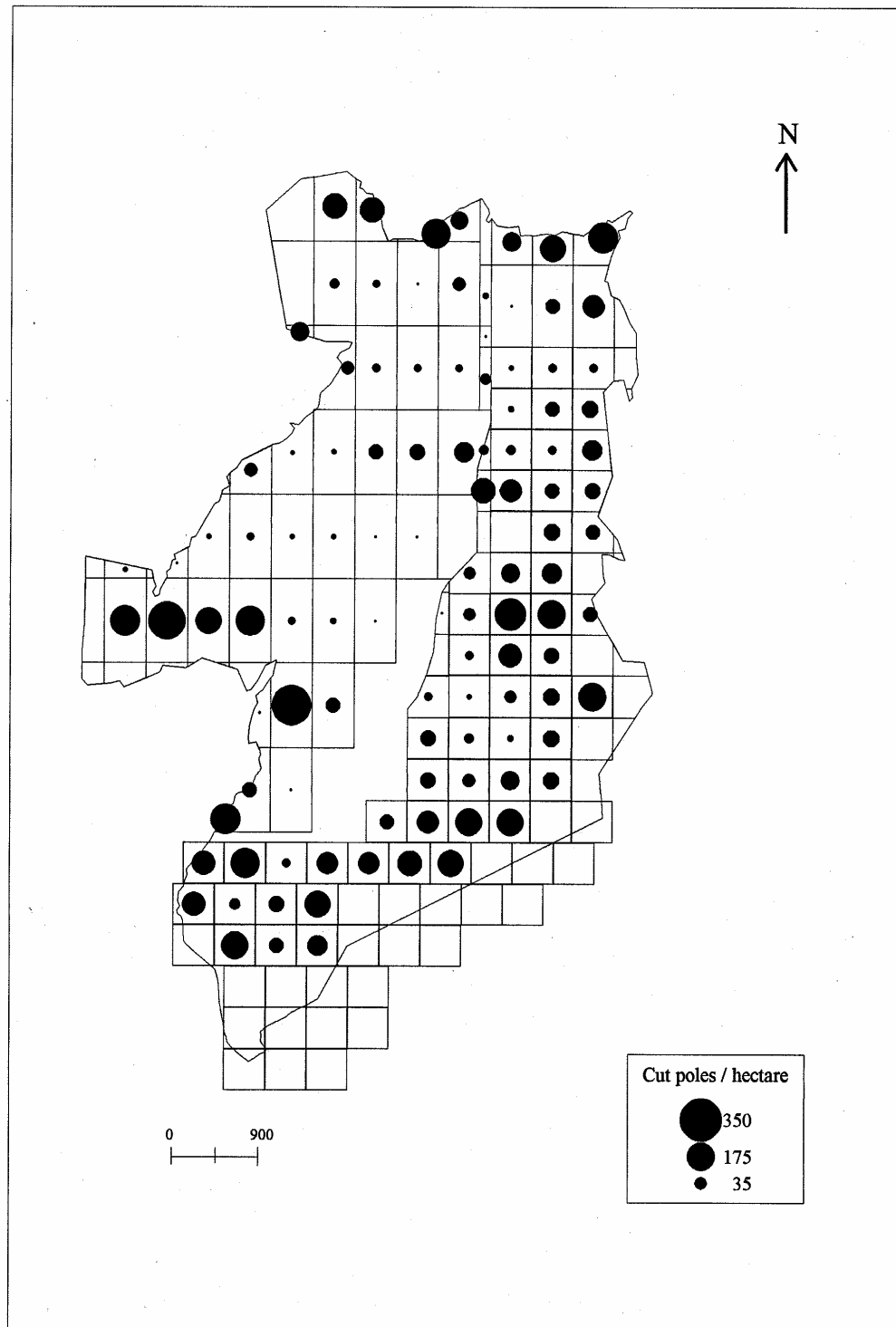


Figure 17. Distribution of pole cutting in the reserve.

Table 15. Disturbance transect results for timber counts in the west of Mtai.

Transect number	Length of transect (m)	Total timber recorded	Live trees	Cut timber	Average cut timber per hectare	Naturally fallen timber	Average fallen timber per hectare	Percentage of trees cut
-1	1150	570	483	8	7	79	69	1.4
0	850	395	334	5	6	56	66	1.3
1	2900	993	803	71	24	119	41	7.2
2	3250	1414	1197	11	3	206	63	0.8
3	2550	897	774	34	13	89	35	3.8
4	2100	639	544	16	8	79	38	2.5
5	1650	436	395	23	14	18	11	5.3
6	1700	528	442	31	18	55	32	5.9

Note: Timber is defined as > 15 cm dbh and 3 m straight trunk.

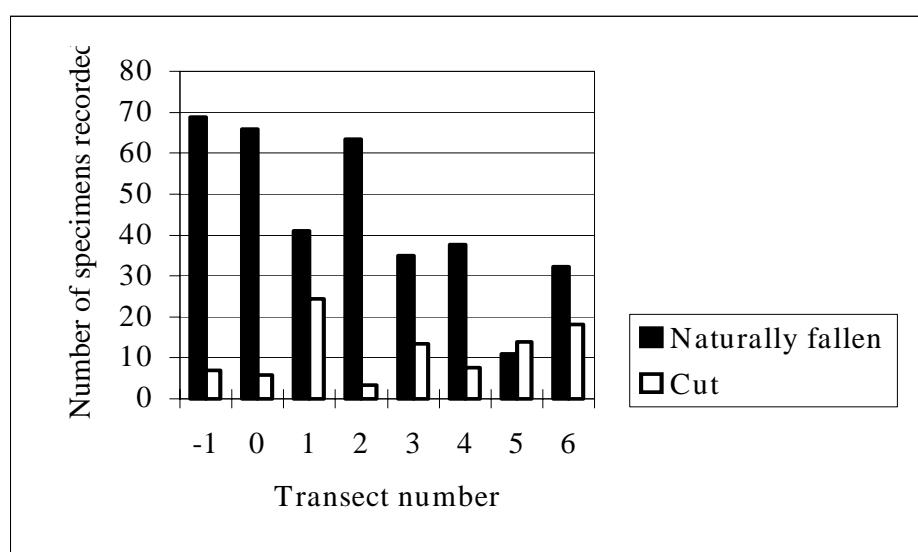
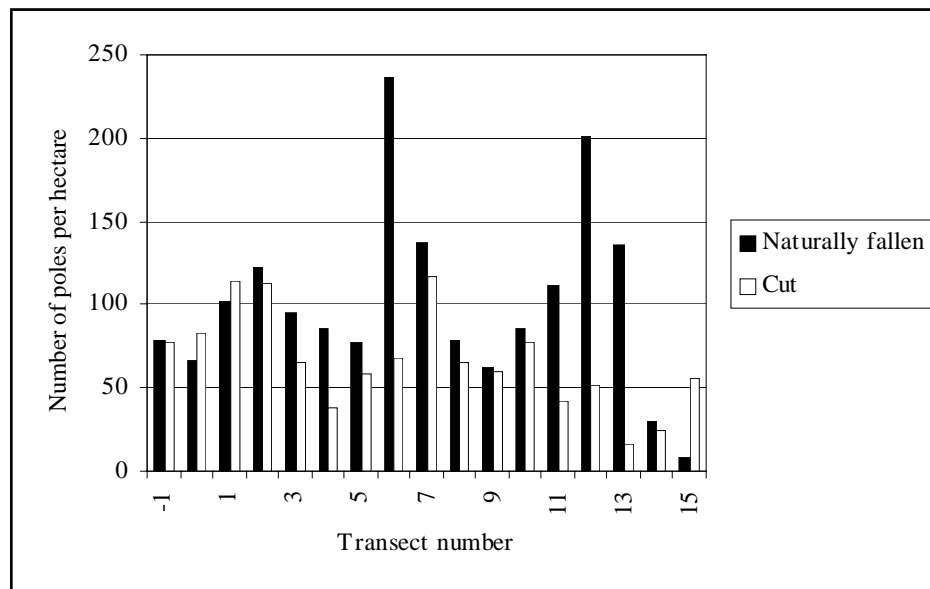
**Figure 18.** Cut and naturally fallen timber recorded per hectare by transect in the west of Mtai.

Table 16. Disturbance transect results for timber counts in the east of Mtai.

Transect number	Length of transect (m)	Total timber recorded	Live trees	Cut timber	Average cut timber per hectare	Naturally fallen timber	Average fallen timber per hectare	Percentage of trees cut
-1	1120	55	n/a	8	7	47	42	n/a
0	1550	26	n/a	9	6	17	11	n/a
1	2770	120	n/a	23	8	97	35	n/a
2	1500	60	n/a	10	7	50	33	n/a
3	1300	27	n/a	8	6	19	15	n/a
4	1600	38	n/a	17	11	21	13	n/a
5	1650	70	n/a	17	10	53	32	n/a
6	1350	88	n/a	12	9	76	56	n/a
7	1790	147	n/a	37	21	110	61	n/a
8	1500	70	n/a	30	20	40	27	n/a
9	668	27	n/a	21	31	6	9	n/a
10	1450	88	n/a	27	19	61	42	n/a
11	1450	49	n/a	11	8	38	26	n/a
12	950	58	n/a	6	6	52	55	n/a
13	1280	56	n/a	3	2	53	41	n/a
14	1450	473	429	5	3	39	27	1.1
15	1350	422	373	34	25	15	11	8.1

n/a: this data is not available as live trees were not recorded during the first survey in the east of Mtai.
 Note: Timber is defined as > 15 cm dbh and 3 m straight trunk.

**Figure 19.** Cut and naturally fallen timbers recorded per hectare by transect in the east of Mtai.

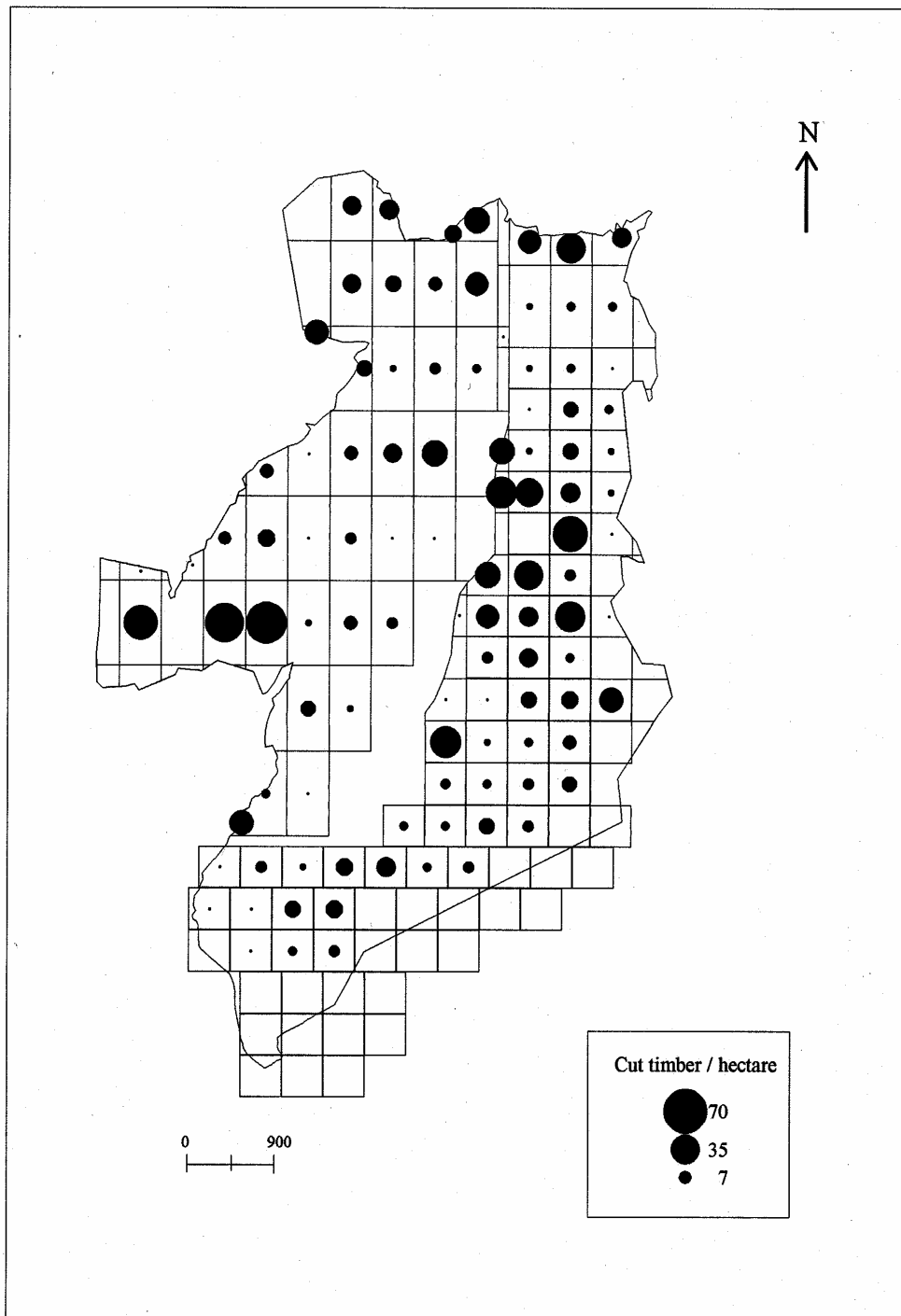


Figure 20. Distribution of timber cutting in the reserve.

Table 17. Frequency of selected human disturbances recorded in the forest in vegetation plots and along disturbance transects.

Disturbance	Number of plots in which disturbance was recorded	Percentage of plots in which disturbance was recorded (n = 99)
Pole cutting	101	102
Timber cutting	92	93
Pitsaws	30	30
Trapping	22	22
Fire	21	21
Abandoned cultivation	14	14
Paths	13	13
Camp fire	2	2
Mining	1	1
Bark Collection	1	1
Settlement	1	1

4.4 Discussion

Mtai Forest Reserve covers an area of 3107 ha with altitudes ranging from 180 m asl to 1016 m asl.

4.4.1 Species richness

In the systematic vegetation plots 2964 trees and shrubs were recorded, representing 223 species from 47 families. Casual observations from outside of the vegetation plots recorded an additional 48 vascular plant species from 35 families including 22 families not recorded in the vegetation plots. In total 271 species of vascular plant from 69 families were recorded.

Of the 99 plots systematically surveyed, 5 (5%) were in submontane forest, 79 (80%) were in lowland forest, one (1%) was in grassland, 13 (13%) were in scrub / thicket and one (1%) was not described.

4.4.2 Species Accumulation Rates

The species accumulation curve rises sharply initially (Figure 4), levelling out after approximately 25 plots. It then rises steeply again after 65 plots. This rapid increase reflects the change in vegetation between the east and west sides of the reserve with the higher plot numbers occurring on the western slopes of the reserve. The curve again flattens out at over 200 species. The levelling out of the species accumulation curve suggests that the majority of tree and shrub species with a potential dbh >10 cm, have been recorded during the survey.

4.4.3 Ecological Type

Forest dependent species, defined as limited to primary forest only, were recorded 1518 times. This represents 51% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve with the highest densities occurring towards the centre of the reserve particularly towards the north-east, lower densities were recorded in the west and south-east of the reserve. The most common forest dependent trees were the near-endemic *Leptonychia usambarensis* and *Funtumia africana*.

Eighteen non-forest species were recorded in 26% of the plots (28 plots). *Melhania velutina* is the most abundant non-forest species. Non-forest species were most abundant in the south-west of the reserve.

4.4.4 Habitat

Although only 10.3% of the forest has been classified as submontane forest, submontane trees accounted for 25% of all trees recorded and 34% of the species. This may be a product of the distribution of the vegetation plots which are slightly clustered around the ridge due to the survey being conducted over two separate

phases. Although 30 trees from six submontane species were recorded in lowland areas, this does not account for the overall skew in the proportion of submontane trees.

4.4.5 Endemic Status

The systematic survey recorded 146 species with widespread distributions and 53 near-endemic species (23%) from 24 families. The near-endemic species account for 979 (29%) of all recorded trees and shrubs in the reserve. Near-endemics are found throughout the reserve except in ten plots. They are particularly abundant in the north-east of the reserve. Of the 99 plots surveyed, 39 (39%) were found to have > 10 near-endemic individuals. The most common near-endemic species in the reserve are *Scorodophloeus fischeri* and *Leptonychia usambarensis*. Of the 53 near-endemic species, 25 are also considered to be forest dependent. Three near-endemics are non-forest species *Dombeya taylorii*, *Premna chrysoclada* and *Premna schliebenii*. Casual observations recorded an additional eight near-endemic species outside of the vegetation plots.

Five tree species endemic to the Usambaras were recorded during the systematic survey. These are: *Cola usambarensis* and *Rinorea scheffleri* found only in the East Usambaras; *Greenwayodendron suaveolens* and *Englerodendron usambarense* found in the East and West Usambaras and *Rytigynia longicaudata* previously thought to be restricted to the West Usambaras. Endemic species are found in seven plots and account for 18 of the individuals recorded or 0.5% of all recorded trees and shrubs in the reserves. In addition one species of the African violet endemic to the East Usambaras *Saintpaulia grotei*; and one species endemic to the East and West Usambaras *S. magungensis* were recorded through casual observations.

4.4.6 Range Extensions

The tree *Rytigynia longicaudata* was previously thought to be endemic to the West Usambara Mountains (Iversen, 1991a). A specimen from this tree is held at the TAFORI herbarium in Lushoto.

4.4.7 Regeneration

Within the regeneration plots 28% of the species found in the main vegetation plots were recorded. Of the endemic species *Englerodendron usambarense* and *Cola usambarensis* were both recorded as regenerating. Three endemic species *Greenwayodendron suaveolens*, *Rytigynia longicaudata* and *Rinorea scheffleri* were not recorded as regenerating.

The four principle timber species found within the reserve *Milicia excelsa*, *Newtonia buchanani*, *Cephalosphaera usambarensis* and *Khaya anthotheca* were all recorded within the regeneration layer.

4.4.8 Disturbance

Timber and poles have been taken throughout the reserve. Signs of pitsawing were observed in at least 30 plots and some were active even during the survey period. For the reserve as a whole, cut poles were found at levels between 0 and 310 per ha. Cut timber occurred at the rate of 0 to 47 trees per ha. Disturbance from pole and timber extraction occurs at a lower rate than the rate of natural tree fall. The highest recorded rates of pole cutting occurred on the western edge of the reserve in plots 83 and 88. High rates were also recorded in the north of the reserve close to Hemsambia Village and in the east close to the path to Maramba.

Fire has affected at least 21 plots. Fires were burning through the western edge of the reserve during the 1997 survey. With the failure of the short rains at the end of 1996, the forest was particularly susceptible to fire. During January – March 1997 many trees, close to the forest edge, were killed by fire. Some of the fires appeared to have been started intentionally in order to flush out animals for hunting.

Trapping for duiker, baboon and cane rats using baited traps was also evident and hunters were encountered close to the ridge on two occasions. A number of mines have been opened up in the west of Mtai, the mines were apparently for rubies and tanzanite. These have now been closed by the EUCAMP (Msoffi pers. comm. 1998).

Recently abandoned agricultural plots were found in the north of the reserve with fruiting banana and mango trees. A path runs along the ridge of the reserve and is used by hunters and wood cutters. The ridge path links with a path running up the eastern slope from the headwaters of the Mizimbazi. Another path runs alongside the Muzi with smaller paths leading to the villages west of the reserve.

Species endemic to the Usambara Mountains were found in plots with below average, average and above average levels of disturbance. *Rinorea scheffleri*, an East Usambara endemic and *Greenwayodredron suaveolens*, an Usambara endemic, were found in plots with above average levels of pole cutting while *Cola usambarensis* was only found in plots with below average levels of pole and timber cutting. Near-endemic trees were similarly found in plots with varying levels of disturbance. Of particular concern is *Polyceratocarpus scheffleri*, a rare submontane tree found in plots 85 and 107. Pole cutting in Plot 85 was high at 190 poles / ha. Timber cutting was similarly high with 60 timbers taken. *Polysphaeria macrantha*, another near endemic species, was found in Plot 75 in a fire-disturbed plot with above average levels of pole and timber cutting.

The invasive species *Maesopsis eminii* was recorded in Plot 105 in the north-east of Mtai. Since its introduction into the area this species has spread rapidly in the Usambara Mountains particularly around Amani where there is concern that it may begin to dominate the forest (Binggeli 1989). In 1997 it was rare in Mtai Forest Reserve.

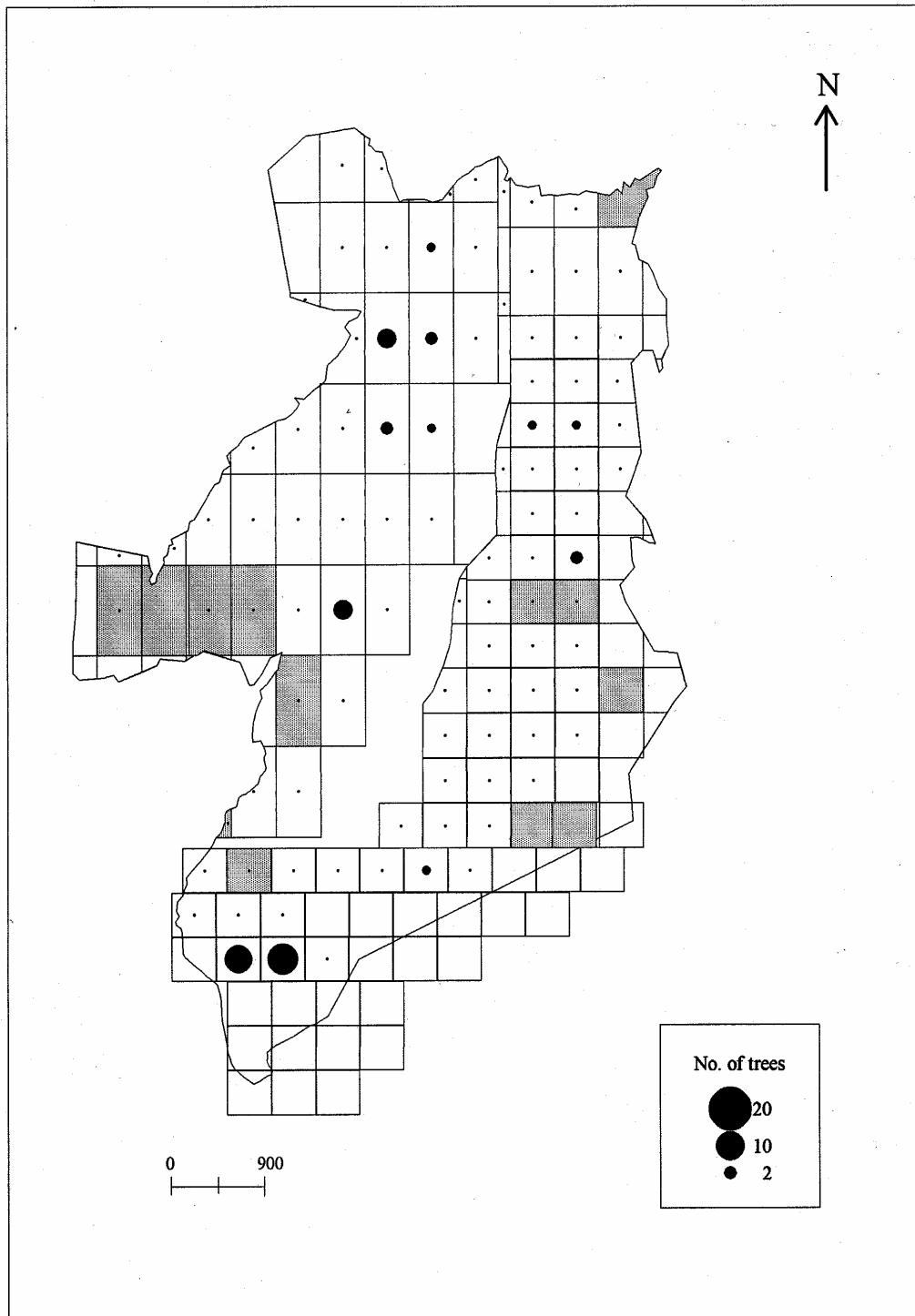


Figure 21. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.

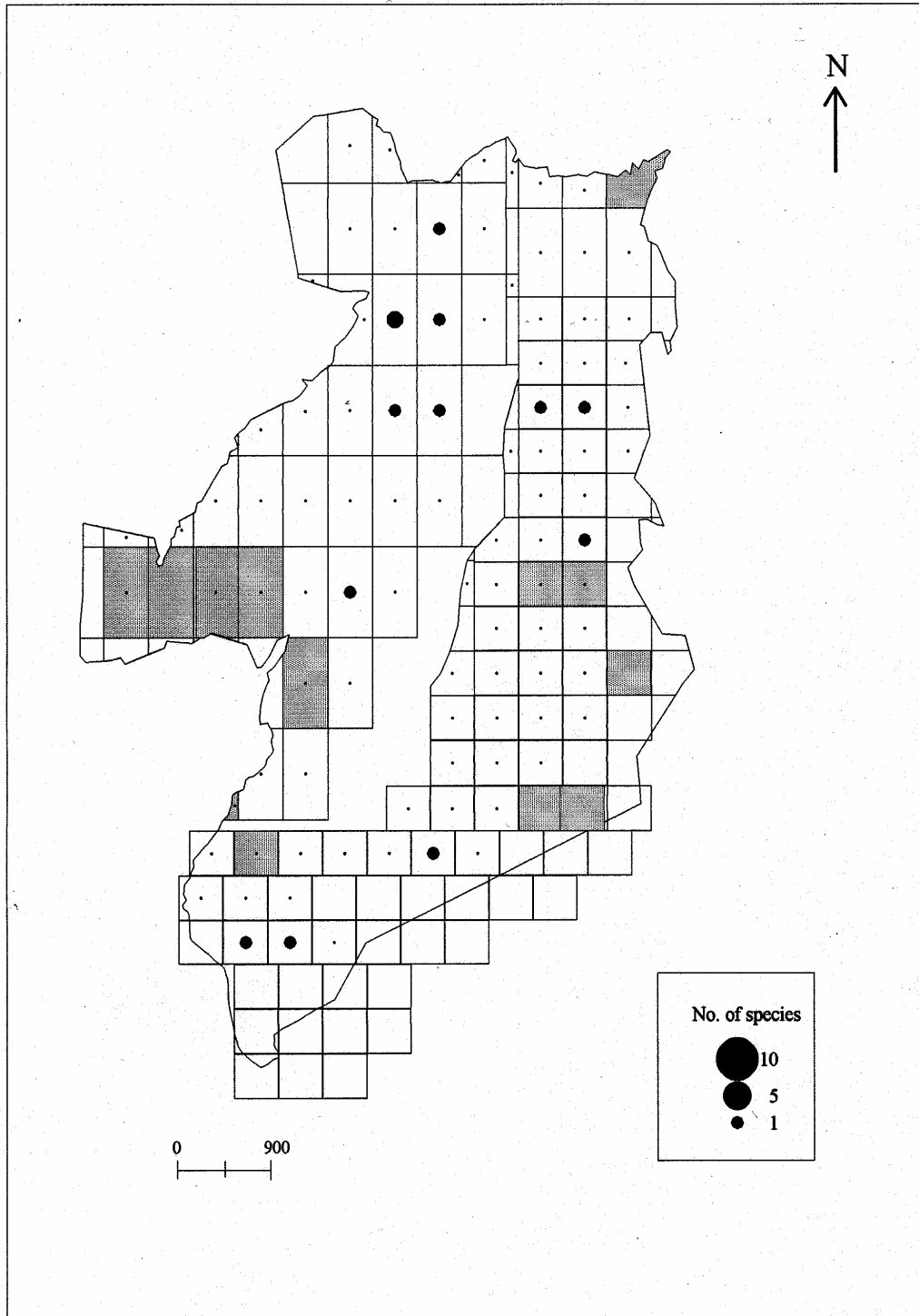


Figure 22. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and endemic.

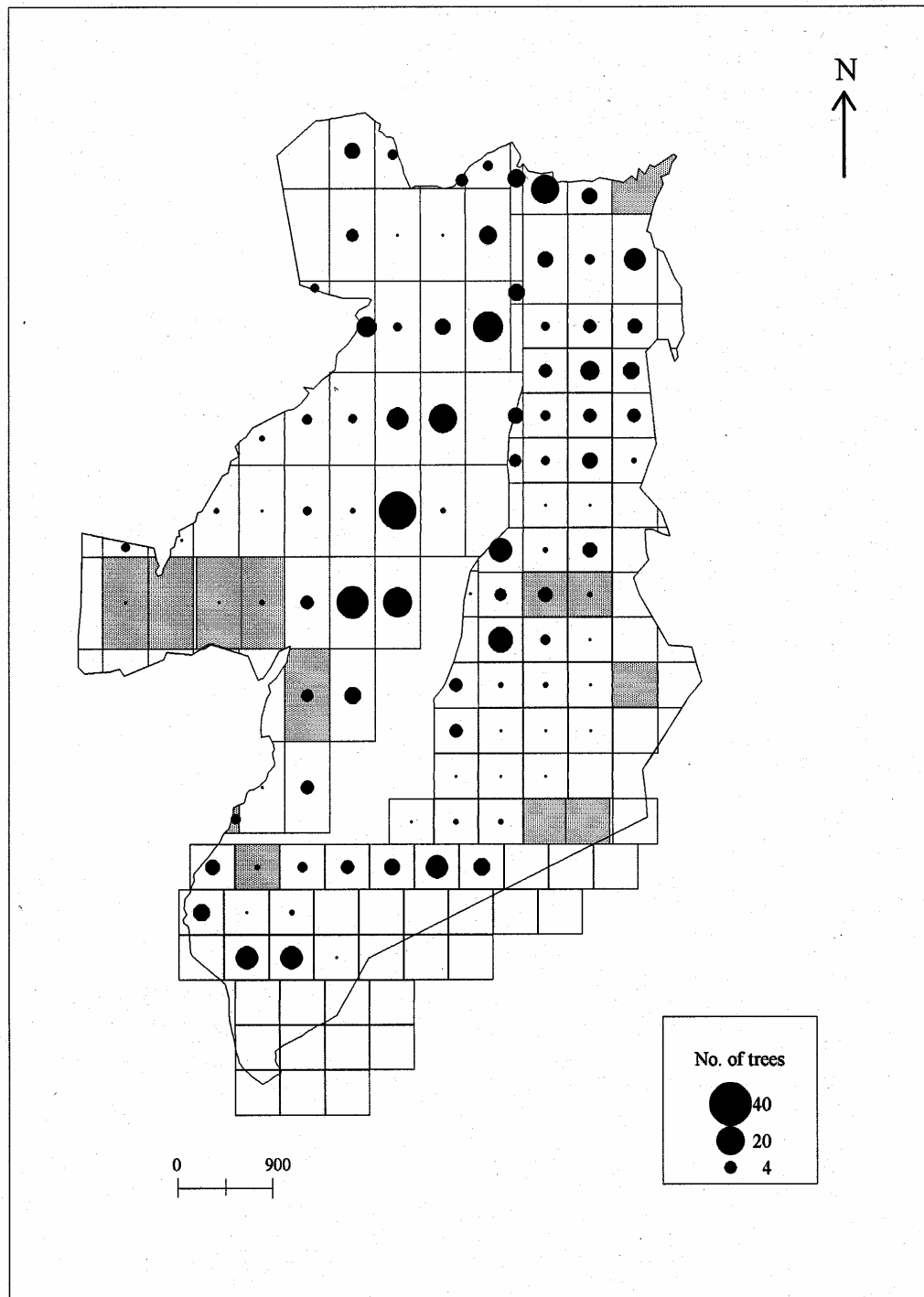


Figure 23. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.

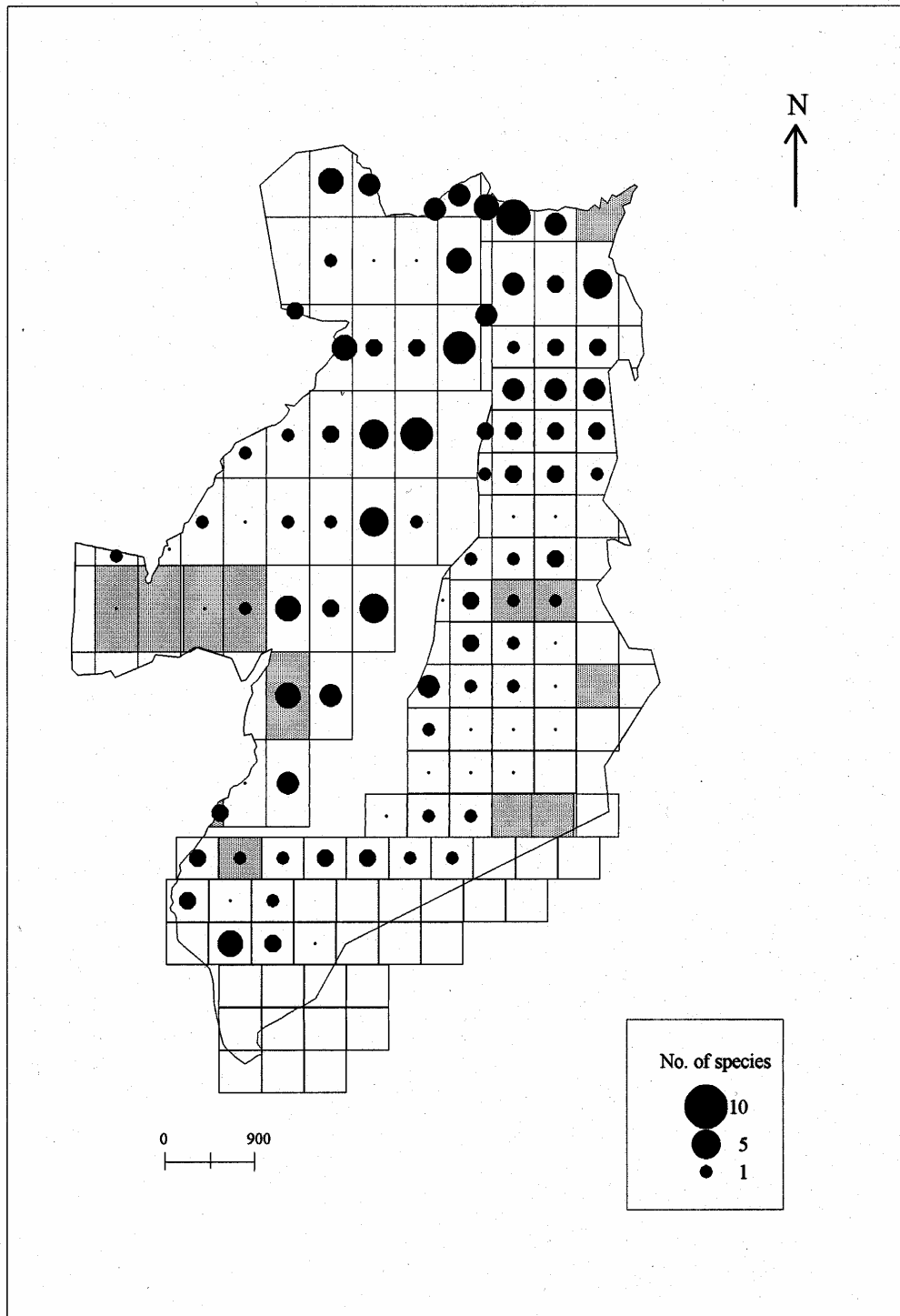


Figure 24. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.

5.0 FAUNA

5.1 Introduction

The faunal biodiversity of Mtai Forest Reserve was studied using systematic and replicable survey methods. An inventory was compiled of mammal, reptile, amphibian and selected invertebrate species. The results of the inventory were analysed to assess the biodiversity value of the reserve.

5.2 Methods

Eight plots were chosen as trapping sites, four in the east and four in the west. In each plot standardised methods were used. These methods are outlined in detail in the FT FRP methodologies report (SEE, 1998). A brief description is presented below. The location of trap sites are presented in Figure 25.

5.2.1 Mammals

Five methods were used to sample the mammal community within Mtai Forest Reserve: (1) snap trap lines, (2) bucket pitfalls, (3) bat netting (4) dung surveys and (5) opportunistic observations. Unless otherwise indicated, specimens were identified by Prof. K. M. Howell or by Dr. D. Kock (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the Frankfurt Zoological Museum.

5.2.1.1 Snap-trap lines

In order to sample the community of rodents, large break-back traps (snap-traps) were used. Typically the traps were set out in three lines of 33 or 34, with traps positioned at least 2m apart. The traps were set each evening and checked early the following morning. Fish, oats and fried coconut rolled in peanut butter were used as bait. Previous forest surveys indicate that these baits are very successful in terms of catch numbers and species diversity (Stanley, *pers. comm.*). Each mammal caught was weighed and measured and detailed habitat notes were recorded. Trapping and biometric data was recorded on standardised data sheets.

5.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consist of three lines of eleven 20l plastic buckets sunk flush to ground level in a linear transect. These were positioned 5m apart. A continuous piece of plastic sheeting ran perpendicular to the ground across the centre of each bucket forming a 'drift fence'. A lip of plastic sheeting was kept on the ground on to which soil and leaf litter was placed. An animal encountering the sheeting was channelled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed for sampling shrews and small mice within the forest. Each mammal captured was weighed and measured. Trapping and biometric information was recorded on standardised data sheets.

5.2.1.3 Bat netting

Bat mist netting was used to collect and study a representative sample of the forest bat community, and also provide data on species' ranges. Mist nets were placed near

potential roost sites and across obvious flight “corridors”, such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed shortly before dawn for 11 nights. Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets.

5.2.1.4 Dung survey

The aim of this study is to provide baseline information on the population size of the reserve’s more cryptic mammals particularly duiker.

The tagged transects are surveyed for dung from border to border of the reserve. The transects are walked by a team of three people. One person surveys 2m on one side of the transect, the other person, 2m on the other side. The third person records the findings.

5.2.1.5 Mammal observations

Other mammals including primates were recorded opportunistically throughout the survey.

5.2.2 Birds

Birds were observed on a casual basis throughout both phases. The list included is a provisional list only as no mist netting was carried out and birds were not surveyed systematically.

5.2.3 Reptiles

The aim of this study was to compile a species list of the reserve’s reptiles. Ground-dwelling reptiles were sampled using bucket pitfall traps (see 5.2.1.2 above). Opportunistic captures were also made by hand, or with a snake stick where necessary. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or Dr. D. Broadley (Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the Natural History Museum of Zimbabwe.

5.2.4 Amphibians

The aim of this study was to compile a species list of the reserve’s amphibians. Ground-dwelling amphibians were sampled using the bucket pitfall method (see 5.2.1.2 above). Opportunistic captures were also made, particularly of tree frogs. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or by Prof. J. Poynton (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the British Natural History Museum.

6.2.5 Invertebrates

Three groups of invertebrates were sampled: (1) butterflies; (2) molluscs and (3) millipedes.

5.2.5.1 Butterflies

The aim of this study was to compile a species list of the reserve's butterflies. Butterflies were sampled using Blendon-style traps set in the upper-, mid- and lower-canopy levels. At each trapping site, ten butterfly traps were set for five nights. Traps were baited with banana or mango. In order to sample a variety of habitats traps were secured at different elevations above the ground and in gaps as well as in undisturbed forest.

In addition sweep netting was used to sample the low-flying butterflies. Two people caught butterflies using sweep nets for one hour after midday.

Taxonomic identifications were provided by Steve Collins. Specimens are deposited at the African Butterfly Research Institute.

5.2.5.2 Millipedes

The aim of this study was to compile a species list of the reserve's millipedes. At each trapping site three sites with representative microhabitats were selected. At each of these sites a 3m x 3m quadrat was established. In this square, the leaf litter and the first 3 cm of soil was searched carefully for millipedes. All millipedes encountered were collected. Taxonomic identifications were not available at the time of publication. Specimens are deposited at the Virginia Museum of Natural History.

5.2.5.3 Molluscs

The aim of this study was to compile a species list of the reserve's molluscs. At each trapping site three sites with representative microhabitats were selected. At each of these sites a 1m x 1m quadrat was established. In this square, the leaf litter and the first 3 cm of soil was searched carefully for molluscs. All molluscs encountered were collected. Unless otherwise indicated, taxonomic identifications were made by Dr. B. Verdcourt (Appendix 2).

5.3 Trapping sites and sampling intensity

Eight trapping sites were established in representative habitats. Table 18 describes the sites and Table 19 summarises the sampling intensity for each site and for each trapping method.

Table 18. Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (metres a.s.l.)	Topography	Slope (degrees)
1	Lowland forest	410	Steep mid-slope	30
7	Lowland forest	710	Gentle mid-slope	20
63	Submontane forest	950	Ridge top	35
63	Submontane forest	1050	Peak	15
69	Submontane forest	950	Ridge	0 - 6
73	Riverine forest	200	Valley floor	0 - 20
96	Riverine forest	420	Valley floor	0 - 12
111	Submontane forest	900	Ridge	0 - 8

Table 19. Sampling intensity by trap night (number of nights x number of traps).*

	Plot 1	Plot 7	Plot 63	Plot 63	Plot 73	Plot 96	Plot 111	Plot 69
Date	July 17-26	July 28 - Aug 6	Aug 7-16	Aug 18 - 27	Jan 17 - 26	Jan 29 - Feb 7	Feb 15 - 24	Mar 2 - 11
large snap traps	987*	990	988	985	990	972	987	992
butterfly traps	0	0	0	0	50	50	50	50
bucket pitfall	33	33	33	33	33	33	33	33
mollusc quadrats**					3	3	3	3
millipede quadrats					3	3	3	3

*Differences in sampling intensity are due to broken or lost equipment, or delay due to weather conditions.

** Molluscs and millipedes were not surveyed during the first survey in 1996.

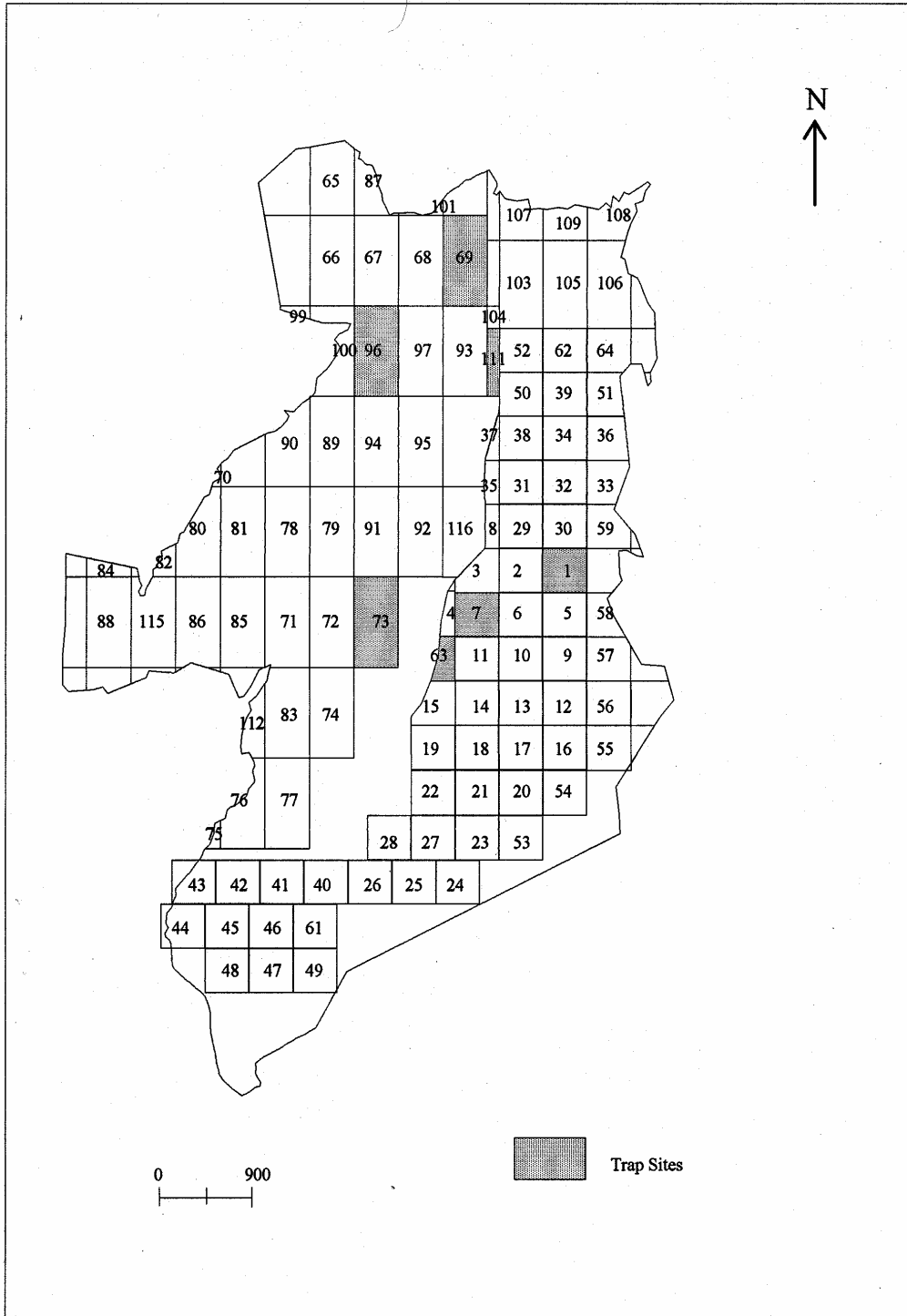


Figure 25. Location of trapping sites.

5.4 Results

5.4.1 Mammals

5.4.1.1 Small mammals (non-bats)

A total of 102 specimens were retained for taxonomic purposes, an additional five animals were identified and released. These represent 12 species from five families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997) Kingdon (1989), Kingdon (1997) and IUCN (1996). Nomenclature names follow Kingdon (1997).

Table 20. Summary of small mammals (non-bats).

Species	Ecol type	Endemic status	IUCN status	Capture location by plot and number collected						Total	
				1	7	63	69	73	96		111
CRICETIDAE											
Lesser pouched rat											
<i>Beamys hindei</i>	f	N	V	2					1	1	4
MURIDAE											
Brush-furred mice											
<i>Lophuromys flavopunctatus</i>											
	f	W			2	1	2			1	6
Soft-furred rats											
<i>Praomys delectorum</i>	F	W		1	1	10	21			4	37
<i>Praomys</i> sp.				1	1	2					4
African wood mice											
<i>Hylomyscus denniae</i>	F	W				8					8
<i>Hylomyscus</i> sp.						1					1
Common mice											
<i>Mus minutoides</i>	f	W		1							1
Narrow-footed woodland mice											
<i>Grammomys dolichurus</i>	f	W				3					3
<i>Grammomys macmillani</i>	O	W		2							2
<i>Grammomys</i> sp.				3						1	4
Black rat											
<i>Rattus rattus</i>	O	W		2							2
MYOXIDAE											
African dormice											
<i>Graphiurus (Claviglis) murinus</i>	f	W				1					1
<i>Graphiurus (Claviglis) parvus</i>	f	W				1					1
<i>Graphiurus</i> sp.										1	1
SCIURIDAE											
Tanganyika mountain squirrel											
<i>Paraxerus lucifer</i>	F	W		1							1
SORICIDAE											
White-toothed shrews											
<i>Crocidura hildegardae</i>	f	W			2	1					3
<i>Crocidura</i> sp.							6	2		11	19
Rodents not yet identified				1	2	4	2				9

KEY TO ABBREVIATIONS FOR TABLE 20 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable

5.4.1.2 Dung survey

Dung from at least ten mammal species was recorded. Duiker dung was most commonly collected between 400 and 550 m a.s.l. Identifications were made based on a reference collection, discussions with local hunters and using Walker (1988). It is difficult to determine the dung of particular duiker species and so the differentiation between *Cephalophus monticola* and *Sylvicapra grimmia* may not be reliable.

Table 21. Abundance of duiker, bushbuck and hyrax dung.

Transect	Transect length	Duiker		Bushbuck		Hyrax	
		Dung sitings	Rate / km	Dung sitings	Rate / km	Dung sitings	Rate / km
-1	1150	0	0	1	0.9	0	0
0	850	0	0	0	0	0	0
1	2900	1	0.3	1	0.3	2	0.7
2	3250	3	0.9	0	0	1	0.3
3	2550	3	1.2	1	0.4	0	0
4	2100	0	0	0	0	1	0.5
5	1650	0	0	0	0	1	0.6
6	1700	0	0	0	0	0	0

Table 22. Summary of dung survey.

Species	Ecological type	Endemic status	Times encountered	Altitudinal range (m)
CERCOPITHECIDAE				
Yellow baboon				
<i>Papio cynocephalus</i>	f	W	1	340
Gentle monkey				
<i>Cercopithecus mitis</i>	f	W	2	320 - 360
MACROSCOLIDIDAE				
Four-toed elephant shrew				
<i>Petrodromus tetradactylus</i>	f	W	4	260 - 600
THRYONOMYIDAE				
Cane rat				
<i>Thryonomys</i> sp.			4	295 - 450
HERPESTIDAE				
Banded mongoose				
<i>Mungos mungo</i>	O	W	1	420
VIVERRIDAE				
African civet				
<i>Civettictis civetta</i>	f	W	6	300 - 545
PROCAVIDAE				
Eastern tree hyrax				
<i>Dendrohyrax validus</i>	f	N	V 6	400 - 860
BOVIDAE				
Bushbuck				
<i>Tragelaphus scriptus</i>	f	W	3	260 - 550
Bush duiker				
<i>Sylvicapra grimmia</i>	O	W	2	490 - 640
Blue duiker				
<i>Cephalophus monticola</i>	f	W	2	400
Unidentifiable duiker			4	400 - 730

KEY TO ABBREVIATIONS FOR TABLE 22 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable

5.4.1.3 Mammal observations

A total of 14 species from 11 families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), Kingdon (1974), Kingdon (1989), Kingdon (1997) and IUCN (1996).

Table 23. Summary of mammal observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation location by plot
COLOBIDAE					
Angola pied colobus					
<i>Colobus angolensis</i>	definite	F	W		1, 75
CERCOPITHECIDAE					
Yellow baboon					
<i>Papio cynocephalus</i>	definite	f	W		73
Vervet monkey					
<i>Cercopithecus aethiops</i>	definite	f	W		58
Gentle monkey					
<i>Cercopithecus mitis</i>	definite	f	W		Many
GALAGONIDAE					
Small-eared galago					
<i>Otolemur garnetti</i>	definite	f	W		83, 111
SCIURIDAE					
Red-bellied coast squirrel					
<i>Paraxerus p. palliatus</i>	probable	F	W		79
HERPESTIDAE					
Marsh mongoose					
<i>Atilax paludinosus</i>	probable	f	W		UK
Banded mongoose					
<i>Mungos mungo</i>	probable	O	W		73
VIVERRIDAE					
Blotched genet					
<i>Genetta tigrina</i>	probable	f	W		0
FELIDAE					
Leopard					
<i>Panthera pardus</i> ¹	probable	f	W		0
PROCAVIDAE					
Eastern tree hyrax					
<i>Dendrohyrax validus</i>	definite	f	W	V	Transect 7, 98, Frequently heard: 111, 51
BOVIDAE					
Blue duiker					
<i>Cephalophus monticola</i>	probable	F	W		111, 72
CRICETIDAE					
Giant pouched rat					
<i>Cricetomys gambianus</i>	probable	O	W		111
MACROSCOLIDIDAE					
Zanj elephant shrew					
<i>Rhynchocyon petersi</i>	definite	F	N	EN	50, 111

KEY TO ABBREVIATIONS FOR TABLE 23 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and

<ul style="list-style-type: none"> • O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge. <p><u>Endemic status:</u></p> <ul style="list-style-type: none"> • N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains; • W - Widespread distribution. <p><u>IUCN status:</u></p> <ul style="list-style-type: none"> • V - Vulnerable • R - Rare <p>OR: Refers to observations outside but in proximity to the reserve to be considered associated to it. Certainty: Indicates the probability of the correctness of the identity of the species observed; Definite: Can be regarded as occurring in the reserve. Probable: Identification is likely but requires confirmation before placing on the reserve's species list.</p>

Table 24. Ranges of near endemic mammal species recorded.

Species	Range
<i>Beamys hindei</i>	Coastal forests in N.E. and E. Tanzania, also S.E. Kenya.
<i>Dendrohyrax validus</i>	E. Tanzania, Kilimanjaro, Mt. Meru, Usambara, Uluguru and Pare Mountains, Pemba Island, Zanzibar and S. Kenya.

¹Leopard, *Panthera pardus* has not been observed in the area for at least ten years due to pressure from hunting (Johansson, pers. comm.). Two probable sightings were made of leopard although both observations were from outside the reserve, a kill was observed in a tree suggesting that leopard is also found within the reserve.

5.4.1.4 Bats

A total of 20 specimens were retained for taxonomic purposes. These represent 13 species from four families. Ecological type and endemic status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (1996), Howell (1993) and Kingdon (1974). Nomenclature follows Kingdon (1997).

Table 25. Summary of bats for Mtai East.

Species	Common name	Ecological type	Endemic status	Number collected
PTEROPODIDAE				
<i>Rousettus aegyptiacus</i> spp. <i>leachi</i>	Egyptian rousette bat	f	W	2
<i>Epomophorus wahlbergi</i>	Epauletted fruit bat	F	W	3
<i>Epomophorus anurus</i>	Epauletted fruit bat	f	W	1
RHINOLOPHIDAE				
<i>Rhinolophus hildebrandti</i>	Horseshoe bat	f	W	1
<i>Rhinolophus deckenii</i>	Horseshoe bat	f	W	5
<i>Rhinolophus eloquens</i>	Horseshoe bat		W	1
<i>Rhinolophus landeri lobatus</i>	Horseshoe bat	f	W	1
HIPPOSIDERIDAE				
<i>Hipposideros ruber</i>	Leaf-nosed bat	f	W	1
<i>Triaenops persicus afer</i>	Persian leaf-nosed bat	f	W	2
VESPERTILIONIDAE				
<i>Eptesicus capensis</i>	Serotine bat	f	W	1
<i>Eptesicus rendalli</i>	Serotine bat	O	W	1
<i>Scotophilus nucella</i>	House bat	f	W	1
<i>Miniopterus fraterculus</i>	Long-fingered bat		W	1

KEY TO ABBREVIATIONS FOR TABLE 25 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types.
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- W - Widespread distribution.

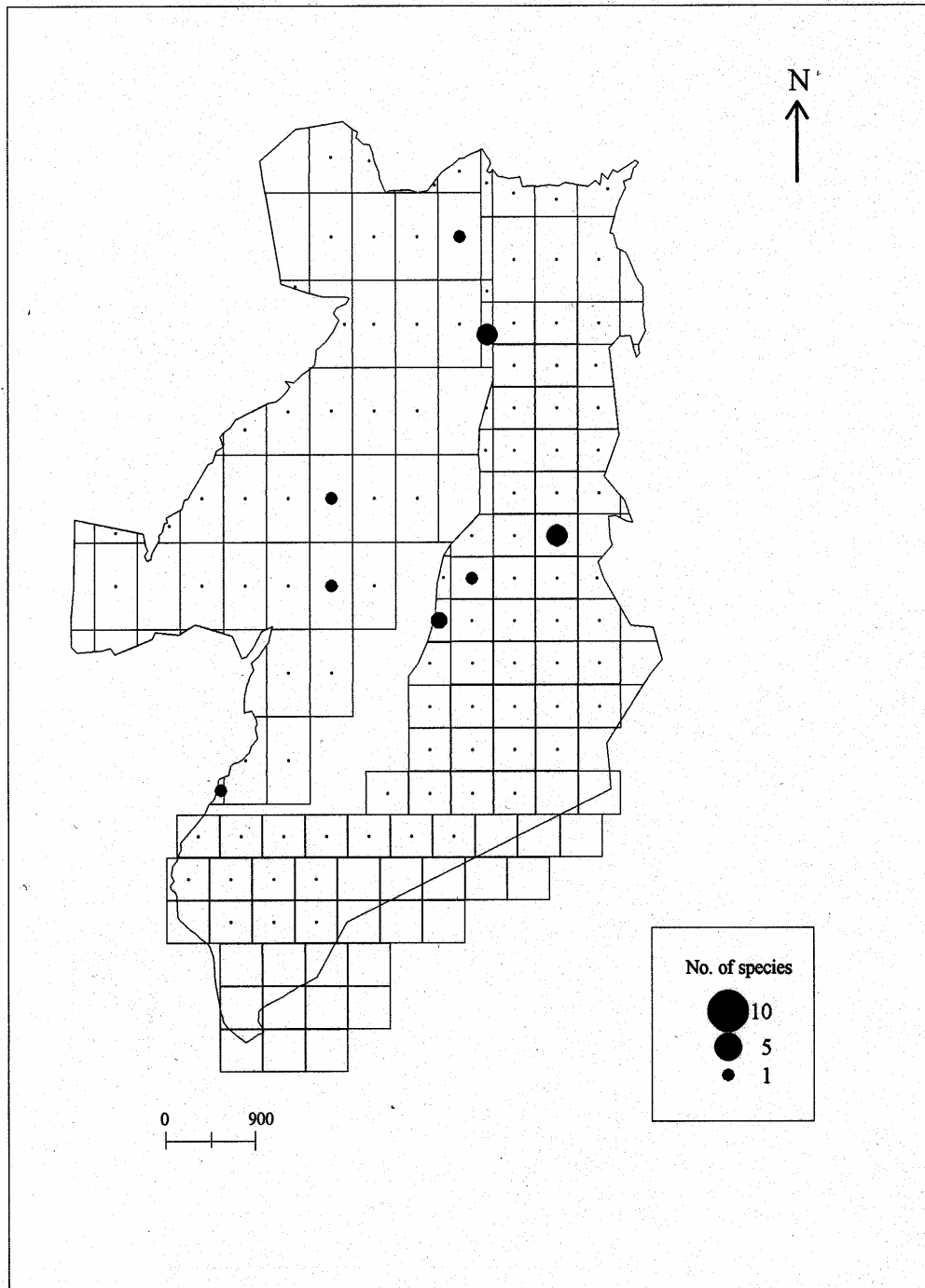


Figure 26. Distribution of forest dependent mammal species.

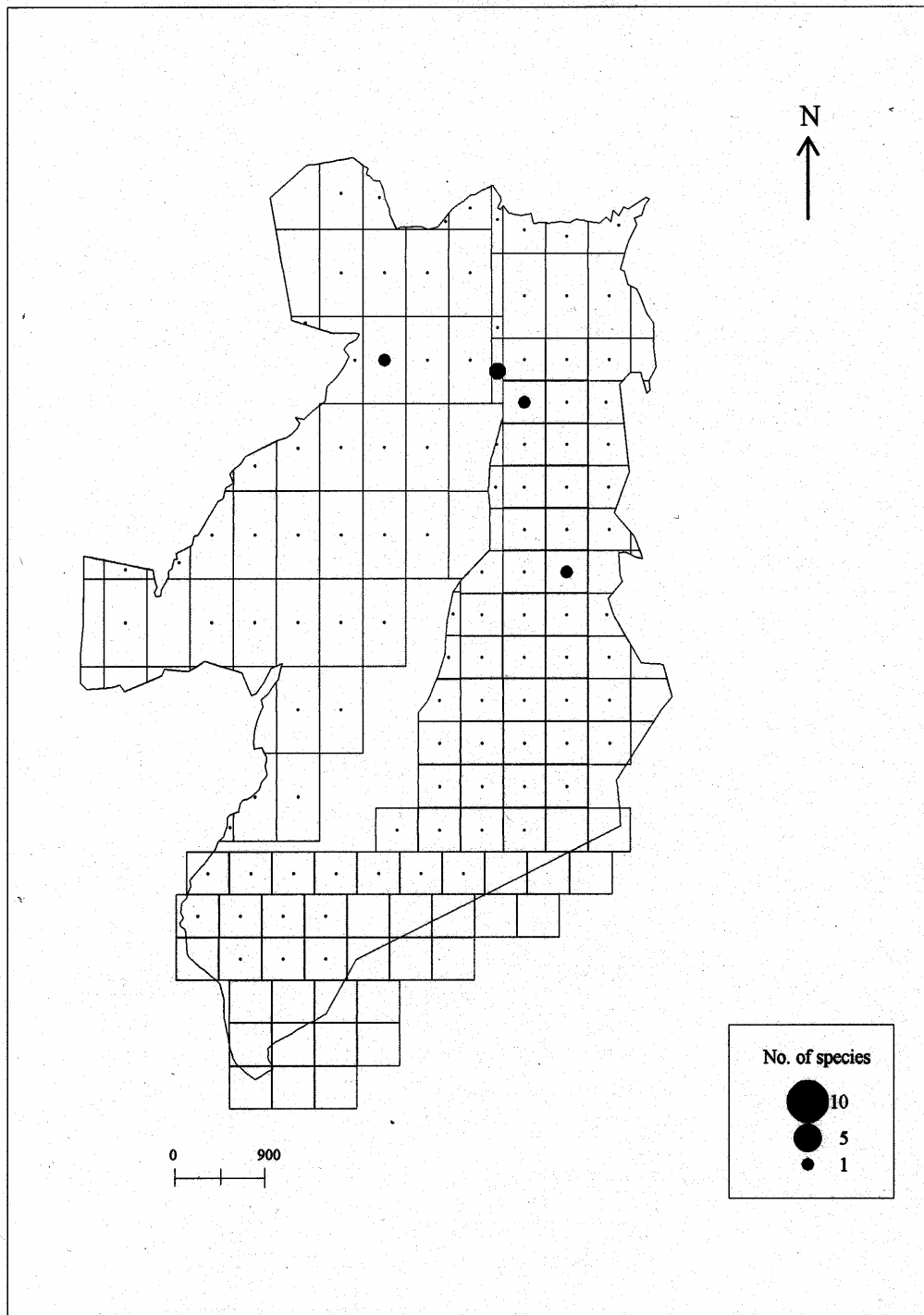


Figure 27. Distribution of near-endemic mammal species.

5.4.2 Birds

A total of 94 species from 38 families were recorded during the surveys. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1997) IUCN (1996) and Zimmerman *et al.* (1996). Nomenclature follows Zimmerman *et al.* (1996).

Table 26. Summary of birds.

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
ACCIPITRIDAE					
<i>Accipiter minullus</i>	Little sparrowhawk	F	W	LC	II
<i>Aquila rapax</i>	Tawny eagle	O	W	LC	II
<i>Buteo augur</i>	Augur buzzard	O	W	LC	II
<i>Circaetus cinereus</i>	Brown snake eagle	O	W	LC	II
<i>Circaetus fasciolatus</i>	Sothorn banded snake eagle	F	W	LC	II
<i>Gypohierax angolensis</i>	Palm-nut vulture	f	W	LC	II
<i>Kaupifalco monogrammicus</i>	Lizard buzzard	O	W	LC	II
<i>Lophaetus occipitalis</i>	Long-crested eagle	f	W	LC	II
<i>Polyboroides typus</i>	African harrier hawk	f	W	LC	II
<i>Stephanoaetus coronatus</i>	African crowned eagle	f	W	LC	II
NUMIDIDAE					
<i>Guttera pucherani</i>	Crested guineafowl	f	W		
SCOLOPACIDAE					
<i>Tringa glareola</i>	Wood sandpiper	f	W		
COLUMBIDAE					
<i>Columba delegorguei</i>	Eastern bronze naped pigeon	F	W		
<i>Streptopelia semitorquata</i>	Red-eyed dove	f	W		
MUSOPHAGIDAE					
<i>Tauraco fischeri</i>	Fischer's turaco	f	W	NT	II
CUCULIDAE					
<i>Ceuthmochares aereus</i>	Yellowbill	f	W		
<i>Centropus superciliosus</i>	White-browed coucal	O	W		
STRIGIDAE					
<i>Strix woodfordii</i>	African wood owl	f	W		
APODIDAE					
<i>Apus affinis</i>	Little swift	O	W		
<i>Cypsiurus parvus</i>	African palm swift	O	W		
COLIIDAE					
<i>Colius striatus</i>	Speckled mousebird	O	W		
TROGONIDAE					
<i>Apaloderma narina</i>	Narina trogon	f	W		
ALCEDINIDAE					
<i>Alcedo cristata</i>	Malachite kingfisher	O	W		
<i>Halcyon albiventris</i>	Brown-hooded kingfisher	f	W		
PHOENICULIDAE					
<i>Phoeniculus purpureus</i>	Green wood-hoopoe	f	W		
BUCEROTIDAE					
<i>Bycanistes brevis</i>	Silvery-cheeked hornbill	f	W		
<i>Bycanistes bucinator</i>	Trumpeter hornbill	f	W		
<i>Tockus alboterminatus</i>	Crowned hornbill	f	W		

Table 26. Cont.

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
CAPITONIDAE					
<i>Stactolaema leucotis</i>	White-eared barbet	f	W		
<i>Stactolaema olivacea</i>	Green barbet	F	W	LC	
INDICATORIDAE					
<i>Indicator variegatus</i>	Scaly-throated honeyguide	f	W		
PICIDAE					
<i>Campethera mombassica</i>	Mombasa woodpecker	f	W		
<i>Campethera cailliautii</i>	Green-backed woodpecker	f	W		
EURYLAIMIDAE					
<i>Smithornis capensis</i>	African broadbill	F	W	LC	
MOTACILLIDAE					
<i>Motacilla clara</i>	Mountain wagtail	f	W		
HIRUNDINIDAE					
<i>Psalidoprocne holomelas</i>	Black saw-wing	f	W		
<i>Hirundo abyssinica</i>	Lesser striped swallow	f	W		
<i>Hirundo fuligula</i>	Rock martin	O	W		
<i>Hirundo rustica</i>	Barn swallow	O	W		
PYCNONOTIDAE					
<i>Andropadus masukuensis</i>	Shelley's greenbul	F	W	LC or NT in TZ	
<i>Andropadus milanjensis</i>	Stripe-cheeked greenbul	F	W		
<i>Andropadus virens</i>	Little greenbul	f	W		
<i>Chlorocichla flaviventris</i>	Yellow-bellied greenbul	f	W		
<i>Nicator gularis</i>	Eastern nicator	f	W		
<i>Phyllastrephus debilis</i>	Tiny greenbul	F	W		
<i>Phyllastrephus fischeri</i>	Fischer's greenbul	f	W	LC or NT in TZ	
<i>Pycnonotus barbatus</i>	Common bulbul	f	W		
TIMALIIDAE					
<i>Turdoides squamulatus</i>	Scaly babbler	f	W		
TURDIDAE					
<i>Cossypha natalensis</i>	Red-capped robin-chat	f	W		
<i>Neocossyphus rufus</i>	Red-tailed ant thrush	f	W		
<i>Sheppardia gunningi</i>	East coast akalat	F	W	V	
MUSCICAPIDAE					
<i>Muscicapa caerulescens</i>	Ashy flycatcher	f	W		
SYLVIIDAE					
<i>Apalis flavida</i>	Yellow-breasted apalis	f	W		
<i>Apalis melanocephala</i>	Black-headed apalis	F	W		
<i>Prinia subflava</i>	Tawny-flanked prinia	O	W		
MONARCHIDAE					
<i>Erythrocerus holochlorus</i>	Little yellow flycatcher	f	W		
<i>Terpsiphone viridis</i>	African paradise flycatcher	f	W		
<i>Trochocercus cyanomelas</i>	Blue-mantled crested flycatcher	F	W		
PLATYSTEIRIDAE					
<i>Batis mixta</i>	Forest batis	f	W		
<i>Bias musicus</i>	Black-and-white flycatcher	F	W		
<i>Platysteira peltata</i>	Black-throated wattle-eye	f	W		
PRIONOPIDAE					
<i>Prionops retzii</i>	Retz's helmet-shrike	f	W		
<i>Prionops scopifrons</i>	Chestnut-fronted helmet-shrike	f	W		

Table 26. Cont.

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
MALACONOTIDAE					
<i>Dryoscopus cubla</i>	Black-backed puffback	f	W		
<i>Laniarius aethiopicus</i>	Tropical boubou	f	W		
<i>Malaconotus nigrifrons</i>	Black-fronted bush-shrike	F	W		
<i>Tchagra australis</i>	Brown-crowned tchagra	O	W		
<i>Tchagra minuta</i>	Marsh tchagra	O	W		
CAMPEPHAGIDAE					
<i>Campephaga flava</i>	Black cuckoo-shrike	f	W		
<i>Coracina caesia</i>	Grey cuckoo-shrike	F	W	LC	
DICRURIDAE					
<i>Dicrurus adsimilis</i>	Comon drongo	f	W		
<i>Dicrurus ludwigii</i>	Square-tailed drongo	f	W		
ORIOOLIDAE					
<i>Oriolus auratus</i>	African golden oriole	f	W		
<i>Oriolus chlorocephalus</i>	Green-headed oriole	F	W		
CORVIDAE					
<i>Corvus albus</i>	Pied crow	O	W		
<i>Corvus albicollis</i>	White-naped raven	O	W		
STURNIDAE					
<i>Lamprotornis corruscus</i>	Black-bellied starling	f	W		
<i>Onychognathus morio</i>	Red-winged starling	O	W		
<i>Onychognathus walleri</i>	Waller's starling	F	W		
<i>Poeoptera kenricki</i>	Kenrick's starling	F	W	LC or NT in TZ	
NECTARINIIDAE					
<i>Anthreptes collaris</i>	Collared sunbird	f	W		
<i>Anthreptes neglectus</i>	Uluguru violet-backed sunbird	F	W		
<i>Anthreptes pallidigaster</i>	Amani sunbird	F	N	NT	
<i>Anthreptes reichenowi</i>	Plain-backed sunbird	F	W	NT	
<i>Anthreptes rubritorques</i>	Banded green sunbird	F	N	VU	
<i>Nectarinia olivacea</i>	Olive sunbird	f	W		
<i>Nectarinia senegalensis</i>	Scarlet-chested sunbird	f	W		
<i>Nectarinia venusta</i>	Variable sunbird	f	W		
PLOCEIDAE					
<i>Ploceus bicolor</i>	Dark-backed weaver	f	W		
<i>Ploceus cucullatus</i>	Black-headed weaver	O	W		
ESTRILDIDAE					
<i>Estrilda astrild</i>	Common waxbill	O	W		
<i>Hypargos niveoguttatus</i>	Peter's twinspot	f	W		
<i>Lonchura bicolor</i>	Black-and-white mannikin	O	W		
FRINGILLIDAE					
<i>Serinus mozambicus</i>	Yellow-fronted canary	O	W		
EMBERIZIDAE					
<i>Emberiza cabanisi</i>	Cabinis's bunting	O	W		

KEY TO ABBREVIATIONS FOR TABLE 26 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;

- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
 - W - Widespread distribution.
- IUCN status:
- E - Endangered
 - V - Vulnerable
 - NT - Near-threatened
 - LC - Least concern

Table 27. Ranges of near-endemic bird species recorded (Zimmerman, 1996).

Near-endemic Species	Range
Amani sunbird	
<i>Anthreptes pallidigaster</i>	E. Usambara Mountains, Sokoke Forest
Banded green sunbird	
<i>Anthreptes rubritorques</i>	E and W Usambara, Nguru and Uluguru Mountains

5.4.3 Reptiles

A total of 113 specimens were retained for taxonomic purposes and two specimens were observed and released. These represent 33 species from 10 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (1996), Broadley and Howell (unpubl.); Howell (1993); and Branch (1994). Nomenclature follows Broadley and Howell (1991).

Table 28. Summary of reptiles

Species	Ecol. type	End. status	IUCN status	Capture location and number collected							Plots with one specimen	Total
				39	63	69	73	96	111	O R		
TESTUDINIDAE												
South-eastern hinge-back tortoise												
<i>Kinixys belliana</i>	f	W									1	1
CHAMAELEONIDAE												
Eastern Usambara two-horned chameleon												
<i>Chamaeleo f. fischeri</i>	F	N CITES II	V			1		1				2
Usambara soft-horned chameleon												
<i>Chamaeleo tenue</i>	F	N CITES II	V				1			1		2
Rosette-nosed chameleon												
<i>Chamaeleo spinosus</i>	F	E CITES II	E			1						1
<i>Chamaeleo</i> sp.											100	1
Usambara three-horned chameleon												
<i>Chamaeleo (Trioceros) deremensis</i>	F	N CITES II	E					1				1
Bearded pigmy-chameleon												
<i>Rhampholeon brevicaudatus</i>	F	N	V					2				2
Kenya pigmy-chameleon												
<i>Rhampholeon k. kerstenii</i>	O	W	LC							1		1
GEKKONIDAE												
Usambara forest gecko												
<i>Cnemaspis africana</i>	F	W	NT			6		3	4		93	14
Uluguru forest gecko												
<i>Cnemaspis barbouri</i>	F	N	EN					4			76	5
<i>Cnemaspis</i> sp.						2						2
<i>Lygodactylus kimhowelli</i>	F	N	EN							1		1

Table 28 cont.

Species	Ecol type	End. status	IUCN status	Capture location and number collected							Total	
				39	63	69	73	96	111	O R		Plots with one specimen
GEKKONIDAE cont.												
Yellow-headed dwarf gecko												
<i>Lygodactylus l.</i>		W	LC								57	1
<i>Luteopicturatus</i>												
Tropical house gecko												
<i>Hemidactylus mabouia</i>	f	W									1,7,76,85	5
Baobab gecko												
<i>Hemidactylus platycephalus</i>	f	W							1			1
SCINCIDAE												
Speckle-lipped snake												
<i>Mabuya maculilabris</i>	f	W				4	1	1	1			7
Peters' writing skink												
<i>Lygosoma afrom</i>	f	W			1							1
Kilimanjaro five-toed skink												
<i>Leptosiaphos kilimensis</i>	F	W	V	3	7		4	11			92	26
CORDYLIDAE												
Southern tawny plated-lizard												
<i>Gerrhosaurus m. major</i>	f	W				1						1
SERPENTES												
LEPTOTYPHLOPIDAE												
Merker's worm-snake												
<i>Leptotyphlops scutifrons merkeri</i>	f	W	LC						1			1
VIPERIDAE												
Eastern gaboon viper												
<i>Bitis gabonica</i>	F	W									51,71,77	3
ELAPIDAE												
Usambara garter-snake												
<i>Elapsoidea nigra</i>	F	N	V		1				2		1	4
COLUBRIDAE												
Brown house snake												
<i>Lamprophis capensis</i>	f	W				1						1
Usambara wolf-snake												
<i>Lycophidion capense loveridgei</i>	F	W				1			1			2
Usambara centipede-eater												
<i>Aparallactus wernerii</i>	F	N	V			1		2			7	4
Usambara forest-snake												
<i>Buhoma vauerocegae</i>	F	N	V	2		1		2			101	6
<i>Buhoma</i> sp.						1						1
Olive marsh-snake												
<i>Natriciteres olivacea</i>	f	W				1						1

Table 28. Cont.

Species	Ecol. type	End. status	IUCN status	Capture location and number collected							Total		
				39	63	69	73	96	111	O R		Plots with one specimen	
East African shovel-snout <i>Prosymna ambigua stuhlmannii</i>	f	W			1								1
Half-banded shovel-snout <i>Prosymna semifasciata</i>	F	E	CR					1					1
Spotted bush-snake <i>Philothamnus punctatus</i>	f	W										1	1
Tornier's cat snake <i>Crotaphopeltis tornieri</i>	F	W	V				1					1	2
Mozambique vine-snake <i>Thelotornis capensis mossambicanus</i>	f	W						3				79	4

Table 29. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation location
VARANIDAE				
Nile monitor <i>Varanus niloticus</i>	definite	f	W (CITES II)	73
ELAPIDAE				
Forest cobra <i>Naja melanoleuca</i>	definite	f	W	73

KEY TO ABBREVIATIONS FOR TABLE 28 & 29 (Definitions based on those described in Section 1.2).

Ecological type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- E - Endangered
- V - Vulnerable
- CR - Critically Endangered
- LC - Least concern

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.

? - Insufficient data

UK - Unknown capture location.

* In cases where the plot number is unknown, the altitude in metres is given. Each altitude represents one specimen captured.

Certainty: Indicates the probability of the correctness of the identity of the species observed;

Definite: Can be regarded as occurring in the reserve.

Probable: Identification is likely but requires further information before being considered on the reserve's species list.

Table 30. Range of endemic and near-endemic reptile species recorded (Howell, 1993).

Endemic species	Range
<i>Chamaeleo spinosus</i>	Usambara Mountains
<i>Prosymna semifasciata</i>	East Usambara Mountains
Near-endemic species	Range
<i>Chamaeleo fischeri fischeri</i>	East Usambara and Nguru Mountains
<i>Chamaeleo tenue</i>	Usambara Mountains, Shimba Hills
<i>Chamaeleo deremensis</i>	Usambara and Nguru Mountains
<i>Rhampholeon brevicaudatus</i>	East Usambara; Uluguru and Uzungwa Mountains, coastal forest
<i>Cnemaspis barbouri</i>	East Usambara and Uluguru Mountains
<i>Lygodactylus kimhowelli</i>	Amboni Caves and East Usambara Mountains
<i>Aparallactus werneri</i>	East Usambara; West Usambara; Uluguru Mountains; coastal forest
<i>Elapsoidea nigra</i>	Usambara Mountains, Magrotto and Uluguru Mountains
<i>Buhome vauerocegae</i>	Usambara Mountains, Magrotto, Uluguru Mountains

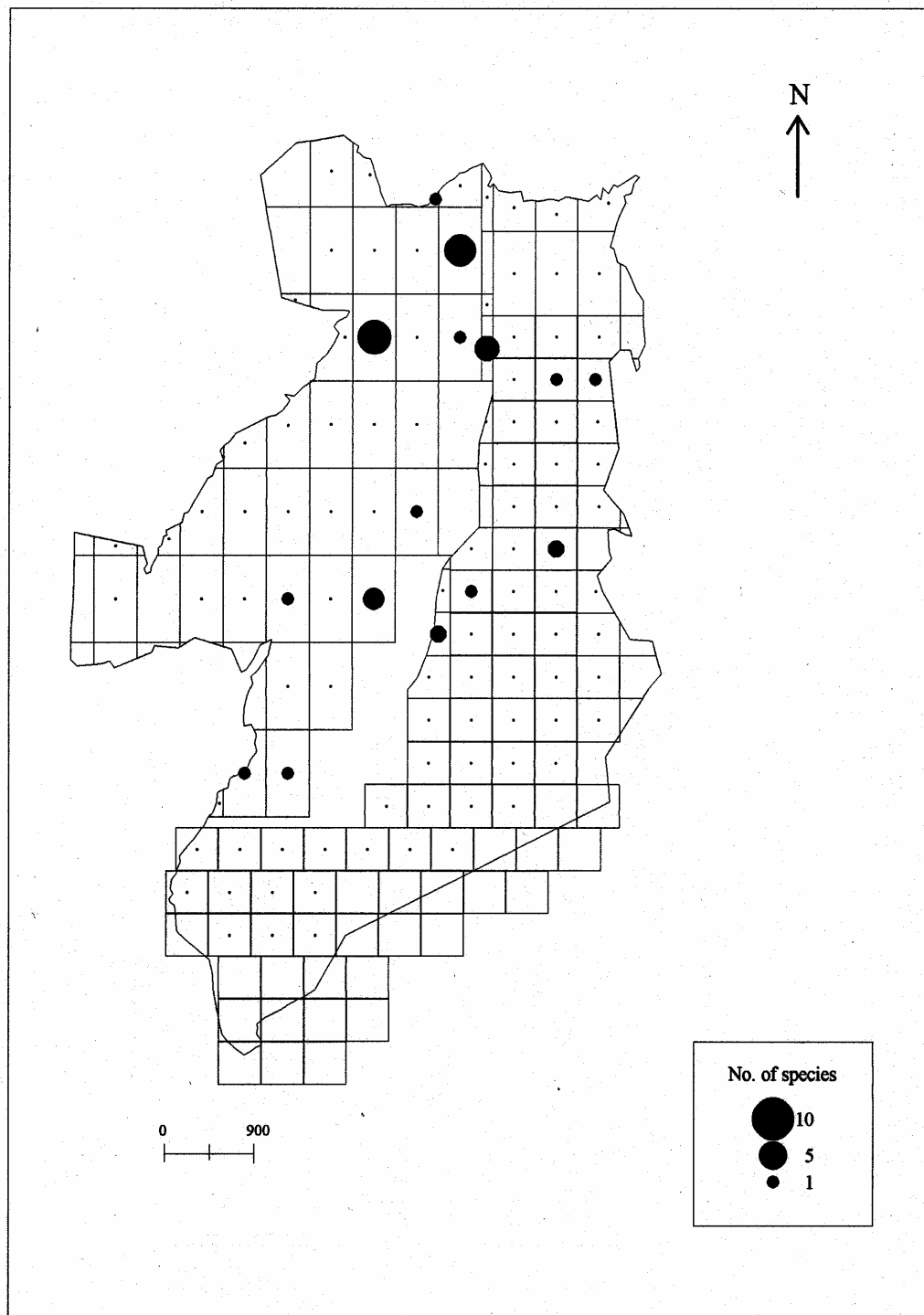


Figure 28. Distribution of forest dependent reptile species.

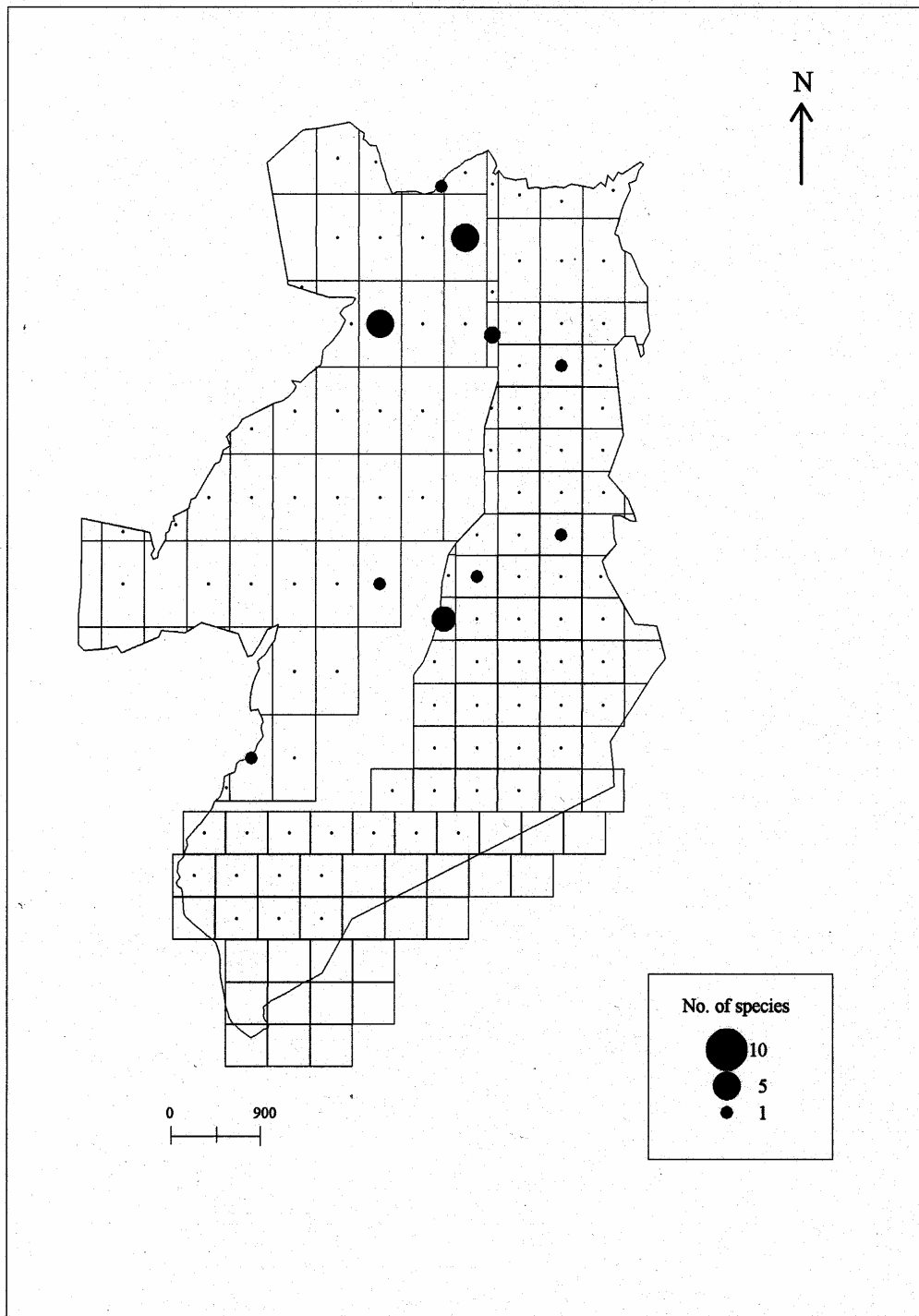


Figure 29. Distribution of endemic and near-endemic reptile species.

5.4.4 Amphibians

A total of 158 specimens were retained for taxonomic purposes. These represent 27 species from seven families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1997), IUCN (1996), Howell (1993); Poynton and Broadley (1991); and Poynton (unpubl.). Common names are taken from Passmore and Carruthers (1995).

Table 31. Summary of amphibians.

Species	Ecol. Type	End. status	IUCN status	Capture site by plot and number collected											Plots with a single specimen	Total	
				1	2	5	10	63	73	96	111	69	O R				
ARTHROLEPTIDAE																	
<i>Arthroleptis affinis</i>	F	N	V							2	3	5	3				13
<i>Arthroleptis xenodactyloides</i>	f	W		3						8		3	8			6,7	23
Shovel-footed squeaker										1						39	2
<i>Arthroleptis stenodactylus</i>	f	W										3	1			7	5
<i>Arthroleptis xenodactylus</i>	F	N	V											1			2
<i>Arthroleptis</i> sp.														1			2
BUFONIDAE																	
Guttural toad																	
<i>Bufo gutturalis</i>	f	W				2				1							3
<i>Bufo brauni</i>	F	N	V		1	2				11	1						15
<i>Bufo</i> sp.										1							1
<i>Stephopaedes</i> sp. nov.										3							3
<i>Nectophrynoides tornieri</i>	F	N	V				1				7	2	7			3,4,7	20
HYPEROLIDAE																	
<i>Leptopelis flavomaculatus</i>	F	W								2				1			3
<i>Leptopelis uluguruensis</i>	F	N	V								8		1				9
<i>Leptopelis parkeri</i>	F	N	V								3						3
<i>Leptopelis</i> sp.																	1
<i>Hyperolius mitchelli</i>	F	W								1							1
<i>Hyperolius ?pusillus</i>	O	W									1						1
<i>Hyperolius puncticulatus</i>	F	W												1			1
Greater leaf-folding frog																	
<i>Afrixalus fornasinii</i>	f	W												1			1
MICROHYLIDAE																	
<i>Probreviceps macrodactylus</i>	F	N	NT	1							1	9	4			7	16
<i>Callulina kreffti</i>	F	N	V								2	1				8	4
<i>Hoplophryne rogersi</i>	F	E	V					1						1			2
RANIDAE																	
East African puddle frog																	
<i>Phrynobatrachus acridoides</i>	f	W								4				1			5
<i>Arthroleptides martiensseni</i>	F		V								1	1	1				3
Plain grass frog																	
<i>Ptychadena anchietae</i>	f	W				1								1			2

Table 31. Cont.

Species	Ecol. Type	End. status	IUCN status	Capture site by plot and number collected										Plots with a single specimen	Total		
				1	2	5	10	63	73	96	111	69	O			R	
RANIDAE cont.																	
Common river frog																	
<i>Rana angolensis</i>	f	W								1					1	2	
PIPIDAE																	
Tropical platanna																	
<i>Xenopus muelleri</i>	f	W				1				1						2	
SCOLECOMORPHIDAE																	
<i>Scolecomorphus vittatus</i>	F	N	V							2						2	
Unidentified				5	2	1	1	2								7,8, 11	16

KEY TO ABBREVIATIONS FOR TABLE 31 (Definitions based on those described in Section 1.2).

Ecological (Ecol.) type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

IUCN status:

- E - Endangered
- V - Vulnerable
- NT - Near-threatened

OR - Captured outside the reserve boundaries.

UK - Unknown capture location

Table 32. Ranges of endemic and near-endemic amphibian species recorded (Howell 1993).

Endemic	
<i>Hoplophryne rogersi</i>	Usambara and Magrotto Mountains
Near-endemic	
<i>Arthroleptis affinis</i>	Usambara and Udzungwa Mountains
<i>Arthroleptis xenodactylus</i>	Usambara, Nguru and Uluguru Mountains
<i>Bufo brauni</i>	Usambara, Uluguru and Udzungwa Mountains
<i>Nectophrynoides tornieri</i>	East Usambara, Uluguru, Nguru and Udzungwa Mountains
<i>Scolecophorus vittatus</i>	Usambara, Uluguru, N. Pare, Magrotto Mountains and lowlands near Usambara Mountains.
<i>Leptopelis flavomaculatus</i>	Coastal zone, also Zanzibar; from Kenya to Mozambique.
<i>Leptopelis uluguruensis</i>	Usambara, Uluguru, Nguru and Udzungwa Mountains.
<i>Leptopelis parkeri</i>	Usambara, Uluguru and Udzungwa Mountains
<i>Arthroleptides martiensseni</i>	Usambara, Magrotto, Uluguru, Nguru and Udzungwa Mountains.
<i>Probreviceps macrodactylus</i>	Usambara, Uluguru, Rungwe and Udzungwa Mountains, Nguru Mts?, Pare Mts?,
<i>Callulina krefftii</i>	Usambara, Magrotto, Uluguru, Nguru and Udzungwa Mountains also Taita Hills, Kenya.

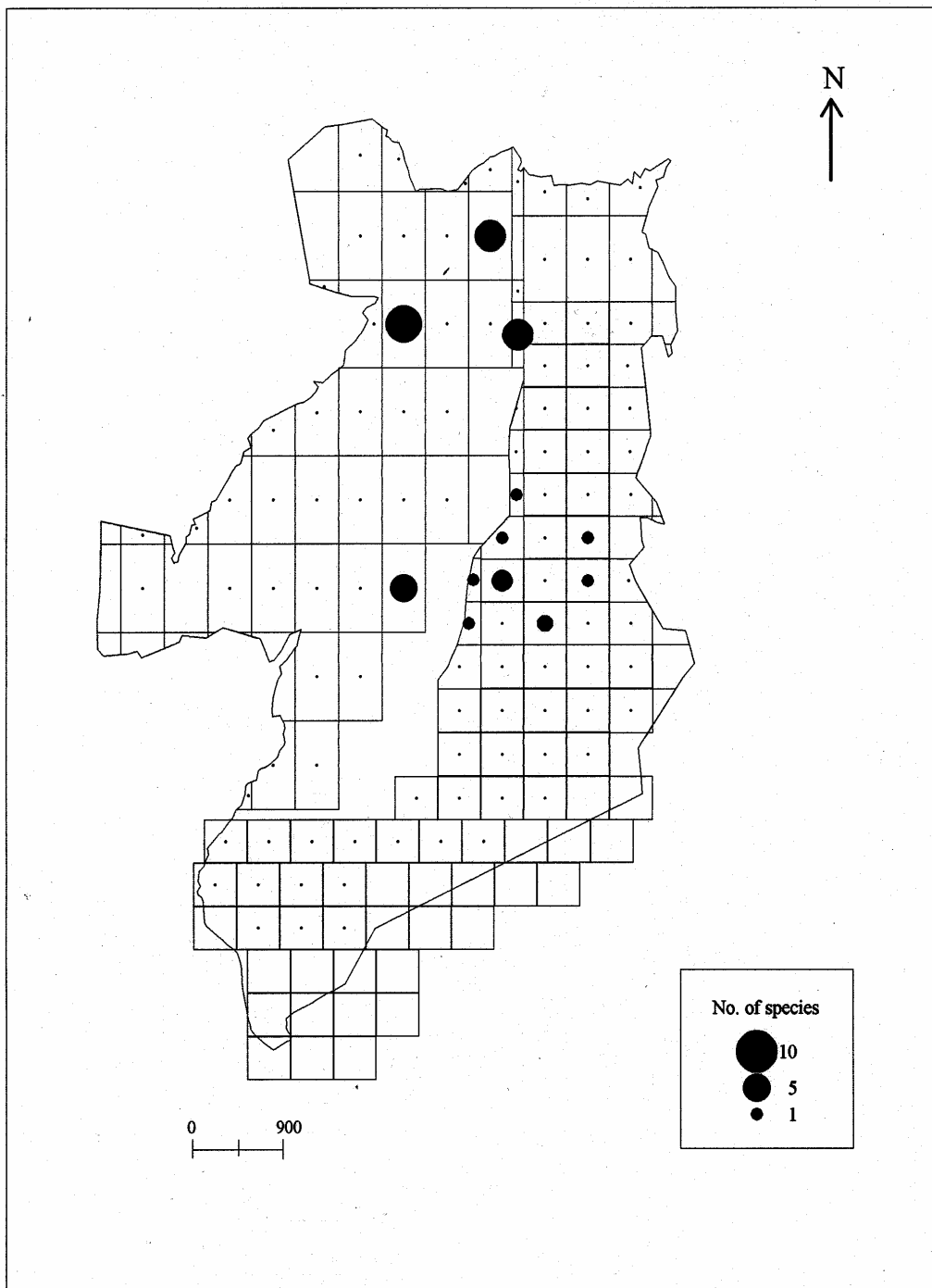


Figure 30. Distribution of forest dependent amphibian species.

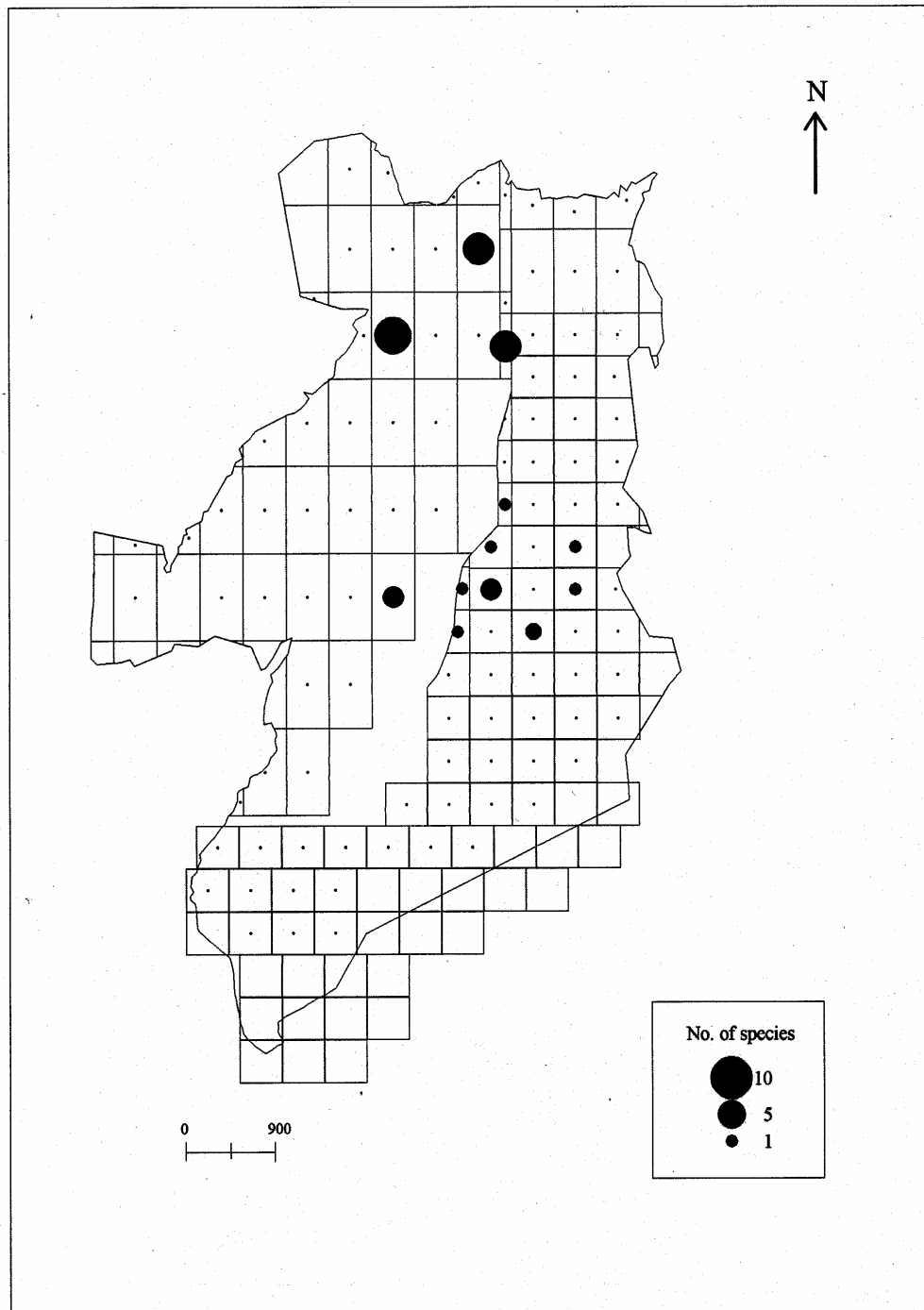


Figure 31. Distribution of near-endemic and endemic amphibian species.

5.4.5 Invertebrates

5.4.5.3. Butterflies

A total of 133 specimens were retained for taxonomic purposes. These represent 55 species from five families. Ecological type and endemic status were compiled from Kielland (1990) and Larsen (1996). Identifications were provided by Steve Collins from the African Butterfly Research Institute. Nomenclature follows Kielland (1990).

Table 33. Summary of butterflies.

Species	Ecol. Type	End. Status	Capture location and number collected					Total
			69	73	96	111	U/K	
PAPILIONIDAE								
<i>Graphium antheus</i>	f	W	1					1
<i>Graphium policeses</i>	F	W	2					2
<i>Papilio dardanus</i>	f	W	1					1
<i>Papilio nireus lyaeus</i>	f	W	1					1
PIERIDAE								
<i>Eurema hecabe</i>	f	W	1	5				6
<i>Leptosia alcesta</i>	f	W		6				6
<i>Nepheronia thalassina</i>	f	W		1				1
DANAIDAE								
<i>Danaus chrysippus</i>	f	W		1				1
<i>Amauris niavius dominicus</i>	F	W				1		1
SATYRIDAE								
<i>Melanitis leda</i>	f	W		1	1			2
<i>Bicyclus campinus</i>	F	W		3				3
<i>Physcaeneura jacksoni</i>	f	N					1	1
NYMPHALIDAE								
<i>Bebearia chriemhilda</i>	F	N		2				2
<i>Apaturopsis cleochares schultzei</i>	F	W		8	1			9
<i>Charaxes acuminatus usambarensis</i>	F	W (E)			8		2	10
<i>Charaxes brutus alcyone</i>	F	W					1	1
<i>Charaxes candiope</i>	F	W					5	5
<i>Charaxes cithaeron</i>	F	W		1				1
<i>Charaxes lasti</i>	F	N		3		1		4
<i>Charaxes pleione oriens</i>	F	W			1			1
<i>Charaxes pollux mirabilis</i>	F	W (N)	1				2	3
<i>Charaxes protoctlea</i>	F	W			1			1
<i>Charaxes protoctlea azota</i>	F	W		1		1	1	3
<i>Charaxes violetta</i>	F	W		1			1	2
<i>Euphaedra neophron littoralis</i>	F	W (N)		3				3
<i>Euptera kinungnana</i>	F	W		2	1			3
<i>Euryphura achlys</i>	F	W		3				3
<i>Eurytela dryope</i>	F	W		3				3
<i>Euxanthe tiberius</i>	F	N			2	2		4
<i>Euxanthe wakefieldi</i>	F	W			1			1
<i>Hypolimnias anhedon</i>	f	W		1				1
<i>Hypolimnias missipus</i>	f	W		1				1
<i>Neptis alta</i>	f	W		1				1

Species	Ecol. Type	End. Status	Capture location and number collected					Total
			69	73	96	111	U/K	
NYMPHALIDAE (cont.)								
<i>Neptis carcassoni</i>	F	W		3				3
<i>Neptis morosa</i>	f	W		1				1
<i>Neptis saclava</i>	f	W		2				2
<i>Neptis saclava marpessa</i>	f	W		5				5
<i>Neptis serena</i>	f	W		2				2
<i>Pseudacraea lucretia</i>	F	W		7				7
<i>Sallya morantii</i>	f	W			1			1
ACRAEIDAE								
<i>Acraea egina</i>	F	W			1		1	2
<i>Acraea encedana</i>	F	W		1				1
<i>Acraea johnstoni</i>	F	W	2					2
<i>Acraea natalica</i>	F	W		1				1
<i>Acraea pharsalus</i>	F	W	2					2
<i>Bematistes adrasta</i>	F	N				1		1
LYCAENIDAE								
<i>Anthene kersteni</i>	F	W		1	2			3
<i>Baliochila hildegarda</i>	F	W					1	1
<i>Oboronia bueronica</i>	F	N	1					1
<i>Pentila tropicalis mombasae</i>	F	W					2	2
<i>Zizula hylax</i>	F	W	1					1
HESPERIIDAE								
<i>Borbo gemella</i>	F	W					1	1
<i>Coeliades chalybe</i>	F	W					1	1
<i>Pardaleodes incerta</i>	F	W					2	2
<i>Platylesches galesa</i>	F	W	1					1
<i>Tagiades flesus</i>	F	W		1			1	2

KEY TO ABBREVIATIONS FOR TABLE 33

Ecological (Ecol.) type:

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;
- f - Forest dwelling but not forest dependent: Species occurring in primary forest as defined above as well as other vegetation types. Thus these are not forest-dependent species; and
- O - Non-forest species: These are species that do not occur in primary or secondary forest or forest edge.

Endemic (End.) status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

Capture location

U/K Unknown

5.4.5.3 Molluscs

110 specimens were retained for taxonomic purposes. These represent 33 species from six families. Endemic status is compiled from Seddon *et al.* (1996).

Table 34. Summary of molluscs.

Species	Endemic status	Capture location and number collected				Total
		69	73	96	111	
CYCLOPHORIDAE						
<i>Cyathopoma</i> ?sp. nov.			1			1
<i>Cyathopoma</i> ?sp. nov.				4		4
<i>Cyathopoma</i> ?sp. nov.		1				1
MAIZANIIDAE						
<i>Maizania</i> juv.		3				3
SUBULINIDAE						
? <i>Subulina</i> sp.		2				2
<i>Opeas crenatum</i>	E (E&W)			4	1	5
<i>Pseudoglessula</i> ? <i>leroyi</i> juv			1			1
<i>Pseudoglessula</i> ? sp. nov			3			3
<i>Pseudoglessula leroyi</i> juv.		1				1
<i>Pseudoglessula leroyi</i>				5	3	8
<i>Pseudoglessula leroyi fasciata</i>		5			2	7
EUCONULIDAE						
<i>Afroguppya rumrutiensis</i>	W		6			6
UROCYCLIDAE						
<i>Thapsia leroyi</i>		8		1	5	14
<i>Trochozonites usambarensis</i> juv.		1				1
STREPTAXIDAE						
? <i>Gonaxis</i> juv		1		1		2
? <i>Gulella</i> sp. juv.		1		1		2
? <i>Tayloria</i>					1	1
<i>Gonaxis denticulatus</i>		4			4	8
<i>Gulella</i> ? <i>radius</i>			1			1
<i>Gulella aenigmatica</i>	N	4			1	5
<i>Gulella alleni</i> var.		1				1
<i>Gulella gouldi globulosa</i>		1		1		2
<i>Gulella grossa</i>	E (EU)	2				2
<i>Gulella intrusa</i>	E (E&W)			3		3
<i>Gulella</i> juv.			4			4
<i>Gulella lornae</i>	E (E)			1		1
<i>Gulella near radius</i>		2				2
<i>Gulella habibui</i>			1			1
<i>Gulella translucida</i>	E (E&W)	1				1
<i>Edentulina</i>		1				1
<i>Edentulina ovoidea</i> juv.		1				1

KEY TO ABBREVIATIONS FOR TABLE 34

Endemic (End.) status:

- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges usually only including coastal forest and/or the Eastern Arc mountains;
- W - Widespread distribution.

5.5 Discussion

6.5.1 Species richness and abundance

In this section, species are examined in terms of how frequently they were recorded. Those species which have been captured or observed three or more times during the survey are considered locally common. An assumption is made that the frequency with which an animal is recorded reflects its abundance. It is recognised that some species are highly cryptic and so are easily overlooked. Such cryptic species may therefore be more abundant than is suggested by this survey. However the objective of this discussion is to identify species which may of concern because of their rarity as well as broadly to describe the typical fauna of the forest.

Table 35. Summary of faunal families and species.

Taxon	Number of families	Number of species
Mammals (not bats)	15	31
Bats	4	13
Birds	38	94
Reptiles	10	34
Amphibians	7	27
Butterflies	5	55
Molluscs	7	33

Table 36. Summary of capture locations of faunal species.

Taxon	Trapping Site ¹						
	1	7	63	69	73	96	111
Small mammals	8	4	9	3	1	1	6
Reptiles	4	2	3	9	7	9	5
Amphibians	3	5	2	8	13	11	9
Molluscs	n/a	n/a	n/a	18	7	9	7
Butterflies	n/a	n/a	n/a	7	33	11	6

¹Casual collections not included

n/a these taxa were not surveyed during the first survey in 1996.

5.5.1.1 Mammals

The most commonly recorded mammal was *Praomys delectorum*. Other species which appear to be common locally are *Beamys hindei*, *Grammomys dolichurus*, *Hylomyscus denniae*, *Lophuromys flavopunctatus* and *Crocidura hildegardae*. The most commonly caught bat was *Rhinolophus deckenii*. No other bats appear to be locally common.

5.5.1.2 Reptiles

The most commonly caught reptile species was *Leptosiaphos kilimensis* which is listed as vulnerable by the IUCN. It was recorded 26 times. Other species which appear to be locally common are *Cnemaspis africana*, *Cnemaspis barbouri*, *Hemidactylus mabouia*, *Mabuya maculilabris*, *Bitis gabonica*, *Aparallactus werneri*, *Elapsoidea nigra*, *Buhoma vauerocegae* and *Thelotornis capensis*.

5.5.1.3 Amphibians

The most commonly caught amphibian species was *Arthroleptis xenodactyloides*. Other amphibians that appear locally common are *Arthroleptis affinis*, *A.*

xenodactylus, *Bufo gutturalis*, *Bufo brauni*, *Stephopaedes usambarae*, *Nectophrynoides tornieri*, *Leptopelis flavomaculatus*, *L. uluguruensis*, *Phrynobatrachus acridoides*, *Arthroleptides martiensseni*, *Probreviceps macrodactylus* and *Callulina krefftii*.

5.5.1.4 Butterflies

The most commonly caught species was *Charaxes acuminatus usambarensis*. Other butterflies that appear to be locally common are: *Anthene kersteni*, *Apaturopsis cleochares schultzei*, *Bicyclus campinus*, *Charaxes candiope*, *Charaxes lasti*, *Charaxes pollux mirabilis*, *Charaxes protoclea azota*, *Euphaedra neophron littoralis*, *Euptera kinungnana*, *Euryphura achlys*, *Eurytela dryope*, *Euxanthe wakefieldi*, *Neptis carcassoni*, *Neptis saclava marpressa*, *Pseudacraea lucretia*, *Eurema hecabe* and *Leptosia alcesta*.

5.5.1.5 Molluscs

The most commonly collected mollusc species was *Thapsia leroyi*. Other molluscs that appear to be locally common are: *Cyathopoma* ?sp. nov., *Maizania* sp., *Pseudoglossula*?sp. nov, *P. leroyi*, *Afroguppya rumrutiensis*, *Gonaxis denticulatus*, *Gulella aenigmatica*, *G. intrusa*, and *G. sp.*

5.5.1.6 Endemics and near-endemics

Of the 36 species that are endemic or near-endemic to the Usambaras and were recorded during this survey, 17 appear to be locally. These are: *Cnemaspis barbouri*, *Aparallactus werneri*, *Elapsoidea nigra*, *Buhoma vauerocegae*, *Arthroleptis affinis*, *A. xenodactylus*, *Bufo brauni*, *Nectophrynoides tornieri*, *Leptopelis uluguruensis*, *Arthroleptides martiensseni*, *Probreviceps macrodactylus*, *Callulina krefftii*, *Charaxes lasti*, *Euxanthe tiberius*, *Opeas crenatum*, *Gulella aenigmatica* and *Gulella intrusa*. This does not include birds as abundance was not systematically recorded for birds.

5.5.1.7 Forest dependent species

Of the 62 forest dependent species, 29 appear to be locally common. These are: *Colobus angolensis*, *Hylomyscus denniae*, *Praomys delectorum*, *Cnemaspis africana*, *Cnemaspis barbouri*, *Leptosiaphos kilimensis*, *Bitis gabonica*, *Aparallactus werneri*, *Elapsoidea nigra*, *Buhoma vauerocegae*, *Athroleptis affinis*, *Athroleptis xenodactylus*, *Bufo brauni*, *Nectophrynoides tornieri*, *Leptopelis flavomaculatus*, *Leptopelis uluguruensis*, *Arthroleptides martiensseni*, *Probreviceps macrodactylus*, *Callulina krefftii* and ten butterfly species. This does not include birds as their abundance was not systematically recorded. Molluscs are also not included as their ecological requirements are not known.

5.5.1.8 High risk species

The locally uncommon species that are both forest dependent and near-endemic or endemic should be of conservation concern due to their low population density and restricted range. These species are: *Bradypodion fischeri fischeri*, *B. tenue*, *B. spinosum*, *Rhampholeon brevicaudatus*, *Lygodactylus kimhowelli*, *Prosymna semifasciata*, *Scolecophorus vittatus*, *Leptopelis parkeri* *Hoplophryne rogersi*,

Oboronia bueronica, *Bebearia chriemhilda* and *Bematistes adrasta*. This does not include molluscs or birds as insufficient information is available.

5.5.2 Ecological type

Of the forest dependent species, nine are small mammals, 16 are reptiles, 14 are amphibians and 23 are butterflies. The forest dependent mammals were most abundant close to the ridge suggesting that this is an important area for forest dependent mammals. They were not present at the lower elevation, riverine forest trap sites in plots 73 and 96 suggesting that these areas are of less importance for forest dependent mammals. Forest dependent reptiles and amphibians were recorded in all eight trapping sites. Similarly forest dependent butterflies were recorded in all four butterfly trapping sites.

Eight non-forest species are established in the reserve. These non-forest species are: *Rattus rattus*, *Grammomys macmillani*, *Mungos mungo*, *Sylvicapra grimmia*, *Cricetomys gambianus*, *Eptesicus rendalli*, *Rhampholeon k. kerstenii* and *Hyperolius ?pusillus*. *Rattus rattus* and *Grammomys macmillani* were both caught in Plot 1 close to the forest edge in disturbed forest. Other species appear to follow the River Muzi into the riverine forest within the reserve, these include *Mungos mungo*, *Eptesicus rendalli* and *Hyperolius pusillus*. *Cricetomys gambianus* was observed close to the forest edge in the north of the reserve and *Rhampholeon k. kerstenii* was found just outside of the reserve.

Table 37. Summary of ecological type of faunal species.

Ecological type*	No. of species	% of total species recorded
(F) Forest dependent	62	41
(f) Forest dwelling but not forest dependent	66	43
(O) Non-forest species	8	5
Unknown	16	11
Total	152	100

* Not including birds or molluscs.

5.5.3 Endemic Status

The eight species which are endemic to the Usambara Mountains are: *Prosymna semifasciata*, *Bradypodion spinosum*, *Hoplophryne rogersi*, *Opeas crenatum*, *Gulella grossa*, *G. intrusa*, *G. lornae* and *G. translucida*. The snake *Prosymna semifasciata* was caught close to the River Muzi in undisturbed forest.

Table 38. Summary of endemic status of faunal species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	8	4
(N) Near-Endemic: ranges in restricted locations	28	14
(W) Widespread	120	62
Unknown	39	20
Total	195	100

5.5.4 CITES

Panthera pardus is listed under Appendix I of CITES.

The following species are listed under CITES Appendix II: *Accipiter minullus*, *Aquila rapax*, *Buteo augur*, *Circaetus cinereus*, *Circaetus fasciolatus*, *Gypohierax angolensis*, *Kaupifalco monogrammicus*, *Lophaetus occipitalis*, *Polyboroides typus*, *Stephanoaetus coronatus*, *Tauraco fischeri*, *Bradypodion fischeri fischeri*, *B. tenue*, *B. spinosum*, *Chamaeleo deremensis*, *Varanus niloticus* and *Nectophrynoides tornieri*.

5.5.5 IUCN Status

According to IUCN criteria (see Section 1.2), the snake *Prosymna semifasciata* is critically endangered.

According to IUCN criteria, the survival of five species found in Mtai Forest Reserve are endangered. These are: *Bradypodion spinosum*, *Chamaeleo deremensis*, *Cnemaspis barbouri* and *Lygodactylus kimhowelli*.

According to IUCN criteria the following species are vulnerable to extinction: *Dendrohyrax validus*, *Sheppardia gunningi*, *Anthreptes rubritorques*, *Bradypodion fischeri fischeri*, *Bradypodion tenue*, *Rhampholeon brevicaudatus*, *Leptosiaphos kilimensis*, *Aparallactus werneri*, *Elapsoidea nigra*, *Buhoma vauerocegae*, *Crotaphopeltis tornieri*, *Arthroleptis affinis*, *A. xenodactylus*, *Bufo brauni*, *Nectophrynoides tornieri*, *Scolecormorphus vittatus*, *Leptopelis uluguruensis*, *Leptopelis parkeri*, *Arthroleptides martiensseni*, *Callulina krefftii* and *Hoplophryne rogersi*.

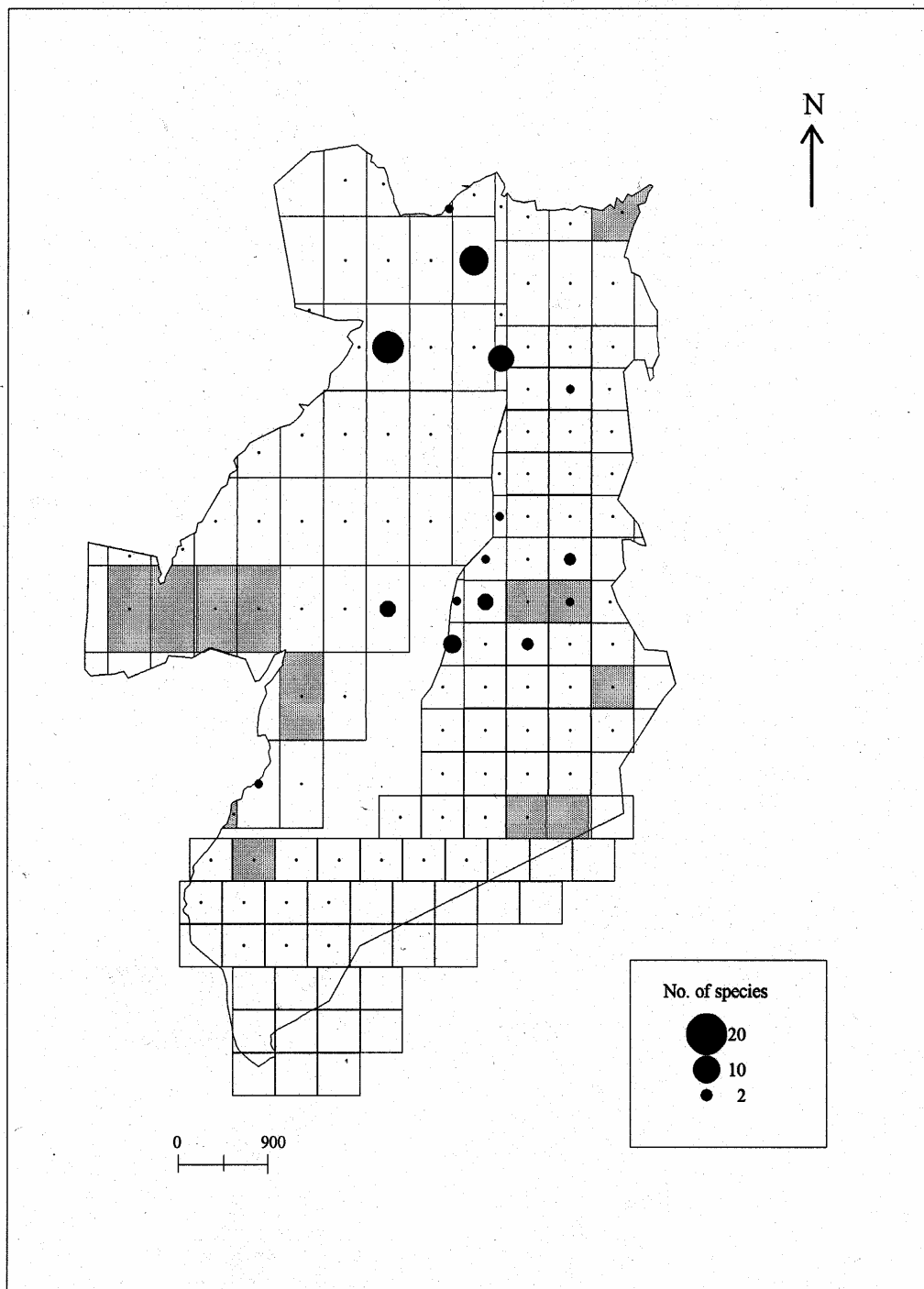


Figure 32. Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent and endemic or near-endemic.

6.0 CONCLUSION

This report presents the raw data of the survey of Mtai Forest Reserve with preliminary descriptions and analyses in terms of ecological type and endemic status. These two factors provide an indication of three main aspects of biodiversity and conservation:

1. the relationship between forest dependency and endemism;
2. the extent to which non-forest species are established in the reserve; and
3. the relationship between disturbance and areas of biological value.

Mtai forest, first gazetted as a Forest Reserve in 1913, covers an area of 3107 ha in the north of the East Usambara range. With altitudes between 180 m asl and 1016 m asl, it consists of approximately 94.1% mature forest, 5% previously disturbed, colonising or poorly stocked forest, 0.7% peasant cultivation and 0.2% barren land.

Species Richness

Mtai was found to contain a minimum of 271 species of trees, shrubs and herbs; 31 mammal, 94 bird, 34 reptile, 27 amphibian, 55 butterfly and 33 species of mollusc.

Relative to other forest reserves in the East Usambaras, Mtai is exceptionally diverse. It has the highest diversity of birds and reptiles and the second highest diversity of amphibians of the 11 forest reserves so far surveyed. It also has the highest botanical species richness on the basis of the vegetation plots, although more casual collections were made in Manga Forest Reserve.

Flora

Five tree species and two *Saintpaulia* spp. were recorded which are endemic to the Usambara Mountains. Sixty-two species have ranges limited to the Eastern Arc and/or East African lowland forests. Eighty-eight species are dependent on primary forest only, and of these species 33 are endemic or near endemic to the Usambara mountains. There are 18 tree and shrub species typical of open habitats in the Forest Reserve. Of the 11 forest reserves currently to have been surveyed by the FT FRP, Mtai has the highest number of endemic and near-endemic plant species.

Fauna

Three vertebrate species were recorded which are endemic to the Usambara mountains and 21 species were recorded as near-endemics, having ranges restricted to the Eastern Arc and/or East African lowland forests. Thirty-nine species are considered dependent only on primary forest, and of these species, 23 are also endemic or near endemic to the Usambara mountains. Eight non-forest species are in the reserve.

Disturbance

Timber cutting was recorded in 85% of the plots and pole cutting was even more abundant. Pole cutting is highest close to the edge of the reserve particularly in the

west and along the path to Maramba in the east of the reserve. Timber cutting is more evenly spread throughout the reserve than pole cutting. Active pitsaws were recorded close to Maramba. 20% of the plots had been affected by fire and this appears to be the most serious cause of damage to the forest particularly at the forest edge. The forest close to the Mtai ridge is mature with lower levels of disturbance. Hunting is widespread throughout the reserve. Mining was taking place in the north east of the reserve. At the time of writing the mines had been closed by the EUCAMP.

Conservation

The East Usambara Mountains are important due to their floral and faunal diversity and to their water catchment value. The forests also provide an important source of fuel wood, poles, timber, food and medicinal plants for the local people. Differences in the perceived values of the forests have caused and still cause a conflict of interest between the villagers and the forest conservation authorities. The remaining forests of the East Usambara mountains are now only small refuges of what was present just one hundred years ago (Hamilton, 1989). The area continues to be vulnerable because as the local populations increase, there will be a need for access to new agricultural land. Over the last century the forest area under protection around Mtai has been halved suggesting a corresponding loss in forest area.

As has been documented many times before, the problem of resource exploitation of the forest is that the forest is a fragile ecosystem. The soils are highly susceptible to erosion once the land has been cleared. Due to the tight nutrient recycling in the forest, once the land has been cleared the soil quickly loses fertility (Hamilton, 1989b). Soil erosion increases dramatically with the removal of the canopy cover, causing increased siltation of the rivers (Bruen, 1989). This is of great concern considering that the East Usambaras are a major water catchment site. This water is critical for the local people and also the Sigi river is the main source of water for the coastal town of Tanga. In addition, the possible long-term effect of deforestation is the apparent decrease in rainfall and increase in temperatures particularly at submontane altitudes as well as the greater unpredictability of the rainy seasons (Hamilton, 1989b).

A number of the species encountered are at risk of local extinction as they are uncommon, forest dependent and endemic or near-endemic. Degradation and fragmentation of Mtai forest will inevitably cause local extinction of some populations of these vulnerable species.

7.0 REFERENCES

- Binggeli, P. 1989. The ecology of *Maesopsis* invasion and dynamics of the evergreen forest of the East Usambaras, and their implications for forest conservation and forestry practices. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 269-300.
- Branch, B. 1994. Field Guide to the snakes and other reptiles of Southern Africa. Struik Publ., Cape Town.
- Broadley, D.G. 1995. A new species of *Prosymna* Gray (Serpentes: COLUBRIDAE) from coastal forest in northeastern Tanzania. *Arnoldia Zimbabwe* 10 (4): 29 - 32.
- Broadley, D.G. & Howell, K.M., in press. Reptiles. In N.D. Burgess & G.P. Clarke (eds.), *The coastal forests of eastern Africa: status, history, biodiversity & conservation*.
- Broadley, D.G. & Howell, K. M. 1991 A check list of the reptiles of Tanzania, with synoptic keys. *Syntarsus* 1: 1 – 70.
- Bruen, M. 1989. Hydrological considerations of development in the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 117-139.
- Collar, N.J.; Crosby, M.J. & Stattersfield, A.J. 1994. Birds to watch 2. The world list of threatened birds. Birdlife International, Cambridge.
- Cunneyworth, P. & Stubblefield, L. 1996. Bamba Ridge Forest Reserve: A biodiversity survey. East Usambara Conservation Area Management Programme Technical Paper No. 31. - Forestry and Beekeeping Division & Finnish Forest and Park Service & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.
- Griffiths, C.J. 1993. The geological evolution of East Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 9-22.
- Groombridge (ed.) 1993. 1994 IUCN red list of threatened animals. Cambridge IUCN.
- Hamilton, A.C. 1989. The place and the problem: a survey of forest types on the East Usambaras using the variable-area tree plot method. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 213-226.
- Hamilton, A.C. 1989. History of resource utilisation and management. The pre-colonial period. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 213-226.
- Howell, K.M. 1989. The East Usambara Fauna. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 315-355.
- Howell, K.M. 1993. Herpetofauna of the eastern African forests. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 173-201.
- Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara mountains. *East Usambara Conservation Area Management Programme*.
- IUCN 1996. 1996 IUCN Red list of threatened animals. IUCN, Gland, Switzerland.

- Iversen, S.T. 1991a. The Usambara mountains, NE Tanzania: Phytogeography of the vascular plant flora. Uppsala University, Uppsala.
- Iversen, S. T. 1991b The Usambara mountains, NE Tanzania: History, vegetation and conservation. Uppsala University, Uppsala.
- Johansson S. & Sandy R. 1996. Updated Forest area information in the Usambara mountains. East Usambara Conservation Area Management Programme, working paper 20.
- Kielland, J. 1990 Butterflies of Tanzania. Hill House, Melbourne/London.
- Kikula, 1989. Spatial changes in forest cover on the East Usambara Mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 79 - 86.
- Kingdon, J. 1989. East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats. University of Chicago Press, Chicago.
- Kingdon, J. 1974. East African Mammals. An atlas of evolution in Africa. Vol. 2B: Hares and rodents. University Chicago Press, Chicago.
- Kingdon, J. 1997. The Kingdon field guide to African Mammals. Academic Press, London.
- Kingdon, J & Howell, K. M. 1993 Mammals in the forests of Eastern Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 229-241.
- Larsen, T. B. 1996 The butterflies of Kenya and their natural history. Oxford University Press, Oxford.
- Litterick, M. 1989. Assessment of water quality of the Sigi river. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 141-155.
- Lovett, J.C. 1989. The botanical importance of the East Usambara forests in relation to other forests in Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 207-212.
- Lovett, J.C. 1993. Eastern Arc moist forest flora. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 33-56.
- Msoffe, E. 1998 Personal Communication with Nike Doggart, Tanga Catchment Forest Office.
- National biodiversity database (1996). Unpubl. Department of Zoology and Marine Biology. UDSM, Dar es Salaam.
- Passmore, N. I. And V. C. Carruthers 1995 South African frogs: a complete guide. Southern book publishers.
- Poynton, J.C. Unpubl. Amphibians. In N.D. Burgess & G.P. Clarke (eds.), *The coastal forests of eastern Africa: status, history, biodiversity & conservation*.
- Poynton J.C. & Broadley, D.G. 1991. Amphibia zambesiaca 5. Zoogeography. Ann. Natal Mus. Vol 32:221-277.
- Rodgers, W.A. 1996. Biodiversity values of Tanzanian forests: A training and awareness manual for forest managers and conservationists. FAO, Dar es Salaam.

- Rodgers, W.A. & Homewood, K.M. 1982. The conservation of the East Usambara Mountains, Tanzania: a review of biological values and land use pressures. *Biol. J. Linn. Soc.* 24: 285-304.
- Ruffo .K.; Mmari, C.; Kibuwa, S.P.; Lovett, J.; Iversen, S. & Hamilton, A.C. 1989. A preliminary list of the plant species recorded from the East Usambara forests. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 157-179.
- Schmidt, P. 1989. Early exploitation and settlement in the Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 357-361.
- Seddon, M.B.; Tattersfield, P. & Ruparella, B. 1996. Manual for research on Molluscan biodiversity conservation: From survey to analysis. Cardiff, U.K.
- SEE, 1998. Frontier Tanzania Forest Research Programme: Methodology report. Technical Paper of the Society for Environmental Exploration, London.
- Shaka, J.M., W. Kabushemera & A. Msangi. 1996. Soils and vegetation of Mtai Forest Reserve, Bombwera Division, Muheza District, Tanga. East Usambara Conservation Area Management Programme Technical Paper No. 26. - Forestry and Beekeeping Division & Finnish Forest and Park Service, Dar es Salaam & Vantaa.
- Stuart, S.N. 1989. The avifauna of the East Usambara mountains. Chapter 35 - Forest conservation in the East Usambara mountains Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 357-361.
- Tye, A. 1994. Magoroto rainforest conservation - Proposal for establishment of a new reserve. *EUCDP, IUCN, Amani, Tanzania (unpubl.)*.
- Walker, C. 1988 Signs of the Wild. Struik.
- Zimmerman, D. A., D. a. Turner and D. J. Pearson. 1996. Birds of Kenya and Northern Tanzania. Russel Friedman Books.

Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	SL	375	25	FC	20 - 30
2	GL	420	20	M	20 - 30
3	SM	625	25	M	20 - 30
4	SM	800	30	P	<10
5	SL	320	25	M	>30
6	SL	450	30	M	20 - 30
7	GM	710	10	P	10 - 20
8	SU	N/A	45	P	20 - 30
9	SM	450	34	FC	10 - 20
10	SL	500	38	P	10 - 20
11	SM	650	30	P	20 - 30
12	SL	525	30	P	20 - 30
13	GM	580	19	M	>30
14	GU	660	25	M	20 - 30
15	SU	780	37	M	20 - 30
16	GL	N/A	17	FC	<10
17	SL	N/A	35	M	10 - 20
18	GU	N/A	20	G	<10
19	GU	N/A	20	P	20 - 30
20	SL	350	28	P	<10
21	SL	350	25	M	10 - 20
22	SM	390	30	M	20 - 30
23	GL	250	10	P	20 - 30
24	GL	240	14	P	10 - 20
25	SM	310	35	FC	10 - 20
26	GM	340	20	FC	10 - 20
27	GM	270	20	P	>30
28	SM	340	45	P	20 - 30
29	SU	850	45	B	<10
30	SM	400	35	P	20 - 30
31	Gulley	700			20 - 30
32	SL	500		P	20 - 30
33	SL	N/A		P	20 - 30
34	MS	570		P	>30
35	SU	900	25	M	20 - 30
36	LS	540		P	>30
37	SM	420	28	P	>30
38	GM	580	22	P	>30
39	SM	750	25	FC	20 - 30
40	SM	365	25	FC	20 - 30
41	SM	400	30	P	10 - 20
42	GL	180	20	P	20 - 30
43	SU	180	30	P	10 - 20
44	GL	340	22	M	10 - 20
45	GL	340	18	EC	10 - 20
46	GM	310	10	B	10 - 20
47	GU	400	10	EC	20 - 30

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
48	GM	295	20	M	20 - 30
49	GM	280	20	M	20 - 20
50	SU	790	26	P	>30
51	SM	690	42	M	>30
52	GM	760	15	M	>30
53 - 59	No vegetation plot				
60 - 61	Skipped number				
62	Gulley	700	30	FC	20 - 30
63	No vegetation plot				
64	SM		35	FC	>30
65	GU	830	22	EC	10 - 20
66	SM	570	27	FC	
67	SM	600	57	EC	<10
68	SU	740	35	EC	<10
69	SM	790	34	M	>30
70	SU	620		P	<10
71	GL	280	15	B	20 - 30
72	GL	400	15	M	10 - 20
73	SM	640	28	M	20 - 30
74	SM	500	35	P	10 - 20
75	SL	300	25	M	10 - 20
76	GM	420	20	M	10 - 20
77	SU	570	45	P	20 - 30
78	FV	400	5	M	10 - 20
79	GL	450	23	P	20 - 30
80	SM	410	25	B	10 - 20
81	SL	350	35	P	20 - 30
82	GL	490	20	P	10 - 20
83	SL	290	25	P	10 - 20
84	SM	450	36	M	10 - 20
85	SL	200	30	EC	10 - 20
86	SL	180	35	EC	10 - 20
87	SU	850	30	P	10 - 20
88	GM	320	20	EC	10 - 20
89	GM	310	18	M	10 - 20
90	GM	360	16	P	10 - 20
91	GM	500	22	M	20 - 30
92	SM	700	32	EC	10 - 20
93	SU	890	38	M	10 - 20
94	SM	450	27	M	>30
95	SL	600	35	M	>30
96	SM	500	28	M	10 - 20
97	GL	600	15	P	20 - 30
98	SL	470	32	P	10 - 20
99	SM	540	25	P	20 - 30
100	SM	400	25	M	10 - 20
101	SU	815	32	M	10 - 20
102	GU	840		M	10 - 20
103	GM	760	18	M	20 - 30
104	GU	890	22	M	10 - 20
105	GM	770	14	M	20 - 30
106	GM	780	13	M	20 - 30
107	GM	820	20	M	20 - 30

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
108	No vegetation plot				
109	GM	840	25	M	10 - 20
110	SL	880	26	M	20 - 30

KEY TO ABBREVIATIONS FOR APPENDIX 1

Topography

GL - gentle lower slope
 SL - steep lower slope
 M - mid-slope
 GM - gentle mid-slope
 SM - steep mid-slope
 GU - gentle upper slope
 SU - steep upper slope
 FV - flat valley floor
 RT - ridge top
 F - mature mixed forest
 SG - steep gully

Vegetation Condition

M - mature mixed forest/more or less natural forest
 P - disturbed primary forest or secondary forest
 G - grassland

 B - bushland and/or thicket
 W - woodland
 FC - forest edge/colonising
 EC - former encroachment/colonising

No vegetation plot: No 50m x 20m plot was surveyed in this area. This is a trapping site only.

Appendix 2:

Taxonomic Verification

BOTANY

Frank Mbago	Department of Botany	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Ahmed Mndolwa Charles Kisena Mabula	TAFORI	Silvicultural Research Centre, P.O. Box 95, Lushoto, Tanzania

ZOOLOGY - VERTEBRATES

Bats and small mammals:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania khowell@twiga.com
Dr. Dieter Kock	Frankfurt Zoological Museum	Saugetiere III, Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany dkock@sng.uni-frankfurt.de

Rodents and Shrews:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania khowell@twiga.com
Dr. Dieter Kock	Frankfurt Zoological Museum	Saugetiere III, Senckenberg, Senckenberganlage 25, 60325 Frankfurt am Main, Germany dkock@sng.uni-frankfurt.de
Dr. W. Stanley	Field Museum Natural History	Chicago, Illinois, USA stanley@fm.fmnh.org

Amphibians:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania khowell@twiga.com
Prof. J. Poynton	British Natural History Museum	Cromwell Road, South Kensington, London, UK.

Reptiles:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania khowell@twiga.com
Dr. Don Broadley	The Natural History Museum of Zimbabwe	P.O. Box 240, Bulawayo, Zimbabwe bfa@coldfire.dnet.co.zw

East Usambara Conservation Area Management Programme Technical Paper Series

(ISSN 1236-620X)

The East Usambara Conservation Area Management Programme Technical Papers Series consists of reports on forestry issues in the East Usambara Mountains. This series started in 1991. These reports aim to make information more widely available to staff members of the East Usambara Conservation Area Management Programme, to the Forestry and Beekeeping Division, and to other institutions and individuals concerned and interested in the conservation of the East Usambara forests.

The reports are prepared by staff members of the East Usambara Conservation Area Management Programme or by other researchers, consultants and interested individuals. The views expressed in the reports are those of the author(s).

Current titles in the series are:

1. Mwihomeke, S.T. 1991. Some notes to identify and discuss cooperation in forestry research in the East Usambara mountains.
2. Räsänen, P.K. 1991. Outline of a research planning programme for the East Usambara Conservation Area Management Programme.
3. Hyytiäinen, K. 1992. Forest management plan for Longuza teak plantations.
4. Seymour, M. 1992. Manual harvesting of *Maesopsis eminii* in the East Usambara mountains, Tanzania.
5. Newmark, W.D. 1992. Recommendations for wildlife corridors and the extension and management of Forest Reserves in the East Usambara mountains, Tanzania.
6. Häkkinen, I. & Wambura, M. 1992. A Frame plan for the Amani Nature Reserve.
7. Masilingi, W.M.K. 1992. Consultancy report on the legal establishment of the Amani Nature Reserve.
8. Binagi, E.R. 1992. Consolidation of environmental education for adults: critique of FINNIDA-funded forestry projects in Tanzania. A case study of the East Usambara Conservation Area Management Programme.
9. Tuominen, V. 1993. Marking of the Forest Reserve boundaries in the East Usambara mountains.
10. Pirttilä, I. 1993. The discharge of Sigi River as an indicator of water catchment value of the East Usambara mountains in Tanzania.
11. Hyytiäinen, K. 1993. Combined seed and timber production in Longuza Teak plantations, Tanzania.
12. Kajembe, G.C. & Mwaseba, D. 1994. The extension and communication programme for the East Usambara Conservation Area Management Programme.
13. Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara Mountains.
14. Hall, J.B. 1995. *Maesopsis eminii* and its status in the East Usambara Mountains.
15. Heinonen, P. 1995. PSPs in East Usambara Mountains: present findings and future recommendations.
16. Munuyku, F.C.N. 1995. Report on an inventory of selected proposed Forest Reserves in Muheza District, Tanga Region.
17. Kamugisha, S.M. & Materu, E.M.A. 1995. Preliminary results from a study on water flow and in Sigi and Bombo rivers in the East Usambara mountains.
18. Ellman, A., Tye, A., Rwamugira, S., Mallya, B., Mahenge, F. and Mndolwa, A. 1995. Development of forest trails and drive routes in the Amani Nature Reserve.
19. Ellman, A.E. 1996. Handing over the stick? Report of a village forest management and farm forestry consultancy
20. Katigula, M.I.L., Mmasi, S.E., Matiko, W., Mshana, L., Kijazi, M.S., Rwamugira, S. 1995. Planning ourselves. Evaluation report on the participatory planning of the EUCAMP Phase II project document.
21. Fowler, S. & Nyambo, B. 1996. Invasive species and biodiversity - Report of a short consultancy on the potential of biological control of invasive species in Amani Nature Reserve. International Institute for Biological Control & EUCAMP.

21. Howard, P.C. 1996. Baseline biological surveys in selected East Usambara Forest Reserves and forests, 1995-96 - project evaluation report
22. Woodcock, K. 1995. Indigenous knowledge and forest use: two case studies from the East Usambaras, Tanzania.
23. Shaka, J.M. & A. Msangi. 1996. Soils and vegetation of Bamba Ridge Forest Reserve, Maramba Division, Muheza District, Tanga.
24. Shaka, J.M. & H. Mwanga. 1996. Soils and vegetation of Mlungui Proposed Forest Reserve, Maramba Division, Muheza District, Tanga.
25. Shaka, J.M. & A. Msangi. 1996. Soils and vegetation of Kwamarimba Forest Reserve, Bombwera Division, Muheza District, Tanga.
26. Shaka, J.M., W. Kabushemera & A. Msangi. 1996. Soils and vegetation of Mtai Forest Reserve, Bombwera Division, Muheza District, Tanga.
27. Shelutete, M. 1996. Focus on women - report of a consultancy on conservation and women in the East Usambara mountains.
28. Johansson, S.G. & Sandy, R. 1996. Protected areas and public lands - land use in the East Usambara mountains.
29. SEE. 1996. Biodiversity survey methods report. – Technical Paper ?? of the Society for Environmental Exploration, London.
30. Cunneyworth, P. & Stubblefield, L. 1996. Magoroto Forest: A biodiversity survey.
31. Cunneyworth, P. & Stubblefield, L. 1996. Bamba Ridge Forest Reserve: A biodiversity survey.
32. Cunneyworth, P. & Stubblefield, L. 1996. Mlungui Proposed Forest Reserve: A biodiversity survey.
33. Cunneyworth, P. 1996. Kwamarimba Forest Reserve: A biodiversity survey.
34. Cunneyworth, P. 1996. Longuza Forest Reserve: A biodiversity survey.
35. Cunneyworth, P. 1996. Mtai Forest Reserve: A biodiversity survey.
36. Shaka, J. M., W. Kabushemera & A. Msangi 1997. Soils and vegetation of Semdoe Proposed Forest Reserve, Bombwera Division, Muheza District, Tanga.
37. Vainio-Mattila, K., L. Mwasumbi and K. Lahti 1997 Traditional use of wild vegetables in the East Usambara Mountains.
38. Sandy, R.O., G. Boniface and I. Rajabu 1997 Amani Botanical Garden Survey.
39. Doggart, N. H., M. S. Dilger, R. Kilenga and E. Fanning 1999 Mtai Forest Reserve: A biodiversity survey.
40. Doggart, N. H., M. S. Dilger, P. Cunneyworth and E. Fanning 1999 Kwamgumi Forest Reserve: A biodiversity survey.
41. Doggart, N. H., L. Joseph, J. Bayliss and E. Fanning 1999 Manga Forest Reserve: A biodiversity survey.
42. Doggart, N. H., A. Ntemi, K. Doody and E. Fanning 1999 Semdoe Forest Reserve: A biodiversity survey.
43. Doody, K., N. H. Doggart, L. Joseph and E. Fanning 1999 Segoma Forest Reserve: A biodiversity survey.

Suggested citation: Doggart, N. H., M. S. Dilger, R. Kilenga, and E. Fanning 1999 Mtai Forest Reserve: A biodiversity survey. East Usambara Conservation Area Management Programme Technical Paper No. 39.