

TECHNICAL PAPER 50

Segoma Forest Reserve

A biodiversity survey

**Frontier Tanzania
2001**

East Usambara Conservation Area Management Programme

Technical Paper 50

Segoma Forest Reserve

A biodiversity survey

Doody, K. Z., Howell, K. M. and Fanning, E. (eds.)

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

**Department of International
Development Co-operation, Finland
Metsähallitus Consulting**

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

Tanga 2001

© Metsähallitus - Forest and Park Service

Cover painting: Jaffary Aussi (1995)

ISSN 1236-630X

ISBN 9987-646-06-9

Suggested citation: Frontier Tanzania 2001. Doody, K. Z., Howell, K. M., and Fanning, E., (eds.). Segoma Forest Reserve: A biodiversity survey. East Usambara Conservation Area Management Programme Technical Paper No. 50. Frontier Tanzania, Forestry and Beekeeping Division & Metsähallitus Consulting, Dar es Salaam & Vantaa, Finland.

East Usambara Conservation Area Management Programme (EUCAMP)

The East Usambara rain forests are one of the most valuable conservation areas 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 Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism implement the programme with financial support from the Government of Finland, and implementation support from the Metsähallitus Consulting . 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 Frontier Tanzania, of which one component is 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: 255-22-2111 061/2/3/4
Fax: 255-22-2114 659
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: 255-27-2643453, 46907, 43820
Fax: 255-27-2643820
E-mail: usambara@twiga.com
Internet: www.usambara.com

Metsähallitus Consulting
P.O. Box 94, FIN-01301 Vantaa, Finland
Tel: 358-205-62100
Fax: 358-205-644401
E-mail: knowhow@metsa.fi

Dept of Zoology
University of Dar es Salaam
P.O. Box 35064, Dar es Salaam, Tanzania
Tel: 255-22-2410462
E-mail: zoology@udsm.ac.tz

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

This report is dedicated to the memory of

Daniel Saer
(17.12.75 – 26.1.98)

who died tragically while working on the biodiversity
survey of Segoma Forest Reserve.

We hope that this work, to which he contributed, may
help to secure the future of this unique and beautiful
forest.

TABLE OF CONTENTS

LIST OF TABLES	iii
LIST OF FIGURES	v
EXECUTIVE SUMMARY.....	vii
ACKNOWLEDGEMENTS	xii
1.0 INTRODUCTION	1
1.1 THE EAST USAMBARA MOUNTAINS AND FOREST DIVERSITY.....	1
1.2 REPORT STRUCTURE.....	3
1.3 MAPS.....	4
1.4 DATA AND MONITORING	4
1.5 SURVEY PERIOD AND PERSONNEL.....	4
2.0 AIMS OF THE SURVEY.....	5
3.0 DESCRIPTION OF THE FOREST.....	7
3.1 GENERAL DESCRIPTION.....	7
3.1.1 <i>Description</i>	7
3.1.2 <i>Location</i>	7
3.1.3 <i>Topography</i>	7
3.1.4 <i>Land use</i>	7
3.1.5 <i>History and Status</i>	8
4.0 VEGETATION.....	13
4.1 INTRODUCTION.....	13
4.2 METHODS.....	13
4.2.1 <i>Forest composition</i>	13
4.3 RESULTS.....	16
4.3.1 <i>Quantitative vegetation analysis</i>	16
4.3.2 <i>Disturbance transects</i>	39
4.4 DISCUSSION	48
5.0 FAUNA.....	51
5.1 INTRODUCTION.....	51
5.2 METHODS.....	51
5.2.1 <i>Mammals</i>	51
5.2.2 <i>Birds</i>	52
5.2.3 <i>Reptiles</i>	52
5.2.4 <i>Amphibians</i>	52
5.2.5 <i>Invertebrates</i>	52
5.3 TRAPPING SITES AND SAMPLING INTENSITY	54
5.4 RESULTS.....	57
5.4.1 <i>Mammals</i>	57
5.4.2 <i>Birds</i>	65
5.4.3 <i>Reptiles</i>	68
5.4.4 <i>Amphibians</i>	73
5.4.5 <i>Invertebrates</i>	77

5.5	DISCUSSION	79
5.5.1	<i>Species richness and abundance</i>	79
5.5.2	<i>Ecological type</i>	81
5.5.3	<i>Endemic Status</i>	81
5.5.4	<i>Range Extensions</i>	82
5.5.5	<i>IUCN Status</i>	82
6.0	CONCLUSIONS	84
7.0	REFERENCES	86
	APPENDIX 1: GENERAL PLOT INFORMATION	89
	APPENDIX 2: TAXONOMIC VERIFICATION.....	91

LIST OF TABLES

Table 1 Summary of biodiversity of the taxa surveyed.	vii
Table 2 Forest area in the East Usambaras (based on Johansson and Sandy 1996).	2
Table 3 Land use distribution in Segoma Forest Reserve (Johansson and Sandy, 1996).	8
Table 4 Checklist of trees and shrubs.	16
Table 5 Species recorded exclusively in the regeneration layer.	20
Table 6 Summary of opportunistic botanical records.	21
Table 7 Tree and shrub species found outside their previously recorded range in the East Usambara mountains.	23
Table 8 Summary of ecological type for tree and shrub species (based on Table 4).	24
Table 9 Summary of habitat for tree and shrub species (based on Table 4).	24
Table 10 Submontane species in lowland areas and the altitudes where they were recorded.	25
Table 11 Summary of endemic status for tree and shrub species (based on Table 4).	26
Table 12 The abundance of selected timber species.	26
Table 13 Disturbance transect results for pole counts.	39
Table 14 Disturbance transect results for timber counts.	41
Table 15 Summary descriptions of trapping sites.	54
Table 16 Sampling intensity by trap night (number of nights x number of traps).	54
Table 17 Summary of bat-netting sites.	54
Table 18 Summary of small mammals.	57
Table 19 Abundance of duiker, bushbuck and hyrax dung.	58
Table 20 Summary of dung survey.	58
Table 21 Summary of mammal observations.	60
Table 22 Summary of bats.	62
Table 23 Summary of birds.	65
Table 24 Ranges of near-endemic bird species (Zimmerman, 1996).	67
Table 25 Summary of reptiles.	68
Table 26 Ranges for endemic and near-endemic reptile species recorded (Howell, 1993).	69
Table 27 Summary of reptile observations.	70
Table 28 Summary of amphibians.	73
Table 29 Ranges for endemic and near-endemic amphibian species recorded (Howell, 1993).	74
Table 30 Summary of butterflies.	77
Table 31 Summary of faunal families and species.	79
Table 32 Summary of capture locations of faunal species by plot number.	81
Table 33 Summary of ecological type of mammal, bird, reptile and amphibian species.	81
Table 34 Summary of endemic status of mammal, bird, reptile and amphibian species.	82

LIST OF FIGURES

Figure 1	The location of Segoma Forest Reserve in relation to other East Usambara forests.....	10
Figure 2	Topographical map of Segoma Forest Reserve (m asl).....	11
Figure 3	Location of vegetation plots and disturbance transects.....	15
Figure 4	Species accumulation rates of recorded species by vegetation plot.....	23
Figure 5	Distribution of forest dependent tree and shrub individuals.....	27
Figure 6	Distribution of forest dependent tree and shrub species.....	28
Figure 7	Distribution of non-forest tree and shrub individuals.....	29
Figure 8	Distribution of non-forest tree and shrub species.....	30
Figure 9	Distribution of submontane tree and shrub individuals.....	31
Figure 10	Distribution of submontane tree and shrub species.....	32
Figure 11	Distribution of endemic tree and shrub individuals.....	33
Figure 12	Distribution of endemic tree and shrub species.....	35
Figure 13	Distribution of near-endemic tree and shrub individuals.....	36
Figure 14	Distribution of near-endemic tree and shrub species.....	37
Figure 15	Vegetation of Segoma Forest Reserve.....	38
Figure 16	The relative abundance of live, naturally dead and cut poles.....	39
Figure 17	Rate of Pole cutting.....	40
Figure 18	The relative abundance of live, naturally dead and cut timber.....	41
Figure 19	Rate of timber extraction.....	42
Figure 20	Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.....	43
Figure 21	Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and endemic.....	44
Figure 22	Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.....	47
Figure 23	Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.....	48
Figure 24	Location of trapping sites.....	56
Figure 25	Distribution of forest dependent mammal species.....	63
Figure 26	Distribution of near-endemic mammal species.....	64
Figure 27	Distribution of forest dependent reptile species.....	71
Figure 28	Distribution of near-endemic reptile species.....	72
Figure 29	Distribution of forest dependent amphibian species.....	75
Figure 30	Distribution of near-endemic amphibian species.....	76
Figure 31	Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent, endemic and near-endemic.....	83

EXECUTIVE SUMMARY

Segoma Forest Reserve, situated in the East Usambara Mountains in north-east Tanzania was gazetted in 1955. It is located in Muheza District, Tanga Region and covers an area of 1933.8 ha between 80 - 920m asl, encompassing submontane, lowland and plantation 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 Segoma Forest Reserve in January 1998 and between July - September 1998 for a total of 78 research-days. The systematic vegetation survey covered all parts of the reserve with a sampling intensity of 0.25% of the area, the zoological survey was focused on five trapping sites. This report provides an inventory of the trees, shrubs, herbs, mammals, reptiles, amphibians, birds and butterflies recorded during the survey. The report also describes patterns of human disturbance within the reserve. The species richness, endemism and ecological affinities of the taxa recorded are summarised as Table 1.

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 and shrubs	207	27	17	4	31	15
Mammals	31	38.7	1	0	3	3
Birds	50	32	15	0	1	1
Reptiles	29	41.4	2	1	6	7
Amphibians	19	42	1	0	7	7
Total	336	n/a	36	5	48	33

Segoma Forest Reserve is part of a larger forest block that includes Kwamgumi and Bamba Ridge Forest Reserves. In terms of conservation it is significant as habitat for a number of endemic and threatened species including the East Usambara endemic plant *Cola scheffleri*. It is also a good example of lowland forest and relative to other East Usambara forest reserves surveyed by Frontier-Tanzania it has above average botanical species richness.

In terms of fauna, the reserve is home to one critically endangered, three endangered and 13 vulnerable species according to IUCN categories. The reserve has a high diversity of reptiles, particularly snakes, of which 15 species were recorded.

Poles and timber continue to be taken illegally from within the reserve. Evidence of pit-sawing was observed throughout the reserve on five of the eight transects, although no active pit-sawing was observed during this survey.

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 are stored on a Microsoft Access database in the EUCAMP library in Tanga, and parts of it are 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 International), 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 technical support from Metsähallitus Consulting .

Although a considerable amount of biological information exists from the East Usambaras much of this is restricted to the Amani area and systematic surveys elsewhere 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 Tanzanian national biodiversity database available at the UDSM.

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.

Evarist Nashanda
Project Manager

Dr V. 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 / Dr D. Stanwell-Smith
UDSM Co-ordinators: Prof. K. M. Howell and Dr M. 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: Henry Baumer, Daniel Bridges, Claire Bullen, Geoffrey Caesar, Michael Cheetham, Ben Deakin, Duncan Ellis, Sean Hill, Phil Hoolihan, Sally Huband, Helen Goddard, Edward Mannsaker, Andy Marshall, Barry Marston, Andrew Mellor, Paul Monteith, Ben Moody, Claire Percy, Daniel Saer, Adam Seaward, Richard Silcock, Vicky Stanley, Angie Stephenson, Jon Stokes, Sam Thompson, Olivia Scholtz and Amy Wilson.

Project Co-ordinator: Nike Doggart
Assistant Research Co-ordinator: Kathryn Doody, Roy Hinde and Liana Joseph
Logistics Co-ordinator: James Davey
Field Assistants: Hassani Abadi, Ramathan Rajabu and Zahara Rashidi.

EUCAMP: Raymond R. Kilenga, Albert Ntemi, Rashidi Shughuli, Restiel Materu, Emmanuele Msoffe and Seleman Hamad.

TECHNICAL SUPPORT

We would also like to thank the following staff:

UDSM: Prof. K. M. Howell and Dr C. Msuya, Department of Zoology and Marine Biology.

TAFORI: Ahmed Mndolwa and Iddi Rajabu, Botanists.

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

Authors: Kathryn Doody, Nike Doggart, Liana Joseph, Raymond Kilenga and Albert Ntemi.

Editorial Comments: Dr V. Pohjonen, Chief Technical Adviser for the East Usambara Conservation Area Management Programme; Prof. K. M. Howell from the University of Dar es Salaam and Dr D. Stanwell-Smith, SEE. Neil Burgess, Technical

Advisor for the Uluguru Mountains Biodiversity
Conservation Project.

1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara 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. Due to their age, isolation and their role as condensers of the moisture from the Indian Ocean, the East Usambara Mountains support ancient and unique forests, rich in endemic species (Hamilton, 1989).

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 (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). Many are threatened with extinction (Rodgers, 1996).

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 deterioration in water quality due to siltation.

The latest survey of the East Usambaras, conducted by Johansson & Sandy (1996) shows that approximately 45,137 ha of the East Usambaras remain as natural forest. This can be divided into two types: submontane rain 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 Zanzibar 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, *Beomys hindoi* 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 Kwangumi Forest Reserve (Broadley, 1995) and a new amphibian species *Stephopaedes usambarae* (Poynton, 1999) has been recorded by the surveys in Mtai and Kwangumi 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*; Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertoni*; 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, 1991).

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

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 <i>et al.</i> (1996) |
| Reptiles: | Howell (1993) and Broadley and Howell (1991). |

Amphibians: Howell (1993)
Butterflies: Kielland (1990) and Larsen (1996)

The IUCN category of threat 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 that they represent. In those plots where no spot is shown, the relevant taxa were not surveyed.

1.4 Data and monitoring

Data are stored in a Microsoft Access database (version 97), currently stored at the East Usambara Conservation Area Management Programme, Frontier-Tanzania and at the University of Dar es Salaam. Parts of it will shortly be available on the Internet. Zoological data are also stored on the National Biodiversity Database at the University of Dar es Salaam. This is also a Microsoft Access database. These data are geographically referenced and so can be used as a baseline for biodiversity monitoring.

1.5 Survey period and personnel

The survey of Segoma Forest Reserve was conducted in January 1998 and between July and September 1998 for a total of 78 research-days. The survey was conducted by Frontier-Tanzania staff, Catchment Forest Officers, expatriate 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 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 six forests of the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.25% of the area of each forest reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, 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 invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against IUCN categories of threat and other conservation criteria 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:	Segoma Forest Reserve Muheza District, Tanga Region, Tanzania.
Area:	1168.2 ha (including proposed extended area: 1933.8 ha)
Status:	Central Area Forest Reserve Gazetted 1955, Gazettement notice GN 113
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 220

3.1.2 Location

Lat/Long:	38°43'E –38°47'E, 4° 57S - 5° 01S
Elevation:	80 – 920m above sea level (a.s.l.)

Segoma Forest Reserve is situated in the central area of the East Usambaras northern forests, (Figure 1) on the northern side of the River Sigi and east of the Muzi River, approximately 40 km from Tanga. This reserve forms part of a forest continuum with the adjoining Kwangumi and Bamba Ridge Forest Reserves. Kwangumi F.R. is continuous along the entire northern boundary of Segoma F.R. and Bamba Ridge F.R forms the eastern boundary.

3.1.3 Topography

The reserve encompasses the catchment basin for tributaries of the Sigi river. The Sigi river is the main catchment river of the East Usambara mountains. On the eastern border lies Muhinduro Peak of Bamba Ridge Forest Reserve. The north eastern corner of the reserve rises to Segoma Peak. (See Figure 2) The Muzi River marks some of the western border of the reserve.

3.1.4 Land use

The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results for Segoma Forest Reserve are summarised in Table 3 below. The majority of Segoma Forest Reserve can be classified as lowland forest.

Table 3 Land use distribution in Segoma Forest Reserve (Johansson & Sandy, 1996).

Land use categories	Area (ha)	Percent (%)
Lowland forest	1,840.4	98.0
Submontane forest	11.2	0.6
Peasant cultivation	0.7	0.04
Ponds and rivers	1.5	0.08
Barren land	23.5	1.25
Total for the reserve:	1877.3	100.0

Note: The area surveyed by Johansson & Sandy is slightly different in area to the proposed forest extension.

3.1.5 History and Status

There has been human pressure on the East Usambara Mountains for at least 2000 years. In the 19th Century it appears populations were markedly lower in the East Usambaras relative to the West Usambaras with much of the area remaining forested. There are no records of settlements ever being established at higher elevations in Segoma Forest Reserve, however, at lower elevations there has been logging and cultivation.

In 1955, during the British colonial period, the 1168.2 ha of Segoma Forest Reserve was gazetted. At this time the primary access road to Tanga ran through the reserve along the Muzi River. This road is no longer in use and is impassable.

Since 1993 there have been proposals to extend Segoma F.R. by 765 ha to include the abandoned oil palm and citrus plantation in the south east of the reserve. This area was included in the biodiversity survey although it has not been gazetted as a forest reserve. There have also been proposals to amalgamate Kwangumi, Bamba and Segoma Forest Reserves into one forest reserve. Gazettement of this single, extended forest reserve awaits a detailed survey of the forest boundary.

The plantation in the proposed south-east extension of the reserve primarily consists of citrus and oil palm. There are also rubber, cocoa and jack fruit trees. Products from these trees are no longer harvested commercially. Within the proposed extension there remains a grove of nutmeg trees which were still being managed and harvested at the time of the biodiversity survey. The estate's factory and network of roads are still visible although the forest is rapidly reclaiming the area. Close to the border with Bamba Forest Reserve there is a small reservoir formerly used for irrigating the plantation.

When the original company who planted the estate ran into difficulties the land was taken over by the Shirika la Wilaya Muheza la Maendeleo. Subsequently it was bought by a company called Swiftcom. Agreements have now been reached between Swiftcom and EUCAMP for the transfer of the land into the forest reserve. Gazettement of the forest extension into a government forest reserve awaits the final mapping of the boundary.

During the late 1980s Sikh Saw Mills a nationally owned subsidiary of the Tanzanian Wood Industry Corporation logged the forest and logging tracks are still evident.

Segoma Forest Reserve has cultural significance to the villager's as parts of the forest are an ancestral worship site. There are numerous tales about the forest being inhabited by willo-the-wisps and other spirits.

A number of other researchers have visited the reserve recently including Westergaard (1994) and a Cambridge University Expedition (1994).

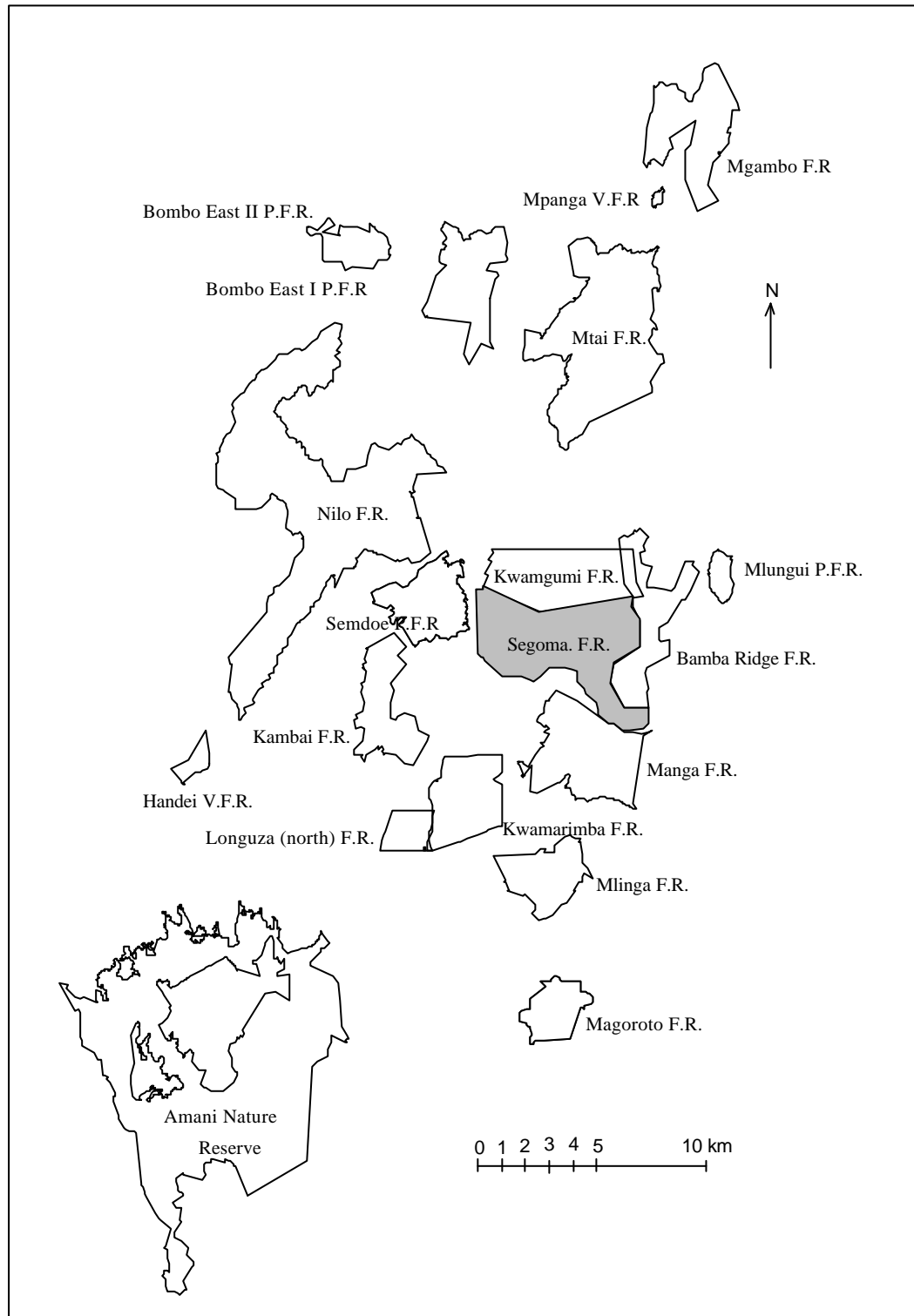


Figure 1 The location of Segoma Forest Reserve (including proposed extension) in relation to other East Usambara forests.

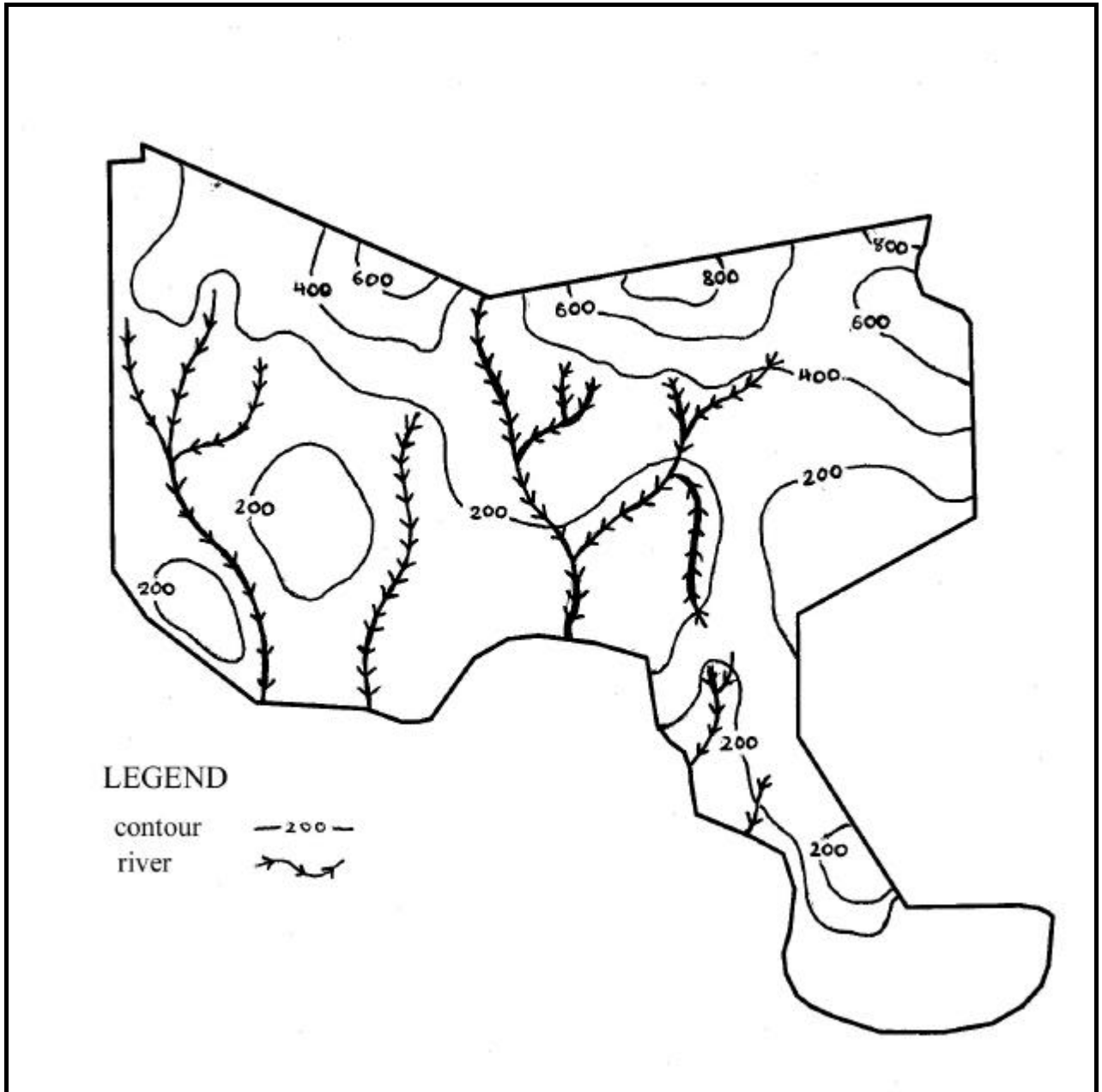


Figure 2 Topographical map of Segoma Forest Reserve (m asl).

4.0 VEGETATION

By Kathryn Doody, Raymond Kilenga and Albert Ntemi

4.1 Introduction

An inventory was conducted of the trees and shrubs found within the reserve. Simple, quantitative and repeatable methods were employed and the results are comparable with other forest surveys undertaken by FT FRP. Human disturbance within the forest was also documented. Botanical and disturbance data collected by this survey have been entered onto the EUCAMP database.

4.2 Methods

The forest block is divided into a grid of numbered rectangles 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. The location of vegetation plots and disturbance transects are illustrated in Figure 3.

4.2.1 Forest composition

Two methods were used to analyse forest composition and a third to assess disturbance: (1) quantitative vegetation analysis; (2) opportunistic observations and (3) disturbance transects.

4.2.1.1 *Quantitative vegetation analysis*

The botanical survey was based on a 450m x 900m grid marked in the field using tagged transect lines. One plot 50m x 20m was sampled in each grid square, giving an approximate sampling intensity of 0.25%. Within each sample plot, every tree with a dbh (diameter at breast height) of 10cm and over was recorded, tagged and identified. Botanists from the Tanzanian Forestry Research Institute (TAFORI) provided the field identification of plant species.

The regeneration layer was recorded within 3m x 3m plots at the centre of each vegetation plot. All plants with a dbh below 10cm 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 were used to record the intensity of pole cutting and logging in a forest block. The disturbance transects were based on the 450m x 900m grid prepared for the vegetation plots. Each transect running north-south was sampled from border to border. Disturbance was recorded by 50m section along the transect.

Every self-standing tree and sapling (i.e. not lianas or creepers) above 5cm dbh was measured within an area 5m either side of each transect line. 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 15cm and a minimum of 2m relatively straight trunk. Timber is classified as having a dbh > 15cm with a minimum 3m relatively straight trunk. These divisions are based on differences in use. Timber and pole cutting data are presented as an average per hectare.

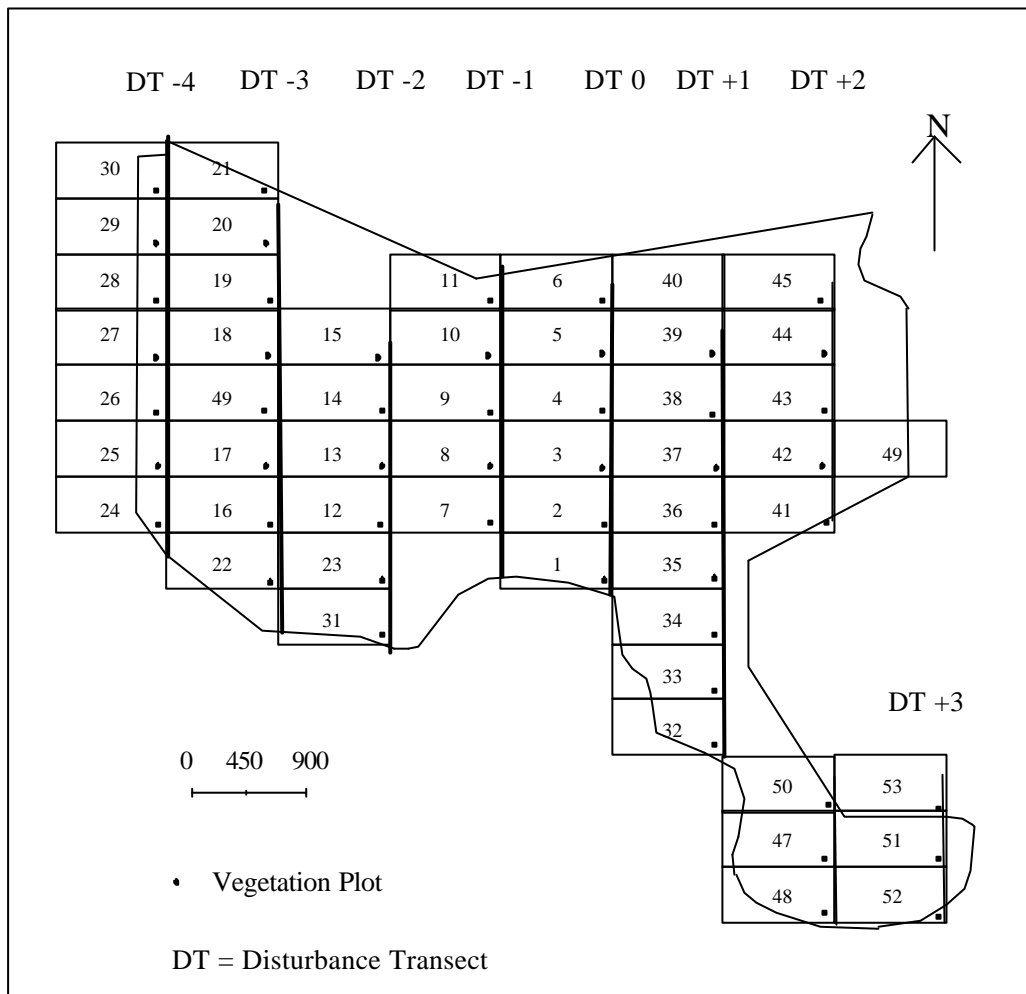


Figure 3 Location of vegetation plots and disturbance transects in Segoma F.R..

4.3 Results

4.3.1 Quantitative vegetation analysis

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

Table 4 Checklist of trees and shrubs.

Species	Ecological type	Habitat ²	Endemic status
ANACARDIACEAE			
<i>Lannea schweinfurthii</i>	F	L&S	W
<i>Lannea welwitschii</i>	F	L	N
<i>Rhus natalensis</i>	f	L&S	W
* <i>Sorindeia madagascariensis</i>	f	S&L	W
ANNONACEAE			
<i>Annona senegalensis</i>	f	S&L	W
<i>Enantia kummeriae</i>	F	S	N
<i>Lettowianthus stellatus</i> ¹	f	S&L	N
<i>Monodora grandidieri</i>	f	L&S	N
<i>Uvariadendron gorgonis</i>	f	S	N
* <i>Xylopia parviflora</i>	f	L	W
APOCYNACEAE			
* <i>Funtumia africana</i>	F	L&S	W
<i>Holarrhena febrifuga</i> ¹	f	L&S	W
* <i>Tabernaemontana ventricosa</i>	F	L	W
* <i>Voacanga thouarsii</i>	f	L&S	W
BIGNONIACEAE			
* <i>Fernandoa magnifica</i>	f	L	N
* <i>Markhamia lutea</i>	f	L&S	W
<i>Stereospermum kunthianum</i>	f	L&S	W
BOMBACACEAE			
<i>Bombax rhodognaphalon</i>	f	L	N
<i>Ceiba pentandra</i>	f	S	W
BORAGINACEAE			
<i>Ehretia cymosa</i>	f	L&S	W
BURSERACEAE			
<i>Commiphora eminii zimmermannii</i>	f	L	W
CELASTRACEAE			
<i>Maytenus undata</i>	f	S	W
<i>Maytenus sp.</i>			
<i>Salacia lehmbachii var. usambarensis</i>	F	L&S	N
COMBRETACEAE			
<i>Combretum padoides</i>	f	L&S	W
* <i>Combretum schumannii</i>	f	L	N
* <i>Terminalia sambesiaca</i>	f	L	W
DRACAENACEAE			
* <i>Dracaena steudneri</i> ¹	f	S (forest gaps)	W

Table 4 continued.

Species	Ecological type	Habitat ²	Endemic status
EBENACEAE			
* <i>Diospyros kabuyena</i>	f	S	N
<i>Diospyros mespiliformis</i>	f	L	W
* <i>Diospyros natalensis</i>	f	L	W
* <i>Diospyros squarrosa</i> ¹	F	L	W
EUPHORBIACEAE			
<i>Antidesma membranaceum</i>	F	L&S	W
<i>Bridelia cathartica melanthesoides</i>	F	L&S	W
<i>Bridelia micrantha</i>	f	L&S	W
<i>Croton sylvaticus</i>	f	L	W
<i>Drypetes usambarica</i>	f	S	N
<i>Macaranga capensis</i>	F	L&S	W
		(forest gaps)	
<i>Margaritaria discoidea</i>	f	S	W
* <i>Manihot glaziovii</i>	?	L&S	W
			(Introduced species)
* <i>Mildbraedia carprinifolia</i>	f	L&S	N
* <i>Ricinodendron heudelotii</i>	f	L	W
<i>Ricinus communis</i>	f	L&S	W
<i>Sapium ellipticum</i>	f	L & S	W
<i>Suregada zanzibarensis</i>	f	L	W
FLACOURTIACEAE			
<i>Ludia mauritiana</i>	f	L&S	W
GUTTIFERAE			
<i>Harungana madagascariensis</i>	F	S	W
LECYTHIDACEAE			
<i>Barringtonia racemosa</i>	f	L	W
LEGUMINOSAE: CAESALPINACEAE			
<i>Cynometra sp.</i>			
* <i>Dialium holtzii</i>	f	L	N
<i>Erythrophleum suaveolens</i>	F	L	W
<i>Julbernardia magnistipulata</i>	f	L	N
* <i>Scorodophloeus fischeri</i>	f	L	N
* <i>Senna siamea</i> ¹			
LEGUMINOSAE: MIMOSACEAE			
<i>Acacia robusta</i>	f	?	W
<i>Albizia adianthifolia</i>	f	L&S	W
<i>Albizia anthelmentica</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 saman</i> ¹			
<i>Albizia zimmermanni</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
LEGUMINOSAE: PAPILIONACEAE			
<i>Erythrina caffra</i> ¹	O	S	W
<i>Millettia oblata intermedia</i>	F	S	N
<i>Millettia usambarensis</i>	O	L	N

Table 4 continued.

Species	Ecological type	Habitat ²	Endemic status
<i>Pterocarpus mildbraedii</i>	F	L	N
* <i>Pterocarpus tinctorius</i>	F	S & L	W
MELIACEAE			
<i>Trichilia dregeana</i>	f	L	W
<i>Trichilia emetica</i>	f	L&S	W
MORACEAE			
* <i>Antiaris toxicaria</i>	f	L & S	W
<i>Artocarpus heterophyllus</i>	O	?	W
			(Introduced species)
<i>Castilla elastica</i>	?	?	W
			(Introduced species)
<i>Ficus exasperata</i>	f	L & S	W
<i>Ficus lutea</i>	f	L	W
* <i>Ficus sur</i>	f	L&S	W
* <i>Ficus sycomorus</i>	f	L	W
<i>Ficus vallis-choudae</i>	f	L	W
<i>Milicia excelsa</i>	f	L & S	W
* <i>Slotiopsis usambarensis</i>	F	L	W
* <i>Trilepisium madagascariensis</i>	f	L & S	W
MYRTACEAE			
<i>Psidium guajava</i>	f	L	W
OCHNACEAE			
<i>Ochna macrocalyx</i>	f	?	W
PALMAE			
<i>Elaeis guineensis</i> ¹ (oil palm)	F	L&S	W
PITTOSPARAECIAE			
<i>Pittosporum viridiflorum</i>	f	S	W
RHAMNACEAE			
<i>Maesopsis eminii</i>	F	S&L	W
			(Introduced species)
<i>Ziziphus pubescens</i>	f	L	W
<i>Ziziphus mucronata</i>	O	L	W
RUBIACEAE			
* <i>Coffea robusta</i> ¹	O	L&S	W
<i>Hallea rubrostipulata</i>	f	S	W
<i>Khaya anthotheica</i> ¹	F	L&S	W
<i>Leptactina platyphylla</i>	f	S	W
<i>Oxyanthus speciosus</i>	F	S (forest gaps)	W
<i>Polysphaeria multiflora</i>	F	L	W
<i>Psychotria griseola</i>	F	?	N
* <i>Rothmannia manganjae</i>	F	L&S	W
<i>Rytigynia flavida</i>	F	S	N
* <i>Rytigynia schumannii</i> ¹	?	?	?
<i>Rytigynia sp.</i> ¹	?	?	?
* <i>Tarenna pavettoides</i>	F	L&S	W
<i>Tarenna nigrescens</i> ¹	f	L	W
* <i>Tricalysia anomala</i>	F	S	N
<i>Tricalysia acidophylla</i>	f	L	N
<i>Tricalysia myrtifolia</i>	f	S	W

Table 4 continued.

Species	Ecol. type	Habitat ²	Endemic status
RUTACEAE			
* <i>Citrus aurantium</i> ¹	O	?	W
* <i>Citrus limon</i> ¹	O	?	W
<i>Parvetta sp.</i> ¹	?	?	?
* <i>Teclea nobilis</i>	f	S	W
<i>Teclea simplicifolia</i>	f	S	W
* <i>Teclea trichocarpa</i>	f	L&S	W
<i>Zanthoxylum usambarense</i>	F	S	W
SAPINDACEAE			
<i>Allophylus callophylus</i> ¹	f	S&L	W
* <i>Blighia unijugata</i>	F	L&S	W
* <i>Deinbollia kilimandscharica</i>	f	S	N
* <i>Lecaniodiscus fraxinifolius</i>	F	L	W
<i>Melanodiscus oblongus</i> ¹	f	L&S	W
* <i>Zanha golungensis</i>	F	L&S	W
SAPOTACEAE			
<i>Chrysophyllum gorungusunum</i>	F	S	W
* <i>Englerophytum natalense</i>	f	L&S	W
* <i>Malacantha alnifolia</i>	f	L&S	W
<i>Malacantha cerasiferum</i> ¹	?	?	?
* <i>Manilkara sulcata</i>	f	L	W
<i>Manilkara sansibarenensis</i> ¹	f	L	W
<i>Mimusopis kummel</i>	f	L	W
* <i>Pachystela msolo</i>	F	L&S	W
<i>Vincentella passargei</i>	f	L	W
STERCULIACEAE			
* <i>Cola clavata</i> ¹	F	L	W
* <i>Cola minor</i> ¹			
<i>Cola scheffleri</i>	F	L	E (EU)
<i>Dombeya rotundifolia</i> ¹	O	S	W
<i>Dombeya shupangae</i>	f	?	N
* <i>Leptonychia usambarenensis</i>	F	L	N
<i>Sterculia appendiculata</i>	F	L	W
<i>Tebroma cocoa</i> ¹	?	?	?
TILIACEAE			
<i>Grewia goetzeana</i>	f	L	N
* <i>Grewia holstii</i>	f	?	W
<i>Nesogordonia holtzii</i> ¹		L	N
ULMACEAE			
<i>Celtis africana</i>	F	L	W
* <i>Celtis gomphophylla</i>	F	L&S	W
<i>Celtis mildbraedii</i>	F	L&S	W
<i>Celtis wightii</i>	f	S	W
VERBENACEAE			
<i>Premna chrysoclada</i>	O	L	N
<i>Vitex keniensis</i>	F	S	W
VIOLACEAE			
* <i>Rinorea ferruginea</i>	F	S	W
<i>Rinorea sp.</i> ¹	?	?	?
* <i>Rinorea albersii</i> ¹	F	S	E

¹ Species which do not appear in Iversen (1991b). 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, 5 & 6.

Ecological type: (based on Iversen, 1991b)

- 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.
- ? - Unknown

Habitat: (based on Hamilton, 1989)

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

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, 1991b):

- 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 lowland forests;
- W - Widespread distribution.

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

Regeneration Layer

**Trema orientalis*: species recorded in the regeneration layer are marked with an asterisk.

In Table 5, ten species are listed which were recorded in the regeneration layer but not in the larger vegetation plots.

Table 5 Species recorded exclusively in the regeneration layer.

Species	Ecological type	Habitat	Endemic status
ARALIACEAE			
<i>Cussonia zimmermannii</i>	F	L	N
BURSERACEAE			
<i>Commiphora africana</i>	?	?	?
FLACOURTIACEAE			
<i>Grandidiera boivinii</i>	F	L&S	W
HERNANDIACEAE			
<i>Gyrocarpus americanus</i>	F	L	W
LEGUMINOSAE: PAPILIONACEAE			
<i>Millettia</i> sp.	?	?	?
OCHNACEAE			
<i>Ochna</i> sp.	?	?	?
RUBIACEAE			
<i>Tricalysia</i> sp.	?	?	?
SAPINDACEAE			
<i>Deinbolla</i> sp.	?	?	?
ULMACEAE			
<i>Trema orientalis</i>	F	L&S	W
MIMOSOIDEAE			
<i>Leucaena leucocephala</i>	O	L&S	W

Table 6 Summary of opportunistic botanical records.

Species	Ecological type	Habitat	Endemic status
ACANTHACEAE			
<i>Cyclanthus bipartitus</i> ¹²	?	?	?
<i>Thunbergia grandifolia</i>	F	S	W
ANACARDIACEAE			
<i>Mangifera indica</i>	F	L&S	W (introduced)
ANNONACEAE			
<i>Cananga odorata</i>	O	L	W (introduced)
<i>Polyceratocarpus scheffleri</i>	F	S&L	N
APOCYNACEAE			
<i>Schizogygia coffaeoides</i>	F	L	W
ARACEAE			
<i>Callopsiopsis volkensii</i>	F	L	W
<i>Monstera deliciosa</i> ¹²	?	?	W (introduced)
<i>Philodendron sagittifolium</i> ¹²	?	?	?
<i>Scindapsus aureus</i> ¹²	?	?	W
ARISTOLOCHIACEAE			
<i>Aristolochia brasiliensis</i> ¹²	F	?	W
BIGNONIACEAE			
<i>Tecomaria capensis</i>	O	L&S	W (introduced)
BURSERACEAE			
<i>Canarium mehenbethene</i> ¹²	?	?	?
CAESALPINICEAE			
<i>Glaricidia Sapium</i>	O	L	W (introduced)
COMBRETACEAE			
<i>Terminalia cattapa</i> ¹²	?	?	W
CYCADACEAE			
<i>Cycas revoluta</i> ¹²	?	?	?
CYCLANTHACEAE			
<i>Carludovica palmata</i> ¹²	?	?	?
EUPHORBIACEAE			
<i>Hevea brasiliensis</i>	O	?	W
<i>Homalanthus populifolius</i>	F	S	W
<i>Hura crepitans</i>	F	L&S	W
<i>Pycnocoma macrantha</i>	F	S&L	E (EU)
<i>Synadenium glaucescens</i>	O	L&S	N
<i>Tragia brevipes</i> ¹	F	L&S	W
FLAGELLARIACEAE			
<i>Flagellaria guineensis</i> ¹	O	L	W
GESNERIACEAE			
<i>Saintpaulia</i> sp.	?	?	?
GRAMINEAE			
<i>Bambusa bambosoides</i> ¹	F	?	W
<i>Bambusa vulgaris</i> ¹	F	?	W
LEGUMINOSAE-MIMOSOIDEAE			
<i>Derris elliptica</i> ¹²	?	?	W (introduced)
<i>Albizia chinensis</i>	F	?	W
<i>Entada pursaetha</i>	F	L	W
<i>Mimosa pudica</i>	F	L&S	W

Table 6 continued.

Species	Ecological type	Habitat	Endemic status
LEGUMINOSAE-PAPILIONOIDEAE			
<i>Desmodium</i> sp.	?	?	?
<i>Dolichus oliveri</i>	O	S	W
<i>Mucuna pruriens</i>	O	L&S	W
LILIACEAE			
<i>Aloe</i> sp.	?	?	?
MALVACEAE			
<i>Abutilon</i> sp.	?	?	?
MUSACEAE			
<i>Musa rosea</i> ¹²	?	?	?
<i>Musa</i> sp.	?	?	?
<i>Musa textiles</i> ¹²	?	?	?
MYRISTICACEAE			
<i>Myristica fragans</i>	O	?	W
OCHNACEAE			
<i>Brackenridgea zanguebarica</i>	F	S	W
OLEACEAE			
<i>Chionanthus mildbraedii</i> ²	F	?	W
PALMAE			
<i>Arenga pinnata</i> ¹²	?	?	W (introduced)
<i>Chrysalidocarpus madagascariensis</i> ¹²	?	?	?
<i>Roystenia oleracea</i> ¹²	?	?	W (introduced)
PANDANACEAE			
<i>Pandanus stuhlmannii</i> ²	O	S	W
PIPERACEAE			
<i>Piper betle</i>	O	L	W
<i>Piper nigrum</i>	O	S&L	W
RUTACEAE			
<i>Citrus aurantifolia</i>	Cultivated	?	W (introduced)
<i>Citrus medica</i>	Cultivated	?	W (introduced)
<i>Citrus paradisi</i>	Cultivated	?	W (introduced)
<i>Citrus reticulata</i>	Cultivated	?	W (introduced)
<i>Citrus sinensis</i>	Cultivated	?	W (introduced)
SIMAROUBACEAE			
<i>Harrisonia abyssinica</i>	F	?	W
SOLANACEAE			
<i>Capsicum</i> spp.	?	?	?
STERCULIACEAE			
<i>Cola usambarensis</i>	F	S	E (EU)
VERBENACEAE			
<i>Stachytarpheta jamaicensis</i>	O	L	W
<i>Tectona grandis</i>	?	?	W
ZAMIACEAE			
<i>Encephalartos hildebrandtii</i>	F	?	W

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

² Species which do not occur in the LEAP database (Knox, 2000).

Species accumulation rate of trees and shrubs recorded in vegetation plots:

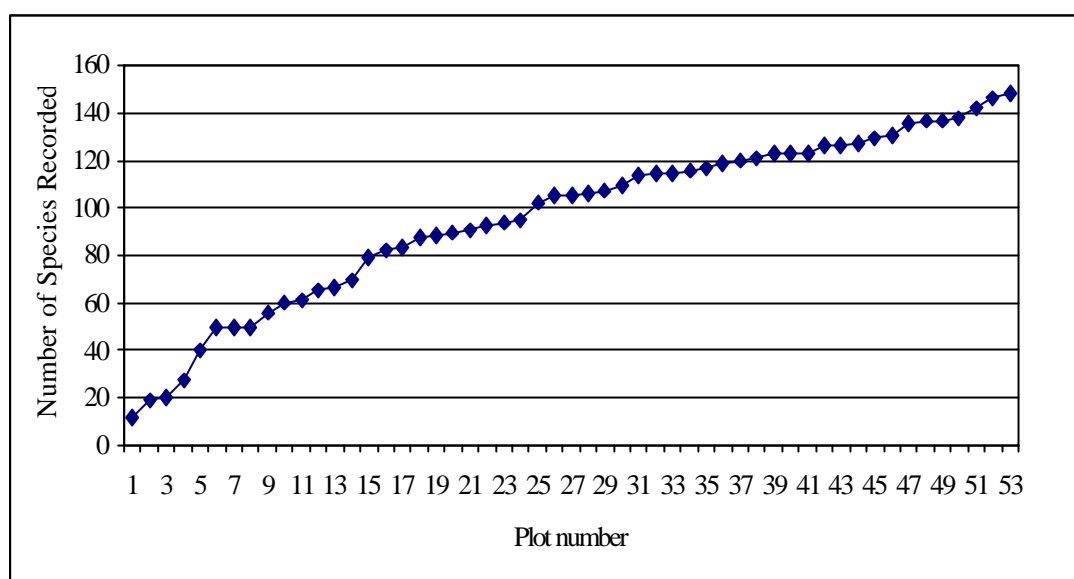


Figure 4 Species accumulation rate of recorded species by vegetation plot.

In 1986 - 1987 a botanical survey was conducted in the East Usambaras (Ruffo et al. 1989). 32 species recorded in Segoma by the current survey were not recorded by Ruffo *et al.* in Segoma 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 ¹
<i>Albizia glaberrima</i>	Southern and northern parts of main range, Longuza Forest Reserve, Mlinga and Mtai
<i>Barringtonia racemosa</i>	Southern part of main range, Longuza Forest Reserve, Mlinga and Mtai
<i>Bridelia micrantha</i>	Southern part of main range, Lutindi Forest Reserve, Longuza Forest Reserve and Mlinga
<i>Chrysophyllum gorungusunum</i>	Southern and northern parts of the reserve and Mtai
<i>Commiphora eminii zimmermannii</i>	Northern part of main range and Mtai
<i>Deinbolla kilimandscharica</i>	Southern part of main range and Sigi valley area
<i>Dombeya shupangae</i>	Northern part of main range
<i>Drypetes usambarica</i>	Southern and northern parts of main range, Marimba and Mlinga
<i>Ehretia cymosa</i>	Southern and northern parts of main range
<i>Erythrophleum suaveolens</i>	Southern part of main range, Longuza Forest Reserve, and Mtai
<i>Ficus lutea</i>	Southern and northern parts of main range, Longuza Forest Reserve
<i>Grewia holstii</i>	Longuza Forest Reserve
<i>Hallea rubrostipulata</i>	Southern part of main range
<i>Harungana madagascariensis</i>	Southern and northern parts of main range, Longuza Forest

Reserve and Mlinga

Table 7 continued.

Species	Location as previously recorded ¹
<i>Julbernardia magnistipulata</i>	Southern part of main range, and Longuza Forest Reserve
<i>Leptactina platyphylla</i>	Southern part of main range
<i>Lettowianthus stellatus</i> ¹	Southern part of main range
<i>Manilkara sulcata</i>	Northern parts of main range and Longuza Forest Reserve
<i>Maytenus undata</i>	Northern part of main range
<i>Mildbraedia carprinifolia</i> (syn. <i>M. fallax</i>)	Marimba
<i>Monodora grandidieri</i>	Longuza Forest Reserve
<i>Newtonia buchananii</i>	Southern and northern parts of main range, Longuza Forest Reserve, Mlinga and Mtai
<i>Oxyanthus speciosus</i>	Southern part of main range, Longuza Forest Reserve and Mlinga
<i>Pittosporum viridiflorum</i>	Not seen during Ruffo survey 1989
<i>Pterocarpus tinctorius</i>	Southern and northern parts of main range, Longuza Forest Reserve, and Mlinga
<i>Rothmannia manganjae</i>	Southern and northern parts of main range, Longuza Forest Reserve and Mtai
<i>Teclea simplicifolia</i>	Lutindi Forest Reserve and Mtai
<i>Teclea trichocarpa</i>	Not seen during Ruffo survey 1989, but known from Longuza Forest Reserve
<i>Vincentella passargei</i>	Mtai
<i>Voacanga thouarsii</i>	Kwamkoro Forest Reserve and Amani Sigi Forest Reserve
<i>Ziziphus mucronata</i>	Mtai
<i>Ziziphus pubescens</i>	Mtai

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

Ecological type (refer to figures 5,6,7 and 8):**Table 8** Summary of ecological type for tree and shrub species (based on Table 4).

Ecological Type	Number of species	% of total number of species	Number of individuals	% of total number of individuals
(F) Forest dependent species	41	27.7	699	33.1
(f) Non-forest dependent species	84	56.8	1150	54.4
(O) Non-forest species	9	6.1	184	8.7
Unknown	14	9.5	81	3.8
Total:	148	100.0	2114	100.0

Habitat (refer to Figures 9 and 10):**Table 9** Summary of habitat for tree and shrub species (based on Table 4).

Habitat	Number of species	% of total number of species	Number of individuals	% of total number of individuals
(L) Lowland Species	92	62.2	1686	79.7
(S) Submontane Species	36	24.3	247	11.7
Unknown	20	13.5	181	8.6

Total:	148	100.0	2114	100.0
---------------	------------	--------------	-------------	--------------

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

Species	Lowest Recorded Altitude (metres)
<i>Albizia gummifera</i>	125
<i>Allophylus callophylus</i>	110
<i>Annona senegalensis</i>	105
<i>Ceiba pentandra</i>	125
<i>Celtis wightii</i>	160
<i>Chrysophyllum gorungusunum</i>	160
<i>Deinbolla kilimandscharica</i>	80
<i>Diospyros kabuyeana</i>	160
<i>Dombeya rotundifolia</i>	215
<i>Dracaena steudneri</i>	182
<i>Drypetes usambarica</i>	140
<i>Enantia kummeriae</i>	160
<i>Erythrina caffra</i> (syn. <i>E. lysistemom</i>)	125
<i>Hallea rubrostipulata</i>	340
<i>Harungana madagascariensis</i>	340
<i>Leptactina platyphylla</i>	120
<i>Lettowianthus stellatus</i>	105
<i>Maesopsis eminii</i>	110
<i>Margaritaria discoidea</i>	215
<i>Maytenus undata</i>	100
<i>Millettia oblata intermedia</i>	160
<i>Newtonia buchananii</i>	125
<i>Oxyanthus speciosus</i>	160
<i>Pittosporum viridiflorum</i>	105
<i>Pterocarpus tinctorius</i>	135
<i>Rinorea albersii</i>	200
<i>Rinorea ferruginea</i>	80
<i>Rytigynia flavida</i>	340
<i>Sorindeia madagascariensis</i>	105
<i>Teclea nobilis</i>	240
<i>Teclea simplicifolia</i>	115
<i>Tricalysia anomala</i>	80
<i>Tricalysia myrtifolia</i> syn <i>T. pallens</i>	200
<i>Uvariadendron gorgonis</i>	125
<i>Vitex keniensis</i> (syn. <i>V. balbi</i>)	135
<i>Zanthoxylum usambarense</i>	160

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

Table 11 Summary of endemic status for tree and shrub species (based on Table 4).

Endemic status	Number of species	% of total number of species	Number of individuals	% of total number of species
(E) Endemic	2 (1-EU)*	1.4	13	0.6
(N) Near Endemic	29	19.6	351	16.6
(W) Widespread	106	71.6	1694	80.1
Unknown	11	7.4	56	2.6
Total:	148	100.0	2114	100.0

* EU - East Usambara mountains

Timber value

Formerly logging was permitted in Segoma Forest Reserve. Table 10 lists the most commonly extracted trees (Ruffo, 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
<i>Milicia excelsa</i>	18	35	39	1.8
<i>Khaya anthotheica</i>	1	2	2	0.1
<i>Newtonia buchananii</i>	1	2	2	0.1
<i>Ocotea usambarensis</i>	0	0	0	0

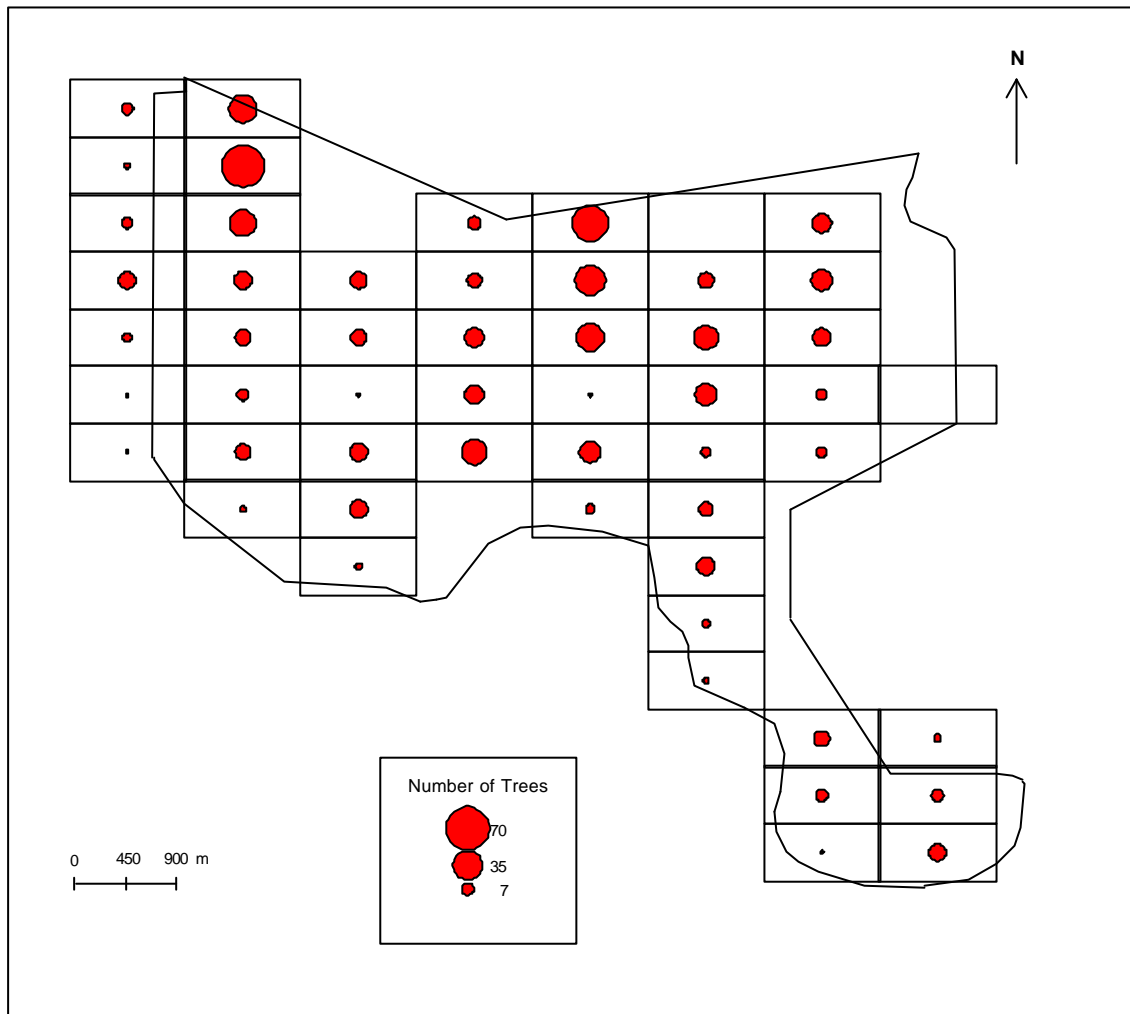


Figure 5 Distribution of forest dependent tree and shrub individuals in Segoma F.R..

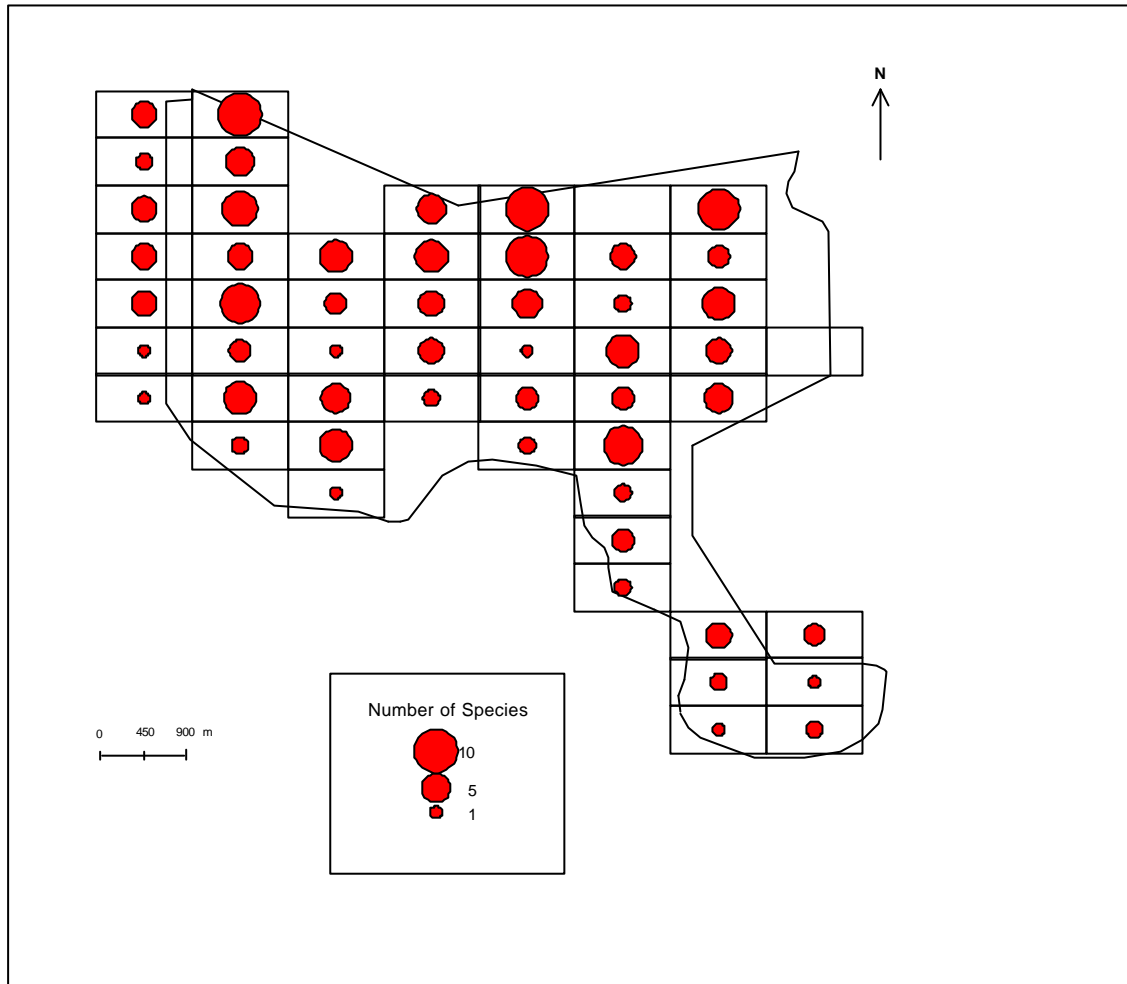


Figure 6 Distribution of forest dependent tree and shrub species in Segoma F.R..

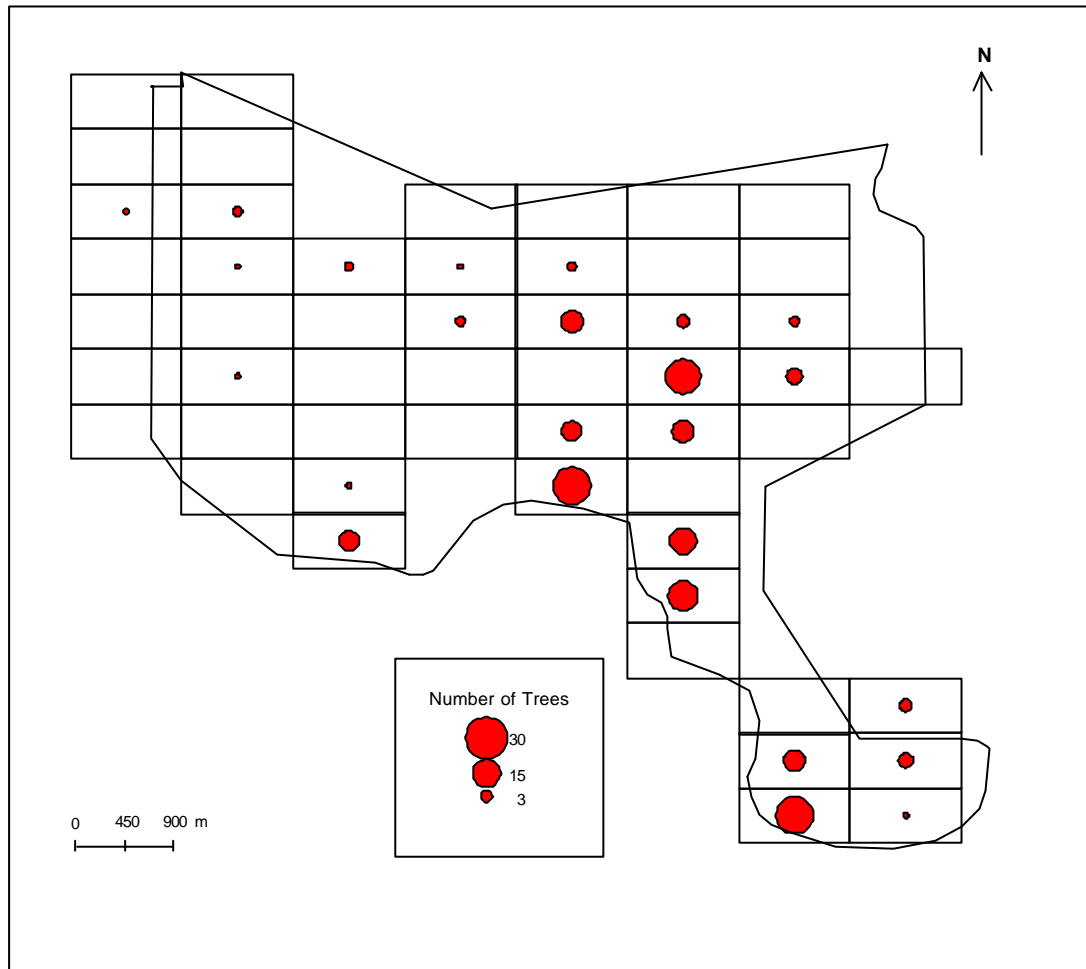


Figure 7 Distribution of non-forest tree and shrub individuals in Segoma F.R..



Figure 8 Distribution of non-forest tree and shrub species in Segoma F.R..

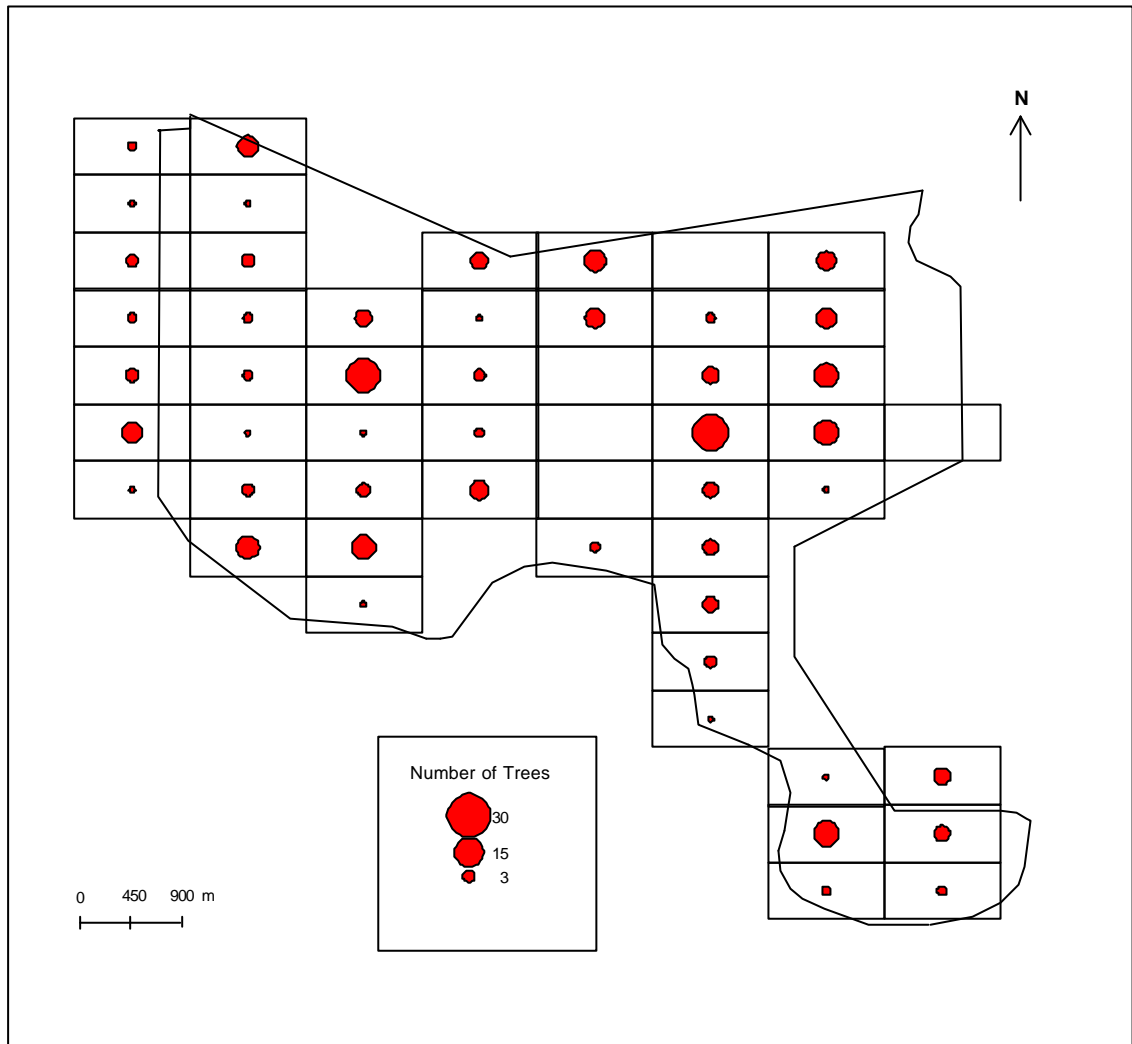


Figure 9 Distribution of submontane tree and shrub individuals in Segoma F.R..

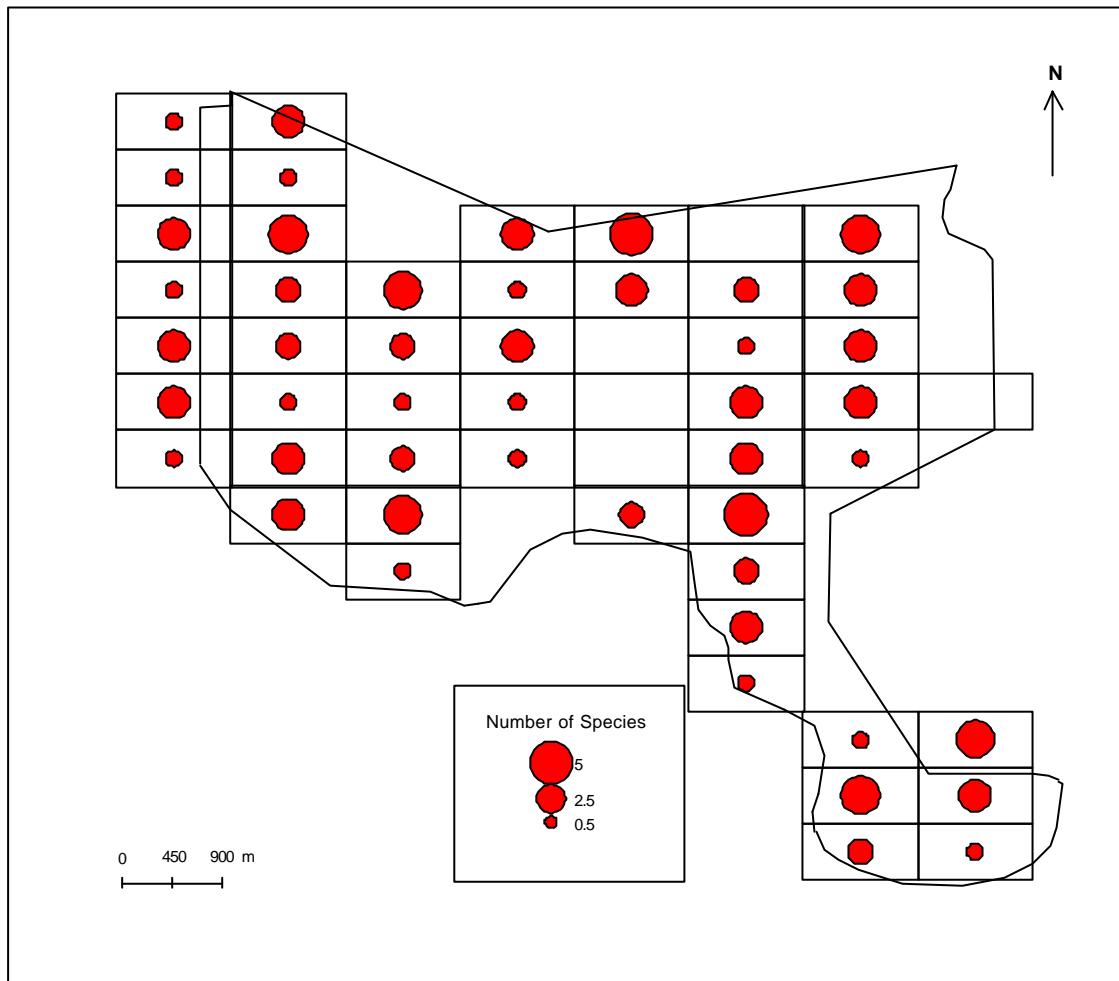


Figure 10 Distribution of submontane tree and shrub species in Segoma F.R..

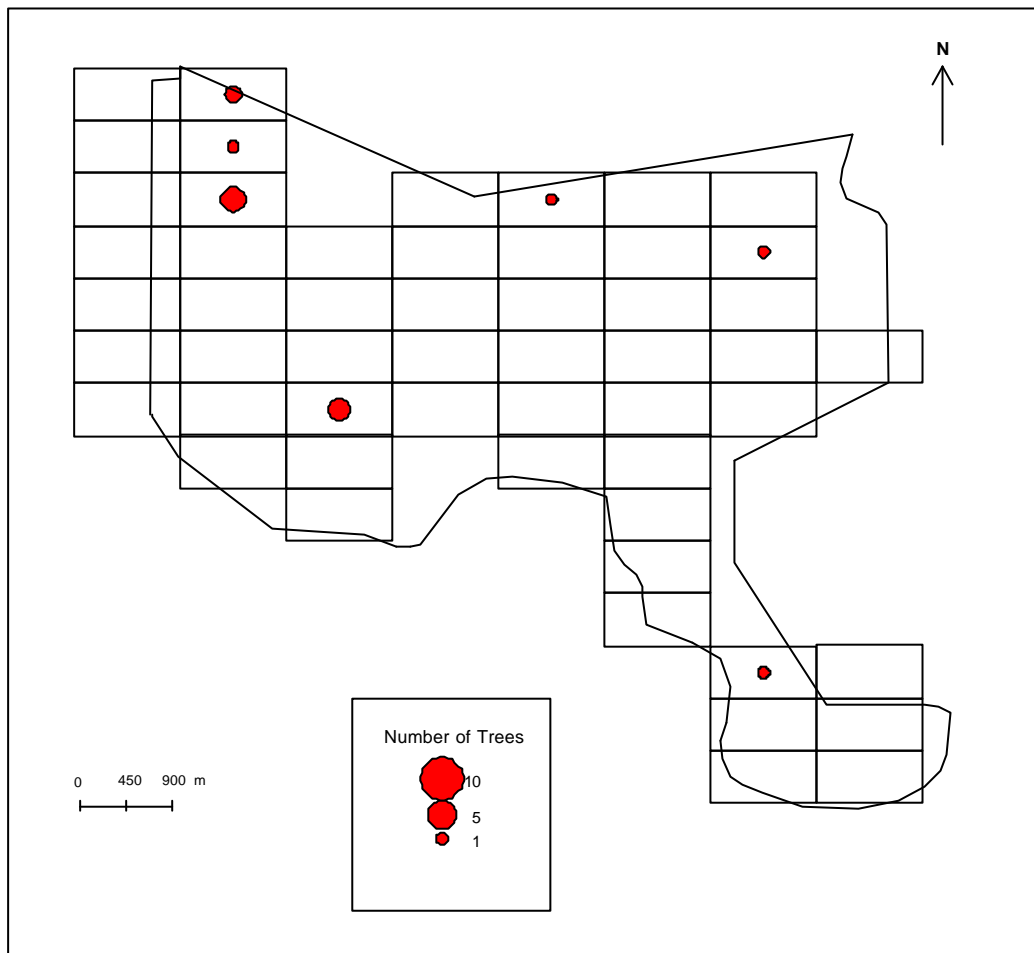


Figure 11 Distribution of endemic tree and shrub individuals in Segoma F.R..

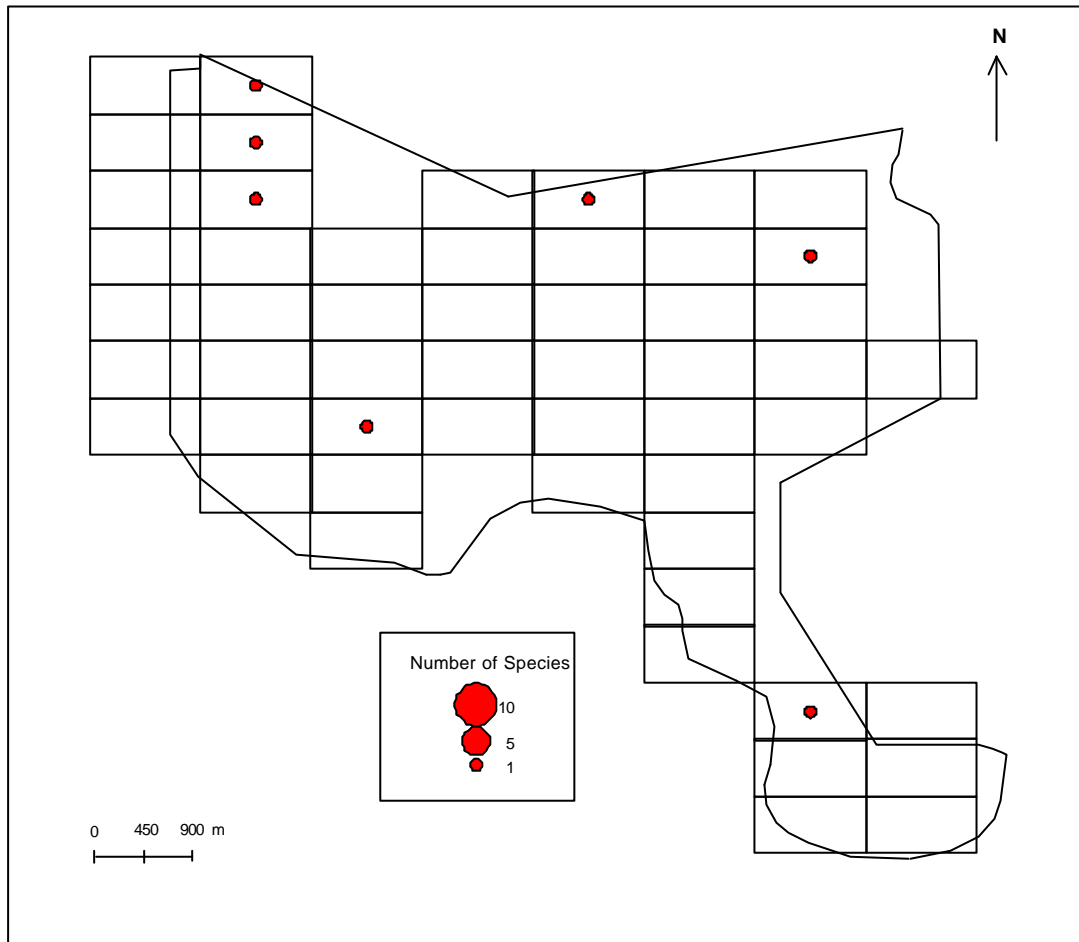


Figure 12 Distribution of endemic tree and shrub species in Segoma F.R..

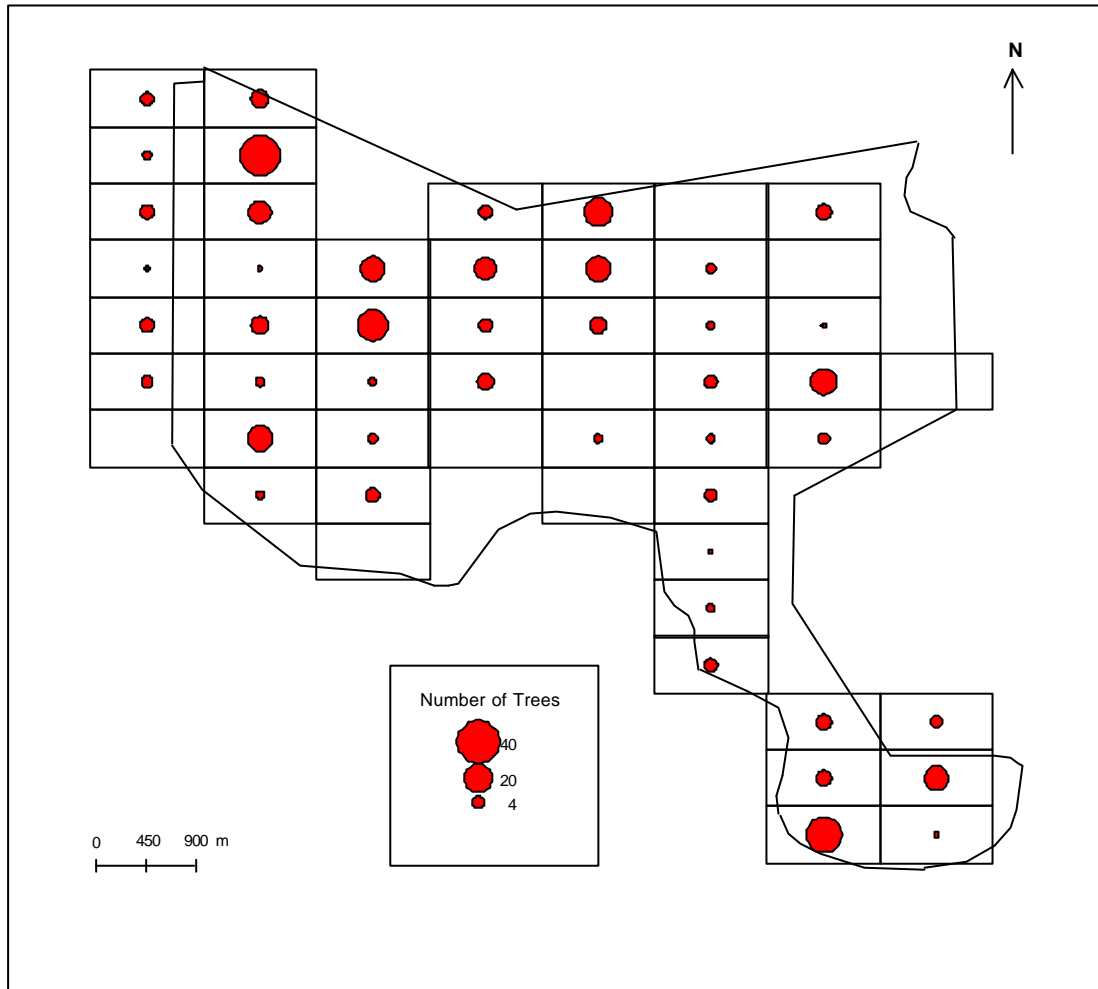


Figure 13 Distribution of near-endemic tree and shrub individuals in Segoma F.R..

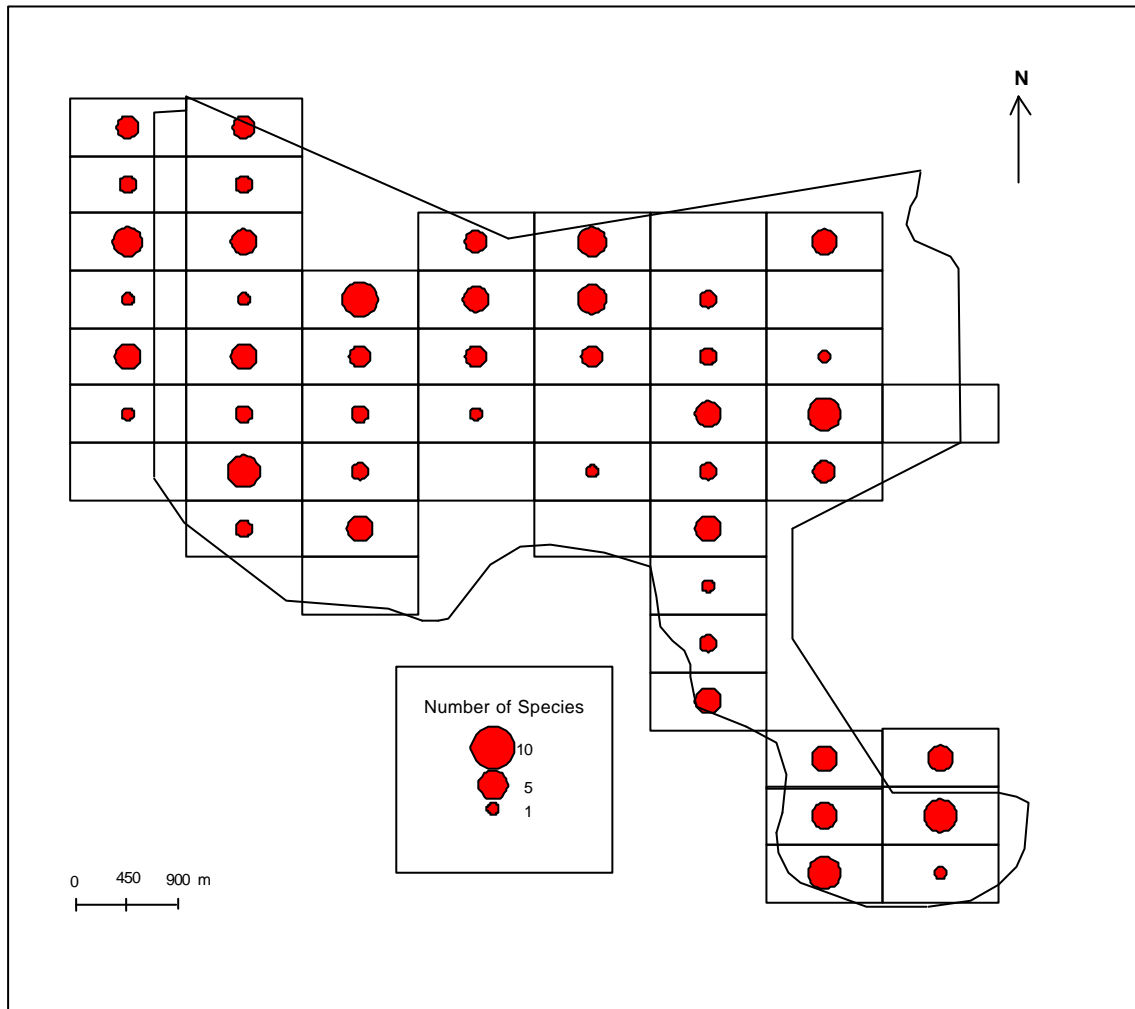


Figure 14 Distribution of near-endemic tree and shrub species in Segoma F.R..

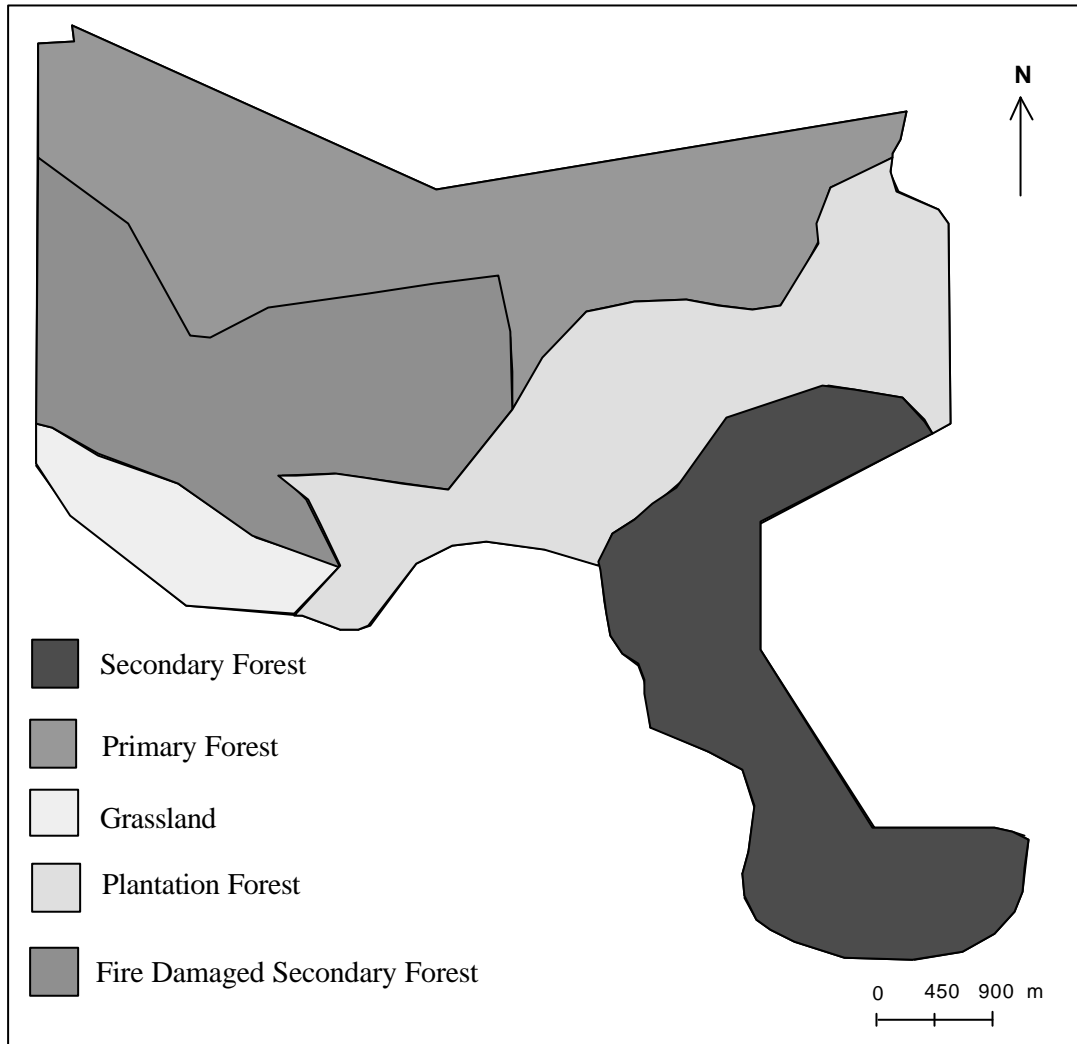


Figure 15 Vegetation of Segoma Forest Reserve.

4.3.2 Disturbance transects

Pole and timber extraction was recorded along all eight transects. The results are summarised in Table 13 for poles and Table 14 for timber. The term pole refers to all stems 5 – 15cm dbh, the term timber refers to stems > 15cm dbh. Other disturbances recorded systematically are discussed in the summary.

Table 13 Disturbance transect results for pole counts.

Transect number	Length of transect (m)	Total poles sampled	Standing poles	Cut poles	Average cut poles per ha	Naturally fallen poles	Average fallen poles per ha
-4	3000	1042	867	13	4.3	162	54.0
-3	3600	1862	1589	5	1.4	268	74.4
-2	2670	1239	862	23	8.6	354	132.6
-1	2250	1434	1163	2	0.9	269	119.6
0	2450	2451	2238	23	9.4	190	77.6
1	3750	2391	2064	14	3.7	313	83.5
2	3350	2543	2245	8	2.4	290	86.6
3	1550	917	779	5	3.2	133	85.8

Note: A pole is defined as 5-15cm dbh with 2m straight trunk.

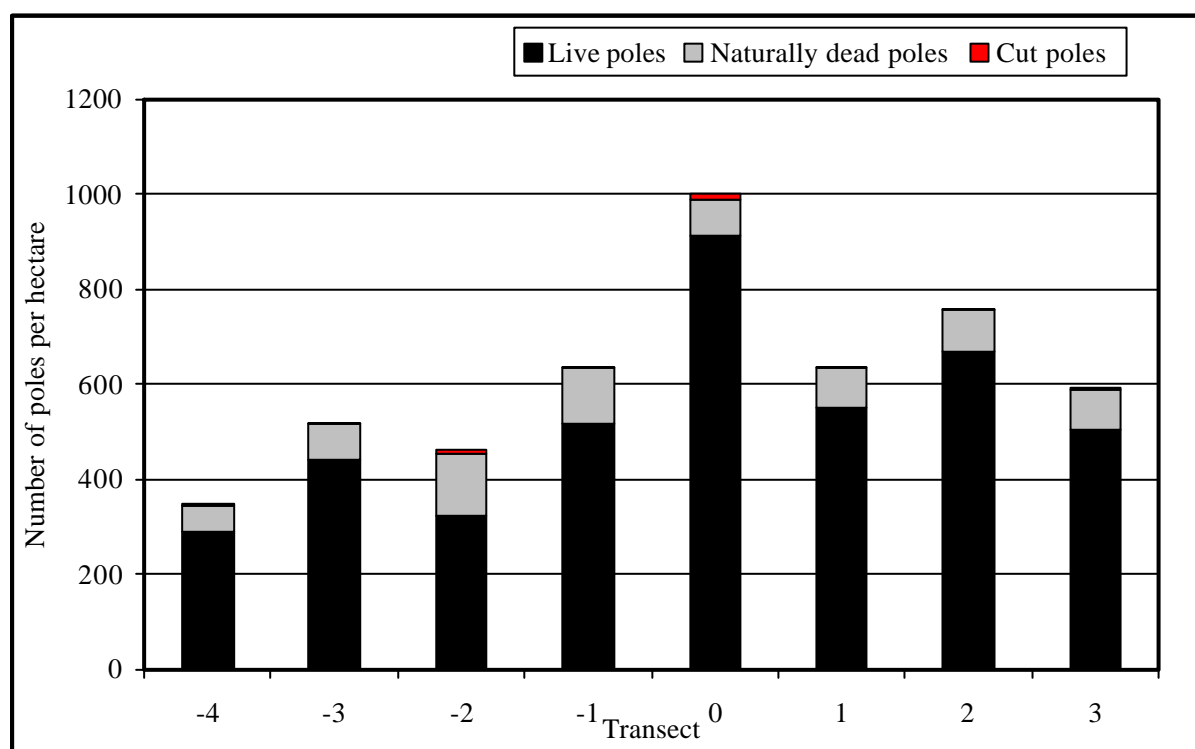


Figure 16 The relative abundance of live, naturally dead and cut poles in Segoma F.R..

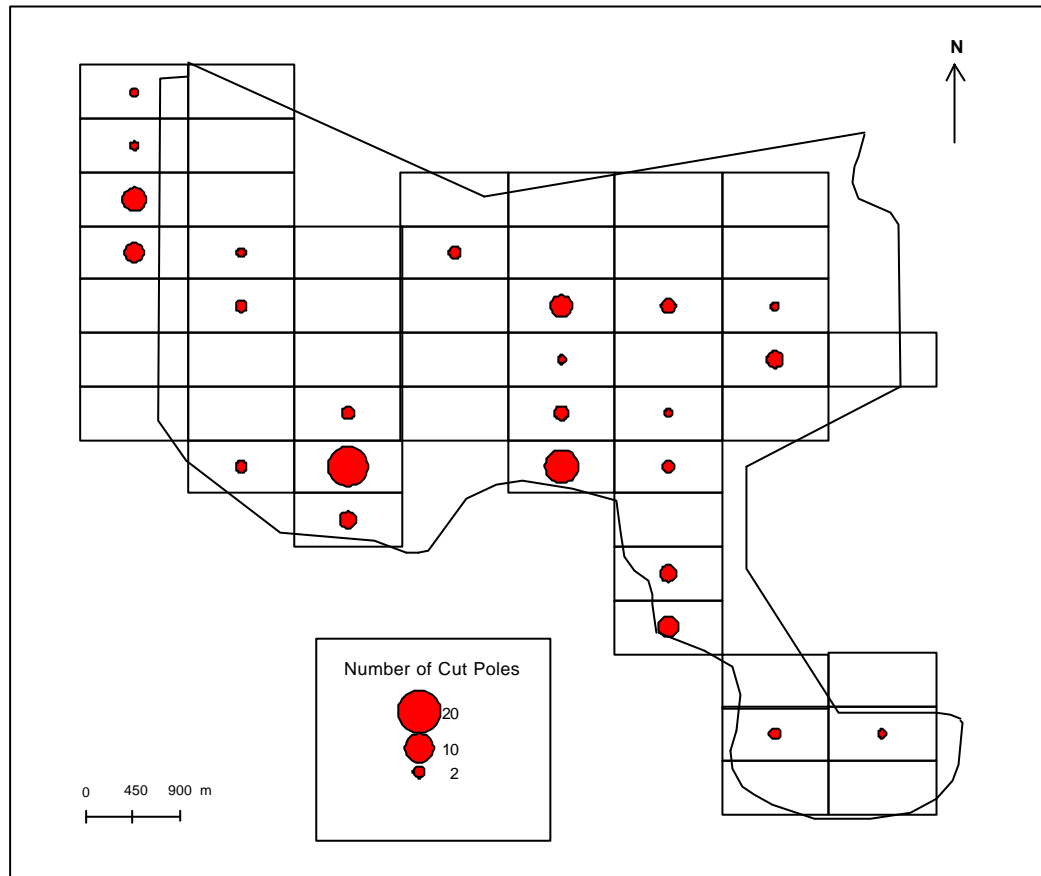
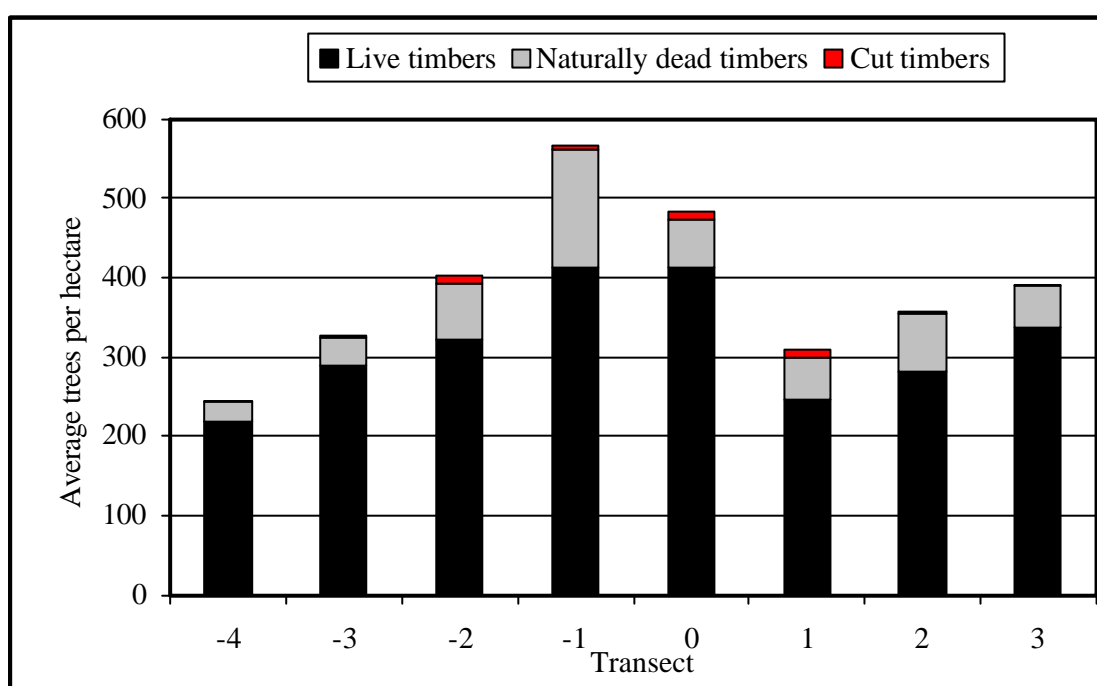


Figure 17 Rate of Pole cutting in Segoma F.R.(1998).

Table 14 Disturbance transect results for timber counts.

Transect number	Length of transect (m)	Total timber sampled	Standing timber	Cut timber	Average cut timber per ha	Naturally fallen timber	Average fallen timber per ha
-4	3000	735	655	4	1.3	76	25.3
-3	3600	1177	1042	9	2.5	126	35.0
-2	2670	1076	862	28	10.5	186	69.7
-1	2250	1276	929	14	6.2	333	148.0
0	2450	1185	1013	28	11.4	144	58.8
1	3750	1159	929	37	9.9	193	51.5
2	3350	1198	948	6	1.8	244	72.8
3	1550	605	521	1	0.6	83	53.5

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

**Figure 18** The relative abundance of live, naturally dead and cut timber in Segoma F.R..

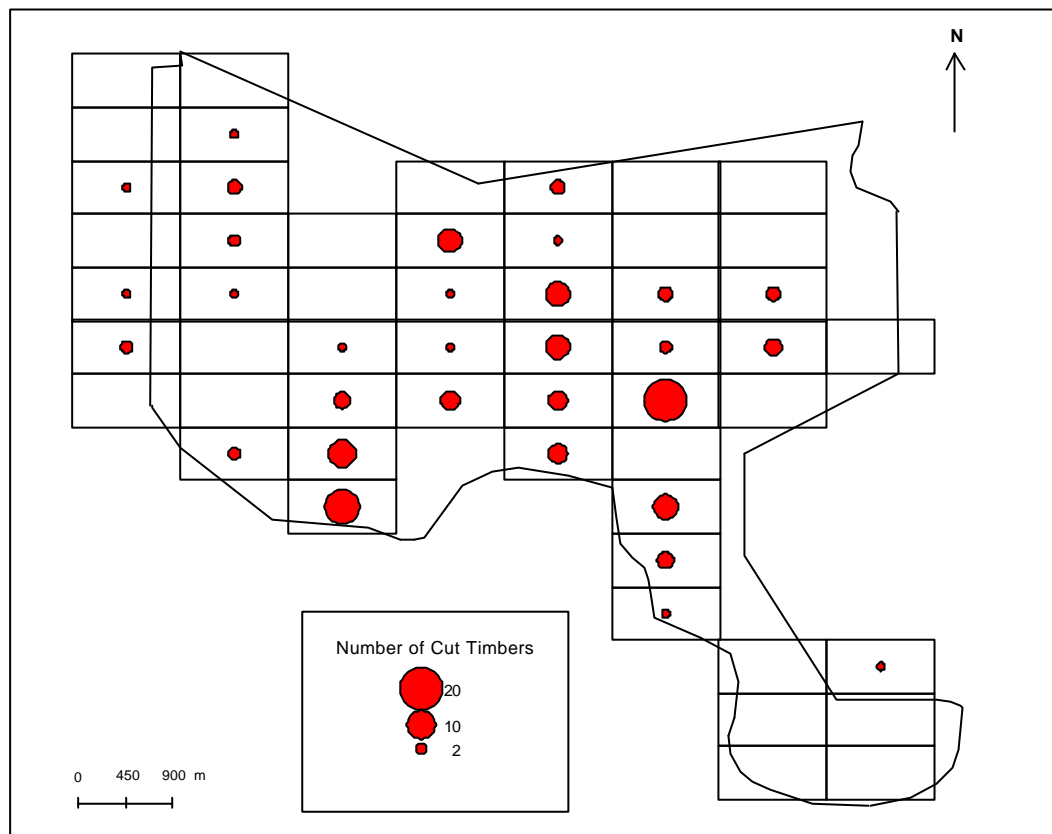


Figure 19 Rate of timber extraction in Segoma F.R.(1998).

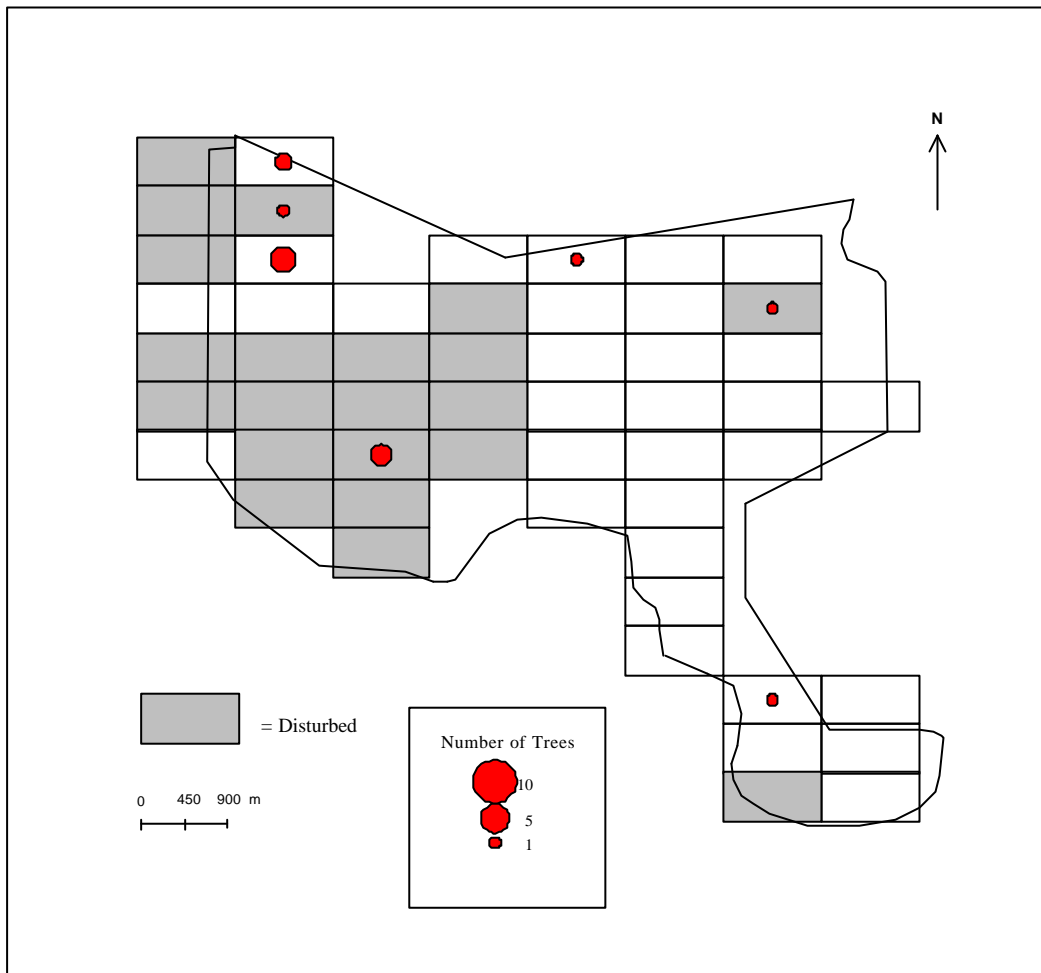


Figure 20 Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic in Segoma F.R..

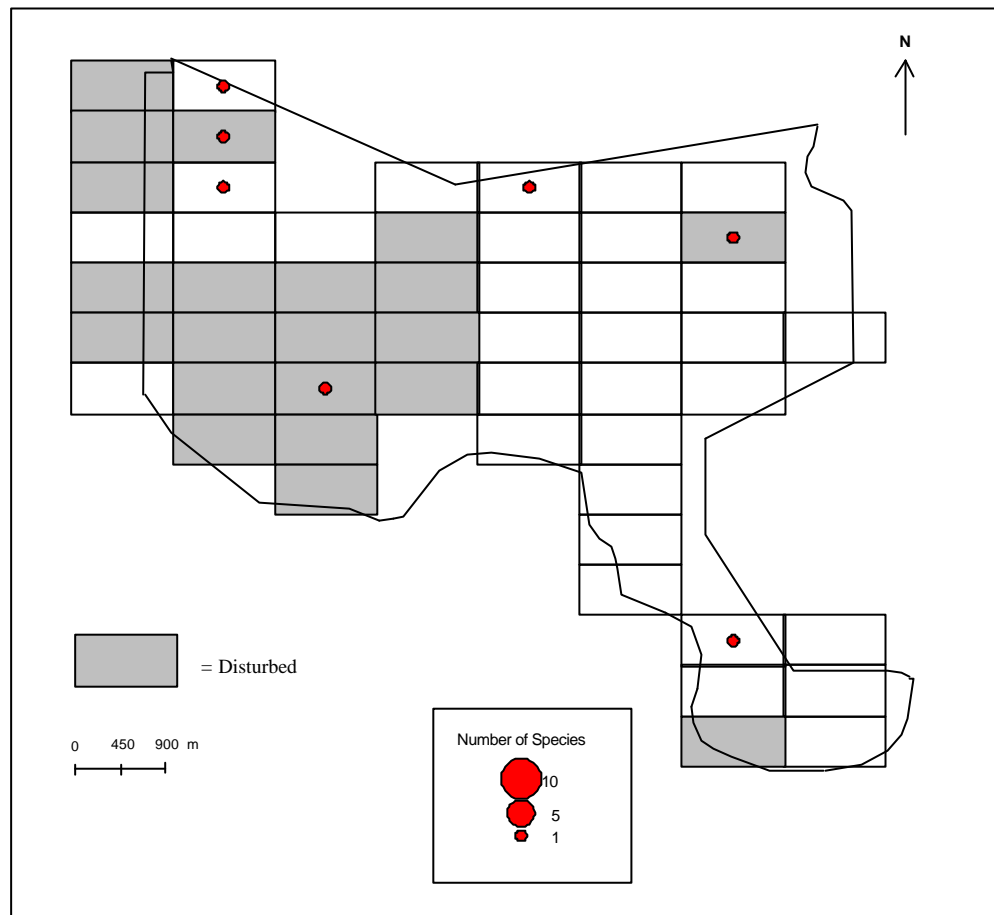


Figure 21 Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and endemic in Segoma F.R..

Figure 22 Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic in Segoma F.R..

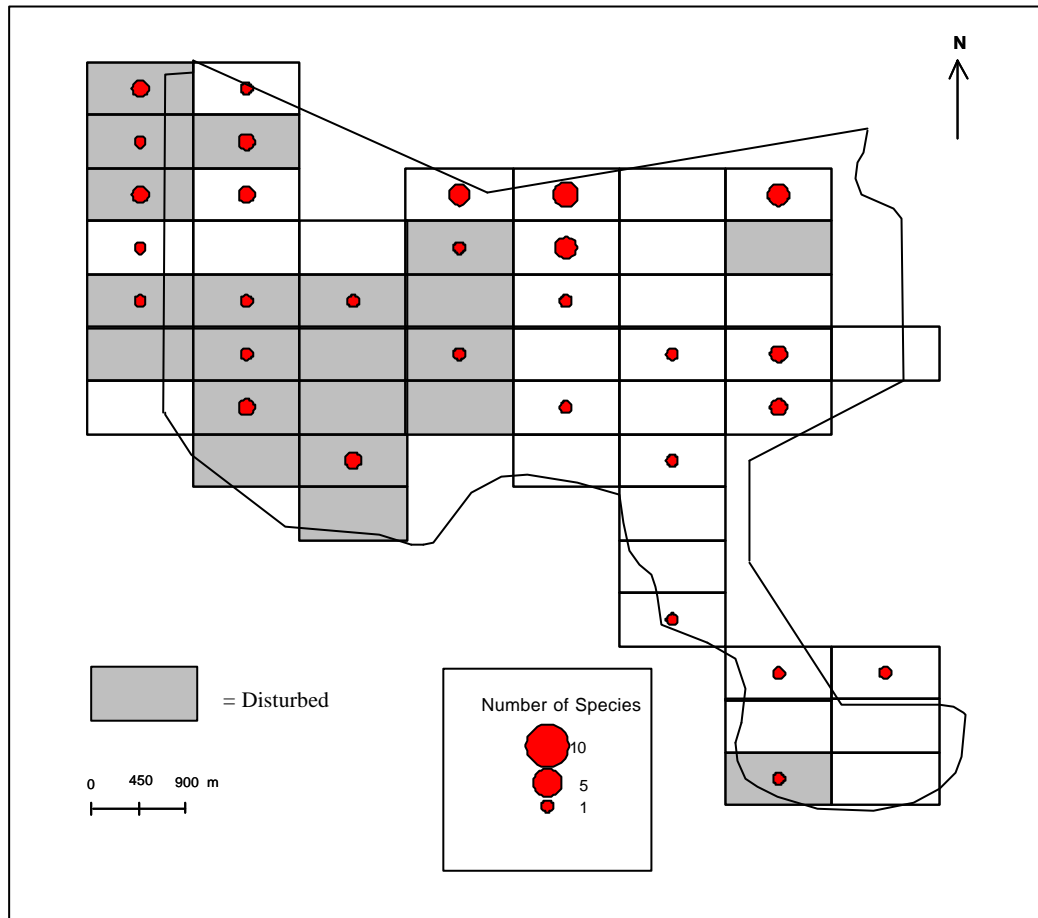


Figure 23 Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic in Segoma F.R..

4.4 Discussion

Species richness

In the systematic vegetation plots 2114 individual trees and shrubs were surveyed, representing 148 species from 33 families. An additional twelve species were recorded in the regeneration plots. Casual observations from outside of the vegetation plots recorded an additional 59 species from 31 families including 18 families not previously recorded.

In total 207 species from 51 families were recorded.

Of the 51 plots systematically surveyed, 46 (90%) of the plots analysed were recorded as lowland forest, 3 (6%) as colonising forest, 1 (2%) as bamboo and 1 (2%) as riverine forest.

Relative to the other ten forest reserves in the East Usambaras surveyed by Frontier-Tanzania, the botanical diversity of Segoma is above average.

Species Accumulation Rates

The species accumulation rate for the 50m x 20m vegetation plots increases rapidly initially and then declines slightly (see **Figure 4**). The species accumulation curve does not reach an asymptote, indicating that the list of vascular plants of 10cm dbh and larger is incomplete. Casual observations may bring the list closer to being comprehensive.

Ecological Type

Forest dependent species defined as limited to primary forest only were recorded 699 times. This represents 33.1% of all specimens recorded. The most common forest dependent tree is *Funtumia africana*. Twelve (29.2%) of the forest dependent species are also endemic or near-endemic to the Usambaras.

Nine species characteristic of more open habitats were recorded in 23 of the 51 plots. The plantation species, *Citrus aurantium* is the most common non-forest species in the forest reserve.

Habitat

Of the tree species surveyed with known altitude characteristics, 71.9% were considered to be typical of lowland forest and 28.1% are considered typical of submontane forest. All vegetation plots in Segoma Forest Reserve occur in lowland forest, however submontane species occur in 94.1% of the plots surveyed. This data indicates the variability in the ecological requirements and niches of these submontane species. The most common submontane species is *Ceiba pentandra*.

Endemic Status

Of the plant species recorded, 106 (71.6%) have widespread distributions. Near-endemics contribute 29 species (19.6%) from 16 families to the floristic composition of the reserve. These near-endemics are found in 45 of the 51 plots surveyed (88.2%) and account for 351 of the surveyed specimens or 16.6% of all recorded trees and shrubs in the reserve. Of the 51 plots surveyed, 11 were found to have greater than ten near-endemic individuals. The most common near-endemic in the reserve is *Leptonychia usambarensis*. Of the 29 near-endemic species, ten species are also considered to be forest dependent. Two near-endemics are non-forest species *Millettia usaramensis* and *Premna chrysoclada*.

Two of the species surveyed are endemic to the Usambaras. These are *Cola scheffleri* which is endemic to the East Usambaras and *Rinorea angustifolia* var. *albersii* which is endemic to the East and West Usambaras.

Range Extensions

The following 23 species recorded in this survey were not recorded by Iversen (1991b): *Lettowianthus stellatus*, *Holarrhena febrifuga*, *Dracaena steudneri*, *Diospyros squarrosa*, *Albizia saman*, *Senna siamea*, *Erythrina caffra*, *Elaeis guineensis*, *Coffea robusta*, *Rytigynia schumannii*, *Tarenna nigrescens*, *Citrus aurantium*, *Citrus limon*, *Allophylus callophylus*, *Melanodiscus (Glennia) oblongus*, *Malacantha cerasiferum*, *Manilkara sansibarensis*, *Cola clavata*, *Cola minor*, *Dombeya rotundifolia*, *Teobroma cocoa*, *Nesogordonia holtzii*, and *Rinorea albersii*.

Regeneration

Within the regeneration plots, 32.4% of the species found in the main vegetation plots were recorded. The endemic species *Rinorea angustifolia* var. *albersii* was recorded regenerating, however, the endemic species *Cola scheffleri* was not recorded regenerating.

None of the three principle timber species found within the reserve, *Khaya anthotheica*, *Milicia excelsa* and *Newtonia buchananii* were recorded in the regeneration layer.

Disturbance

In January and February 1997, fires damaged large areas of Segoma Forest Reserve. The fires were associated with the failure of the short rains between September and December 1996. Fire fighting attempts were not successful and the fires burned for many days. Evidence of fire was observed on five of the eight transects, and particularly widespread damage was recorded on the western side of the reserve.

Evidence of pit-sawing was observed throughout the reserve on five of the eight transects, although none of these were in use during the survey period. Cut timbers, planks and poles were found on about half of the transects and evidence of cultivation was recorded on the southern edge of the reserve.

Throughout the south-eastern proposed extension of the reserve, exotic species have been cultivated within the plantation. In this area there is a network of roads and bridges which were still clearly visible at the time of the survey. The abandoned machinery, buildings and vehicles of the estate are still present although gradually being covered by vegetation.

The invasive species *Maesopsis eminii* was recorded in Plots 18 and 21 in the west of Segoma. 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). This species remains rare in Segoma Forest Reserve.

Numerous traps were recorded during the survey particularly in the vicinity of the old Tanga road which is still used as a footpath. The reservoir is popular for fishing, although this is illegal, and there are a number of well-used camp sites in this area.

5.0 FAUNA

By Kathryn Doody, Nike Doggart and Liana Joseph.

5.1 Introduction

The faunal biodiversity of Segoma 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

Methods used during the survey are described in detail in the FT FRP methodologies report (SEE, 1996). A brief description is presented below. The locations of trap sites are presented in Figure 24.

5.2.1 Mammals

The aim of this survey was to compile a species list of the reserve's mammals. Five different methods were used to sample mammals within Segoma Forest Reserve: (1) snap trap and Sherman live 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 and Sherman-trap lines*

Rodents were sampled using fifty large break-back traps (snap-traps) and fifty Sherman live traps. Typically the traps were set out in three lines of approximately 33, with traps positioned at least 2m apart. The traps were set each evening and checked early the following morning. The traps were baited with fried coconut rolled in peanut butter. 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 consisted of three lines of eleven 20 litre plastic buckets sunk flush to ground level in a linear transect. These were positioned approximately 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 onto which soil and leaf litter was placed. Animals were channelled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed to sample shrews within the forest. Each mammal captured was weighed and measured. Trapping and biometric information were recorded on standardised data sheets.

5.2.1.3 *Bat netting*

Nocturnal mist netting was used to sample the forest's bats. Mist nets were placed near potential roost sites and across flight "corridors", such as paths and rivers. Nets were set

up at dusk, observed continuously throughout the night and closed shortly before dawn. 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 were surveyed for dung from one border to another border of the reserve. The transects are walked by a team of three people. One person surveyed 2m on one side of the transect, the other person, 2m on the other side. The third person recorded the findings.

5.2.1.5 *Mammal observations*

Observations of other mammals, particularly primates, were recorded throughout the survey

5.2.2 *Birds*

Birds were observed on a casual basis. The list is a provisional list only as no netting was carried out.

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. Unless otherwise indicated, taxonomic identifications were made by Prof. K. M. Howell or Dr D. Broadley (see 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. M. 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.

5.2.5 *Invertebrates*

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

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 tree canopy. Rotting banana was used as bait. Traps were checked at midday. Five traps were set for 10 days in each of the five

trapping sites. Unless otherwise indicated, taxonomic identifications were made by Steve Collins (see Appendix 2). Specimens are deposited at the African Butterfly Research Institute.

5.2.5.2 *Molluscs*

The aim of this study was to compile a species list of the reserve's molluscs. At each trapping site three plots 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 3cm of soil was searched carefully for molluscs. All specimens were collected. Due to the limited number of mollusc specialists taxonomic identifications of the specimens collected were not available at the time of writing this report. Specimens are currently held at the Zoological Museum of the University of Copenhagen.

5.2.5.3 *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 3cm of soil was searched carefully for millipedes. All specimens were collected. Due to the limited number of millipede specialists taxonomic identifications of the specimens collected were not available at the time of writing this report. Specimens are deposited at the Virginia Museum of Natural History.

5.3 Trapping sites and sampling intensity

Five trapping sites were placed in areas representative of habitats within the forest reserve. Table 15 describes the sites and Tables 16 and 17 summarise the sampling intensity for each site and for each trapping method.

Table 15 Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
1	Plantation forest	180	Gentle lower slope	Nil
16	Lowland forest	150	Gentle lower slope	Nil
15	Lowland forest	320 - 340	Gentle mid-slope	Nil
40	Lowland forest	600 - 620	Gentle mid slope	5
49	Plantation forest	240 - 260	Gentle lower slope	15

Table 16 Sampling intensity by trap night (number of nights x number of traps).

Trapping method	Plot 1	Plot 16	Plot 15	Plot 40	Plot 49
Date	Jan 17 – Jan 26 1998	July 12 – 21 1998	July 25 – Aug 3 1998	Aug 9 - 18 1998	Aug 21 - 30 1998
Snap traps	993	974	984	994	977
Bucket pitfall*	330	330	330	330	330
Butterfly traps	50	50	50	50	50
Molluscs**	3	3	3	3	3
Millipedes**	3	3	3	3	3

* Each bucket represents one trap night.

**This represents plots sampled not trap nights – Molluscs 1m x 1m plot, Millipedes 3m x 3m plot.

Table 17 Summary of bat-netting sites.

Site description	Sampling intensity (hours)	Altitude	Topography
Over River Sito, Palm Nut/Oil Palm plantation forest	12	180	Valley floor
Across road near camp, plantation and lowland forest	12	120	Gentle lower slope
Plot 1: Across Stream, Oil palm plantation forest	24	120	Gentle lower slope
Plot 15: At entrance to small cave, lowland forest.	8	320	Gentle mid slope
Plot 40: Lowland forest	12	550	Gentle mid slope
Plot 49: Herb. Marsh/Swamp next to fish	12	240	Gentle lower slope.

pond, plantation forest.

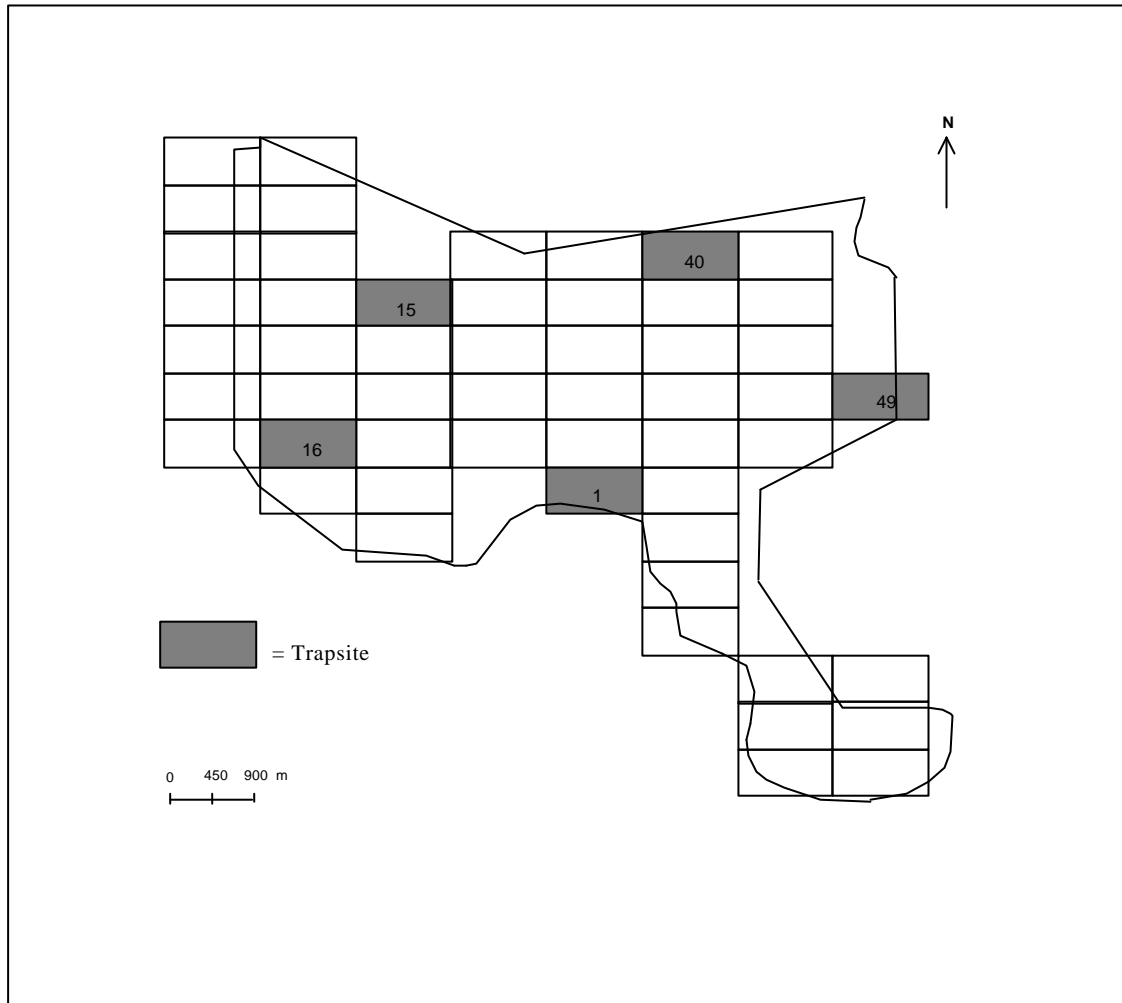


Figure 24 Location of trapping sites in Segoma F.R..

5.4 Results

5.4.1 Mammals

5.4.1.1 Small mammals (not bats)

A total of 108 specimens were retained for taxonomic purposes. These specimens represent at least 11 species from five families. Many have yet to be identified to species level. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Kingdon (1989). Nomenclature follows Kingdon (1997) and Kingdon (1989).

Table 18 Summary of small mammals.

Species	Ecol. type	End. status	IUCN status	Capture location by plot and number collected					Total	
				1	16	15	40	49		OR
CRICETIDAE										
Lesser pouched rat										
<i>Beamys hindei</i>	F	N	V	1						3
MURIDAE										
Brush-furred mice										
<i>Lophuromys</i> sp.							3			3
Narrow-footed woodland mice										
<i>Grammomys</i> sp.								1		1
Soft-furred rats										
<i>Praomys</i> sp.					4	8	4	1		17
Common mice										
<i>Mus</i> sp.							1	1		2
Black rat										
<i>Rattus rattus</i>	O	W		2	4	2				8
African dormice										
<i>Graphiurus</i> sp.								1		1
Rodents not yet identified by taxonomist				49						49
SORICIDAE										
White-toothed shrews										
<i>Crocidura</i> sp.				7	9	3	3	1		23
PROCAVIDAE										
Tree hyrax										
<i>Dendrohyrax</i> sp.							1		1	2
VIVERRIDAE										
Blotched genet										
<i>Genetta tigrina</i>	f	W							1	1

KEY TO ABBREVIATIONS FOR TABLE 18 (Definitions based on those described in the botanical section of this report).

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:

- N - Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests;
- W - Widespread distribution.

IUCN status:

- V - Vulnerable

OR Outside reserve

5.4.1.2 Dung survey

Dung from at least six mammal species were recorded. 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 *Sylvicapra grimmia* and *Cephalophus monticola* may not be reliable.

Table 19 Abundance of duiker, bushbuck and hyrax dung.

Transect	Transect length	Duiker		Bushbuck		Hyrax	
		Dung sitings	Rate / ha	Dung sitings	Rate / ha	Dung sitings	Rate / ha
-4	3000	1	1.7	0	0.0	0	0.0
-3	3600	4	5.6	0	0.0	0	0.0
-2	2670	1	1.9	0	0.0	1	1.9
-1	2250	1	2.2	0	0.0	0	0.0
0	2450	5	10.2	1	2.0	1	2.0
1	3750	4	5.3	0	0.0	2	2.7
2	3350	5	7.5	0	0.0	0	0.0
3	1550	5	3.3	0	0.0	0	0.0

Table 20 Summary of dung survey.

Species	Ecol. Type	End. status	IUCN status	Times encountered	Altitudinal range (m)
CERCOPITHECIDAE					
<i>Cercopithecus mitis</i>	f	W		4	250 – 400
CRICETIDAE					
<i>Cricetomys sp.</i>	?	?		3	100 – 350
PROCAVIIDAE					
<i>Dendrohyrax validus</i>	f	W	V	6	300 – 620
BOVIDAE					
<i>Cephalophus harveyi</i>	f	W		4	50 – 150

<i>Sylvicapra grimmia</i>	f	W	16	160 – 380
<i>Cephalophus monticola</i>	f	W	15	180 – 480

5.4.1.3 Mammal observations

A total of 13 species from eight families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Kingdon (1989).

Table 21 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, 4, 12, 14, 15, 16, 36, 42, 49
CERCOPITHECIDAE					
Yellow baboon <i>Papio cynocephalus</i>	Definite	f	W		1, 3, 8, 23, 35, 41, 49
Vervet monkey <i>Cercopithecus aethiops</i>	Definite	f	W		1
Gentle monkey <i>Cercopithecus mitis</i>	Definite	f	W		1, 2, 5, 7, 12, 13, 15, 16, 19, 23, 37, 49
GALAGONIDAE					
Small-eared galago <i>Otolemur garnetti</i>	Definite	f	N		1
MACROSCOLIDIDAE					
Four-toed elephant shrew <i>Petrodromus tetradactylus</i>	Probable	f	W		1
Zanj elephant shrew <i>Rhynchocyon petersi</i>	Probable	f	N	EN	3, 12
SCIURIDAE					
Red-bellied coast squirrel <i>Paraxerus palliatus</i>	Probable	F	W		1
CRICETIDAE					
Pouched rat <i>Cricetomys sp.</i>	Definite		W		Unknown
PROCAVIDAE					
Eastern tree hyrax <i>Dendrohyrax validus</i>	Definite	f	W	V	40 Frequently heard
BOVIDAE					
Blue duiker <i>Cephalophus monticola</i>	Probable	F	W		1, 14
Bushbuck <i>Tragelaphus scriptus</i>	Probable	f	W		18

KEY TO ABBREVIATIONS FOR TABLE 20 & 21 (Definitions based on those described in the botanical section of this report).

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 East African lowland forests;
- W - Widespread distribution.

IUCN status:

- NT - Near-threatened
- EN - Endangered
- V - Vulnerable

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

? - No data available

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.

Possible: Species identification is may not be accurate.

5.4.1.4 Bats

A total of 11 individuals were retained for taxonomic purposes, a further two individuals were caught, identified and then released. These represent six species from four families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Kingdon (1974). Nomenclature follows Kingdon (1997).

Table 22 Summary of bats.

Species	Ecol. Type	End. status	IUCN status	Capture location by plot and number collected					
				1	15	40	49	OR	Total
Megachiroptera									
PTEROPODIDAE									
Egyptian rousette bat									
<i>Rousettus aegyptiacus leachi</i>	f	W		5		1			6
Collared fruit bat									
<i>Myonycteris relicta</i>	F	W	V					1	1
Microchiroptera									
RHINOLPHIDAE									
Horseshoe bat									
<i>Rhinolophus hildebrandti</i>	f	W					1		1
HIPPOSIDERIDAE									
Leaf-nosed bat									
<i>Hipposideros cyclops langi</i>	F	W			3				3
VESPERTILIONIDAE									
Serotine bat									
<i>Eptesicus flavescens</i>	?	?					1		1
House bat									
<i>Scotophilus</i> sp.	?	?						1	1

KEY TO ABBREVIATIONS FOR TABLE 22 (Definitions based on those described in the botanical section of this report).

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:

- W - Widespread distribution.

IUCN status:

- V - Vulnerable

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

? - No data available

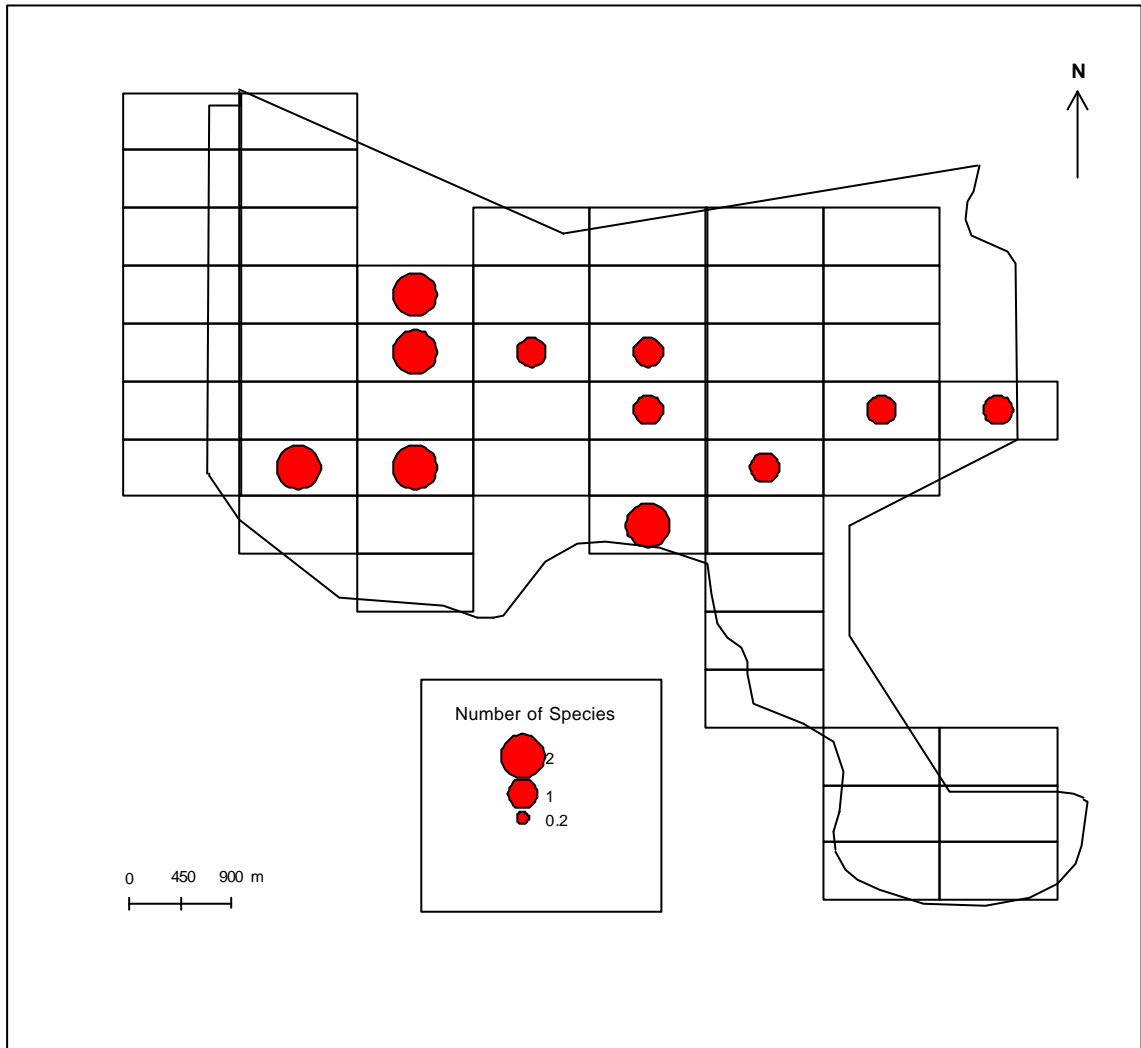


Figure 25 Distribution of forest dependent mammal species in Segoma F.R..

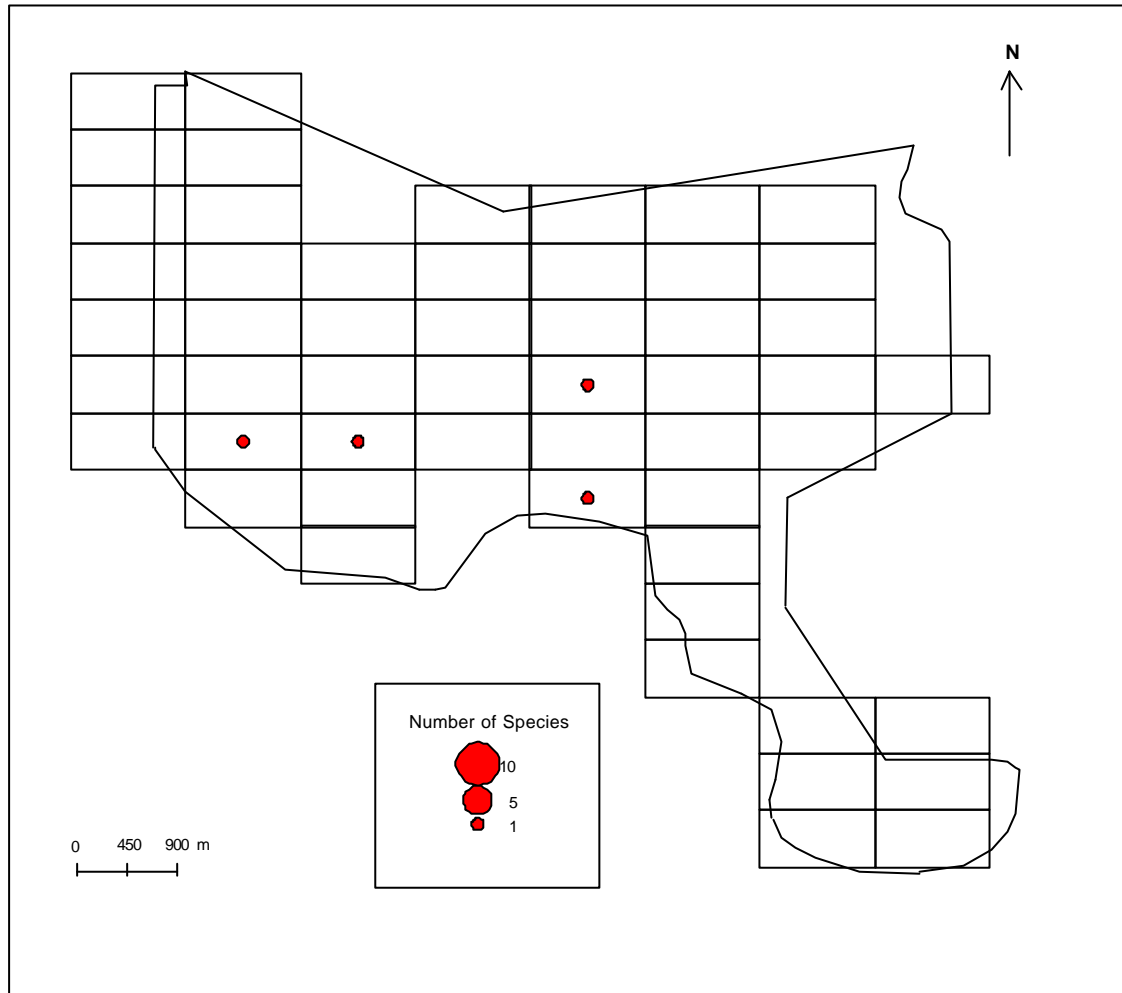


Figure 26 Distribution of near-endemic mammal species in Segoma F.R..

5.4.2 Birds

A total of 50 species from 30 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1997), IUCN (1996) and Zimmerman *et al.* (1996).

Table 23 Summary of birds.

Species	Common name	Ecol. type	End. status	IUCN status	CITES
ARDEIDAE					
<i>Ardeola ralloides</i>	Squacco heron	O	W		
<i>Butorides striatus atricapillus</i>	Green-backed heron	O	W		
SCOPIIDAE					
<i>Scopus umbretta umbretta</i>	Hamerkop	O	W		
ACCIPITRIDAE					
<i>Polyboroides typus</i>	African harrier hawk	f	W	LC	
<i>Aquila wahlbergi</i>	Wahlberg's eagle	O	W		
<i>Stephanoaetus coronatus</i>	African crowned eagle	f	W	LC	II
<i>Gypohierax angolensis</i>	Palm-nut vulture	O	W	LC	II
<i>Buteo buteo vulpinus</i>	Common buzzard	f	W		
HELIORNITHIDAE					
<i>Podica senegalensis somereni</i>	African finfoot	F	W		
NUMIDIDAE					
<i>Gutter sp.</i>	Guineafowl sp.				
COLUMBIDAE					
<i>Aplopelia larvata larvata</i>	Lemon dove	F	W		
<i>Coluba delegorguei</i>	Eastern bronze-naped pigeon	F	W		
<i>Treron calva</i>	African green pigeon	O	W		
<i>Turtur tympanistria</i>	Tambourine dove	F	W		
MUSOPHAGIDAE					
<i>Tauraco fischeri</i>	Fischer's turaco	F	W	NT	II
CUCULIDAE					
<i>Centropus superciliosus</i>	White browed coucal	O	W		
STRIGIDAE					
<i>Strix woodfordii</i>	African wood-owl	f	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	O	W		
PHOENICULIDAE					
<i>Phoeniculus purpureus</i>	Green wood-hoopoe	F	W		
BUCEROTIDAE					
<i>Bycanistes bucinator</i>	Trumpeter hornbill	F	W		
<i>Tockus alboterminatus</i>	Crowned hornbill	F	W		
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 cailliautii</i>	Green-backed woodpecker	f	W		
MOTACILLIDAE					
<i>Motacilla aguimp vidua</i>	African pied wagtail	O	W		

Table 23 continued.

Species	Common name	Ecol. Type	End. status	IUCN status	CITES
<i>Motacilla clara</i>	Mountain wagtail	f	W		
PYCNONOTIDAE					
<i>Pycnonotus barbatus</i>	Common bulbul	f	W		
TURDIDAE					
<i>Swynnertonia swynnertoni</i>	Swynnerton's robin	F	N	V	
<i>Cossypha natalensis</i>	Red-capped robin-chat	f	W		
<i>Neocossyphus rufus</i>	Red-tailed ant thrush	f	W		
MUSCICAPIDAE					
<i>Muscicapa caeruleascens</i>	Ashy flycatcher	f	W		
SYLVIIDAE					
<i>Prinia subflava</i>	Tawny flanked prinia	O	W		
MONARCHIDAE					
<i>Erythrocercus 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		
PRIONOPIDAE					
<i>Prionops retzii</i>	Retz's helmetshrike	f	W		
DICRURIDAE					
<i>Dicrurus adsimilis</i>	Common drongo	f	W		
<i>Dicrurus ludwigii</i>	Square-tailed drongo	f	W		
ORIOOLIDAE					
<i>Oriolus chlorocephalus</i>	Green headed oriole	F	W		
STURNIDAE					
<i>Cinnyricinclus leucogaster</i>	Violet-backed starling	F	W		
NECTARINIIDAE					
<i>Anthreptes collaris</i>	Collared sunbird	f	W		
<i>Nectarinia venusta</i>	Variable sunbird	O	W		
PLOCEIDAE					
<i>Euplectes nigroventris</i>	Zanzibar red bishop	O	W		
<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		

KEY TO ABBREVIATIONS FOR TABLE 23 (Definitions based on those described in the botanical section of this report).

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:

- N - Near endemic: Species with limited ranges usually only including coastal forest and/or East African lowland forests;
- W - Widespread distribution.

IUCN Status.

- V - Vulnerable
- LC - Least Concern
- NT - Near Threatened

CITES

- II – Listed on CITES Appendix II

Table 24 Ranges of near-endemic bird species (Zimmerman, 1996).

Near-endemic species	Range
Swynnerton's robin <i>Swynnertonia swynnertoni</i>	East Usambara Mountains.

5.4.3 Reptiles

A total of 76 individuals were retained for taxonomic purposes. These specimens represent 27 species from 11 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1996), IUCN (1996), Broadley & Howell (unpubl.), Howell (1993), and Branch (1994).

Table 25 Summary of reptiles.

Species	Ecol. Type	End. Status	IUCN status	Capture location by plot and number collected										
				1	16	15	40	49	35	Plots with 1 spec.	O R	U K	Total	
TESTUDINIDAE														
South-eastern hinge-backed tortoise														
<i>Kinixys b. belliana</i>	f	W										1		1
CHAMAELEONIDAE														
Bearded pigmy -chameleon														
<i>Rhampholeon brevicaudatus</i>	F	N	V	1		1		2	1			1		6
Common flap-necked chameleon														
<i>Chamaeleo dilepis</i>	f	W									52			1
GEKKONIDAE														
Uluguru forest gecko														
<i>Cnemaspis barbouri</i>	F	N	EN				4	3						7
Baobab gecko														
<i>Hemidactylus platycephalus</i>	f	W					1				24			2
Tropical house gecko														
<i>Hemidactylus mabouia</i>	f	W		2										2
<i>Lygodactylus capensis grotei</i>		W										1		1
SCINCIDAE														
Speckle-lipped skink														
<i>Mabuya maculilabris</i>	F	W		2	2		1	1				1		7
Common striped skink														
<i>Mabuya striata</i>		W		1										1
Kilimanjaro five-toed skink														
<i>Leptosiaphos kilimensis</i>	F	W	V				1							1
CORDYLIDAE														
East African spiny-tailed lizard														
<i>Cordylus t. tropidosternum</i>	f	W									12, 42			2
LEPTOTYPHLOPIDAE														
Merker's worm-snake														
<i>Leptotyphlops scutifrons merkeri</i>	f	W		1										1
VIPERIDAE														
Eastern gaboon viper														
<i>Bitis gabonica</i>	F	W										1		1

Table 25 continued.

Species	Ecol. Type	End. Status	IUCN status	Capture location by plot and number collected							Total collected	
				1	16	15	40	49	35	Plots with 1 spec.		O R
BOIDAE												
Northern African python <i>Python sebae</i>	O	W									1	1
ELAPIDAE												
Eastern green mamba <i>Dendroaspis angusticeps</i>	f	W								25		1
Usambara garter-snake <i>Elapsoidea nigra</i>	F	N	V	3						36	1	5
COLUBRIDAE												
Common house-snake <i>Lamprophis capensis</i>	F	W								33	1	2
Usambara forest-snake <i>Bufo vauerocegae</i>	F	N	V								1	1
Usambara centipede-eater <i>Aparallactis wernerii</i>	F	N	V	3	1						1	5
Olive marsh-snake <i>Natriciteres olivacea</i>	O	W		3							1	1
Half-banded shovel-snout <i>Prosymna semifasciata</i>	F	E	CR						2			2
Spotted bush-snake <i>Philothamnus punctatus</i>	f	W		2				1		13, 25		5
Usambara green-snake <i>Philothamnus macrops</i>	F	N	V				1			2, 4, 7, 9, 37		6
Tornier's cat snake <i>Crotaphopeltis tornieri</i>	F	W	V	2				1			1	4
Northern marbled tree-snake <i>Dipsadoboa flavida broadleyi</i>	?	W	?	1							1	2
Mozambique vine snake <i>Thelotornis capensis mossambicanus</i>	f	W				1				5	1	3

Table 26 Ranges for endemic and near-endemic reptile species recorded (Howell, 1993).

Endemic Species	Range
<i>Prosymna semifasciata</i>	East Usambaras
Near-endemic Species	Range
<i>Philothamnus macrops</i>	East Usambaras; West Usambaras; Coastal forest
<i>Elapsoidea nigra</i>	East Usambaras; West Usambaras; Ulugurus
<i>Leptosiaphos kilimensis</i>	Kenya, Northern Tanzania
<i>Rhampholeon brevicaudatus</i>	East Usambaras; Ulugurus; Uzungwas; Coastal forest
<i>Cnemaspis barbouri</i>	East Usambaras; Ulugurus

An additional three species from three families were observed but not collected.

Table 27 Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation location
LACERTIDAE				
Eastern serrate-toed tree-lizard				
<i>Holaspis guentheri laevis</i>	Probable	F	W	Plot 49
VARANIDAE				
Nile monitor				
<i>Varanus niloticus</i>	Probable	F	W	Plot 49, 2
BOIDAE				
Northern African python				
<i>Python s. sebae</i>	Certain	O	W	Plot 7

KEY TO ABBREVIATIONS FOR TABLE 25, 26 & 27 (Definitions based on those described in the botanical section of this report).

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 East African lowland forests;
- W - Widespread distribution.

IUCN status:

- CR - Critical Risk
- EN - Endangered
- V - Vulnerable
- NT - Near-threatened
- DD - Data deficient

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

UK - Unknown capture location

? - No data available

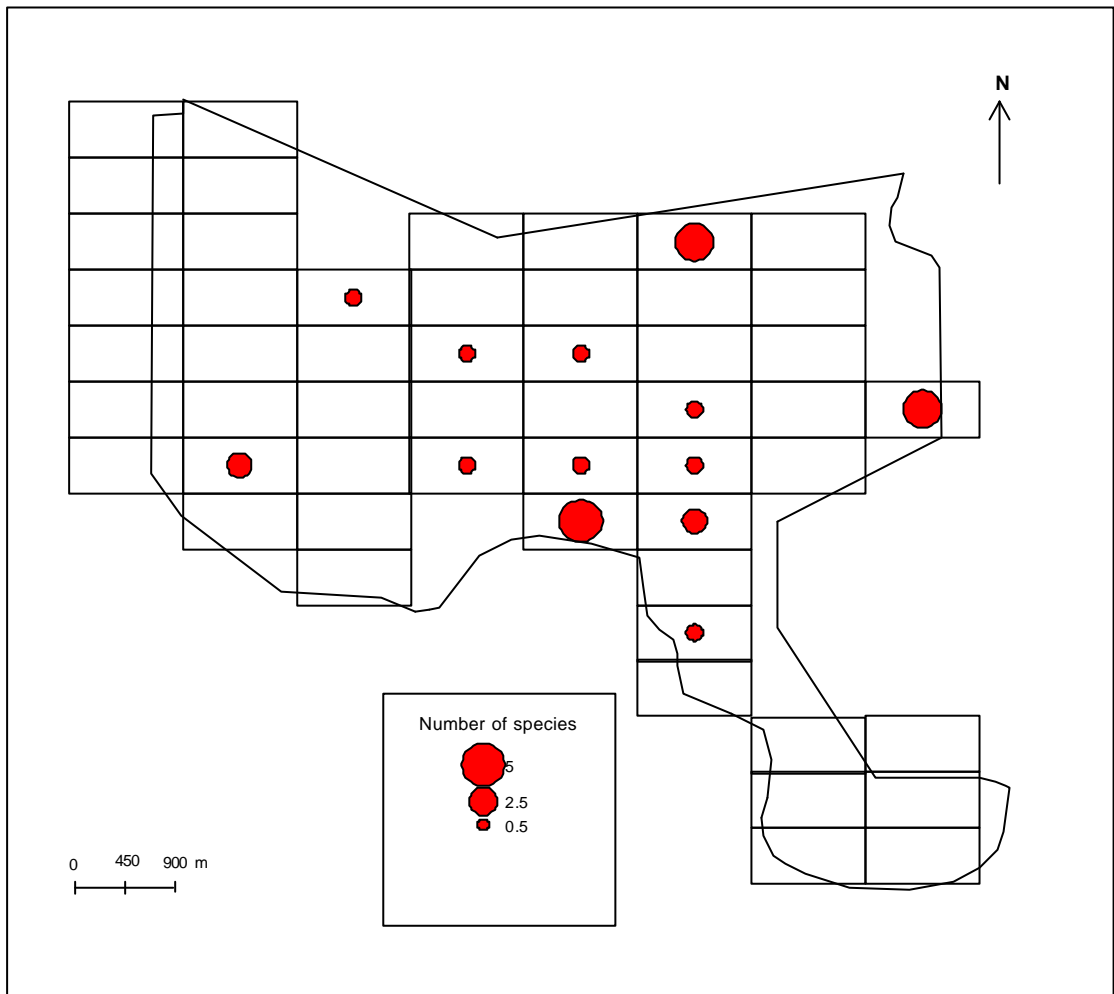


Figure 27 Distribution of forest dependent reptile species in Segoma F.R..

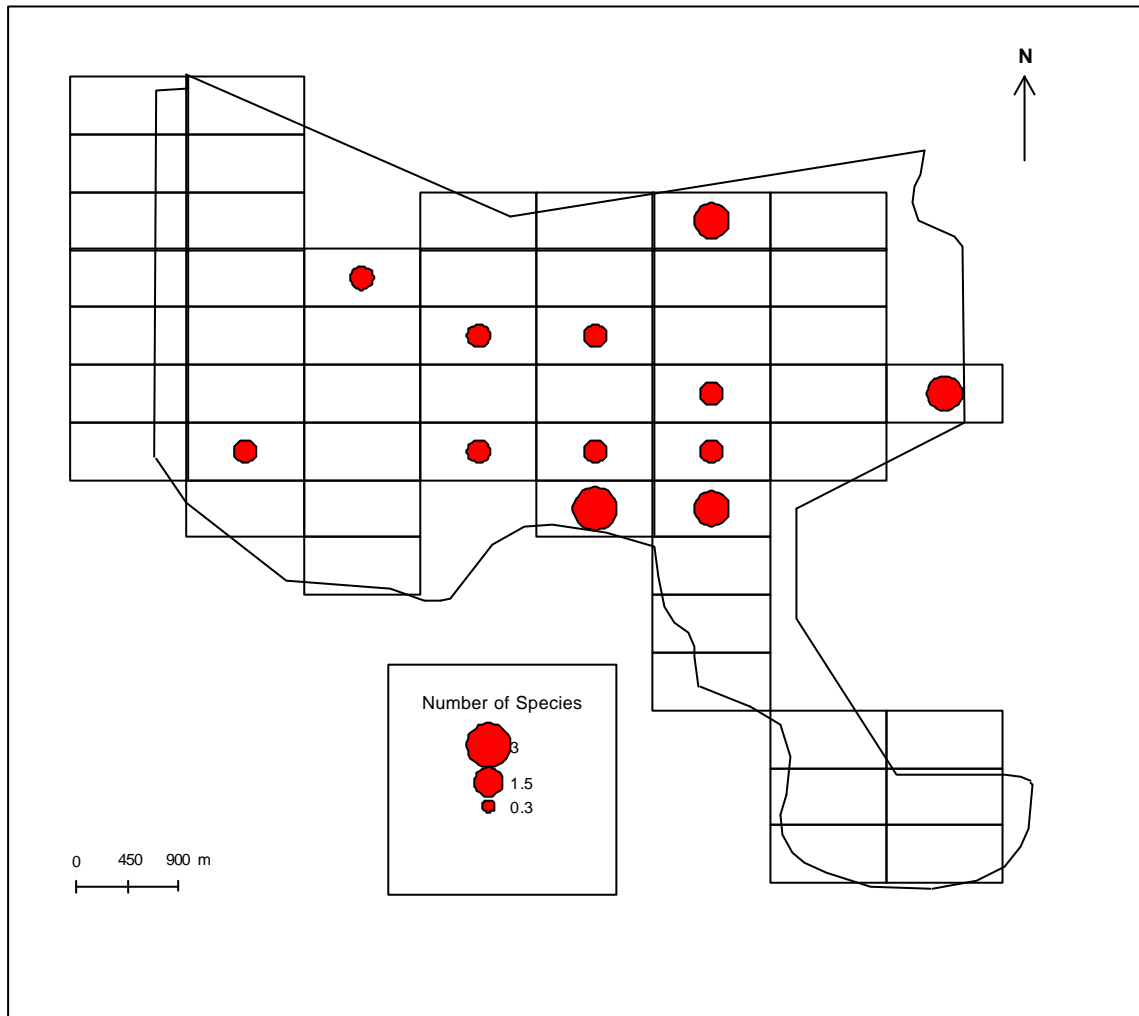


Figure 28 Distribution of near-endemic reptile species in Segoma F.R..

5.4.4 Amphibians

A total of 292 individuals were retained for taxonomic purposes. These specimens represent 19 species from 9 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Poynton & Broadley (1991). Identifications were provided by either K. M. Howell or J. C. Poynton. Common names are from Passmore & Carruthers (1995).

Table 28 Summary of amphibians.

	Ecol. Type	End. status	IUCN status	Capture site by plot and number collected										Total
				OR	1	12	15	16	42	40	49	Plots with a single specimen		
ARTHROLEPTIDAE														
<i>Arthroleptis xenodactyloides</i>	f	W		1	11		9	82				4		107
Shovel-footed squeaker														
<i>Arthroleptis stenodactylus</i>	f	W			14		14	18		2			7	49
<i>Arthroleptis</i> sp.					3		2	10		3	3		2	22
BUFONIDAE														
<i>Bufo brauni</i>	F	N	V		2			20				1	2	24
Flat-backed toad														
<i>Bufo maculatus</i>	O	W		1	4			3						8
<i>Bufo</i> sp.												1		1
<i>Stephopaedes usambarae</i>						2							18	3
<i>Nectophrynoides tornieri</i>	F	N	V							1				1
<i>Mertensophryne micranotis</i>	F	N	EN		1									1
HEMISIDAE														
Mottled shovel-nosed frog														
<i>Hemisis marmoratus</i>	f	W			2			1						3
HYPEROLIIDAE														
<i>Leptopelis</i> sp.										1				1
<i>Leptopelis flavomaculatus</i>	F	W			3	1				3	1		2	9
<i>Leptopelis uluguruensis</i>	F	N	V							2				2
<i>Leptopelis vermiculatus</i>	F	N	NT	1										1
<i>Afrixalus fornasinii</i>	f	W			2			1		4				7
MICROHYLIDAE														
<i>Callulina kreffii</i>	F	N	V		1					3				3
RANIDAE														
East African puddle frog														
<i>Phrynobatrachus acridoides</i>	f	W		1	4							3		8
<i>Arthroleptides martiensseni</i>	F	N	V		2		6			4			17 & 4	14
<i>Ptychadena</i> sp.				2	2									4
RHACOPHORIDAE														
Foam nest frog														
<i>Chiromantis xerampelina</i>	f	W			2									2
PIPIDAE														
Tropical platanna														
<i>Xenopus muelleri</i>		W			1								36	2
SCOLECOMORPHIDAE														
<i>Scolecophorus</i> sp.									2					2
Unidentified							1	15		1			36	18

KEY TO ABBREVIATIONS FOR TABLE 28 (Definitions based on those described in the botanical section of this report).

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 East African lowland forests;
- W - Widespread distribution.

IUCN status:

- EN - Endangered
- V - Vulnerable
- NT - Near-threatened

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

Table 29 Ranges for endemic and near-endemic amphibian species recorded (Howell, 1993).

Near-endemic species	Range
<i>Bufo brauni</i>	East Usambaras; West Usambaras; Ulugurus; Uzungwas;
<i>Nectophrynoides tornieri</i>	East Usambara, Uluguru, Nguru and Udzungwa Mountains
<i>Mertensophryne micranotis</i>	Coastal Forests and East Usambaras.
<i>Leptopelis uluguruensis</i>	East Usambaras; West Usambaras; Uluguru; Nguru and Udzungwa Mountains
<i>Leptopelis vermiculatus</i>	East Usambaras; West Usambaras; Shimba Hills, Kenya
<i>Arthroleptides martiensseni</i>	East Usambaras; West Usambaras; Uluguru; Nguru and Udzungwa Mountains.
<i>Callulina krefftii</i>	East Usambaras; West Usambaras; Uluguru; Nguru and Udzungwa Mountains also Taita Hills, Kenya

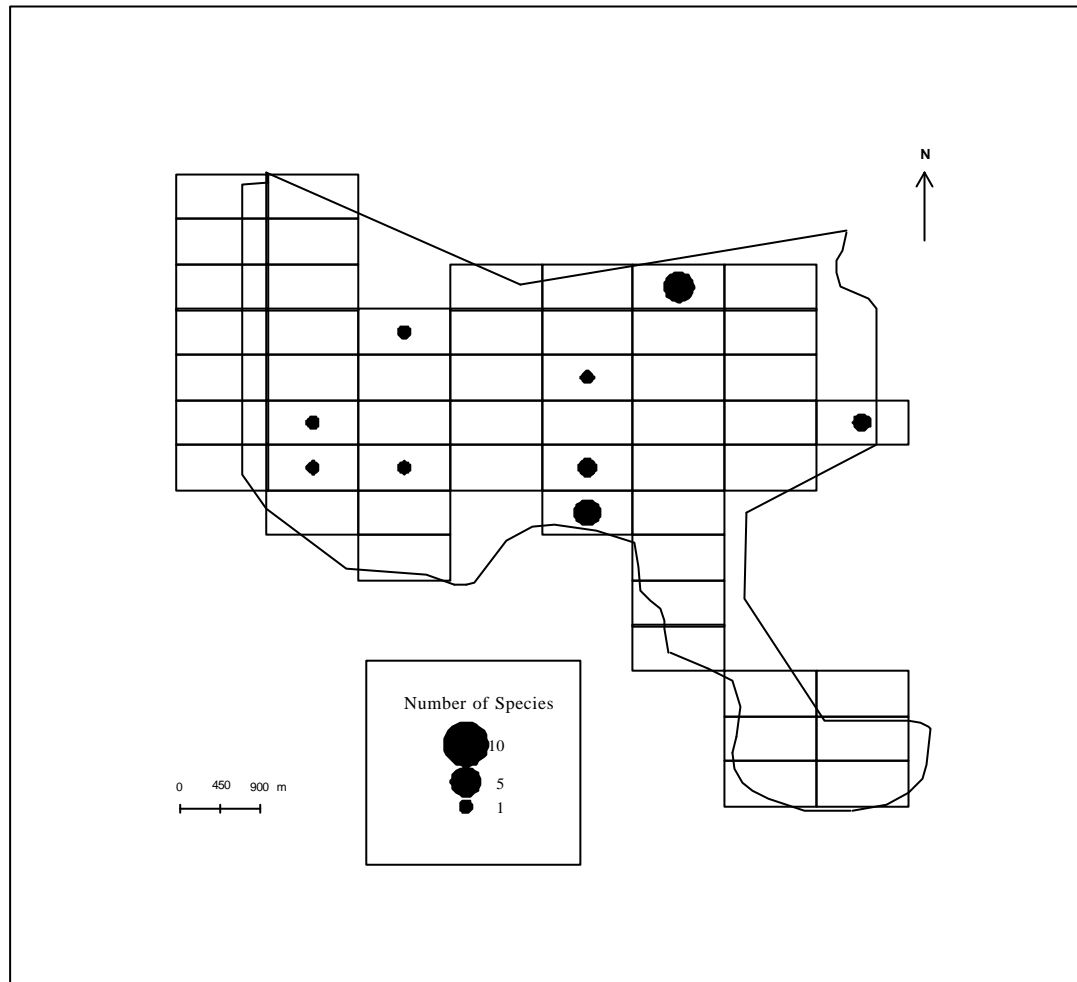


Figure 29 Distribution of forest dependent amphibian species in Segoma F.R..

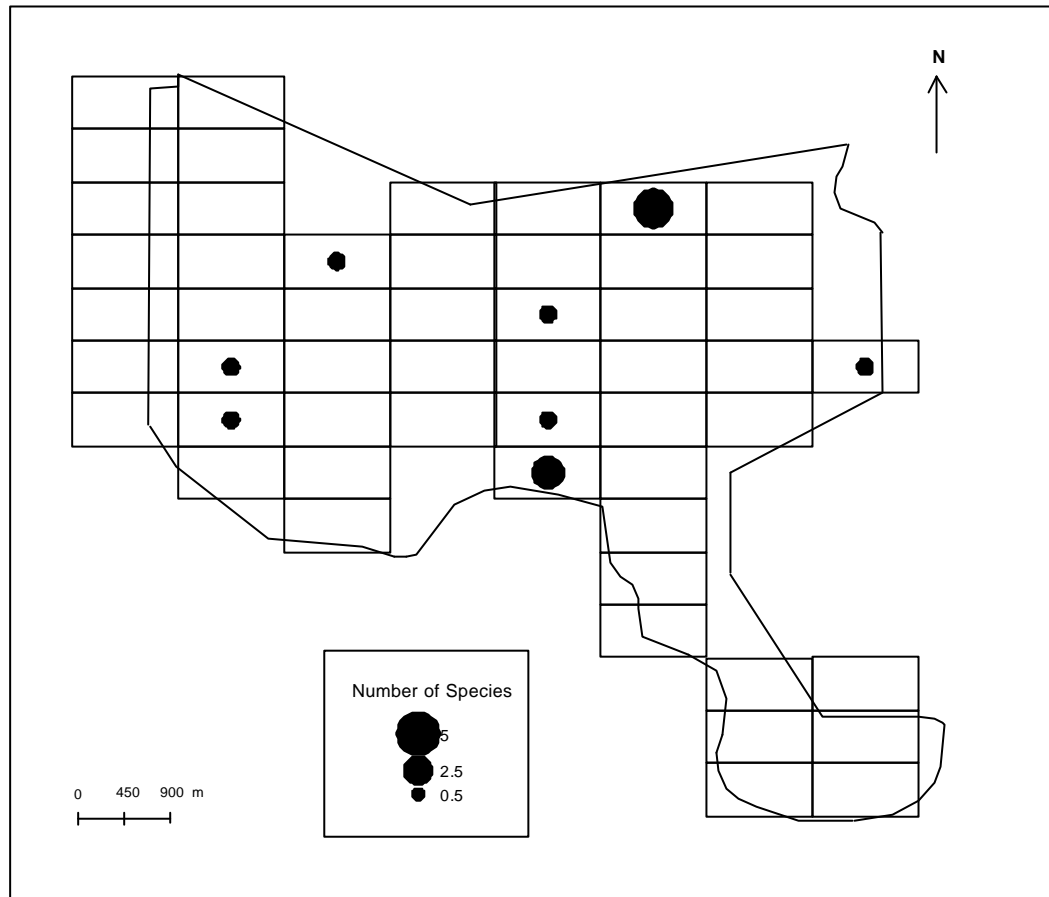


Figure 30 Distribution of near-endemic amphibian species in Segoma F.R..

5.4.5 Invertebrates

5.4.5.1 Butterflies

A total of 420 specimens were retained for taxonomic purposes, however, taxonomic determinations were available only for the first trap-site at the time of publication. These represent 35 species from nine families. Ecological type and endemic status were compiled from Larsen (1996), and Kielland (1990). All are widespread species.

Table 30 Summary of butterflies.

Species	Ecological type	Endemic status
PAPILIONIDAE		
<i>Papilio dardanus tibullus</i>	F	W
<i>Papilio nireus lyaeus</i>	f	W
<i>Graphium colonna</i>	F	W
PIERIDAE		
<i>Eurema floricola</i>	F	W
<i>Belenois thysa</i>	f	W
<i>Appias sabina phoebe</i>	F	W
DANAIDAE		
<i>Amauris niavius dominicanus</i>	F	W
SATYRIDAE		
<i>Melanitis leda africana</i>	f	W
<i>Bicyclus safitza</i>	O	W
<i>Bicyclus campinus ocelligerus</i>	F	W
LIBYTHEIDAE		
<i>Libythea labdaca laius</i>	f	W
NYMPHALIDAE		
<i>Euxanthe tiberius</i>	F	W
<i>Euxanthe wakefieldi</i>	F	W
<i>Charaxes acuminatus</i>	F	W
<i>Charaxes candiope</i>	F	W
<i>Charaxes contrarius</i>	F	W
<i>Charaxes zoolina</i>	f	W
<i>Charaxes xiphares maudei</i>	F	W
<i>Charaxes violetta melloni</i>	F	W
<i>Charaxes macclounii</i>	O	W
<i>Charaxes lasti</i>	F	W
<i>Euptera kinungnana</i>	F	W
<i>Bebearia orientis</i>	f	W
<i>Euphaedra neophron littoralis</i>	F	W
<i>Aterica galene</i>	f	W
<i>Pseudacraea lucretia expanca</i>	F	W
<i>Neptis melicerta</i>	F	W
<i>Neptis saclava</i>	f	W
<i>Sallya moranti</i>	F	W
<i>Eurytela dryope</i>	F	W
<i>Apaturopsis cleochares schultzi</i>	F	W
<i>Apaturopsis cleochares</i>	F	W
ACRAEIDAE		
<i>Bematistes adrasta</i>	F	W

Table 30 continued.

Species	Ecological type	Endemic status
LYCAENIDAE		
<i>Pentila tropicalis</i>	F	W
HESPERIIDAE		
<i>Coeliades chalbye</i>	F	W

KEY TO ABBREVIATIONS FOR TABLE 30 (Definitions based on those described in the botanical section of this report).

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 East African lowland forests;
- W - Widespread distribution.

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

UK - Unknown capture location

? - No data available

5.5 Discussion

5.5.1 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 that may be of concern as well as to broadly describe the typical fauna of the forest.

Table 31 Summary of faunal families and species (identified to date).

Taxon	Number of families	Number of species
Mammals (not bats)	13	25 (7 awaiting confirmation)
Bats	4	6 (1 awaiting confirmation)
Birds	30	51
Reptiles	13	29
Amphibians	9	19
Butterflies	9	35

Relative to the other ten forest reserves surveyed by Frontier-Tanzania Segoma has above average species richness for mammals (24), reptiles (22) and amphibians (19).

5.5.1.1 Mammals

The most common small mammal species is *Praomys* sp.(most probably *delectorum*). Other species which appear to be locally common are: *Beamys hindei*, *Rattus rattus*, *Lophuromys flavopunctatus*, and *Crocidura* sp.. However it has not yet been determined whether more than one species is included in the *Praomys* genus. At least two, probably more species are included in the genus *Crocidura* sp..

Bats which appear to be locally common are: *Rousettus aegyptiacus leachi* and *Hipposideros cyclops langi*.

5.5.1.2 Reptiles

The most common reptile species are the gecko *Cnemaspis barbouri* and the skink *Mabuya maculilabris*. Other species which appear to be locally common are: *Philothamnus macrops*, *Philothamnus punctatus*, *Natriciteres olivacea*, *Crotaphopeltis tornieri*, *Thelotornis capensis*, *Aparallactus werneri*, *Elapsoidea nigra* and *Rhampholeon brevicaudatus*. With 15 species Segoma has a particularly rich snake fauna including the East Usambara endemic *Prosymna semifasciata*, and several rare near endemic species.

5.5.1.3 Amphibians

The most commonly recorded amphibian species was *Arthroleptis xenodactyloides* which was recorded 107 times. Other species which appear to be locally common are: *Arthroleptis stenodactylus*, *Bufo brauni*, *Bufo maculatus*, *Stephopaedes usambarae*, *Leptopelis flavomaculatus*, *Afrivalus fornasinii*, *Callulina kreffti*, *Prynobartachus acridoides*, *Arthleptides mariensseni*, *Ptychadena* sp. and *Hemisis marmoratus*.

5.5.1.4 Endemics and near-endemics

Of the 15 mammal, reptile and amphibian species that are endemic or near-endemic to the Usambaras and were recorded during this survey, 9 appear to be locally common as they were recorded at least three times during the survey. These are: *Beamys hindei*, *Philothamnus macrops*, *Aparallactus werneri*, *Elapsoidea nigra*, *Rhampholeon brevicaudatus*, *Cnemaspis barbouri*, *Bufo brauni*, *Callulina kreffti* and *Arthroleptides martiensseni*.

5.5.1.5 Forest dependent species

Of the 22 mammal, reptile and amphibian species which are dependent on primary forest and were recorded during the survey, 13 appear to be locally common. These are: *Beamys hindei*, *Hipposideros cyclops langi*, *Philothamnus macrops*, *Crotaphopeltis tornieri*, *Aparallactus werneri*, *Elapsoidea nigra*, *Rhampholeon brevicaudatus*, *Cnemaspis barbouri*, *Mabuya maculilabris*, *Bufo brauni*, *Leptopelis flavomaculatus*, *Callulina kreffti* and *Arthroleptides martiensseni*.

The area of proposed forest extension to Segoma Forest Reserve, into the oil palm plantation appears to support an abundance of primates. Angola pied colobus, gentle monkeys, small-eared galagos and baboons were frequently observed in this part of the reserve although no systematic assessment of their abundance was conducted.

5.5.1.6 High risk species:

Assuming that the number captured reflects relative population size, the locally uncommon species that are both forest dependent and either endemic or near-endemic should be of conservation concern due to their low population density. These species are: *Myonycteris relicta*, *Bitis gabonica*, *Prosymna semifasciata*, *Lamprophis capensis*, *Leptosiaphos kilimensis*, *Nectophrynoides tornieri*, *Mertensophryne micranotis*, *Leptopelis uluguruensis* and *Leptopelis vermiculatus*.

Table 32 Summary of capture locations of faunal species by plot number.

Taxon	1	15	16	25	35	40	49
Small mammal*	3	5	4			5	3
Bats	1	1				1	2
Reptile	11	2	2	2	2	5	5
Amphibian	14	3	6			7	4
Butterflies	35						

*primates excluded due to their large ranges.

5.5.2 Ecological type

Of the 48 forest dependent species, 12 are mammals, 16 are birds, 12 are reptiles and 8 are amphibians.

Of the 18 species characteristic of open habitats, fifteen are birds many of which were recorded from the forest edge. Of the remaining three species two are reptiles: *Python sebae sebae* and *Natriciteres olivacea*, and one is a mammal *Rattus rattus*. With the exception of three of the records of *Natriciteres olivacea*, these species were recorded from the forest edge or from land adjoining the forest reserve.

Table 33 Summary of ecological type of mammal, bird, reptile and amphibian species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	48	38
(f) Forest dwelling but not forest dependent	44	34
(O) Non-forest species	19	15
Unknown	17	13
Total:	128	100

5.5.3 Endemic Status

One animal species is endemic to the Usambara Mountains; this is the snake, *Prosymna semifasciata*.

17 species are near-endemic, of these seven are amphibians (*Bufo brauni*, *Nectophrynoides tornieri*, *Mertensophryne micranotis*, *Leptopelis ulugurensis*, *Leptopelis vermiculatus*, *Callulina krefftii* and *Arthroleptides martiensenni*), six are reptiles (*Rhampholeon brevicaudatus*, *Cnemaspis barbouri* and *Elapsoidea nigra*), three are mammals (*Beamys hindei*, *Otolemur garnettii* and *Rhynchcyon pertersi*) and one is a bird (*Swynnertonia swynnertonii*).

Table 34 Summary of endemic status of mammal, bird, reptile and amphibian species.

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	1	0.9
(N) Near-Endemic: ranges in restricted locations	17	9.1
(W) Widespread	95	78.2
Unknown	15	11.8
Total:	128	100

5.5.4 Range Extensions

The endemic snake *Prosymna semifasciata*, previously known only from the adjoining Kwangumi Forest Reserve, was recorded twice in Segoma Forest Reserve.

5.5.5 IUCN Status

According to IUCN criteria *Prosymna semifasciata* is critically endangered.

According to IUCN criteria three species found in Segoma Forest Reserve are endangered by global extinction. These are: *Rhynchocyon petersi*, *Cnemaspis barbouri* and *Mertensophryne micranotis*.

According to IUCN criteria the following 13 species are vulnerable to extinction: *Dendrohyrax validus*, *Swynnertonia swynnertoni*, *Philothamnus macrops*, *Crotaphopeltis tornieri*, *Aparallactus weneri*, *Elapsoidea nigra*, *Rhampholeon brevicaudatus*, *Leptosiaphos kilimensis*, *Bufo brauni*, *Nectophrynoides tornieri*, *Leptopelis uluguruensis*, *Callulina krefftii* and *Arthroleptides martiensseni*.

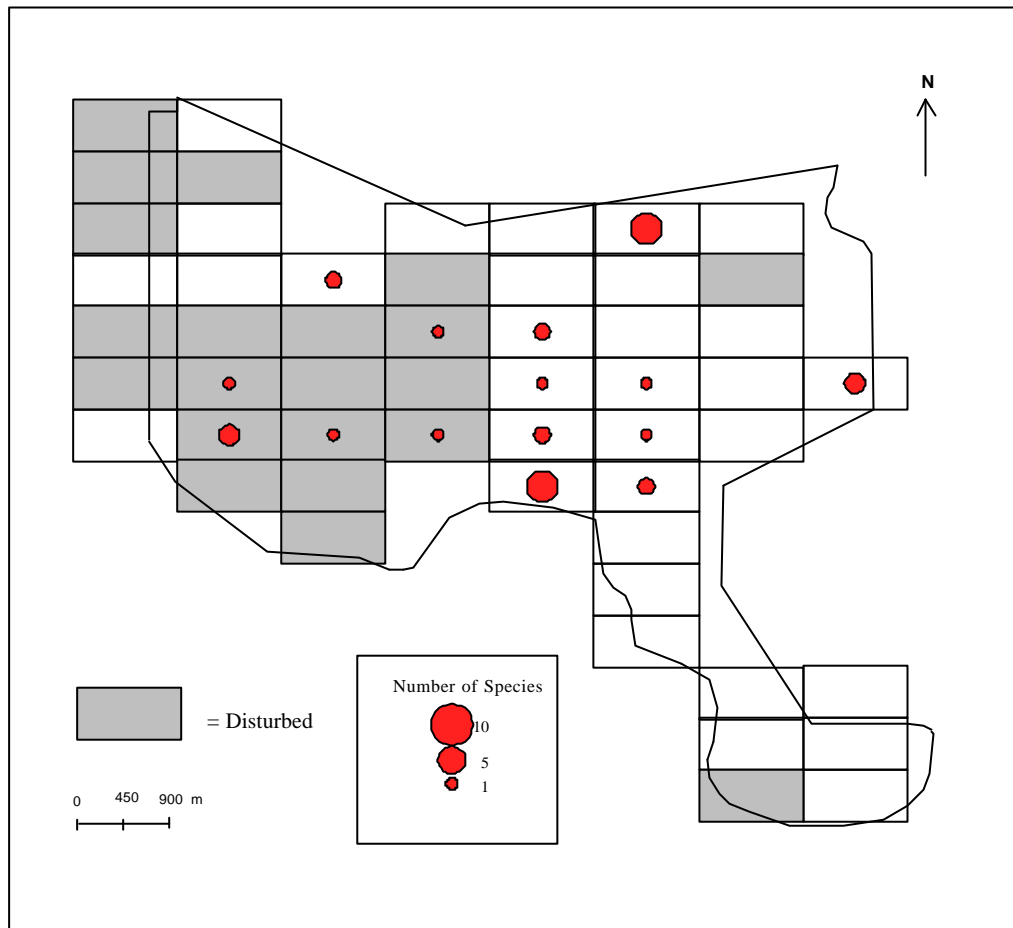


Figure 31 Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent, endemic and near-endemic in Segoma F.R..

6.0 CONCLUSIONS

This report presents the raw data of the survey with preliminary descriptions in terms of ecological type and endemic status. These two factors provide an indication of three 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.

Segoma forest was gazetted as a forest reserve in 1955. The gazetted forest covers an area of 1168 ha. It has been proposed to extend the reserve by 765 ha to a total area of 1933ha. With altitudes between 80 m and 920m, the extended forest area consists of approximately 1395.4 ha mature woodland forest and 80.4 ha of previously disturbed or colonising forest.

Disturbance

Poles and timber continue to be taken illegally from the reserve. Evidence of pit-sawing was observed throughout the reserve on five of the eight transects, although no active pitsaws were observed during this survey, this however maybe due to the presence of the research team.

Fire is a serious threat to the forest, extensive patches of forest were burnt between 1996 and 1997 in the west of the reserve and there are now large patches of the invasive alien plant species, *Lantana camara*.

The invasive tree species *Maesopsis eminii* was only recorded in two of the fifty-one vegetation plots in the west of Segoma.

Species Richness

The forest reserve was found to contain a minimum of 207 species of trees and shrubs; 31 mammal, 50 bird, 29 reptile, 19 amphibian and 35 butterfly species. Relative to the other ten forest reserves surveyed by Frontier-Tanzania it has above average species richness for plants, mammals, reptiles and amphibians.

Flora

Four tree species were recorded which are endemic to the Usambara mountains and 31 have ranges restricted to the Eastern Arc and/or East African lowland or coastal forests. 46 species are dependent on primary forest, and of these species, 15 are also endemic or near endemic to the Usambara mountains. 17 non-forest tree and shrub species are established within the reserve boundaries.

Fauna

One species was recorded which is endemic to the Usambara mountains and 17 species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. 48 species are dependent only on primary forest, and of these species, 18 are also endemic or near endemic to the Usambara mountains. 19 non-forest species are established in the reserve.

Other authors have recognised Segoma's importance in terms of its bird populations particularly from the presence of the near endemic Usambara eagle owl, *Bubo vosseleri*, Sokoke scops owl, *Otus ireneae*, and Swynnerton's robin, *Swynnertonia swynnertoni* (Cambridge Tanzania Rainforest Project, 1994).

Conservation

The forests of the East Usambara Mountains are recognised as being part of a Biodiversity Hotspot (Mittermeier, 1999), an Endemic Bird Area (ICBP, 1992), a Centre of Plant Diversity (WWF and IUCN) and a Globally Important Ecoregion (WWF). They are a conservation priority due to their floral and faunal diversity and to the high number of endemic species. The forests also have a direct value to surrounding communities as a principle water catchment area and as a source of fuel-wood and medicinal plants.

The forests of the East Usambara Mountains have been reduced to fragments within a matrix of agricultural land. Little forest remains outside of the gazetted forest reserves. For those species recorded that are forest dependent the forest reserves now provide almost the only available habitat.

There are differences in the perceived value of the forests between the villagers and the Forest and Beekeeping Division. Alternative sources of building material and fuel are required in order to meet the needs of surrounding villages while ensuring the protection of the forests.

Damage to Segoma Forest Reserve from fire and illegal timber extraction is of serious concern. Degradation and further fragmentation of Segoma Forest Reserve may lead to local extinctions of populations of those species identified as being at high risk. The loss of the forest will also reduce the reliability of the water supply to the region.

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. & Broadley, S. 1996. Serpentes Typhlopidae *Rhinotyphlops pallidus*. *African Herp News* No. 25.
- Broadley, D.G. & Howell, K.M., 2000. Reptiles. In: Burgess, N. D and Clarke, G. P. (Eds.) (2000). *Coastal Forests of Eastern Africa*. xiii + 443pp. IUCN, Gland, Switzerland and Cambridge, UK.
- 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.
- Cambridge Tanzania Rainforest Project. 1994. A biological and human impact survey of the lowland forests, East Usambara Mountains, Tanzania. Birdlife Study Report No. 59. Birdlife International, Cambridge.
- Collar, N.J.; Crosby, M.J. & Stattersfield, A.J. 1994. Birds to watch 2. The world list of threatened birds. Birdlife International, Cambridge.
- Collar, N.J. & Stuart, S.N. 1987. Priorities for conservation action. ICBP Monograph No. 3. 1988. Cambridge.
- Cunneyworth, P. & Stubblefield, L. 1996a. Magoroto Forest: A biodiversity survey. - East Usambara Conservation Area Management Programme Technical Paper No. 30. Forestry and Beekeeping Division & Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.
- Cunneyworth, P. & Stubblefield, L. 1996b. Bamba Ridge Forest Reserve: A biodiversity survey - East Usambara Conservation Area Management Programme Technical Paper No. 31. Forestry and Beekeeping Division & Metsähallitus Consulting & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.
- Cunneyworth, P. & Stubblefield, L. 1996c. Mlungui Proposed Forest Reserve: A biodiversity survey - East Usambara Conservation Area Management Programme Technical Paper No. 32. The Society for Environmental Exploration, London; Forestry & Beekeeping Division, Dar es Salaam; & Finnish Forest & Park Service, Vantaa.
- 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.
- 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.

- Hawthorne, W.D. 1993. East African coastal forest botany. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa*. Cambridge University Press, Cambridge. Pp 57-99.
- 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*.
- ICBP. 1992. Putting Biodiversity on the Map: Priority areas for conservation. Cambridge, UK. International Council for Bird Preservation.
- Iversen, S.T. 1991a. The Usambara mountains, NE Tanzania: History, Vegetation and conservation. Uppsala University, Uppsala.
- Iversen, S.T. 1991b. The Usambara mountains, NE Tanzania: Phytogeography of the vascular plant flora. Uppsala University, Uppsala.
- Johansson S. & Sandy R. 1996. Updated Forest area information in the Usambara mountains. East Usambara Conservation Area Management Programme, working paper 19.
- Kikula, I.S. 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. 1974. East African Mammals. An atlas of evolution in Africa. Vol. 2B: Hares and rodents. University Chicago Press, Chicago.
- Kingdon, J. 1989. East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats. University of Chicago Press, Chicago.
- Kingdon, J. 1997. The Kingdon field guide to African Mammals. Academic Press, London. 464 pages.
- 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.
- Knox, E.B. 2000. List of East African Plants (LEAP). *Database compiled largely from the Flora of Tropical East Africa (Rotterdam: Balkema) and Beentje (1994)*.
- 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. 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.
- 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.
- Mittermeier, R. A., Myers, N., Gil, P. R., and Mittermeier, C. G., 1999. Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. CEMEX and Conservation International. Washington DC, USA.

- 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. Witwatersrand University Press, Johannesburg.
- Poynton, J.C. 2000. Amphibians. In: Burgess, N. D and Clarke, G. P. (eds.) 2000. *Coastal Forests of Eastern Africa*. xiii + 443pp. IUCN, Gland, Switzerland and Cambridge, UK.
- Poynton J.C. & Clarke, B.T., 1999. Two species of *Staphopaedes* (Anura: Bufonidae) from Tanzania, with review of the genus. *African Journal of Herpetology*. 48(1&2): 1-14.
- 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. 1989. Some useful plants of the East Usambaras. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 185-194.
- 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.
- Schulman, L., Junikka, L., Mndolwa, A. and Rajabu, I. 1998. Trees of Amani Nature Reserve NE Tanzania. The Ministry of Natural Resources and Tourism. Helsinki University Printing House.
- SEE, 1996. Frontier Tanzania Forest Research Programme: Methodology report 'Old and New'. L. Stubblefield & P. Cunneyworth eds. Technical paper of the Society for Environmental Exploration, London.
- 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. 1996. Signs of the Wild. Struik. 215 pages.
- Zimmerman, D.A., Turner, D.A. & Pearson, D.J. 1996. *Birds of Kenya and Northern Tanzania*. Russel Friedman Books, South Africa.
- Zimmerman, D.A., Turner, D.A. & Pearson, D.J. 1999. *Birds of Kenya and Northern Tanzania*. Christopher Helm (Publishers) Ltd. London, UK.

APPENDIX 1: GENERAL PLOT INFORMATION

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	GM	125	10	CF	10 - 20
2	SM	120	7	CF	20 - 30
3	GL	140	20	BA	20 - 30
4	GM	110	10	CF	20 - 30
5	GL	182	19	LF	20 - 30
6	GU	340	21	LF	20 - 30
7	SL	125	40	LF	10 - 20
8	GL	150	3	LF	10 - 30
9	SM	205	25	LF	10 - 20
10	GM	240	20	LF	20 - 30
11	GM	340	22	LF	> 30
12	GL	200	15	LF	10 - 20
13	GL	200	13	LF	10 - 20
14	GM	320	10	LF	10 - 20
15	GL	240	27	LF	< 10
16	GL	180	17	LF	20 - 30
17	GL	110	5	LF	< 10
18	GL	160	8	LF	10 - 20
19	GL	150	?	LF	20 - 30
20	GL	140	2	LF	10 - 20
21	GL	130	9	LF	20 - 30
22	GL	80	10	LF	10 - 20
23	SL	110	29	LF	20 - 30
24	GL	65	7	RF	10 - 20
25	SL	105	31	LF	10 - 20
26	GL	200	7	LF	20 - 30
27	GL	160	11	LF	20 - 30
28	GL	150	9	LF	20 - 30
29	GL	140	2	LF	10 - 20
30	GL	110	4	LF	10 - 20
31	GL	100	21	LF	10 - 20
32	GL	120	23	LF	< 10
33	LF	210	21	LF	10 - 20
34	GL	180	15	LF	10 - 20
35	GL	200	15	LF	10 - 20
36	GL	160	0	LF	10 - 20
37	GL	170	12	LF	10 - 20
38	GL	180	3	LF	10 - 20
39	GM	340	27	LF	10 - 20
41	GM	?	22	LF	20 - 30
42	SM	?	?	LF	20 - 30
43	GL	170	24	LF	10 - 20
44	GL	250	21	LF	10 - 20
45	SM	360	29	LF	20 - 30
46	GL	135	14	LF	20 - 30
47	GL	240	21	LF	< 10

General plot information continued.

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
48	GL	215	19	LF	10 - 20
50	GM	25	?	LF	<10
51	GM	?	?	LF	10 - 20
52	GL	?	?	LF	10 - 20
53	GL	115	20	LF	10 - 20

KEY TO ABBREVIATIONS

Topography

GL - gentle lower slope

SL - steep lower slope

M - mid-slope

GU - gentle upper slope

SU - steep upper slope

FV - flat valley floor

RT - ridge top

F - mature mixed forest

Vegetation Condition

LF - Lowland forest

SF - Submontane forest

CF - Colonizing forest

RF - Riverine forest

PF - Plantation forest

S - Scrub / thicket / Bush

W - Woodland

? = Unknown

APPENDIX 2: TAXONOMIC VERIFICATION

BOTANY

Ahmed Mdolwa TAFORI Silvicultural Research Centre, P.O. Box 95,
Lushoto, Tanzania

ZOOLOGY - VERTEBRATES

Bats and small mammals:

Prof. K. M. 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. K. M. 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

Amphibians:

Prof. K. M. 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. K. M. 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

ZOOLOGY - INVERTEBRATES

Mollusca:

C/O Dr N. Scharff Zoological Museum University of Copenhagen,
Universitetsparken 15, DK-2100,
Copenhagen, Denmark

Millipedes

Dr R. Hoffman Virginia Museum of Natural
History 1001 Douglas Avenue, Martinsville,
Virginia 24112, USA
rhoffman@neocomm.net

Butterflies

Steve Collins African Butterfly Research P.O. Box 14308, Nairobi, Kenya

Institute

collinsabri@iconnect.co.ke

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 Catchment Forest Project.
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 Catchment Forest Project.
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 Catchment Forest Project.
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. Mnyuku, 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., Rwamu gira, 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. Kigula, J.J., Kijazi, M., Nyangasa, H., Mtango, J., Mahenge, F. 1998. Local communities aspirations and needs.

20. Fowler, S. & Nyambo, B. 1996. Report of a short consultancy on the potential of biological control of invasive species in Amani Nature Reserve. International Institute for Biological Control & EUCFP.
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. Local utilisation and indigenous knowledge - two case studies on forest resources use in the East Usambaras.
23. Shaka J.M. & Msangi, A. 1996. Soils and vegetation of Bamba Ridge forest reserve, Maramba Division, Muheza District, Tanga.
24. Shaka J.M. & Msangi, A. 1996. Soils and vegetation of Mlungui proposed forest reserve, Maramba Division, Muheza District, Tanga.
25. Shaka J.M. & Msangi, A. 1996. Soils and vegetation of Kwamarimba and north Longuza forest reserve, Bombwera Division, Muheza District, Tanga.
26. Shaka J.M., Kabushemera, W. & Msangi, A. 1996. Soils and vegetation of Kambai forest reserve, Bombwera Division, Muheza District, Tanga.
27. Shelutete, M. 1996. Women in focus. Report of a consultancy on conservation and women in East Usambara.
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. EUCFP. 1996. Magoroto Forest. A biodiversity survey.
31. EUCFP. 1996. Bamba Ridge Forest Reserve. A biodiversity survey.
32. EUCFP. 1996. Mlungui proposed forest reserve. A biodiversity survey.
33. EUCFP. 1996. Kwamarimba Forest Reserve. A biodiversity survey.
34. EUCFP. 1996. Longuza Forest Reserve. A biodiversity survey.
35. EUCFP. 1996. Kambai Forest Reserve. A biodiversity survey.
36. Shaka, J.M., W. Kabushemera & A. Msangi. 1997. A survey and vegetation of Semdoe proposed forest reserve, Bombwera Division, Muheza District, Tanga
37. Vainio-Mattila, K., Mwasumbi, L. & Lahti, K. 1997. Traditional use of wild vegetables in East Usambara mountains.
38. Sandy, R.P., Boniface, G. & Rajabu, I. 1997. A survey and inventory of the Amani Botanical Garden.
39. EUCAMP. 1999. Mtai Forest Reserve. A biodiversity survey.
40. EUCAMP. 1999. Kwamgumi Forest Reserve . A biodiversity survey.
41. Doggart, N. 1999. Manga forest reserve. A biodiversity survey.
42. Frontier Tanzania 2001. Doggart, N. H., Doody, K., Howell, K., and E. Fanning. Semdoe Forest Reserve: A biodiversity survey.
44. Doggart, N. 2000. The East Usambara biodiversity database: A user's manual
45. Jambiya, G. 2000. The Social Impact Assessment of the proposed Derema Forest Reserve and Wildlife Corridors.
46. Kamugisha, S.M. 2000. Progress Report on water flow and sediment load in Sigi & Bombo rivers.
47. Cordeiro, J. N. 2001. Population study on the Long-billed tailorbird in the East Usambara Mountains.
48. Kobb, D. 1998. Forestry royalties in Tanga region: Paper versus reality