TECHNICAL PAPER 52

Amani Nature Reserve

A biodiversity survey

Frontier Tanzania
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East Usambara Conservation Area Management Programme

Technical Paper 52

Amani Nature Reserve

A biodiversity survey

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

Ministry of Natural Resources and Tourism, Tanzania
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Department of International Development Co-operation, Finland
Metsähallitus Consulting

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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 programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

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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.

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FOR MORE INFORMATION:

Forestry and Beekeeping Division
P.O. Box 426, Dar es Salaam, Tanzania
Tel: 255-22-2111 062/3/4
Fax: 255-22-2114 659
E-mail: misitu@twiga.com

East Usambara Conservation Area Management Programme
P.O. Box 5869, Tanga, Tanzania
Tel: 255-27-2643453, 2646907, 2643820
Fax: 255-27-2643820
E-mail: usambara@twiga.com
Internet: www.usambara.com

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

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

Metsähallitus Consulting
P.O. Box 94, FIN-01301 Vantaa, Finland
Tel: 358-205-64100
Fax: 358-205-644401
E-mail: knowhow@metsa.fi

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

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Amani Nature Reserve, in the East Usambara Mountains in northeast Tanzania was gazetted in 1997. It is situated in Muheza District, Tanga Region and covers 8360 ha between approximately 190m and 1130m above sea level (asl), encompassing submontane, lowland and plantation forest.

As part of the East Usambara Conservation Area Management Programme, (EUCAMP), (formerly the East Usambara Catchment Forest Project), Frontier-Tanzania conducted a biological survey of Amani Nature Reserve between January 1999 and March 2000 for a total of 12 research months. The systematic vegetation survey covered all parts of the reserve with a sampling intensity of 0.25%, the zoological survey was focused on 17 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 in Table 1.

Table 1 Summary of biodiversity of taxa surveyed.

Taxon	Total no. of species	% forest dependent	No. of non-forest species	No. of endemic species	No. of near-endemic species	No. of forest dependent endemics and near-endemics
Trees and shrubs	264* 367** 8***	43%	22	19	49	53
Mammals	59 (includes 16 bat species)	15.3%	6	0	3	2
Birds	65	33.8%	15	2	3	3
Reptiles	49	46.7%	6	3	15	17
Amphibians	27	66.6%	0	2	14	16
Butterflies	112	20.5%	4	1	10	9
Total	**943**	**n/a**	**53**	**27**	**94**	**100**

* Species recorded in vegetation plots **Species recorded opportunistically ***Species recorded in the regeneration plots only

Amani Nature Reserve is the largest block of forest in the East Usambara Mountains; it is an amalgamation of six former forest reserves (Amani Sigi, Amani East, Amani West, Kwamsambia, Kwamkoro and Mnyuzi), 1068 ha of forest donated by the East Usambara Tea Company and public land. In terms of conservation it is significant as habitat for a large number of endemic and threatened species. It is also a good example of a continuous forest block of ranging from lowland to submontane forest. Relative to other reserves surveyed by Frontier-Tanzania Amani Nature Reserve has above average botanical and faunal species richness.

In terms of fauna, the reserve is home to seven endangered and 26 vulnerable species according to IUCN categories. The reserve has a high diversity of reptiles and amphibians. Six animal species and one subspecies recorded are endemic to the Usambara Mountains.

Pole cutting and animal trapping continue illegally within the nature reserve.

Fires represent a threat to the nature reserve on the western and southern borders.

Amani Nature Reserve offers an excellent example of continuous Eastern Arc lowland and submontane forest, that is accessible and caters for visitors and students. Thus Amani offers a unique opportunity for eco-tourism, training and study within the Eastern Arc.

The information collected by this survey 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 (version Windows 97) database in the EUCAMP library in Tanga, and parts of it are available on the Internet at the following address: www.usambara.com

Animal specimens have been deposited at: the Department of Zoology and Marine Biology, University of Dar es Salaam; Natural History Museum, London; Zoological Museum of Copenhagen, Denmark; Frankfurt Zoological Museum, Germany; The Natural History Museum of Zimbabwe, Bulawayo and the African Butterfly Research Institute, Nairobi. Contact names and addresses are listed in Appendix 2.

Botanical specimens are held at the TAFORI Herbarium in Lushoto.

FOREWORD

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

Although a considerable amount of biological information exists from the East Usambara Mountains 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 priorities in the conservation of this valuable area.

The programme involves locally employed field 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 Usambara Mountains. 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 into this database, which is linked to the Tanzanian national biodiversity database held at the Department of Zoology and Marine Biology, University of Dar es Salaam.

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 better management and conservation of the East Usambara Mountains 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 Veli Pohjonen
Chief Technical Adviser

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MANAGEMENT

FRONTIER-TANZANIA

Managing Director of SEE:	Eibleis Fanning
Development Programme Manager:	Elizabeth Humphreys
Director of Research:	Dr D. Stanwell Smith
Operations Manager:	Matthew Willson
UDSM Co-ordinators:	Prof. K. M. Howell and Dr M. Muruke

EUCAMP:

Project Manager:	Mr E. Nashanda
Chief Technical Advisor:	Dr V. Pohjonen

FIELD RESEARCH

FRONTIER-TANZANIA

Project Co-ordinators:	Nike Doggart and Kathryn Doody
Research Co-ordinator:	Kathryn Doody
Assistant Research Co-ordinators:	Henry Brink, Hanna Siurua, Olivia Scholtz, Christopher Barrio-Froján and Simon Loader
Logistics Co-ordinator:	James Davey
Field Assistants:	Hassani Abedi, Ramathan Rajabu, Godfrey Mathew, Lawrence Balua, Francis Kiondo and Zahara Rashidi.
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REPORT WRITING

Frontier-Tanzania

Authors:	Kathryn Doody, Raymond Kilenga, Albert Ntemi, Christopher Barrio-Froján, Hanna Siurua, Olivia Scholtz, and Simon Loader.
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.

1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains are situated in northeastern Tanzania within 40 km of the coastal town of Tanga between $4^{O}48'$-$5^{O}13'$S and $38^{O}32'$-$38^{O}48'$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 southeast of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes. Due to topographic 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 and 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 Usambara Mountains of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991a). Many are threatened (Rodgers, 1996).

The forests of the East Usambara Mountains are not only important for their biodiversity, they also play an important role in maintaining the hydrological cycle that feeds the Sigi River. This 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 a more irregular run off and deterioration in water quality due to siltation.

The latest survey of the East Usambara Mountains, conducted by Johansson and Sandy (1996) shows that approximately 45,137 ha of the East Usambara Mountains 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 Usambara Mountains according to these categories is described in Table 2.

Table 2 Forest area in the East Usambara Mountains (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 Usambara Mountains show limited endemism (Kingdon and Howell 1993). However, there are several species of special interest. These include: the restricted Zanj elephant shrew, *Rhynchocyon petersi*, which is common in the Usambara Mountains (Collar and 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 (Hilton-Taylor, 2000), and the Lesser pouched rat, *Beamys hindei* which is also considered 'Vulnerable' by IUCN (Hilton-Taylor, 2000).

There are at least 11 species of reptiles and amphibians endemic to the East and West Usambara Mountains (Howell, 1993). The East Usambara Biodiversity Surveys provide further information on new species and species' range extensions. A new species of snake, *Prosymna semifasciata*, was recently found in Kwamgumi and Segoma Forest Reserves (Broadley, 1995) and a recently described amphibian species; *Stephopaedes usambarae* (Poynton, 1999) has been recorded by the surveys in Mtai and Kwamgumi Forest Reserves.

The forest avifauna of the East Usambara Mountains has a high diversity with at least 110 species (Stuart, 1989). Six species occurring in the lowland forests are considered 'Vulnerable' to global extinction: Sokoke scops owl, *Otus ireneae*; the endemic Usambara eagle owl, *Bubo vosseleri*; Swynnerton's robin, *Swynnertonia swynnertoni*; East coast akalat, *Sheppardia gunningi*; Amani sunbird, *Anthreptes pallidigaster* and the Banded green sunbird, *Anthreptes rubritorques* (IUCN, 1996).

The East Usambara Mountains are essentially forest 'islands' (Lovett, 1989). There has been natural forest in the area for several million years. The Usambara Mountains 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 Amani Nature Reserve. Each species is described in terms of its ecological requirements and its endemic status.

Ecological requirements are defined as:

- **Forest dependent species (F)**: Species dependent on primary forest only. This category 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 as:

- **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.

Habitat type is based on Hamilton (1989) and the List of East African Plants (LEAP) (Knox, 2000).

For those species not listed by Iversen or Hamilton, the information is taken from the Flora of Tropical East Africa and the List of East African Plants database (LEAP), (Knox, 2000).
For the animals, the following references were used (in order of priority):

Mammals:	Kingdon (1997), Kingdon (1989) and Kingdon (1974)
Birds:	Zimmerman *et al.* (1996), Zimmerman *et al.* (1999)
Reptiles:	Howell (1993), Broadley and Howell (1991), and Branch (1994)
Amphibians:	Howell (1993) and Passmore, N. I. and V. C. Carruthers (1995)
Butterflies:	Kielland (1990) and Larsen (1996)

The IUCN category of threat is cited for those animals listed in the 2000 IUCN red list of threatened species (Hilton-Taylor, 2000). However many Tanzanian species are not included in the 2000 IUCN red list as insufficient data was available at the time of its publication. The IUCN status listed in this report for the mammals, amphibians and reptiles is based on the National Biodiversity Database. The status of these species is undergoing national and international evaluation.

1.3 Maps

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

1.4 Data and monitoring

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

1.5 Survey period and personnel

The survey of Amani Nature Reserve was conducted between January 1999 and March 2000 for a total of 12 research months. The survey was conducted by Frontier-Tanzania staff, Catchment Forest Officers, and local employed field assistants from Maramba, Tanga, Amani and Kisiwani.

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 gazettement;
- to provide information on the biological value and importance of these forests in order to assist in the development of management plans and practices for these forests;
- to develop a system for monitoring aspects of forest biodiversity, both on a general as well as a forest-specific level.

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of selected forests of the East Usambara Mountains 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: Amani Nature Reserve
Muheza District, Tanga Region, Tanzania.

Area: 8380 ha

Status: Nature Reserve
Gazetted 9th May 1997, Gazettement notice GN 152 (GG 78(19)).

The forest reserves that were combined to create the nature reserve were gazetted in:

Amani Sigi Forest Reserve (1153.5 ha) gazetted 1934, GN 43.
Amani East Forest Reserve (122.2 ha) gazetted 1955, GN 111.
Amani West Forest Reserve (158.5 ha) gazetted 1955, GN 196.
Kwamsambia Forest Reserve (1822.8 ha) gazetted 1954, GN 95.
Kwamkoro Forest Reserve (2270.9 ha) gazetted 1923, GN 99.
Mnyuzi Scarp Forest Reserve (672.9 ha) gazetted 1958, GN 296.

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742 (DOS 422)
Sheet 130/1 'Mnyuzi' of 1989
Forest Division maps:
Jb 2260 1994 'Amani Nature Reserve'
Jb 505 'Amani Sigi Forest Reserve'
Jb 216 'Amani East Forest Reserve'
Jb 217 'Amani West Forest Reserve'
Jb 370 'Mnyuzi Scarp Forest Reserve'
Jb 177 'Kwamkoro Forest Reserve'
Jb 176 'Kwamsambia Forest Reserve'.

3.1.2 Location

Lat/Long: 5°14'10'' - 5°04'30'' S 38°30'34'' - 38°40'06'' E

UTM: 94 21640 - 94 39000 S 45 0600 - 46 3200 E

Elevation: 190m – 1130 m above sea level

Amani Nature Reserve is situated in the southern area of the East Usambara Mountains (Figure 1), approximately 55 km by road from Tanga. The nature reserve forms the largest single block

of forest in the East Usambara Mountains and is connected to northern forest blocks only by the Derema forest corridor on public land.

3.1.3 Topography

The reserve encompasses the catchment for the Sigi river, which is the main catchment river of the East Usambara mountains. Amani Nature reserve is a 'y'-shaped, ridge orientated from the southwest towards the north and northeast.

The western border follows Mnyuzi scarp, rising steeply from Lwengera Valley to the ridge top at about 1000 metres. The southern leg rises steeply on both the eastern and western borders. The most southern point of the reserve at the bottom of Mnyuzi Scarp is easily observed as there is a telephone tower marking the point.

The central southern border rises steeply (towards the north) to the highest point in the reserve, Kimbo peak at approximately 1128m asl. The southeastern border is the lowest point in the reserve, and slopes gently at first, and then steeply, in a north- westerly direction to the ridge top. The northeastern border rises very steeply to the Amani-Sigi ridge.

The convoluted northern border lies mostly on the plateau at approximately 1000m.

3.1.4 Land use

The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson and Sandy (1996). The results for the former forest reserves that comprise Amani Nature Reserve are summarised in Table 3 below. The majority of the Amani Forests are dense lowland or dense submontane forest.

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

Amani Forest Reserves (Comprising Amani Sigi, Amani East, Amani West, Kwamkoro, Kwamsambia, Mnyuzi)	**Area (hectares)**	**% of area**
Dense Lowland forest	2199.2	35.5
Poorly Stocked Lowland forest	421.3	6.8
Dense Submontane forest	2816.5	45.4
Poorly Stocked Submontane	1.8	0.03
Peasant Cultivation	36.7	0.6
Cultivation Under forest	18.1	0.3
Maesopsis Plantation	508.5	8.2
Teak Plantation	83.9	1.4
Tea Plantation	6.5	0.1
Eucalyptus Plantations	1.7	0.03
Bush	96.5	1.6
Settlement	7.3	0.12
Barren	1.5	0.02
Pond and rivers	1.1	0.02
Total	**6200.6**	**100**

Note: This table does not include the public land and the 1068 ha of Tea Estate forest that was incorporated into the nature reserve.

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 Usambara Mountains relative to the West Usambara Mountains with much of the area remaining forested.

Amani Nature Reserve (Amani N.R.) was gazetted in 1997, amalgamating six forest reserves, (Amani-Sigi, Amani-east, Amani-west, Kwamsambia, Kwamkoro and Mnyuzi Scarp) public land and 1068 ha of forest donated by the East Usambara Tea Company into Tanzania's first nature reserve. However protection of the Amani forests pre-dates the establishment of the nature reserve (see section 3.11) with many of the reserves being gazetted during the German and then British colonial period.

The colonial Germans began logging activities in the Amani area in 1886, clearing land for plantations. These plantations originally grew coffee, but due to poor conditions and disease these were replanted with tea. These tea estates are now thriving and producing tea for the national and global market. Commercial logging activities continued at various intensities until the mid 1980's. Sikh Saw Mills Ltd. was the largest company operating in Amani and the remains of the saw mills are still visible at Mlesa Village. Logging roads are still noticeable in the forest although regenerating trees have made them inaccessible.

A small botanical garden was started in Amani around 1893, this became the basis of the 'Biological-Agricultural Institute of Amani' formerly erected in 1902 (Schulman *et al.* 1998). 'The institute had botanical, zoological and chemical laboratories performing soil analyses, disease, fertilizer, and other basic biological research, and by 1907 a total of 650 'useful plants' were cultivated there' (Iversen, 1991b). Individuals working at and visiting the research station; e.g. F. Stuhlmann; A. Zimmerman; A. Peter and P. Greenway undertook much of the early botanical work (Iversen, 1991b). The classical ornithological work by R. E. Moreau (Moreau, 1935) was conducted whilst he was the secretary and part-time librarian at Amani (Iversen, 1991b). For a detailed history of the research station at Amani please refer to Iversen, 1991a, Iversen, 1991b and Schulman *et al.* 1998.

Although in comparison to other East Usambara forests, great deal of research has been undertaken at Amani, this survey is the first comprehensive, systematic and comparable survey of all accessible parts of the nature reserve.

Amani encompasses a large area within which there are numerous villages and sub-villages. Many people are employed by the East Usambara Tea Company (approximately 4000 during peak season (G. Anderson pers. comm.)), providing a source of income to many households. People from the local communities are permitted to collect dead wood from the nature reserve for fuelwood twice a week. Any changes in the management of Amani Nature Reserve will impact upon the adjacent communities; thus management decisions are not isolated to consideration of forest issues alone. Management issues are discussed at bi-annual Amani Nature Reserve Board meetings attended by representatives of all interested parties, including local communities.

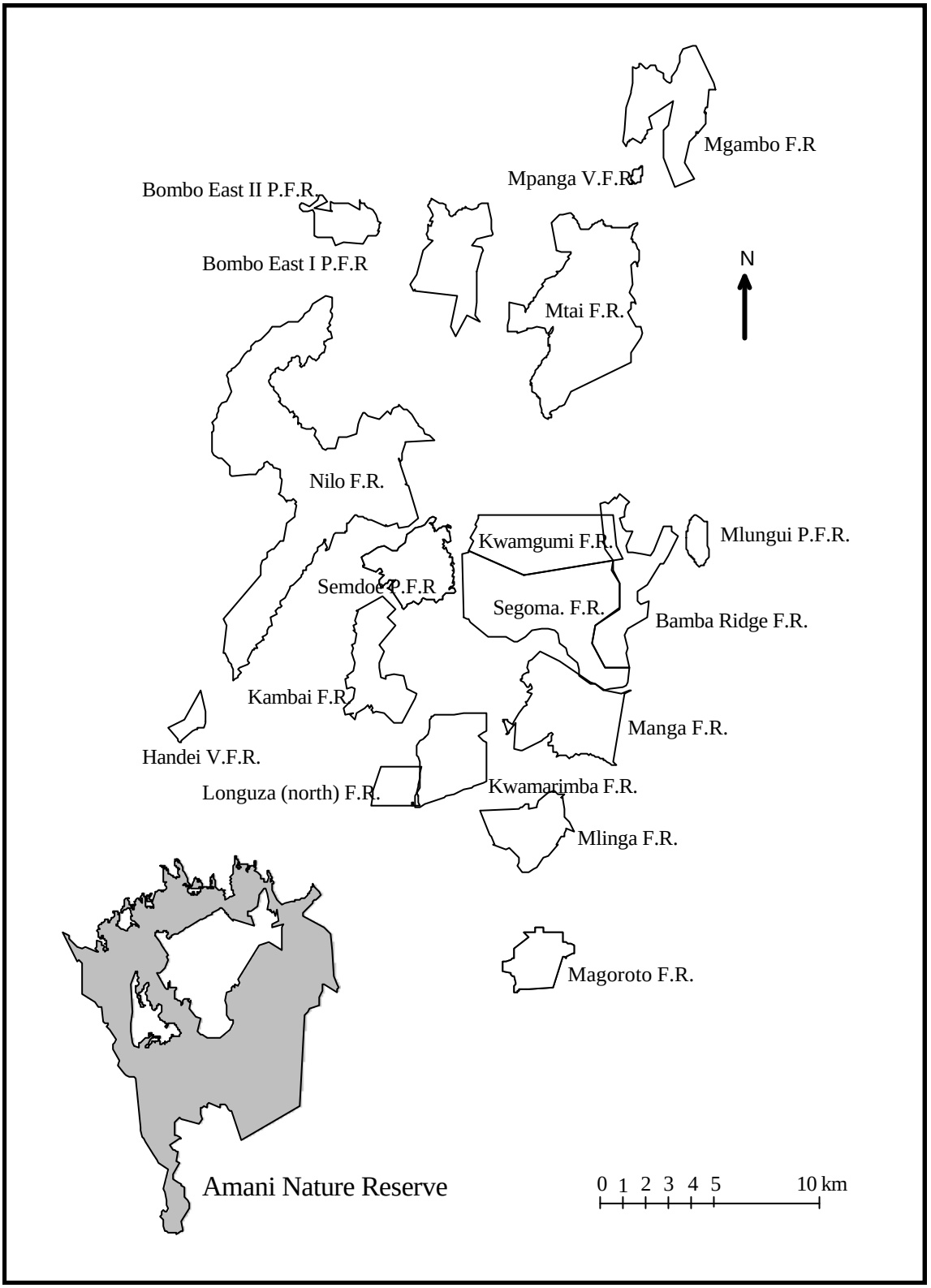

Figure 1 The location of Amani Nature Reserve in relation to other East Usambara forests.

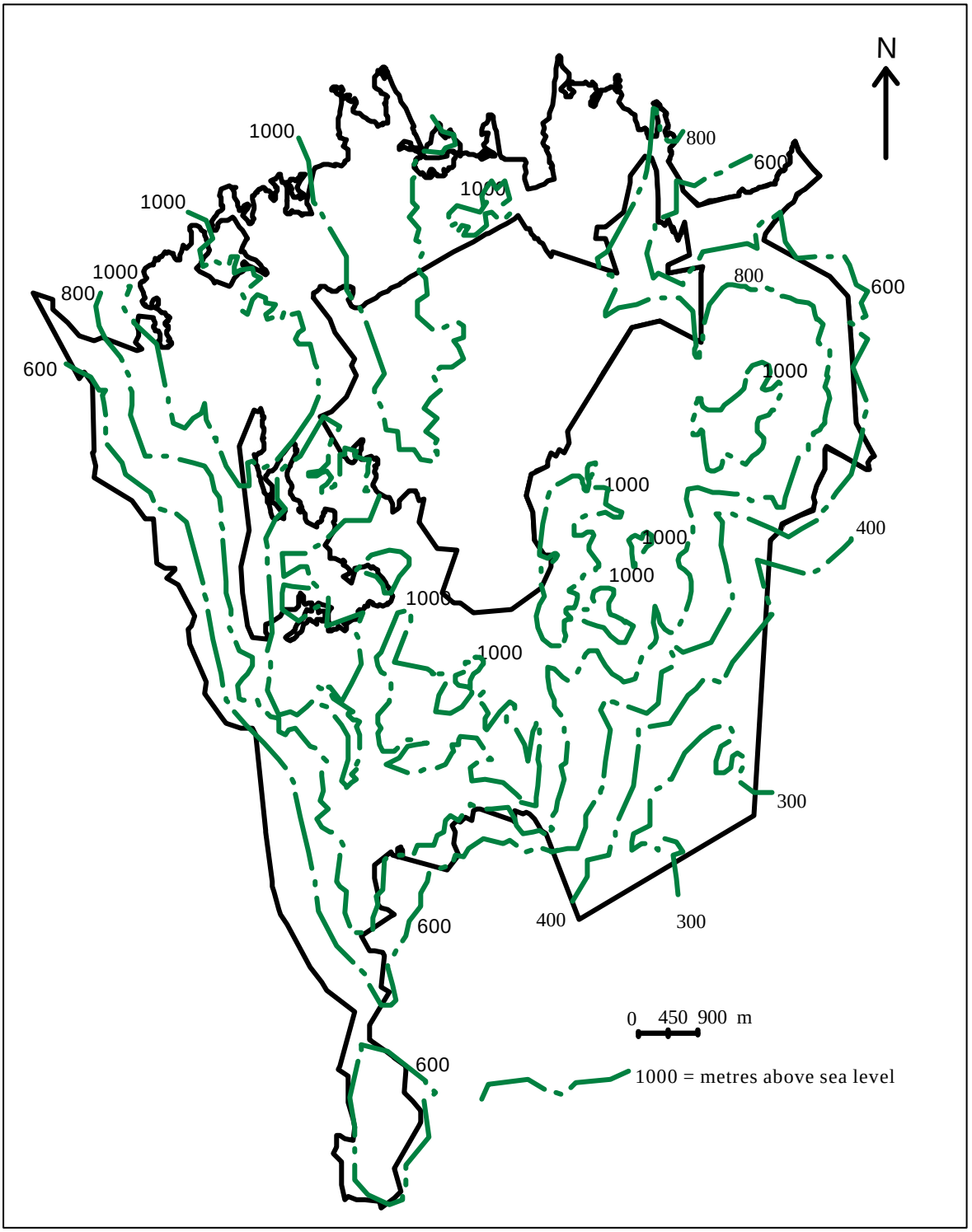

Figure 2 Topographical sketch map of Amani N.R.

4.0 VEGETATION

By Kathryn Doody, Raymond Kilenga, Albert Ntemi and Christopher Barrio-Froján.

4.1 Introduction

An inventory was conducted of the trees and shrubs found within the nature 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 was 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 levels of 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 diameter at breast height (dbh) 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 20m x 50m vegetation plots were located in the southeast corner of each of the 900m x 450m grid rectangles.

The regeneration layer was recorded within nested 3m x 3m and 6m x 6m subplots 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 east-west 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 was made between poles and timbers. Poles were classified as having a dbh (diameter at breast height) between 5 and 15cm and a minimum of 2m relatively straight trunk. Timber was 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.

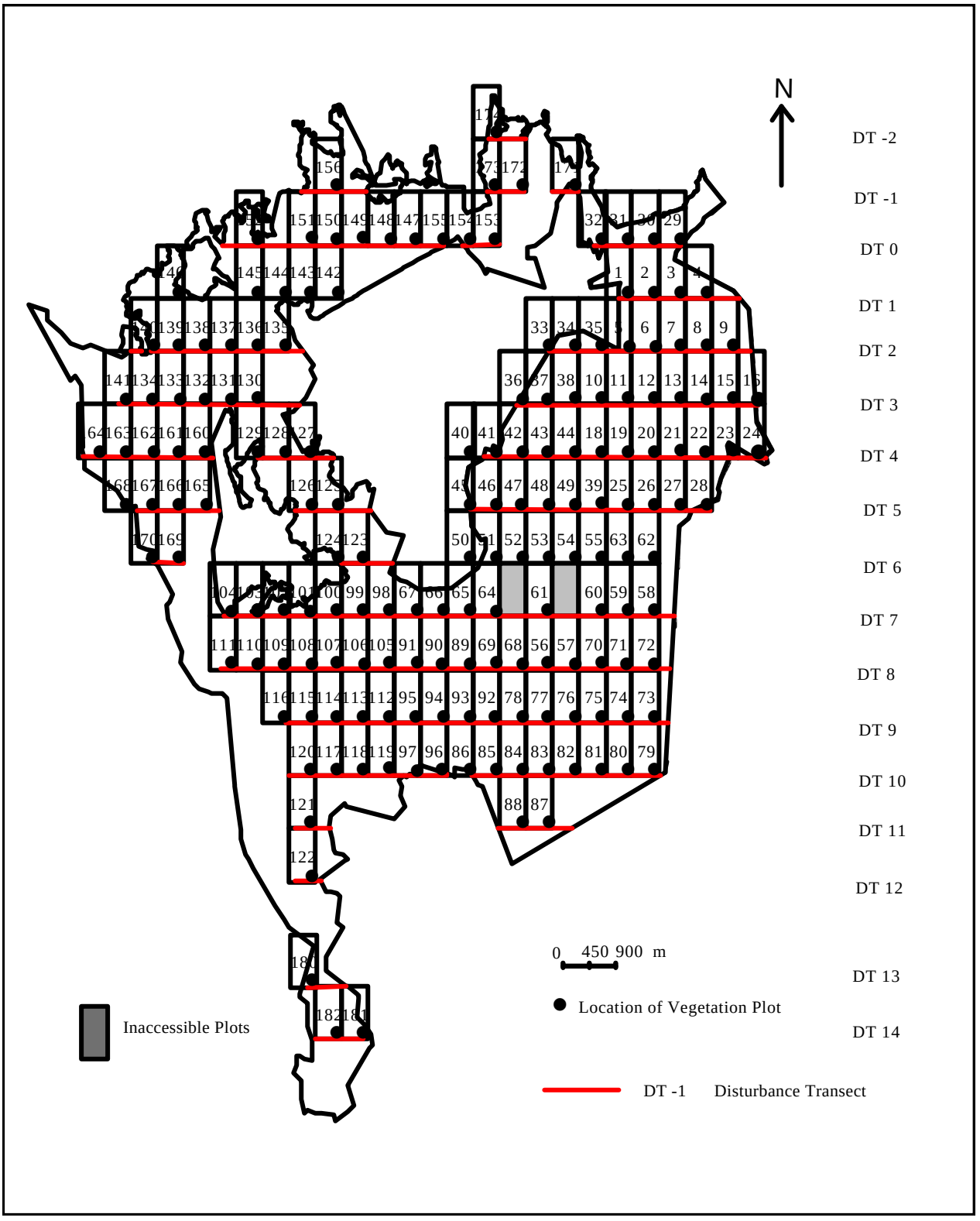

Figure 3 Location of vegetation plots and disturbance transects in Amani N.R.

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 (1991b), the Flora of Tropical East Africa and the LEAP database (Knox, 2000).

Table 4 Checklist of trees and shrubs recorded within the vegetation plots.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
ALANGIACEAE				
* *Alangium chinense*	f	S	W	28
ANACARDIACEAE				
Lannea schimperi	f	S & L	W	2
Lannea schweinfurthii	f	L&S	W	1
Lannea welwitschii var. *ciliolata*	F	L	N	9
Mangifera indica	O	L&S	W	2
* *Sorindeia madagascariensis*	f	S&L	W	585
Spondias lutea[1 2] (exotic)	?	?	W	3
ANNONACEAE				
* *Annickia kummeriae* *(syn. Enantia kummeriae)*	F	S	N	75
* *Annona senegalensis*	f	S&L	W	19
* *Greenwayodendron suaveolens*	F	S	E (EU&WU)	255
Greenwayodendron suaveolens spp. *usambaricum*	F	S	E (EU&WU)	21
Lettowianthus stellatus[1]	f	S&L	N	1
* *Polyceratocarpus scheffleri*	F	S	N	46
* *Uvariodendron oligocarpum*	F	S	E (EU&WU)	32
* *Uvariodendron usambarense*	F	S	N	38
Xylopia aethiopica	f	S&L	W	12
ANYSOPHLLEACEAE				
* *Anysophllea obtusifolia*[1]	?	?	?	29
APOCYNACEAE				
* *Funtumia africana*	F	L&S	W	152
Pleiocarpa pycnantha	F	L&S	W	3
* *Rauvolfia caffra*	F	L&S	W	1
* *Tabernaemontana holstii*[1]	?	L	?	20
* *Tabernaemontana pachysiphon*	F	S	W	92
* *Tabernaemontana stapfiana*	f	S	W	9
* *Tabernaemontana ventricosa*	F	L	W	82
* *Voacanga africana*	f	L&S	W	20
AQUIFOLIACEAE				
Ilex mitis	f	S	W	2
ARALIACEAE				
* *Cussonia arborea*	O	L&S	W	15
* *Polyscias fulva*	F	S (forest gaps)	W	42

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
BIGNONIACEAE				
* *Fernandoa magnifica*	f	L	W	8
* *Markhamia lutea*	f	L & S	W	19
Markhamia obtusifolia	O	L	W	4
* *Spathodea campanulata*	f	?	?	5
* *Stereospermum kunthianum*	f	L&S	W	44
BOMBACACEAE				
Bombax rhodognaphalon	f	L	N	10
BORAGINACEAE				
Cordia africana	f	L (forest gaps)	W	9
Cordia sinensis	f	L&S	W	1
BURSERACEAE				
Commiphora africana	O	L&S	W	1
CARICACEAE				
* *Cylicomorpha parviflora*	f	S&L (forest gaps)	N	47
CASUARINACEAE				
Casuarina equisetifolia (exotic)	Cultivated	L&S	W	1
CECROPIACEAE				
* *Myrianthus holstii*	f	S	W	223
Myrianthus stuhlmanii[1 2]	?	?	?	6
CELASTRACEAE				
Maytenus acuminata	F	S	W	3
Maytenus senegalensis	O	S&L	W	1
* *Maytenus undata*	f	S	W	7
Platypterocarpus tanganyikensis	F	S (M)	E (WU)	1
CHRYSOBALANACEAE				
* *Magnistipula butayei greenwayi*	F	L&S	E (EU)	16
* *Maranthes goetzeniana*	f	S	W	18
* *Parinari excelsa*	f	S	W	55
COMBRETACEAE				
* *Combretum molle*	O	L&S	W	3
* *Combretum schumannii*	F	L	W	14
Terminalia sambesiaca	f	L	W	14
COMPOSITAE				
Vernonia colorata oxyura	O	?	W	2
DRACAENACEAE				
Dracaena usambarensis[1]	f	L	W	4
EBENACEAE				
Diospyros abyssinica	f	S	W	3
Diospyros natalensis	f	L	W	10
Diospyros occulta	F	L&S	N	4
* *Diospyros squarrosa*[1]	F	L	W	5
EUPHORBIACEAE				
* *Alchornea hirtella*	f	S (forest gaps)	W	154
* *Antidesma membranaceum*	f	L&S	W	21
* *Bridelia micrantha*	f	L&S	W	21
Cleistanthus polystachyus	f	L&S	W	4
* *Croton sylvaticus*	f	L	W	17
* *Drypetes gerrardii*	F	S	W	72
Drypetes usambarica var.*usambarica*	f	S	N	13

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
EUPHORBIACEAE continued				
Flueggea virosa	f	L&S	W	1
* *Macaranga capensis*	F	L&S (forest gaps)	W	165
* *Mildbraedia carpinifolia (syn. M. fallax)*	f	L&S	N	2
Phyllanthus inflatus	f	S&L	W	2
* *Ricinodendron heudelotii*	f	L	W	6
Sapium armatum[1]	f	L	N	6
* *Sapium ellipticum*	f	L & S	W	42
FLACOURTIACEAE				
Caloncoba welwitschii	f	S&L	W	1
Dasylepis integra	F	S	N	12
* *Rawsonia lucida*	F	S	W	42
GUTTIFERAE				
* *Allanblackia stuhlmannii*	F	S	N	316
* *Garcinia buchananii*	f	S	W	11
* *Harungana madagascariensis*	F	S	W	33
Pentadesma butyraceae (exotic)[1 2]	?	?	?	2
Vismia orientalis	f	L&S	W	3
ICACINACEAE				
* *Alsodeiopsis schumannii*	F	S	N	70
LAURACEAE				
* *Beilschmiedia kweo*	F	S	N	16
Cryptocarya liebertiana	F	S	N	1
Ocotea usambarensis	F	S	W	2
LECYTHIDACEAE				
Barringtonia racemosa	f	L	W	6
LEGUMINOSAE Subfamily: CAESALPINIOIDEAE				
* *Cynometra brachyrrhachis*	F	L&S	E (EU)	61
* *Cynometra longipedicellata*	F	L&S	E (EU)	7
Cynometra sp.	?	?	?	1
Cynometra sp. A	F	S	E (EU)	2
* *Dialium holtzii*	f	L	N	2
* *Englerodendron usambarense*	F	S	E (EU & WU)	78
Erythrophleum guineense[1 2]	F		W	1
* *Erythrophleum suaveolens*	F	L	W	4
* *Isoberlinia scheffleri*	F	S	N	40
Zenkerella capparidacea grotei	F	S	E (EU)	3
* *Zenkerella grotei*[1]	F	S	E (EU & WU)	17
LEGUMINOSAE Subfamily: MIMOSOIDEAE				
Acacia senegalensis[1]	O	L&S	W	2
Albizia adianthifolia	f	L&S	W	1
Albizia glaberrima	f	L	W	6
* *Albizia gummifera*	f	L&S	W	33
Albizia versicolor	O	L&S	W	3
Albizia zimmermannii	f	L	W	4
* *Newtonia buchananii*	F	S	W	93
Newtonia paucijuga	F	L	N	4
* *Parkia filicoidea*	F	L&S	W	5

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
LEGUMINOSAE Subfamily: PAPILIONOIDEAE				
Senna singueana[1 2]	O	?	W	1
Angylocalyx braunii	F	L	N	2
* *Craibia zimmermannii*	F	L&S	W	9
Erythrina abyssinica	O	L&S	W	6
Lonchocarpus bussei	O	L&S	W	14
* *Lonchocarpus capassa*[1]	O	L&S	W	8
Millettia dura	F	S	W	10
Millettia oblata	F	S	N	6
* *Millettia oblata intermedia*	F	S	N	3
Millettia sacleuxii	F	L	N	9
Pterocarpus mildbraedii	F	L	N	2
* *Pterocarpus tinctorius*	F	S&L	W	3
Schefflerodendron usambarense	F	S	W	13
LOGANIACEAE				
* *Anthocleista grandiflora*	f	S	W	34
Strychnos innocua[1]	?	S	W	1
MELIACEAE				
* *Cedrela odorata*[1] (exotic)	?	?	W	6
* *Entandrophragma excelsum*	F	S	W	2
Khaya anthotheica[1]	F	L&S	W	7
* *Melia azedarach*	f	L&S	W	2
Toona ciliata (exotic)	f	?	W	1
Trichilia dregeana	f	L&S	W	9
* *Trichilia emetica*	f	L	W	29
Turraea holstii	F	S	W	2
MELIANTHACEAE				
* *Bersama abyssinica*	f	S (forest gaps)	N	5
Bersama abyssinica spp. *abyssinica* var. *holstii*	O	L&S	W	8
Bersama abyssinica spp. *paullinioides* var. *usambarica*	F	S	N	11
MONIMIACEAE				
* *Xymalos monospora*	F	S (forest gaps)	W	76
MORACEAE				
* *Antiaris toxicaria*	f	S&L	W	102
Artocarpus heterophyllus (exotic)	O	?	W	3
* *Castilla elastica*[1] (exotic)	?	?	W	3
Ficus craterostoma	f	L&S	W	2
* *Ficus exasperata*	f	S&L	W	17
Ficus lutea	f	L	W	2
Ficus sp.	?	?	?	1
* *Ficus sur*	f	S&L	W	31
Ficus sycomorus	F	L	W	5
* *Ficus vallis-choudae*	f	L	W	21
* *Mesogyne insignis*	F	S	N	97
Milicia excelsa	f	S&L	W	25
* *Morus mesozygia*	F	L	W	6
* *Trilepisium madagascariensis*	f	L&S	W	148

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
MYRISTICACEAE				
* *Cephalosphaera usambarensis*	F	S	N	221
MYRSINACEAE				
* *Maesa lanceolata*	f	S (forest gaps)	W	16
MYRTACEAE				
Eucalyptus saligna[1]	?	?	W	2
* *Syzygium guineense*	F	S	W	12
OCHNACEAE				
Ochna holstii	f	S	W	1
OLACACEAE				
* *Strombosia scheffleri*	F	S	W	167
Ximenia americana[1]	O	L&S	W	1
OLEACEAE				
* *Chionanthus nilotica*[1]	F	S&L	W	8
Olea capensis	F	?	W	4
PALMAE				
Cocus nucifera[1]	O	L&S	W	2
RHAMNACEAE				
* *Lasiodiscus mildbraedii*[1]	?	S	W	1
* *Maesopsis eminii* (exotic)	F	S&L	W	669
Ziziphus pubescens	f	L	W	3
RHIZOPHORACEAE				
* *Anisophyllea obtusifolia*	F	S	E (EU)	42
Cassipourea gummiflua	F	S	W	6
RUBIACEAE				
* *Aoranthe penduliflora*	F	L&S	N	16
Breonadia salicina	F	L&S	W	1
Chazaliella abrupta var. *abrupta*	f	L&S	W	1
Cinchona succirubra[1 2]	?	?	?	1
Coffea mongensis	F	S	N	2
* *Coffea pseudozanguebariae*	F	L	N	2
* *Coffea robusta*[1] *(syn. C. camphora)*	O	L&S	W	1
* *Coffea* sp.	?	?	?	4
* *Cremaspora triflora*	f	S	W	35
Hallea rubrostipulata	f	S	W	11
* *Heinsenia diervilleoides* *(syn. Aulocalyx)*	F	L&S	W	16
Keetia gueinzii	F	L&S	W	3
Keetia sp.	?	?	?	3
* *Leptactina platyphylla*	f	S	W	1
* *Morinda asteroscepa*	f	S (forest gaps)	N	22
Oxyanthus pyriformis	F	S (forest gaps)	W	2
Oxyanthus pyriformis spp. *tanganyikensis*	f	L&S	N	1
* *Oxyanthus speciosus*	F	S (forest gaps)	W	6
Porterandia penduliflora *(syn Aoranthe penduliflora)*	F	L&S	N	1
Rothmannia manganjae	F	S&L	W	15
* *Rytigynia flavida*	F	S	N	6
Rytigynia schumannii[1]	?	?	?	18

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
RUBIACEAE continued				
* *Rytigynia sp.*	?	?	?	6
Rytigynia xanthotricha	F	S	E (EU)	1
Tarenna graveolens	O	L&S	W	1
* *Tarenna pavettoides*	F	L&S	W	22
* *Tarenna nigrenscens*[1]	f	L	W	19
Tricalysia acidophylla	f	L	N	4
* *Tricalysia anomala*	F	S	N	8
* *Tricalysia pallens* (syn. *T. myrtifolia*)	f	S	W	12
Tricalysia sp.	?	?	?	4
* *Vangueria infausta*	f	L&S	W	1
RUTACEAE				
Teclea amaniensis	f	L&S	N	1
* *Teclea nobilis* (syn. *Vepris nobilis)*	f	S	W	13
Zanthoxylum chalybeum[1]	?	L&S	W	4
Zanthoxylum gilletii	F	S	W	2
Zanthoxylum usambarense	F	S	W	1
SAPINDACEAE				
Allophylus abyssinicus	F	S	W	1
* *Allophylus callophylus*[1 2]	f	?	N	2
Allophylus melliodorus	f	?	N	19
Allophylus stachyanthus	F	L	N	1
* *Blighia unijugata* *(syn. Phialodiscus zambesiacus)*	F	L&S	W	24
* *Deinbollia borbonica*	O	L	W	1
* *Deinbollia kilimandscharica*	F	?	W	2
* *Lecaniodiscus fraxinifolius*	f	L&S	W	24
* *Placodiscus amaniensis*[2]	F	?	N	8
Zanha africana[1]	?	?	W	5
* *Zanha golungensis*	F	L&S	W	9
SAPOTACEAE				
Afrosersalicia cerasifera *(syn. Pouteria cerasifera)*	f	S&L	W	29
* *Bequaertiodendron natalense* (syn. *Englerophytum natalense)*	f	L&S	W	9
Chrysophyllum gorungosanum	F	S	W	10
* *Chrysophyllum perpulchrum*	F	S	W	51
Chrysophyllum sp.	?	?	?	1
Chrysophyllum zimmermannii[2]	F	?	E	2
Manilkara densiflora[1 2]	?	?	?	1
Manilkara obovata	f	S	W	2
Manilkara sansibarensis[1]	f	L	W	1
* *Mimusopis kummel* (exotic)	f	L	W	5
* *Pachystela msolo*	F	L&S	W	187
* *Pouteria adolfi-friedericii* *(syn. Aningeria adolfi-friedericii)*	F	S	W	15
* *Pouteria alnifolia*[1]	f	L&S	W	31
Pouteria pseudoracemosa *(syn. Aningeria pseudoracemosa)*	F	L&S	N	9
* *Synsepalum cerasiferum*[1 2]	?	?	?	78

Table 4 continued.

Species	Ecological type	Habitat	Endemic Status	Individuals recorded
SIMAROUBACEAE				
Harrisonia abyssinica	f	?	W	2
* *Odyendea zimmermannii*	F	S	N	83
* *Quassia undulata*[1]	F	S	N	15
STERCULIACEAE				
* *Cola greenwayi*	F	S	W	28
Cola scheffleri	F	L	E (EU)	10
* *Cola usambarensis*	F	S	E(EU)	10
* *Cola vercillata*[1 2]	F	?	E (EU)	8
Dombeya shupangae	O	L	N	13
* *Leptonychia usambarensis*	F	L&S	N	594
Sterculia appendiculata	f	L	W	3
TILIACEAE				
Grewia bicolor	O	S	W	1
* *Grewia goetzeana*	f	L	W	8
ULMACEAE				
* *Celtis africana*	F	L	W	35
* *Celtis gomphopylla (syn. C. durandii)*	F	L	W	9
Celtis mildbraedii	F	L&S	W	20
* *Celtis wightii*	f	S	W	6
* *Trema orientalis*	f	L&S (forest gaps)	W	7
VERBENACEAE				
Premna chrysoclada	F	L	E (EU)	1
Premna schliebenii	F	L	N	3
Vitex doniana	f	L&S	W	1
VIOLACEAE				
* *Rinorea albersii*[1]	F	S	E	8
* *Rinorea ferruginea*	F	L&S	N	16
Unknown	?	?	?	14
Total				**7193**

[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 appear in the LEAP (Knox, 2000) botanical database.
3 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.

Habitat: (based on Hamilton, 1989)

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

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 Usambara Mountains; WU - Range limited to the West Usambara Mountains

Regeneration Layer

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

In Table 5, an additional twelve 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
Cyatheae manniana	f	S	W
Diospyros amaniensis	F	L	W
Suregada zanzibarense	f	L	W
Zenkerella egregia	f	S	N
Memecylon sp.	?	?	?
Dorstenia kameruniana	f	L	W
Syzygium cordatum	F	L&S	W
Ochna sp.	?	?	?
Arenga pinnata (exotic)	?	?	?
Sericanthe odoratissima	F	L & S	E (EU & WU)
Citrus sp.	?	?	?
Dombeya acutangula	f	?	W

Table 6 presents a list of plant species observed opportunistically within Amani Nature Reserve.

Table 6 Summary of opportunistic botanical records from Amani Nature Reserve.

Species	Ecol. type	Habitat	End. Status
ACANTHATHEAE			
Barleria spinisepala[1]	?	M	W
Crossandra tridentata	F	M	W
Ecbolium sp.	?	?	?
Hypoestes aristata	f	M	W
Justicia flava	f	L&S	W
Sclerochiton boivinii	F	L&S	N
Thunbergia usambarica	f	S&L	W
Whitfieldia elongata[2]	f	?	W
ALOEACEAE			
Aloe sp.	?	?	?
AMARANTHACEAE			
Achyranthes aspera	f	?	W
AMARYLLIDACEAE			
Crinum politifolium	f	L&S	N
Scadoxus multiflorus	f	L&S	W
ANACARDIACEAE			
Ozoroa insignis spp. *reticulata*	f	L&S	W
Rhus natalensis	f	L&S	W
Sclerocarya birrea[1]	O	L&S	W
ANNONACEAE			
Isolana heinsenii	F	S	N
Monanthotaxis trichocarpa	F	L	N
Monodora grandidieri	f	L&S	N
Uvaria acuminata	f	L&S	W
Uvaria dependens	F	S	N
Uvaria tanzaniae[2]	F	?	N
Xylopia parviflora	f	L	W
ANTHERICACEAE			
Chlorophytum tuberosum[1]	?	L&S	W
APOCYNACEAE			
Alafia orientalis [2]	F	S	N
Ancylobothrys petersiana	f	L	W
Carvalhoa campanulata	f	L	W
Landolphia kirkii	f	L&S	W
Rauvolfia mombasiana	f	L	N
Saba comorensis[2]	f	L&S	W
Schizozygia coffaeoides	F	L	W
Strophanthus courmontii	f	L&S	W
Strophanthus kombe	f	L	W
Voacanga thouarsii	f	L&S	W
ARACEAE			
Anchomanes abbreviatus	F	L	N
Callopsis volkensii[1]	F	L	N
Culcasia orientalis	f	L	N
Gonatopus boivinii	f	L&S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
ARACEAE continued			
Zamioculcas zamiifolia	f	L	W
Zantedeschia aethiopica[2]	O	?	W
ARISTOLOCHIACEAE			
Aristolochia labiata[2]	O	?	W
ASCLEPIADACEAE			
Gomphocarpus physocarpus[2]	O	?	E
Kanahia laniflora[2]	O	?	N
Mondia whitei[2]	F	?	E
ASPARAGACEAE			
Asparagus aethiopicus	f	L	W
Asparagus falcatus	f	?	W
Asparagus racemosus	f	?	W
BALSAMINACEAE			
Impatiens nana	f	S&L	N
Impatiens walleriana	f	S&L	W
BASELLACEAE			
Basella alba	f	L&S&M	W
BEGONIACEAE			
Begonia engleri[2]	f	?	N
Begonia meyeri-johannis	F	M	W
Begonia oxyloba	f	S	W
BIGNONIACEAE			
Kigelia africana	f	S	W
Markhamia zanzibarica	f	?	W
BOMBACACEAE			
Adansonia digitata	O	L&S	W
Ceiba pentandra (exotic)	f	S	W
Ochroma lagopus[1 2]	O	?	W
BORAGINACEAE			
Cordia monoica (syn. C. ovalis)	f	L&S	W
Ehretia bakeri	f	L&S	W
BURSERACEAE			
Commiphora eminii zimmermannii	f	L&S	W
CACTACEAE			
Rhipsalis baccifera	f	L&S	N
CAPPARIDACEAE			
Boscia salicifolia	f	L&S	W
Capparis erythrocarpos var. *rosea*	f	L	W
Maerua triphylla var. *pubescens*	f	L&S	W
CARYOPHYLLACEAE			
Drymaria cordata	f	S	W
Stellaria mannii	f	S	W
CELASTRACEAE			
Salacia lehmbachii var. *usambarensis*	F	L&S	N
COLCHICACEAE			
Gloriosa minor[1]	?	L	W
Gloriosa superba	f	S	W
COMBRETACEAE			
Combretum schweinfurthii[1]	?	S&L	W
Pteleopsis myrtifolia	f	L	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
COMMELINACEAE			
Aneilema aequinoctiale	f	S	W
Aneilema pedunculosum[1]	F	?	W
Commelina africana	f	?	W
COMPOSITAE			
Ageratum conyzoides	O	S&L	W
Aspilia mossambicensis	f	?	W
Bidens pilosa	O	L&S	W
Bidens schimperi	O	?	W
Galinsoga parviflora	O	S	W
Montanoa hibiscifolia[2]	O	?	W
Senecio syringifolius	F	?	W
Solanecio manni	O	?	W
Tithonia diversifolia	O	S	W
Vernonia sp.	?	?	?
CONNARACEAE			
Agelaea heterophylla[1]	?	S	W
Agelaea pentagyna[2]	F	?	W
Agelaea setulosa[1]	f	?	W
CONVOLVULACEAE			
Hewittia sublobata	f	L&S	W
CRASSULACEAE			
Kalanchoe densiflora var. *densiflora*	f	S	W
Kalanchoe nyikae	f	S	N
CUCURBITACEAE			
Coccinia grandis	f	L&S	W
Luffa cylindrica	f	L&S	W
Momordica foetida	f	L&S	W
Peponium vogelii	f	L&S	W
CYPERACEAE			
Cyperus distans	O	L	W
Cyperus latifolius	O	S	W
DICHAPETALACEAE			
Dichapetalum eickii	f	S	N
Dichapetalum ruhlandii	f	L&S	W
DIOSCOREACEAE			
Dioscorea alata	?	L&S	W
Dioscorea longicuspis	?	S	N
DRACAENACEAE			
Dracaena afromontana	F	S	W
Dracaena laxissima	?	?	W
Dracaena steudneri	f	S (forest gaps)	W
Sanseveria kirkii	?	?	W
EBENACEAE			
Euclea natalensis ssp. *obovata*	f	L&S	W
EUPHORBIACEAE			
Acalypha anata [1 2]	?	?	?
Acalypha racemosa	f	L&S	W
Antidesma venosum	f	L&S	W
Bridelia micrantha	f	L&S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
EUPHORBIACEAE continued.			
Drypetes natalensis	f	L	W
Euphorbia candelabrum	O	S&L	W
Erythrococca kirkii	f	L&S	W
Erythrococca polyandra	F	S	N
Mallotus oppositifolius	f	L&S	W
Margaritaria discoidea var. *fagifolia*	f	S	W
Micrococca scariosa[1]	?	L	W
Neoboutonia macrocalyx	f	S	W
Phyllanthus leucanthus	f	S&L	W
Pycnocoma macrantha[2]	F	S&L	E(EU)
Suregada lithoxyla	F	S	N
Synadenium glaucescens	f	S&L	N
Tragia brevipes [1]	?	S&L	W
Zimmermannia capillipes	F	S	E (EU&WU)
FLACOURTIACEAE			
Grandidiera boivinii	F	S	N
Ludia mauritiana	f	L&S	W
Rawsonia reticulata	f	S	N
Scolopia zeyheri	f	L&S	W
FLAGELLARIACEAE			
Flagellaria guineensis	?	L	W
GESNERIACEAE			
Saintpaulia confusa	f	?	N
Saintpaulia difficilis	f	?	E (EU)
Saintpaulia grotei	f	?	E
Streptocarpus caulescens var. *pallescens*	f	S	W
GRAMINEAE			
Leptaspis cochleata	F	S&L	W
Olyra latifolia	f	S&L	W
Oplismenus hirtellus	F	L&S	W
Oreobambos buchwaldii	F	S&L	W
Oxtenanthera abyssinica[1]	?	S&L	W
Panicum maximum	f	L&S	W
Paspalum conjugatum	f	L&S	W
Pennisetum purpureum	f	L&S	W
Phragmites mauritianus	O	L&S	W
Rottboellia cochinchinensis	O	L&S	W
Setaria homonyma	O	S&L	W
Setaria pumila	O	L&S	W
Sorghum sp.	?	?	?
Themeda triandra	O	L&S	W
GUTTIFERAE			
Garcinia volkensii	F	S	W
Psorospernum febrifugum	f	L&S	W
HERNANDIACEAE			
Gyrocarpus americanus var. *americanus*	f	L	W
ICACINACEAE			
Apodytes dimidiata	f	S	W
Leptaulus holstii	F	S&L	W
Pyrenacantha kaurabassana	f	L&S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
LABIATAE			
Achyrospermum radicans	F	?	W
Hoslundia opposita	f	S&L	W
Hyptis pectinata	O	L&S	W
Hyptis suaveolens	O	?	W
Ocimum suave [1 2]	?	?	W
Plectranthus barbatus	f	S	W
Tetradenia riparia[2]	f	?	W
LAURACEAE			
Cinnamomum camphora[1]	?	?	W
LEGUMINOSAE Subfamily: CAESALPINIOIDEAE			
Afzelia quanzensis	f	L&S	W
Cynometra webberi	f	L	N
Piliostigma thonningii	O	L&S	W
Scorodophloeus fischeri	f	L	N
Tylosema fassoglense	O	L&S	W
LEGUMINOSAE Subfamily: MIMOSOIDEAE			
Acacia polyacantha	f	L&S	W
Acacia schweinfurthiii	F	S	W
Albizia anthelmintica	O	S&L	W
Albizia chinensis (exotic)[2]	f	?	?
Albizia petersiana	f	S&L	W
Albizia schimperiana	F	S	N
Dichrostachys cinerea	O	L&S	W
Entada pursaetha[1]	f	L	W
LEGUMINOSAE Subfamily: PAPILIONOIDEAE			
Arbrus precatorius ssp. *africanus*	f	L&S	W
Crotalaria axillaris[2]	f	?	W
Dalbergia boehmii	f	L	W
Dalbergia lacteal	f	S&L	W
Desmodium adscendens var. *adscendens*	f	S&L	W
Desmodium triflorum	f	S&L	W
Dolichos trilobus ssp. *trilobus* var. *trilobus*	f	L	W
Eriosema psoraleoides	f	L&S	W
Indigofera arrecta	f	L&S	W
Indigofera volkensii[1]	?	S&L	W
Millettia sacleuxii	f	L	N
Millettia usaramensis ssp. *usaramarensis* var. *usaramarensis*	f	L	W
Mucuna gigantea spp. *quadrialata*	f	L&S	W
Mucuna pruriens	O	L&S	W
Ormocarpum kirkii	O	L&S	W
Pterocarpus mildbraedii spp. *usambarensis*	F	L	N
Tephrosia vogelii	f	L&S	W
Xeroderris stuhlmannii	O	L&S	W
LOBELIACEAE			
Lobelia fervens spp. *fervens*	O	L&S	W
LOGANIACEAE			
Strychnos spinosa	f	L	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
LORANTHACEAE			
Phragmanthera usuiensis[2]	f	?	N
Plicosepalus meridianus[1]	?	S	W
Tapinanthus oehleri[1 2]	?	?	?
Tapinanthus pennatulus[1 2]	?	?	?
LYTHRACEAE			
Ammannia prieuriana	O	L&S	W
MALVACEAE			
Abutilon mauritianum	f	S&L	W
Camoemsia scandens[1 2]	?	?	?
Hibiscus vitifolius spp. *vulgaris*	f	?	W
Sida acuta	O	S	N or W?
Thespesia danis	O	L	W
MARANTACEAE			
Marantochloa leucantha	?	S&L	W
MELASTOMATACEAE			
Calvoa orientalis	f	S	W
Clidemia hirta	O	L&S	W
Dissotis senegambiensis var. *alpestris*	f	S	W
Dissotis speciosa[1]	?	S	W
Memecylon brenanii	F	S	E (EU)
Memecylon microphyllum	F	S	E (EU)
Memecylon semseii	F	S	E (EU & WU)
MELIACEAE			
Ekebergia capensis	?	S&L	W
MENISPERMACEAE			
Cissampelos mucronata	f	S&L	W
Tiliacora funifera	f	S&L	W
Triclisia sacleuxii	F	L&S	W
MORACEAE			
Bronssonetia papyrifera[1 2]	?	?	?
Dorstenia goetzei	F	L&S	N
Dorstenia holstii	F	S	N
Dorstenia kameruniana	f	L	W
Ficus bubu	f	L&S	W
Ficus natalensis	f	L	W
Ficus ottoniifolia	f	L&S	N
Streblus usambarensis	f	L	W
MUSACEAE			
Ensete edule[2]	f	?	W
Ensete ventricosum[1]	?	S	W
MYRSINACEAE			
Rapanea melanophloeos	f	S&M	W
MYRTACEAE			
Eucalyptus saligna var. *citrodora*[1]	?	?	?
Psidium guajava (exotic)	f	L	W
Syzygium cordatum	F	S&L	W
Syzygium guineense afromontanum	F	?	W
Syzygium jambos (exotic)[2]	f	?	?
NYCTAGINACEAE			
Mirabilis jalapa	O	S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
NYMPHAEACEAE			
Nymphaea nouchali	f	L&S	W
OCHNACEAE			
Brackenridgea zanguebarica	F	S	W
Ouratea reticulata [2]	f	?	W
OLACACEAE			
Ximenia caffra	f	L&S	W
OLEACEAE			
Chionanthus mildbraedii[2]	f	?	W
ORCHIDACEAE			
Aerangis hologlottis	F	L	N
Calanthe sylvatica	F	S	W
OXALIDACEAE			
Biophytum abyssinicum	f	L&S	W
Oxalis corniculata	O	L&S	W
Oxalis latifolia	O	L&S	W
PALMAE			
Elaeis guineensis (exotic)	F	L&S	W
Phoenix reclinata	f	L&S	W
Raphia farinifera	f	L&S	W
PANDANACEAE			
Pandanus rabaiensis	O	L&S	W
Pandanus stuhlmannii[2]	O	?	W
PASSIFLORACEAE			
Adenia cissampeloides[1]	?	S	W
Adenia rumicifolia var. *rumicifolia*	f	L&S	W
PIPERACEAE			
Piper betle (exotic)	O	L	W
Piper capensis	f	S	W
Piper umbellatum	f	L&S	W
PITTOSPORAECEAE			
Pittosporum viridiflorum spp. *viridiflorum* (var. *viridiflorum)*	F	S	W
PLUMBAGINACEAE			
Plumbago dawei	f	S&L	W
POLYGONACEAE			
Rumex abyssinicus	f	S&L	W
Polygala paniculata[12]	O	?	W
PROTEACEAE			
Gravillea robusta[1]	?	S	W
Protea gaguedi	O	S	W
RHAMNACEAE			
Lasiodiscus usambarensis var.*usambarensis*	F	S	N
Ziziphus mucronata muconata	O	L	W
Ziziphus pubescens	f	L	W
RHIZOPHORACEAE			
Anisophyllea obtusifolia	F	S	E
ROSACEAE			
Rubus niveus	O	?	W
Rubus pinnatus	f	S	W
Rubus rosifolius (exotic)	f	S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
RUBIACEAE			
Chassalia parviflora	F	S&L	W
Crosopteryx febrifuga	F	L&S	W
Galiniera saxifraga	F	S	W
Hemelia eracta[1 2]	?	?	?
Keetia venosa	?	?	?
Lagynias pallidiflora	f	L&S	N
Mussaenda arcuata	f	S	W
Pauridiantha paucinervis	F	S	W
Pavetta abyssinica var. *usambarica*	f	S	E (WU)
Pavetta amaniensis	f	L&S	N
Pentas bussei	f	L&S	W
Polysphaeria bruanii	F	L&S	N
Psychotria goetzei var. *platyphylla*	F	S	N
Psychotira pandurata	F	L&S	N
Psychotria peteri	F	S	N
Rutidea orientalis	f	S	W
Rytigynia uhligii	f	S	W
Sabicea orientalis	f	S&L	W
Sericanthe odoratissima var. *odoratissima*	F	L&S	E(EU&WU)
Tarenna pavettoides	F	L&S	W
Tricalysia acidophylla	f	L	N
Tricalysia elegans	F	L	E
RUTACEAE			
Clausena anisata	f	L&S	W
Teclea simplicifolia	F	S	W
Toddalia asiatica	f	L&S	W
Vepris ngamensis	F	S	E (EU)
Zanthoxylum deremense	F	S&L	N
SAPINDACEAE			
Cardiospernum grandiflorum[1 2]	?	?	?
Chytranthus obliquinervis	f	L (forest gaps)	N
Paullinia pinnata	f	?	W
SCROPHULARIACEAE			
Sopubia ramose	f	S	W
SIMAROUBACEAE			
Brucea tenuifolia[2]	F	?	N
SMILACACEAE			
Smilax anceps	f	S	W
SOLANACEAE			
Capsicum frutescens	O	S&L	W
Physalis peruviana	O	S	W
Solanum auguivi brevipedicellatum[2]	F	?	W
Solanum incanum	?	L&S	W
Solanum kitivuense	f	S&L	N
Solanum nigrum	O	S&L	W
STERCULIACEAE			
Byttneria fruticosa	F	L	E (EU)
Dombeya acutangula	f	?	W
Sterculia africana	O	S	W

Table 6 continued.

Species	Ecol. type	Habitat	End. Status
THEACEAE			
Camellia sinensis[2]	O	?	W
THYMELAEACEAE			
Synaptolepis alternifolia	f	L&S	W
Synaptolepis kirkii	f	L	W
TILIACEAE			
Carpodiptera africana	O	L&S	W
Corchorus trilocularis	O	S	W
Grewia fallax	f	S&L	W
Grewia holstii	f	?	N
Grewia villosa	O	S	W
Triumfelta rhomboidea	f	?	W
TYPHACEAE			
Typha domingensis	?	L&S	W
ULMACEAE			
Celtis zenkeri	F	L&S	W
UMBELLIFERAE			
Steganotaenia araliacea	O	L&S	W
URTICACEAE			
Boehmeria macrophylla	f	S	W
Elatostema welwitschii	f	S	W
*Obetia radula (*syn. *O. pinnatifida)*	?	S&L	W
Pilea holstii	F	L&S	N
Urera hypselodendron	f	M	W
Urera trinervis	f	L&S	W
Urtica urens	O	M	W
VELLOZIACEAE			
Xerophyta spekei	O	S	W
VERBENACEAE			
Clerodendrum capitatum var. *capitatum*	f	S&L	W
Clerodendrum rotundifolium	f	L&S	W
Lantana camara (exotic)	f	L&S	W
Priva adhaerens	O	L&S	W
*Stachytarpheta jamaicensis (*syn. *S. urticifolia)*	f	L	W
Vitex amaniensis	f	S&L	N
Vitex mombasae[1]	?	L&S	W
VIOLACEAE			
Rinorea scheffleri	F	L	E(EU)
VISCACEAE			
Viscum longiarticulatum[2]	F	?	E
Viscum nervosum[2]	f	?	W
VITACEAE			
Ampeliocissus multistriata	f	L&S	W
Cissus oliveri	f	S	W
Cissus quadrangularis	f	L&S	W
Cyphostemma braunii	F	L&S	N
Cyphostemma hildebrandtii	f	L&S	W
ZAMIACEAE (CYCADACEAE)			
Encephalartos hildebrandtii[1 2]	?	?	?

Table 6 continued.

Fern Species (Pteridophyta)	Ecol. type	Habitat	End. Status
ZINGIBERACEAE			
Aframomum amaniense	f	L	N
Aframomum mala	f	S	W
Costus sarmentosus	f	L&S	N
Renealmia engleri	F	S	N
ADIANTACEAE			
Adiantum raddianum	f	S	W
Pellaea quadripinnata	f	S	W
ASPLENIACEAE			
Asplenium formosum	f	S	W
Asplenium nidus	F	L&S	W
Asplenium pellucidum	F	S	N
Asplenium warneckei	F	S	W
CYATHEACEAE			
Cyathea manniana	f	S	W
DENNSTAEDTIACEAE			
Blotiella hieronymii	F	S&L	N
Blotiella stipitata	F	S	N
LYCOPODIACEAE			
Huperzia dura	F	S	N
Huperzia holstii	F	S	N
Lycopodium sp.	?	?	?
MARATTIACEAE			
Marattia fraxinea	f	S&L	W
POLYPODIACEAE			
Platycerium elephantotis	f	L&S	W
SELAGINELLACEAE			
Selaginella myosurus[1]	?	?	W
Selaginella umbrosa	Cultivated	S	W
Selaginella sp.	?	?	?
VITTARIACEAE			
Antrophyum mannianum	f	S	W
Vittaria guineensis var. *orientalis*	f	S	W

In 1986 - 1987 a botanical survey was conducted in the East Usambara Mountains (Ruffo *et al.* 1989). 20 species recorded in Amani Nature Reserve by the current survey were not recorded by Ruffo in the Amani Forests but were recorded elsewhere in the Usambara Mountains. 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]
Cassipourea gummiflua	Distribution uncertain
Tarenna graveolens	Kilanga and Lutindi, (Nilo Forest Reserve)
Teclea amaniensis	Kilanga and Lutindi, (Nilo Forest Reserve), Kwamgumi/Segoma Forest Reserves
Mimusopis kummel (exotic)	Kwamgumi Forest Reserve
Lonchocarpus bussei	Longuza Forest Reserve
Vismia orientalis	Longuza Forest Reserve
Voacanga africana	Longuza Forest Reserve
Tabernaemontana stapfiana	Lutindi - Nilo Forest Reserve
Dracaena usambarensis	Lutindi (Nilo Forest Reserve)
Allophylus melliodorus	Lutindi (Nilo Forest Reserve), Mtai Forest Reserve
Dombeya shupangae	Lutindi, (Nilo Forest Reserve)
Newtonia paucijuga	Lutindi, Kwamarimba, Mlinga, Kwamgumi/Segoma.
Diospyros natalensis	Mhinduro (Segoma, Kwamgumi and Bamba)
Tricalysia acidophylla	Mtai
Ziziphus pubescens	Mtai
Cleistanthus polystachyus	Mtai Forest Reserve
Maytenus undata	Northern part of Main Range (Nilo)
Craibia zimmermannii	Not recorded during 1986 - 1987 survey
Millettia oblata	Not recorded during 1986 - 1987 survey
Placodiscus amaniensis	Not recorded during 1986 - 1987 survey

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

Species accumulation rates:

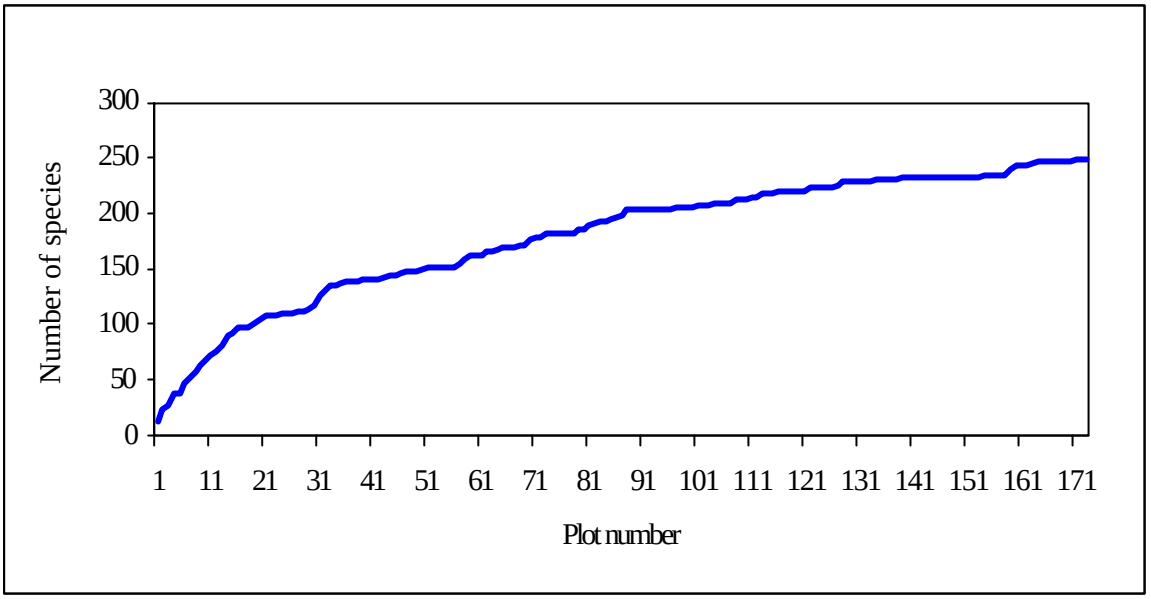

Figure 4 Species accumulation rates of trees and shrubs (10cm dbh and larger) by vegetation plot.

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

Table 8 Summary of ecological type for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

Ecological type	Number of species	% of total species
(F) Forest Dependent Species	107	43
(f) Forest Dwelling Species	92	37
(O) Non-Forest Species	22	9
Unknown	25	11
Total:	**246**	**100**

Habitat (refer to Figures 9 and 10)**:**

Table 9 Summary of the habitat type for tree and shrub species recorded in the 50 x 20m vegetation plots (based on Table 4).

Habitat	Number of species	% of total species
(L) Lowland Forest Species	112	46
(S) Submontane Forest Species	100	41
(U) Unknown	34	14
Total:	**246**	**100**

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

Species	**Altitude (metres above sea level)**
Alangium chinense	580
Alchornea hirtella	800
Allanblackia stuhlmannii	620
Allophylus abyssinicus	700
Annickia kummeriae (syn. *Enantia kummeriae*)	580
Anthocleista grandiflora	210
Beilschmiedia kweo	820
Celtis wightii	240
Cephalosphaera usambarensis	420
Chrysophyllum gorungosanum	245
Chrysophyllum perpulchrum	620
Cola usambarensis	820
Cremaspora triflora	640
Drypetes gerrardii	780
Drypetes usambarica	820
Englerodendron usambariense	820
Entandrophragma excelsum	730
Greenwayodendron suaveolens	700
Grewia bicolor	650
Harungana madagascariensis	720
Isoberlinia scheffleri	800
Leptactina platyphylla	400
Maesa lanceolata	710
Maranthes goetzeniana	800
Mesogyne insignis	620
Millettia oblata	240
Millettia oblata intermedia	450
Morinda asteroscepa	810
Myrianthus holstii	700
Newtonia buchananii	710
Odyendea zimmermannii	580
Oxyanthus speciosus	450
Parinari excelsa	620
Platypterocarpus tanganyikensis	650

Table 10 continued.

Species	Altitude
Polyscias fulva	820
Pouteria adolfi-friedericii Syn. Aningeria adolfi-friedericii	830
Schefflerodendron usambarense	820
Strombosia scheffleri	580
Strychnos innocua	480
Tabernaemontana pachysiphon	560
Tabernaemontana stapfiana	780
Teclea nobilis	720
Tricalysia anomala	700
Tricalysia pallens (syn. T. myrtifolia)	190
Uvariodendron usambarense	620
Xymalos monospora	800
Zanthoxylum usambarense	820

Altitude: metres above sea level

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

Table 11 Summary of endemic status for tree and shrub species recorded in the 50m x 20m vegetation plots (based on Table 4).

Endemic status	Number of species	% of total species
(E) Endemic	19 (7 EU & WU, 1 WU, 11 EU)	8
(N) Near Endemic	49	20
(W) Widespread	161	65
Unknown	17	7
Total:	**246**	**100**

EU - endemic to the East Usambara Mountains; WU - endemic to the West Usambara Mountains

Timber species

Commercial logging was previously extensive in the various forest reserves that were combined to form Amani Nature Reserve. Logging ceased at the beginning of the 1980's. Table 12 lists the most commonly extracted trees (Ruffo *et al.*, 1989) to give an indication of the remaining populations of these species.

Table 12 The abundance of selected timber species.

Species	Number of plots in which present (n= 173)	% of plots in which present	Total individuals	% of all stems sampled
Cephalosphaera usambarensis	61	35.3	221	3.07
Khaya anthotheica	5	2.9	7	0.10
Milicia excelsa	16	9.2	25	0.35
Newtonia buchananii	57	32.9	93	1.29
Ocotea usambarensis	2	1.2	2	0.03

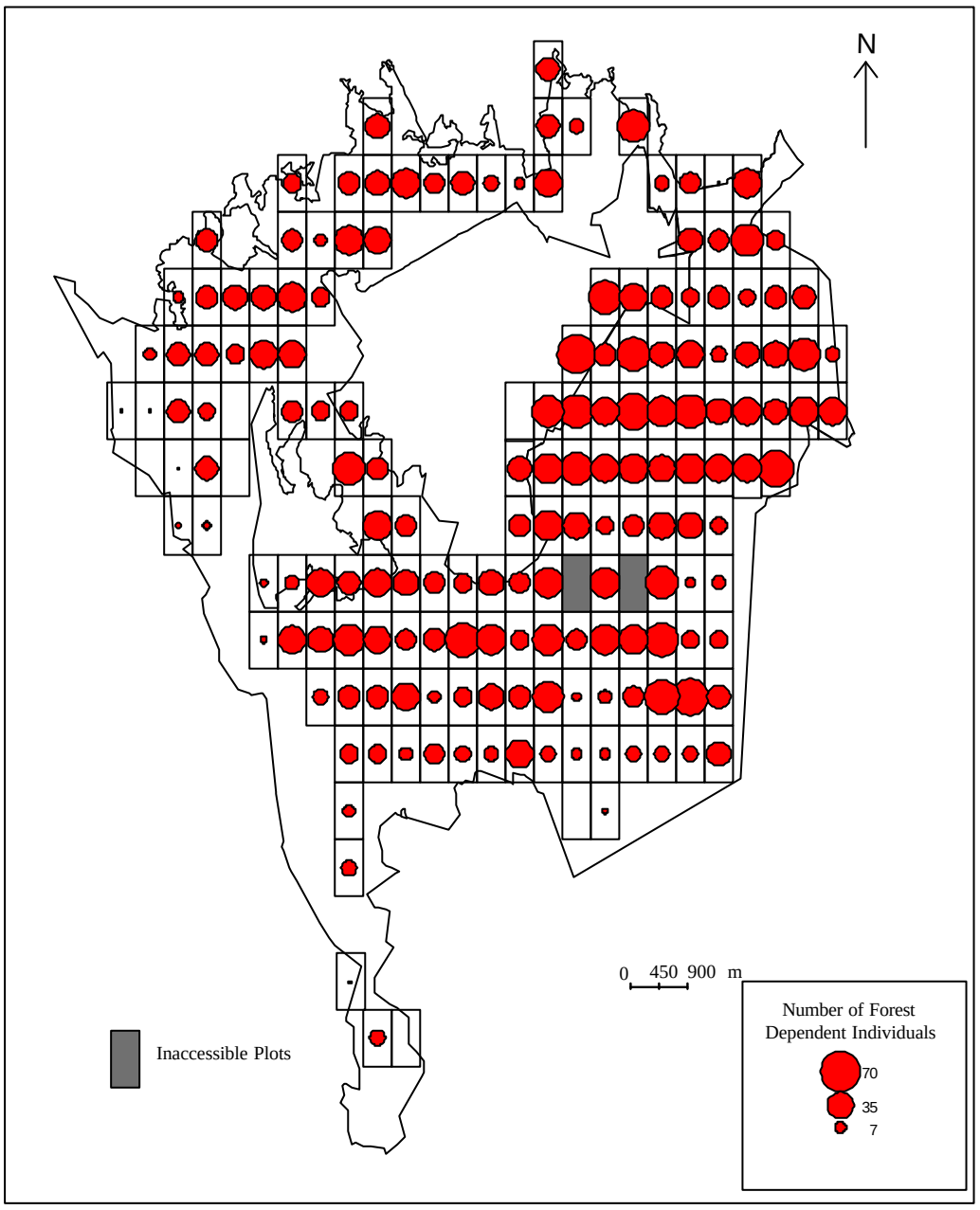

Figure 5 Distribution of forest dependent tree and shrub individuals in Amani N.R.

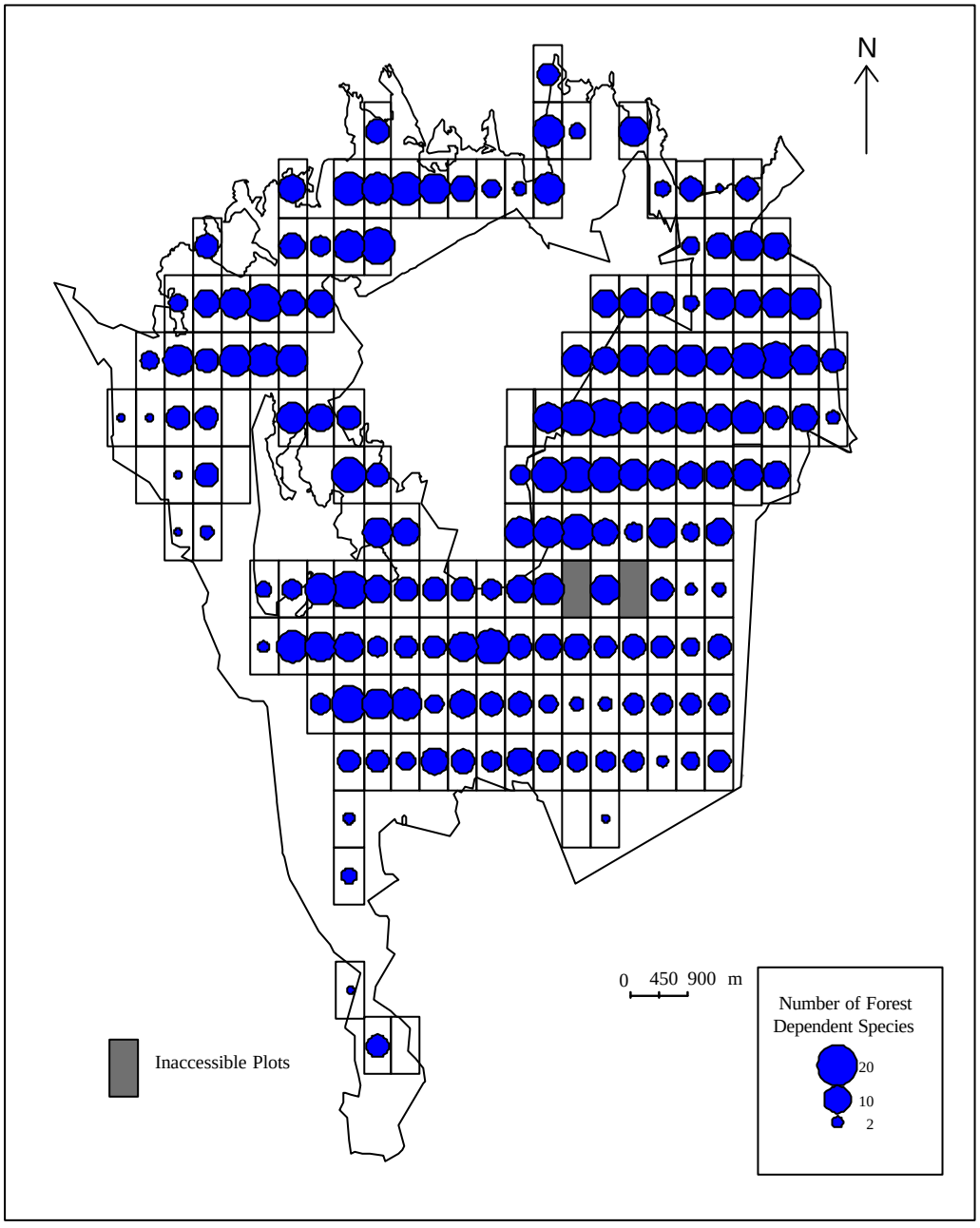

Figure 6 Distribution of forest dependent tree and shrub species in Amani N.R.

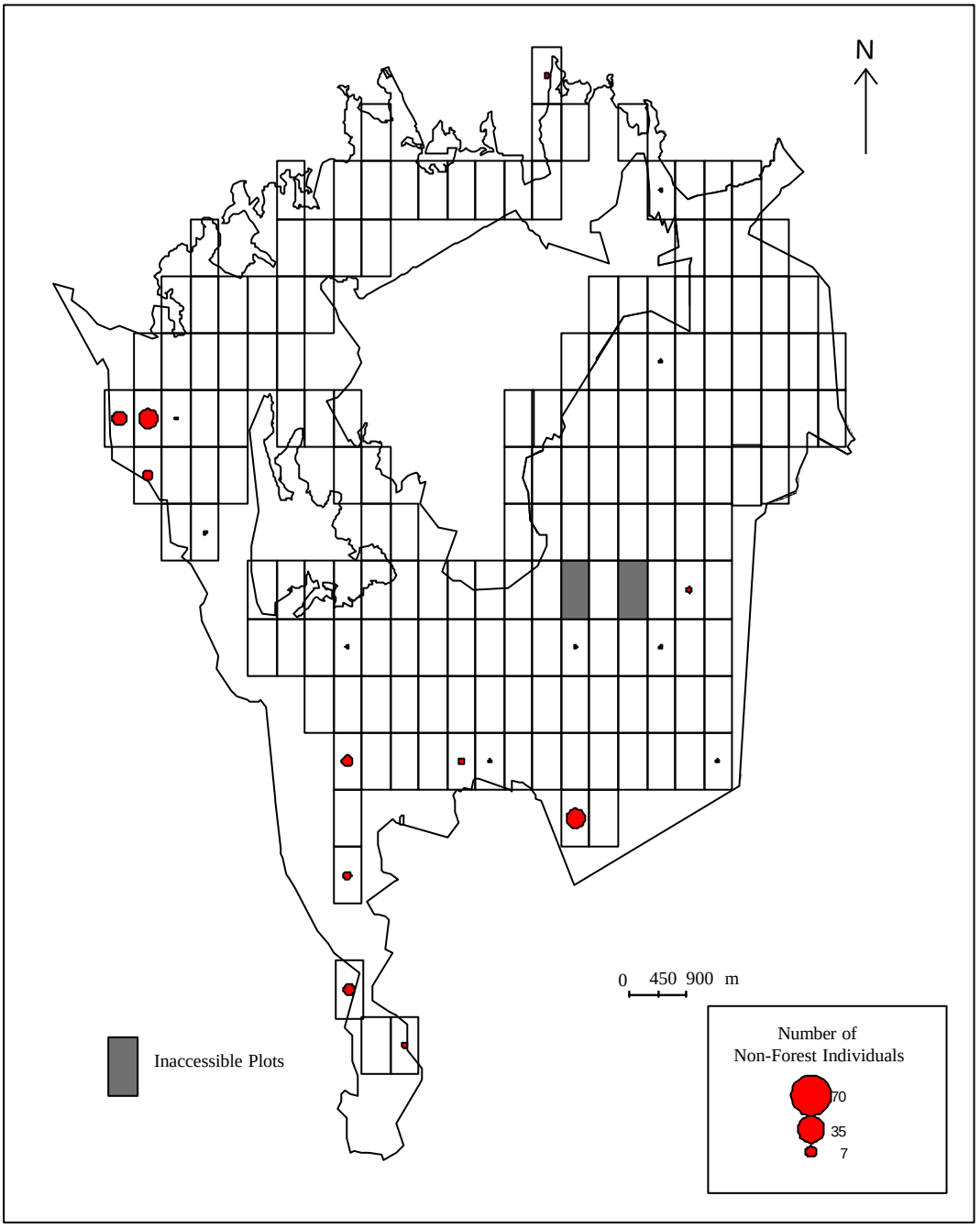

Figure 7 Distribution of non-forest tree and shrub individuals in Amani N.R.

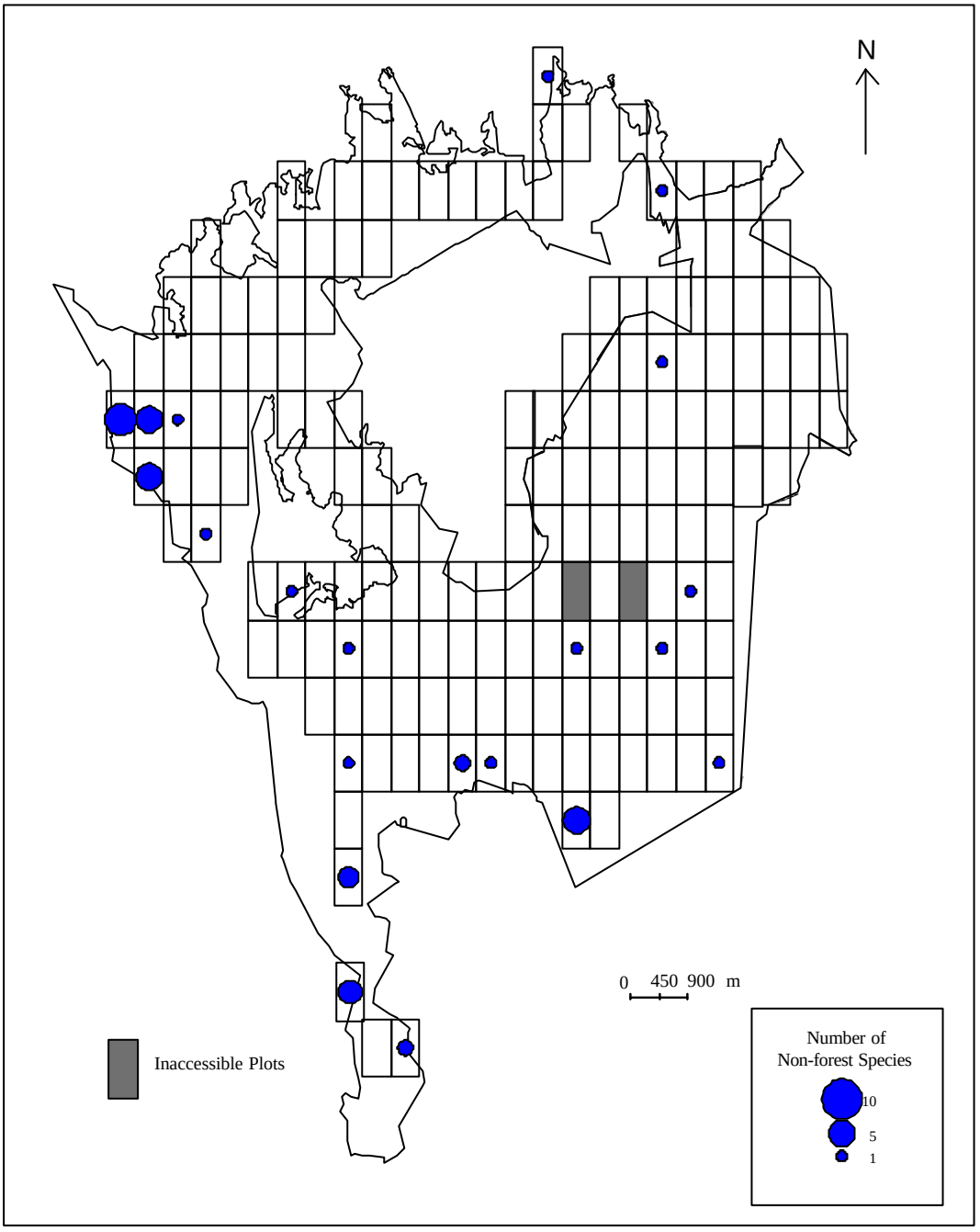

Figure 8 Distribution of non-forest tree and shrub species in Amani N.R.

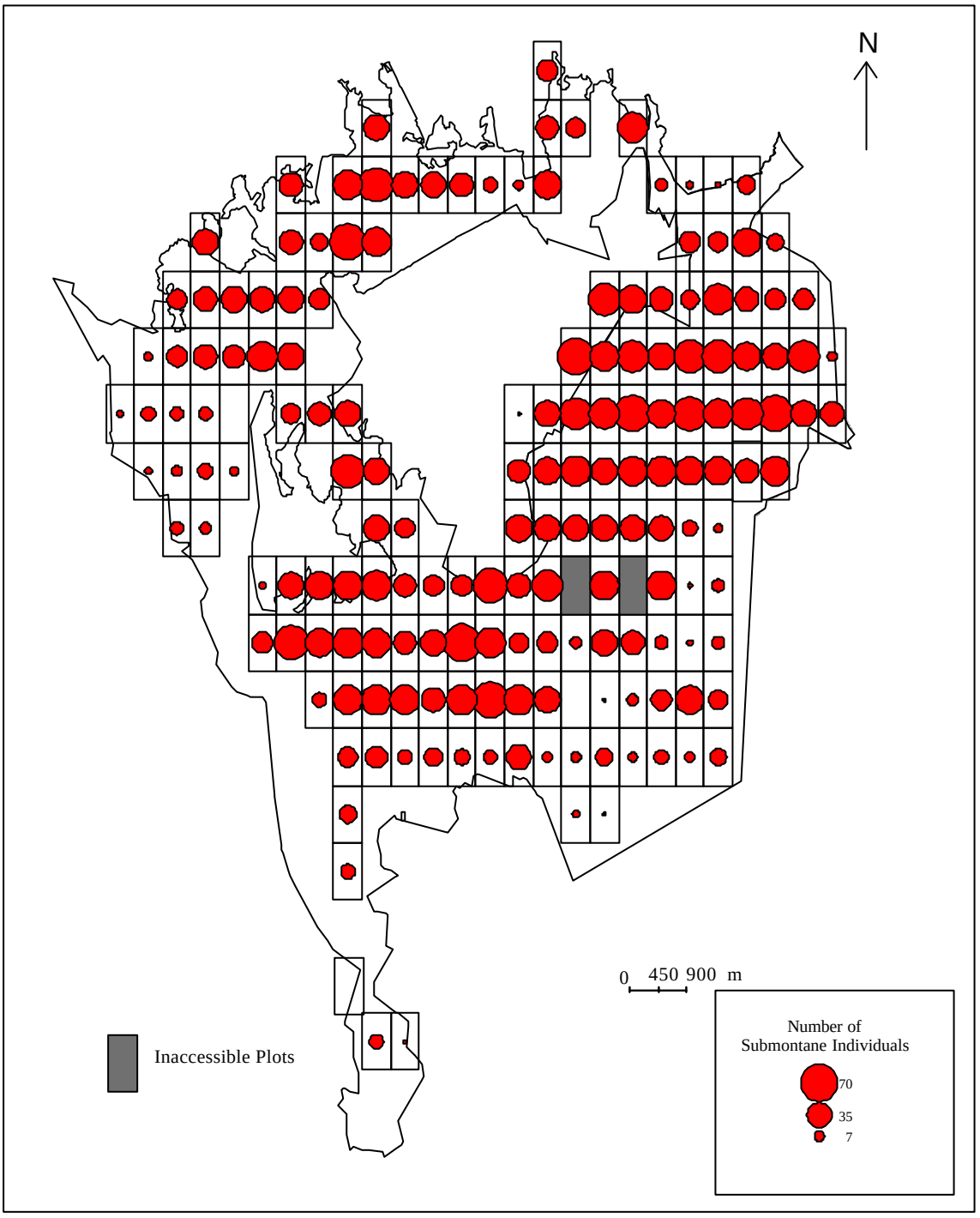

Figure 9 Distribution of submontane tree and shrub individuals in Amani N.R.

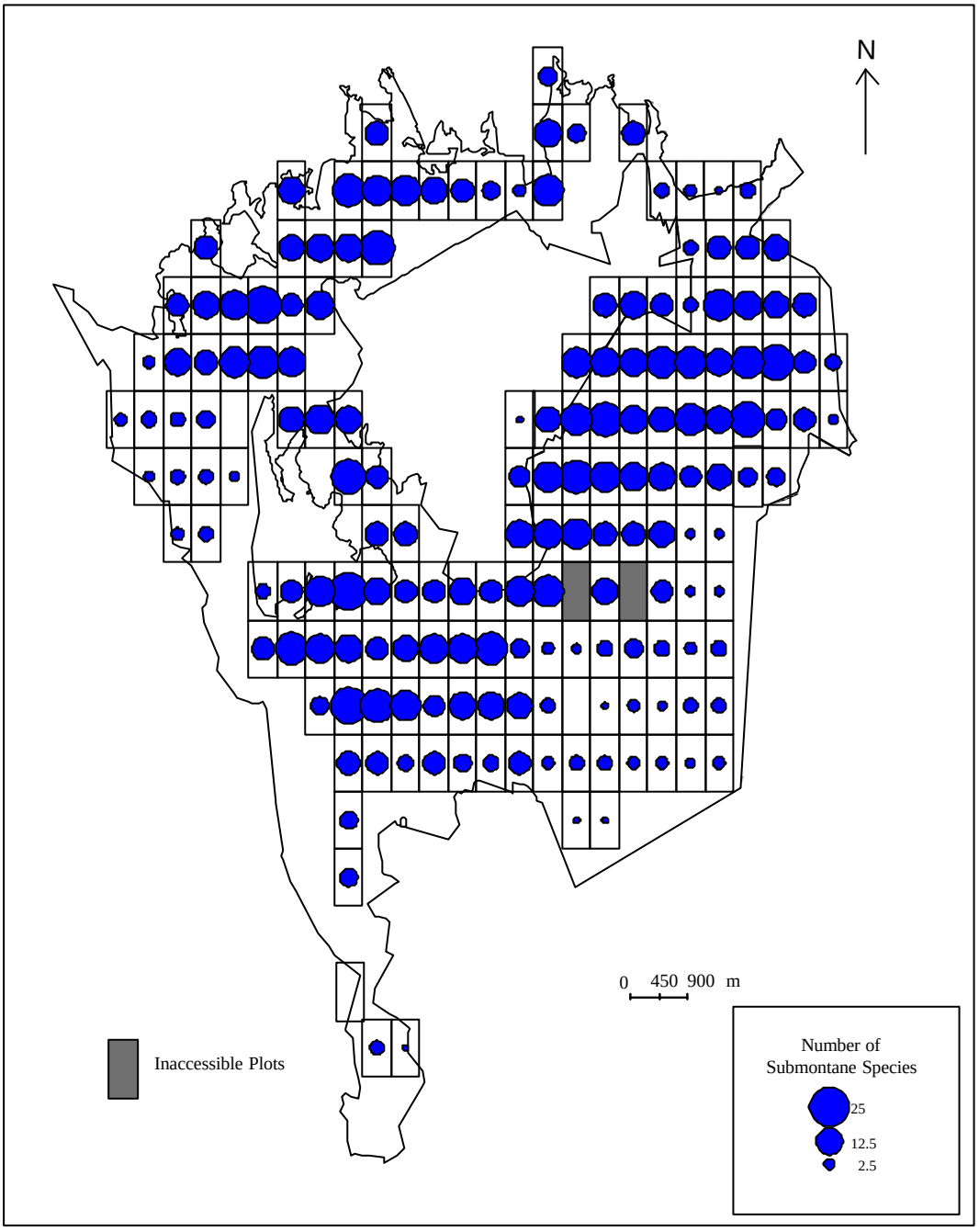

Figure 10 Distribution of submontane tree and shrub species in Amani N.R.

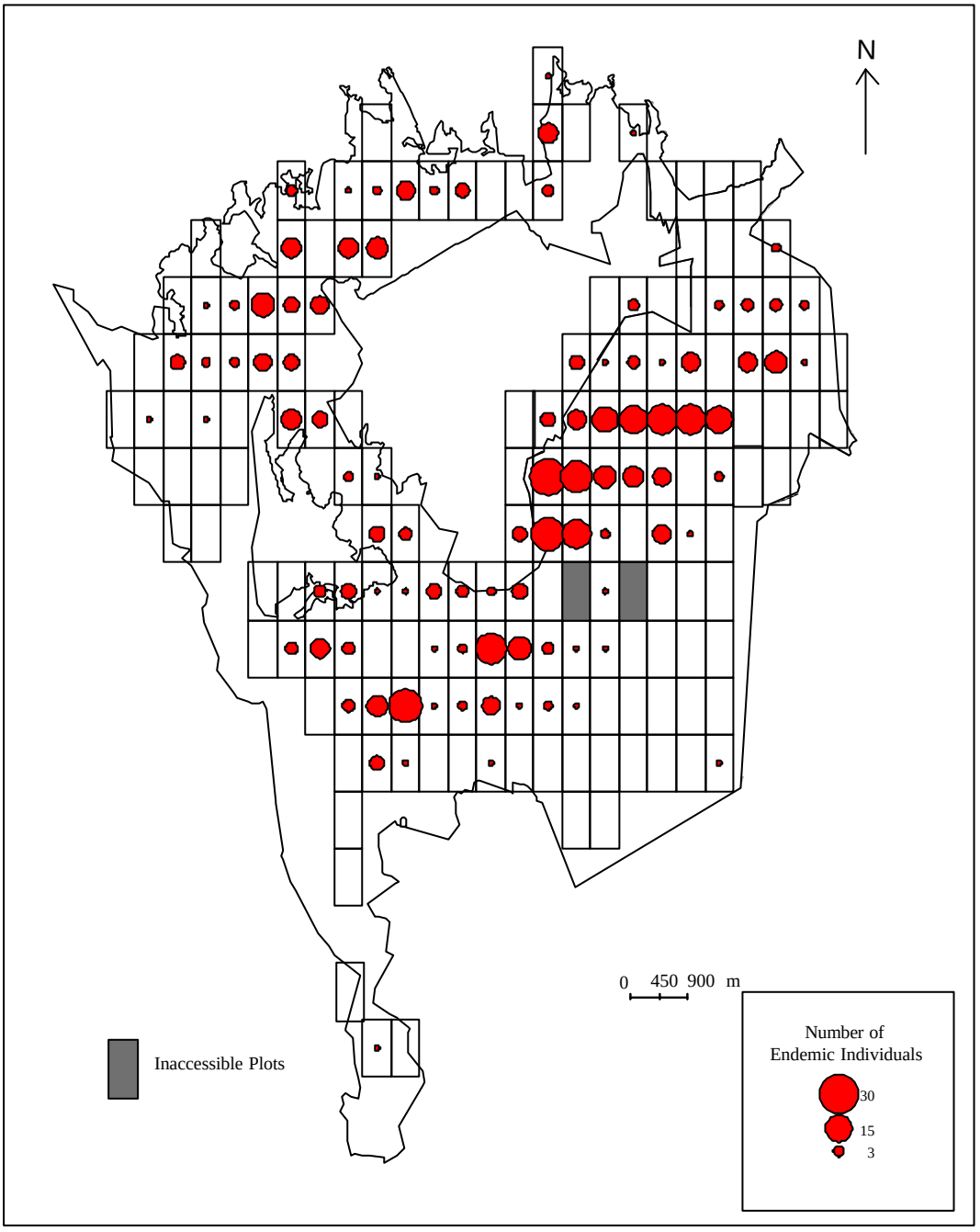

Figure 11 Distribution of endemic tree and shrub individuals in Amani N.R.

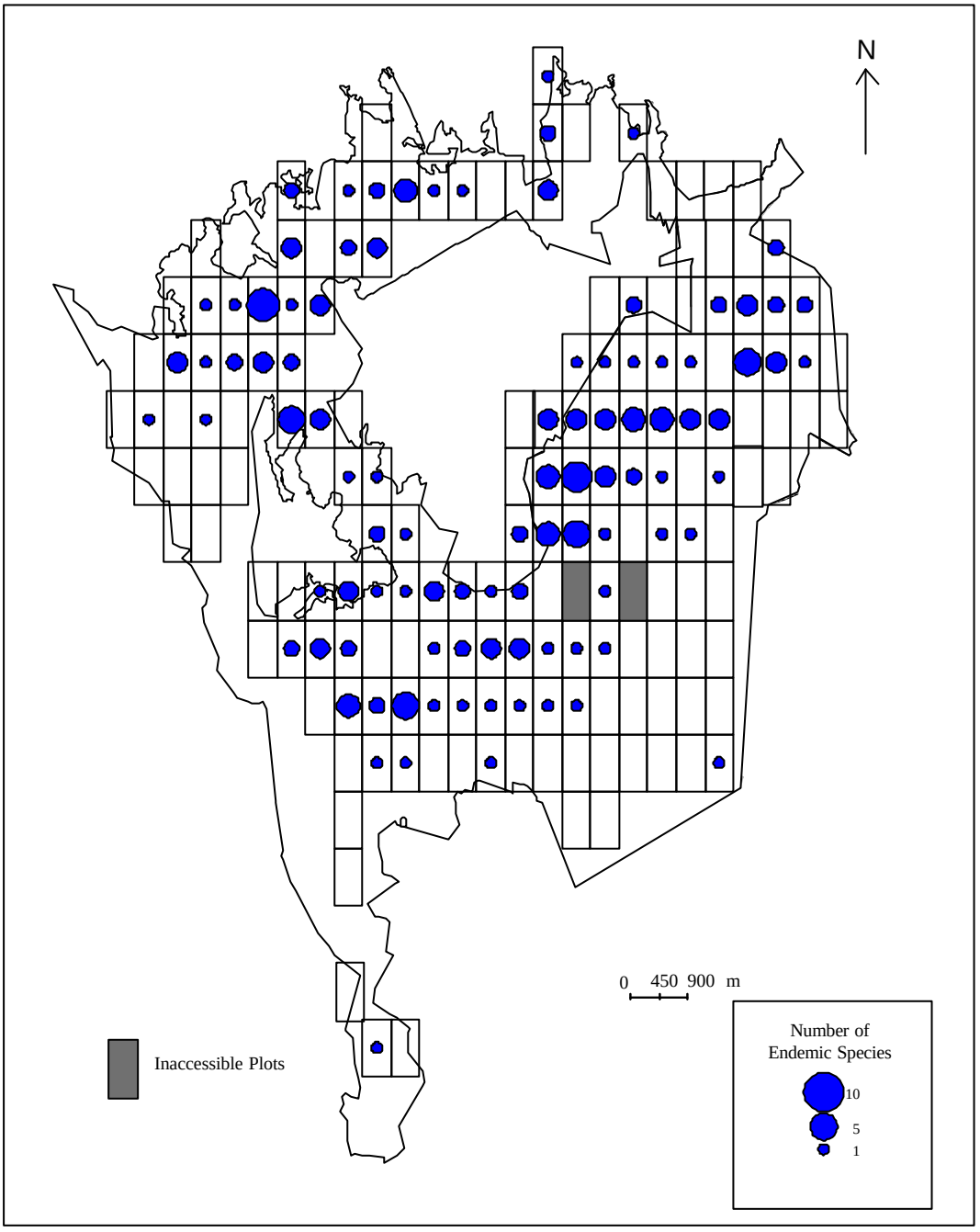

Figure 12 Distribution of endemic tree and shrub species in Amani N.R.

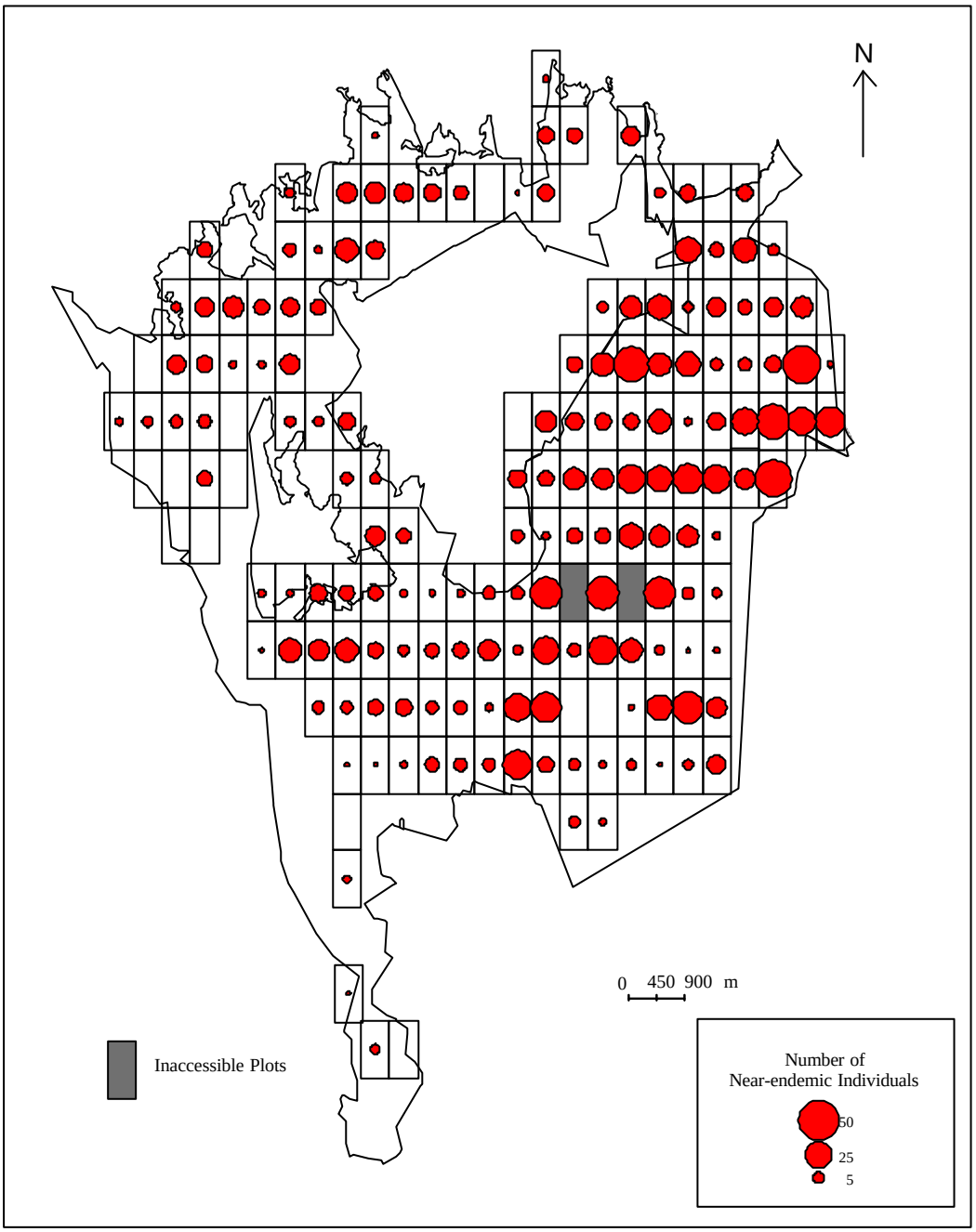

Figure 13 Distribution of near-endemic tree and shrub individuals in Amani N.R.

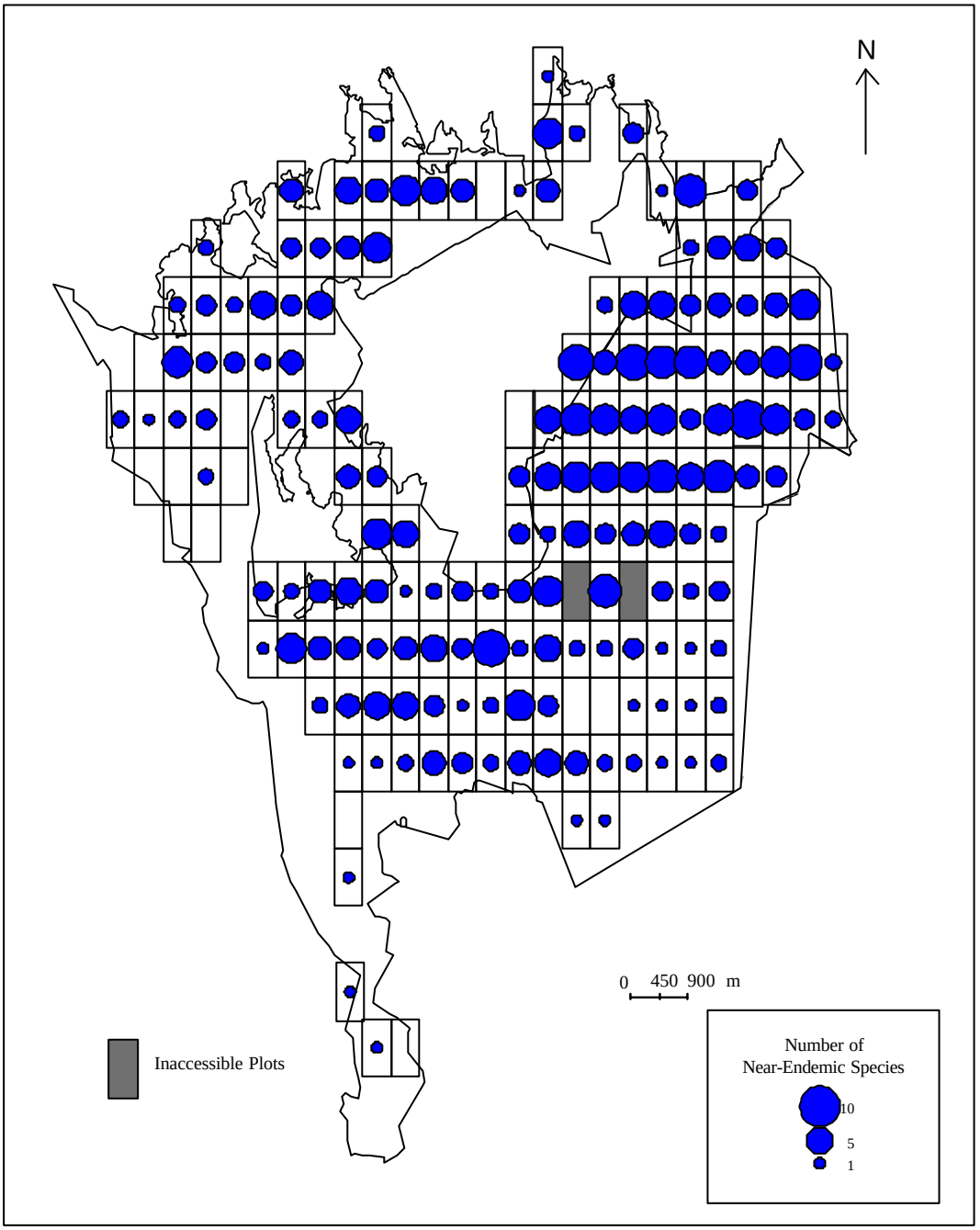

Figure 14 Distribution of near-endemic tree and shrub species in Amani N.R.

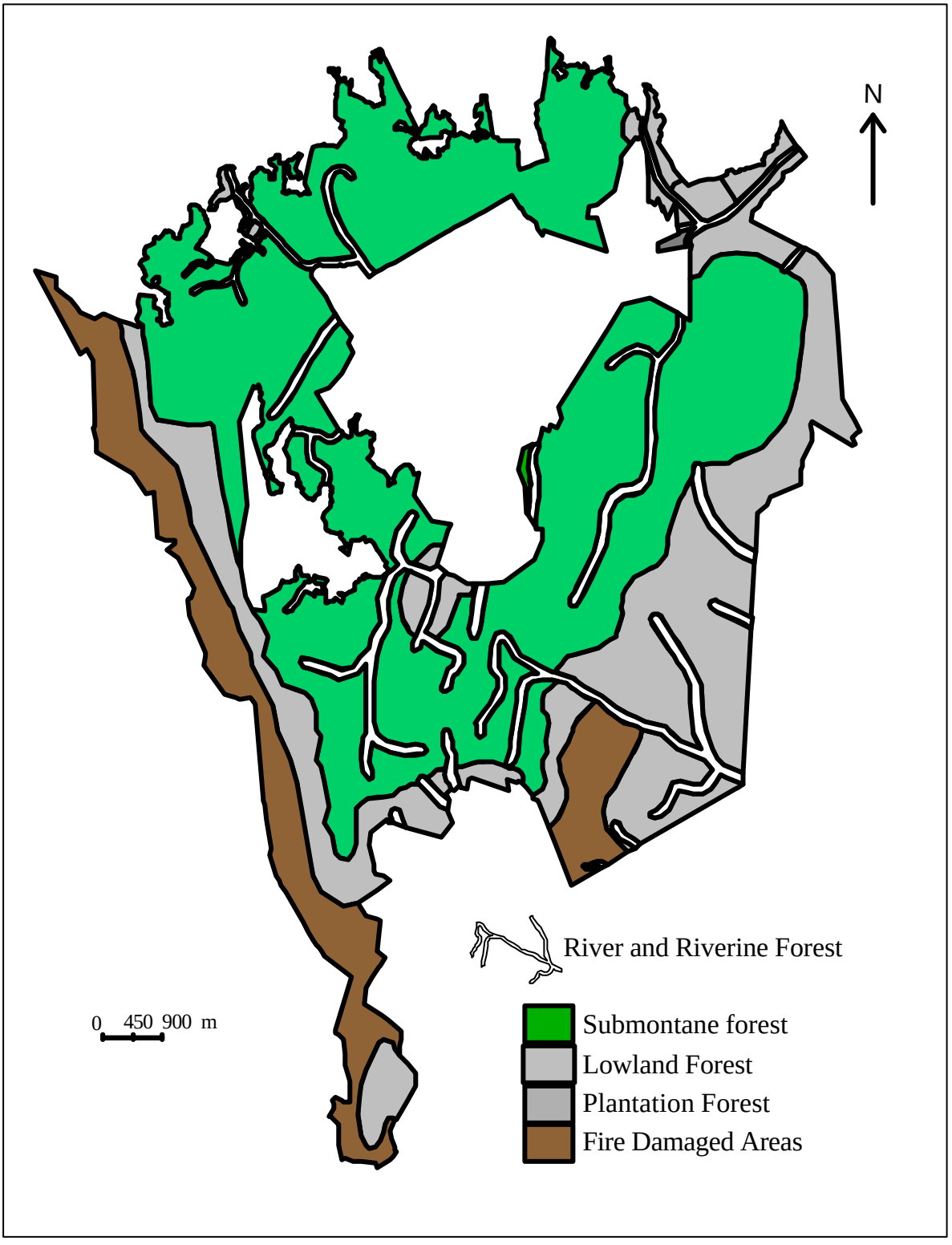

Figure 15 Sketch map of vegetation/habitat types in Amani N.R.

4.3.2 Disturbance transects

4.3.2.1 Pole and Timber extraction

Pole and timber extraction was recorded along all seventeen 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.

Table 13 Disturbance transect results for pole counts.

Transect number	Length of transect (m)	Total poles sampled	Standing poles	Average standing poles per ha	Cut poles	Average cut poles per ha	Naturally dead poles	Average naturally dead poles per ha
-2	550	218	164	298.18	26	47.27	28	50.91
-1	1550	592	470	303.23	45	29.03	77	49.68
0	6100	3349	2721	446.07	444	72.79	184	30.16
1	4465	2439	2084	466.74	132	29.56	223	49.94
2	5577	3991	3574	640.85	216	38.73	201	36.04
3	6950	4506	4067	585.18	162	23.31	277	39.86
4	8420	5394	4842	575.06	182	21.62	370	43.94
5	7470	5013	4408	590.09	168	22.49	437	58.50
6	5295	3486	3093	584.14	108	20.40	285	53.82
7	7340	5250	4805	654.63	28	3.81	417	56.81
8	7445	4646	4231	568.30	49	6.58	366	49.16
9	6440	3867	3501	543.63	54	8.39	312	48.45
10	6395	3932	3466	541.99	74	11.57	392	61.30
11	1830	852	693	378.69	8	4.37	151	82.51
12	550	446	394	716.36	7-	12.73	45	81.82
13	550	176	147	267.27	13	23.64	16	29.09
14	680	210	168	247.06	19	27.94	23	33.82

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

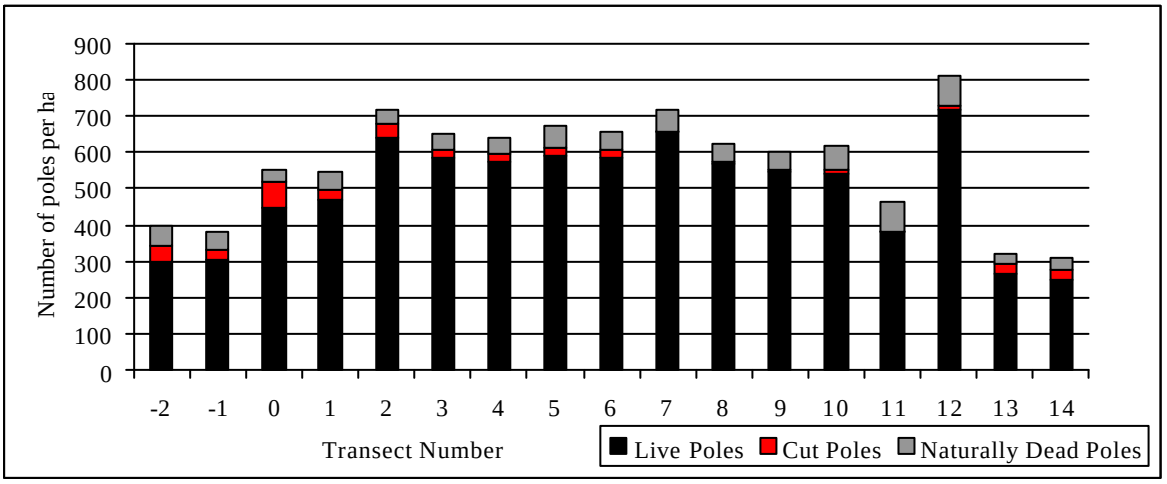

Figure 16 Relative abundance of live, naturally dead and cut poles in Amani N.R.

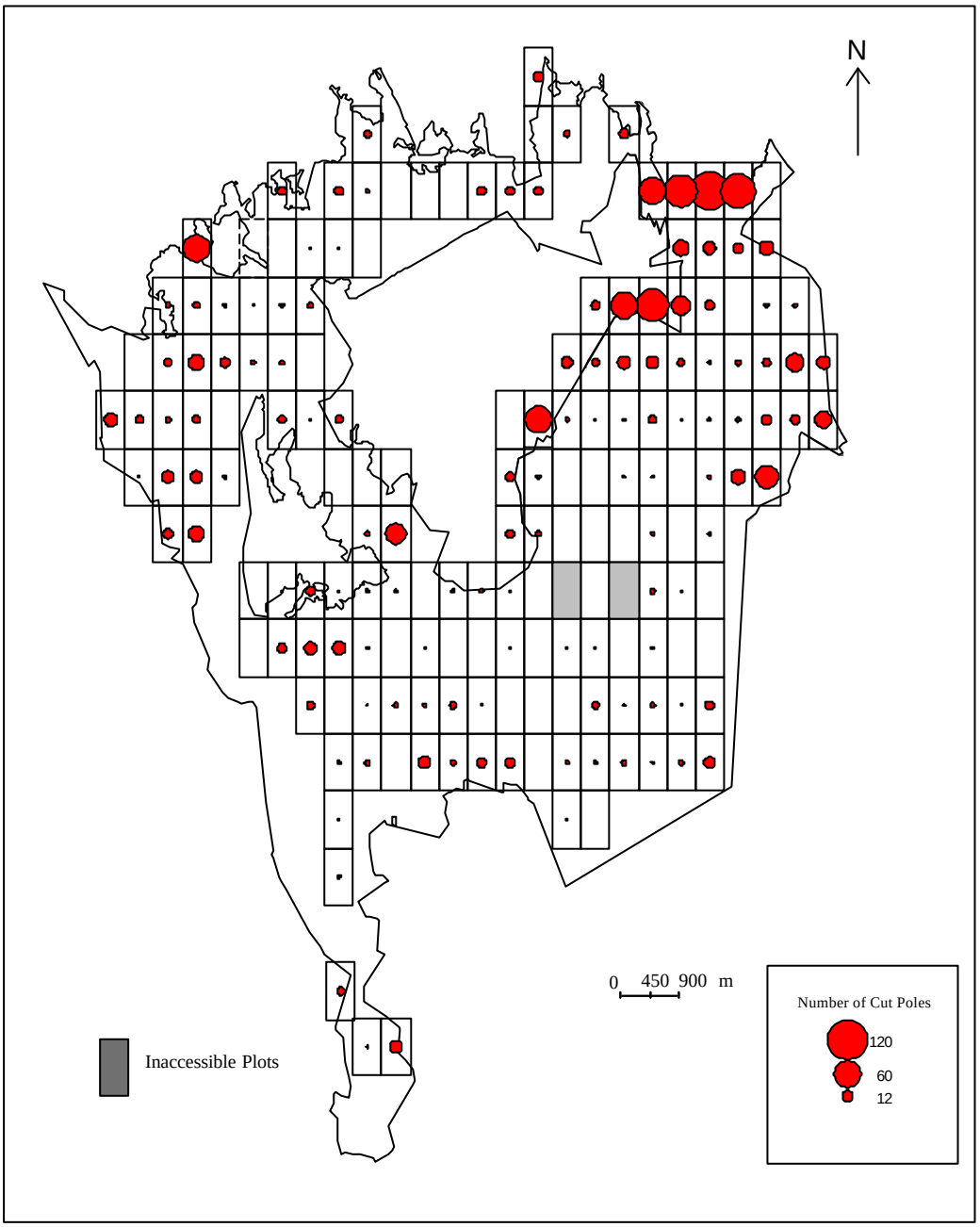

Figure 17 Pole extraction in Amani N. R. (1999 – 2000).

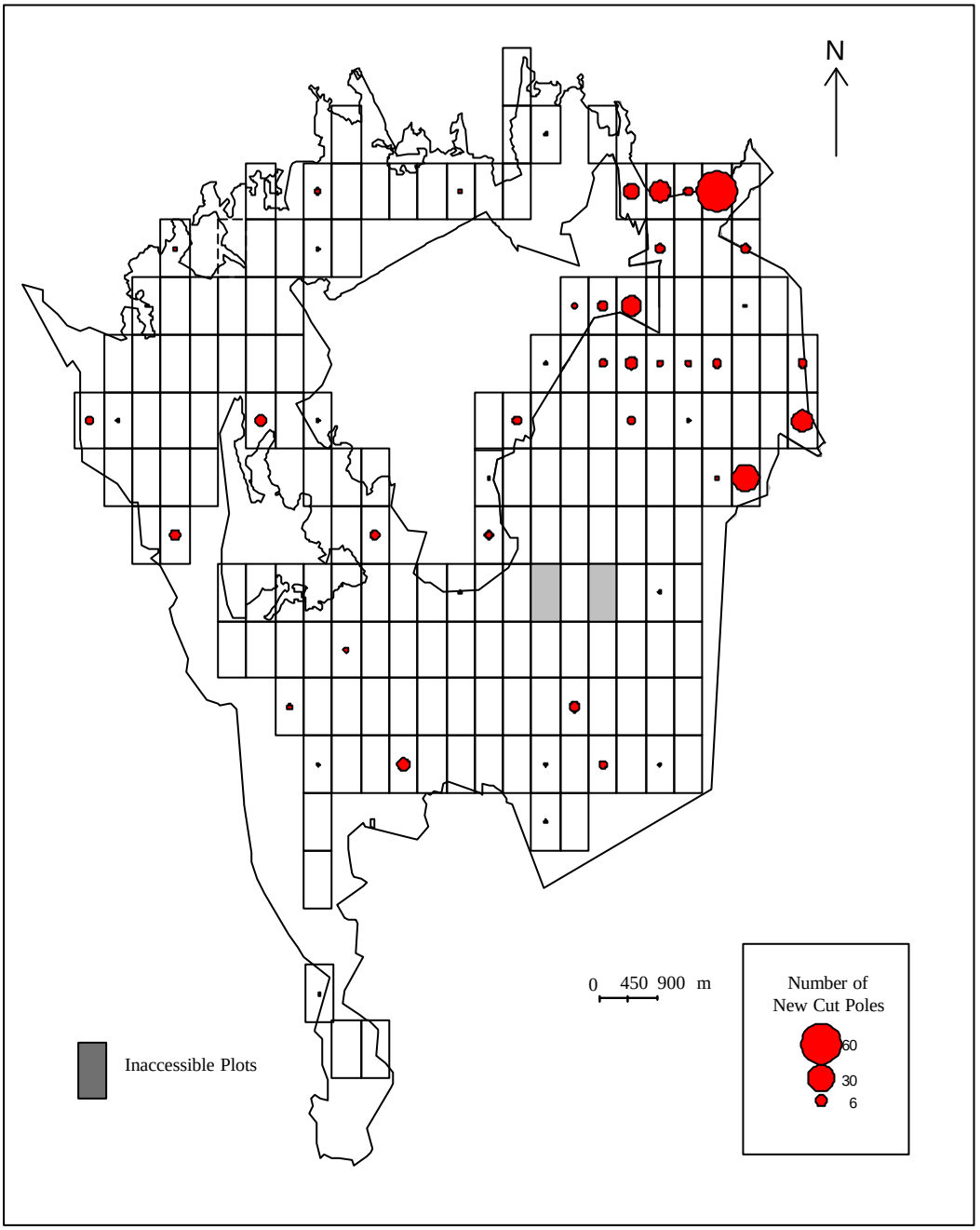

Figure 18 New (Freshly) Cut Poles in Amani N. R. (1999 – 2000).

Table 14 Disturbance transect results for timber counts.

Transect number	Length of transect (m)	Total timbers sampled	Standing timbers	Average standing timbers per hectare	Cut timbers	Average cut timbers per ha	Naturally dead timbers	Average naturally dead timbers per ha
-2	550	165	146	265.45	9	16.36	10	18.18
-1	1550	358	314	202.58	5	3.23	39	25.16
0	6100	2514	2137	350.33	118	19.34	259	42.46
1	4465	1621	1414	316.69	53	11.87	154	34.49
2	5577	2043	1779	318.99	39	6.99	225	40.34
3	6950	2669	2325	334.53	26	3.74	318	45.76
4	8420	3448	3101	368.29	54	6.41	293	34.80
5	7470	2930	2562	342.97	39	5.22	329	44.04
6	5295	1852	1590	300.28	45	8.50	217	40.98
7	7340	2853	2486	338.69	37	5.04	330	44.96
8	7445	2449	2129	285.96	35	4.70	285	38.28
9	6440	1928	1678	260.56	28	4.35	222	34.47
10	6395	1626	1408	220.17	27	4.22	191	29.87
11	1830	429	350	191.26	7	3.83	72	39.34
12	550	142	124	225.45	0	0.00	18	32.73
13	550	54	48	87.27	6	10.91	0	0.00
14	680	79	63	92.65	6	8.82	10	14.71

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

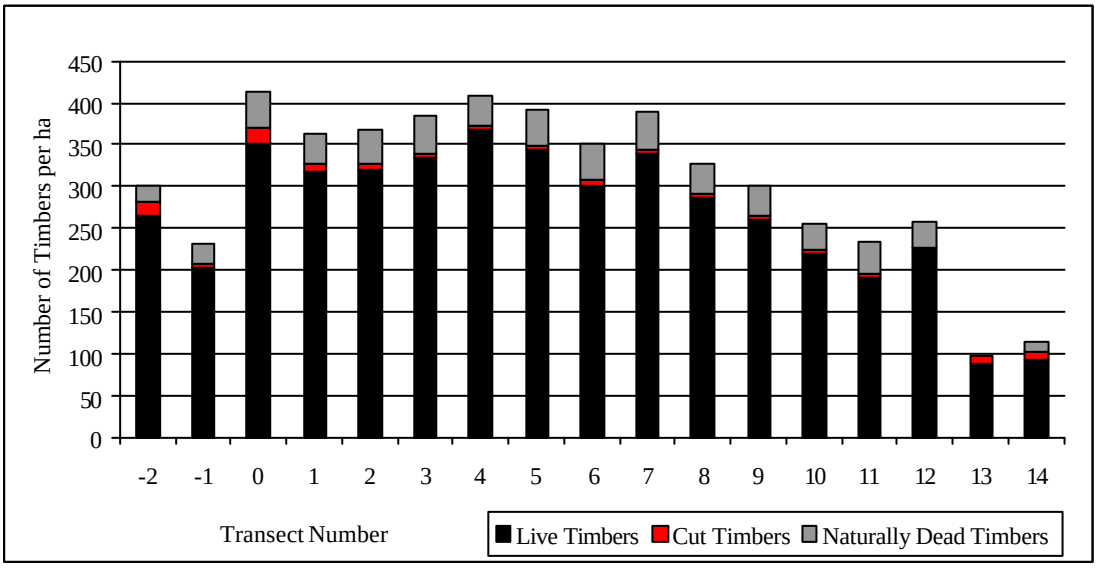

Figure 19 Relative abundance of live, naturally dead and cut timbers in Amani N.R.

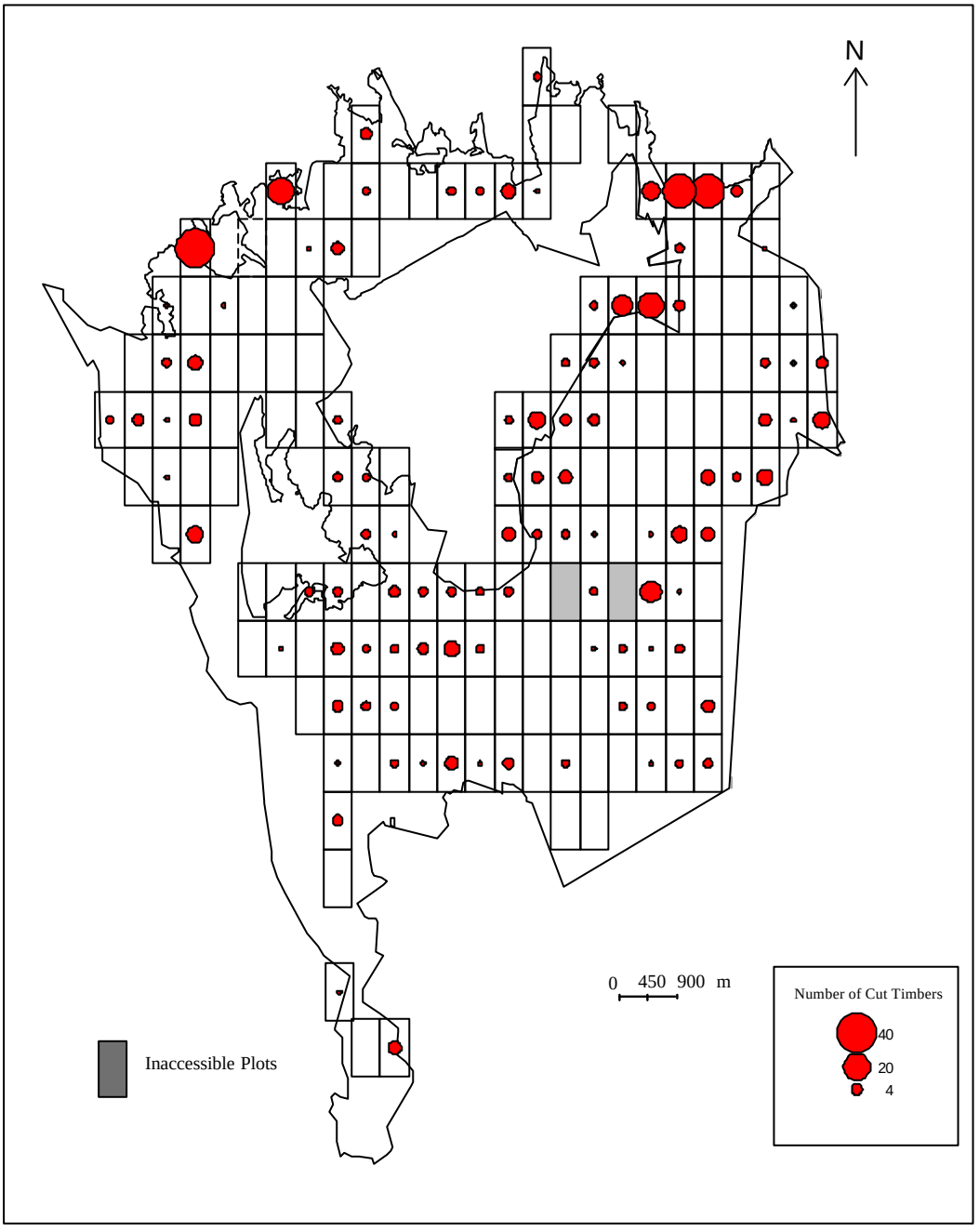

Figure 20 Timber extraction in Amani N. R. (1999 – 2000).

4.3.2.2 Fires

Fires represent a significant threat to specific parts of Amani Nature Reserve. During the survey period, fires spread into the nature reserve from adjacent village land across the western border. Figure 21 shows clearly the three main areas affected by fire.

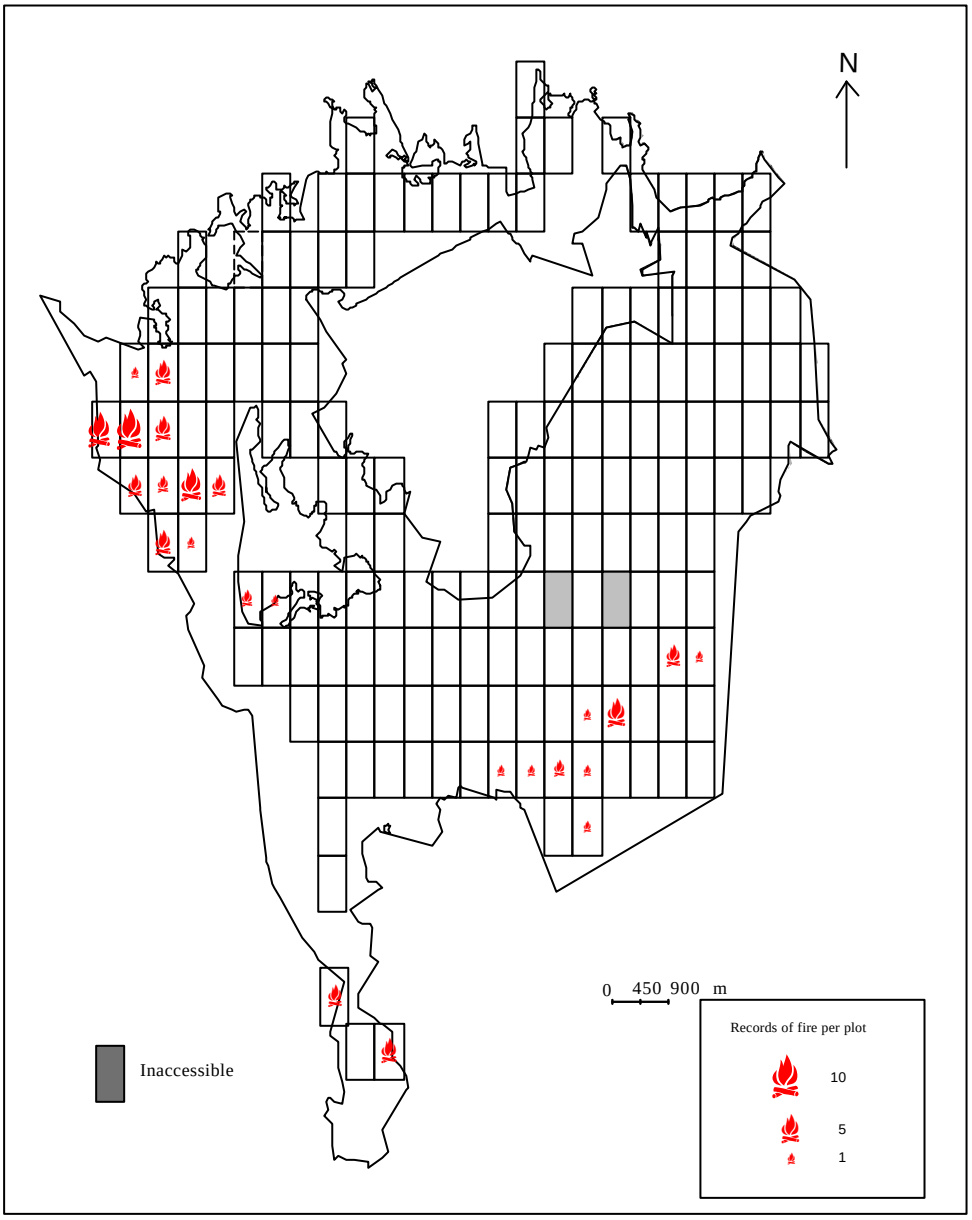

Figure 21 Records of Fire in Amani N. R. (1999 – 2000).

4.3.2.3 Pit-sawing

Evidence of pit-sawing was observed on 11 of the 17 transects, although none of the saw-pits were in use. Figure 22 shows the number of saw-pits recorded.

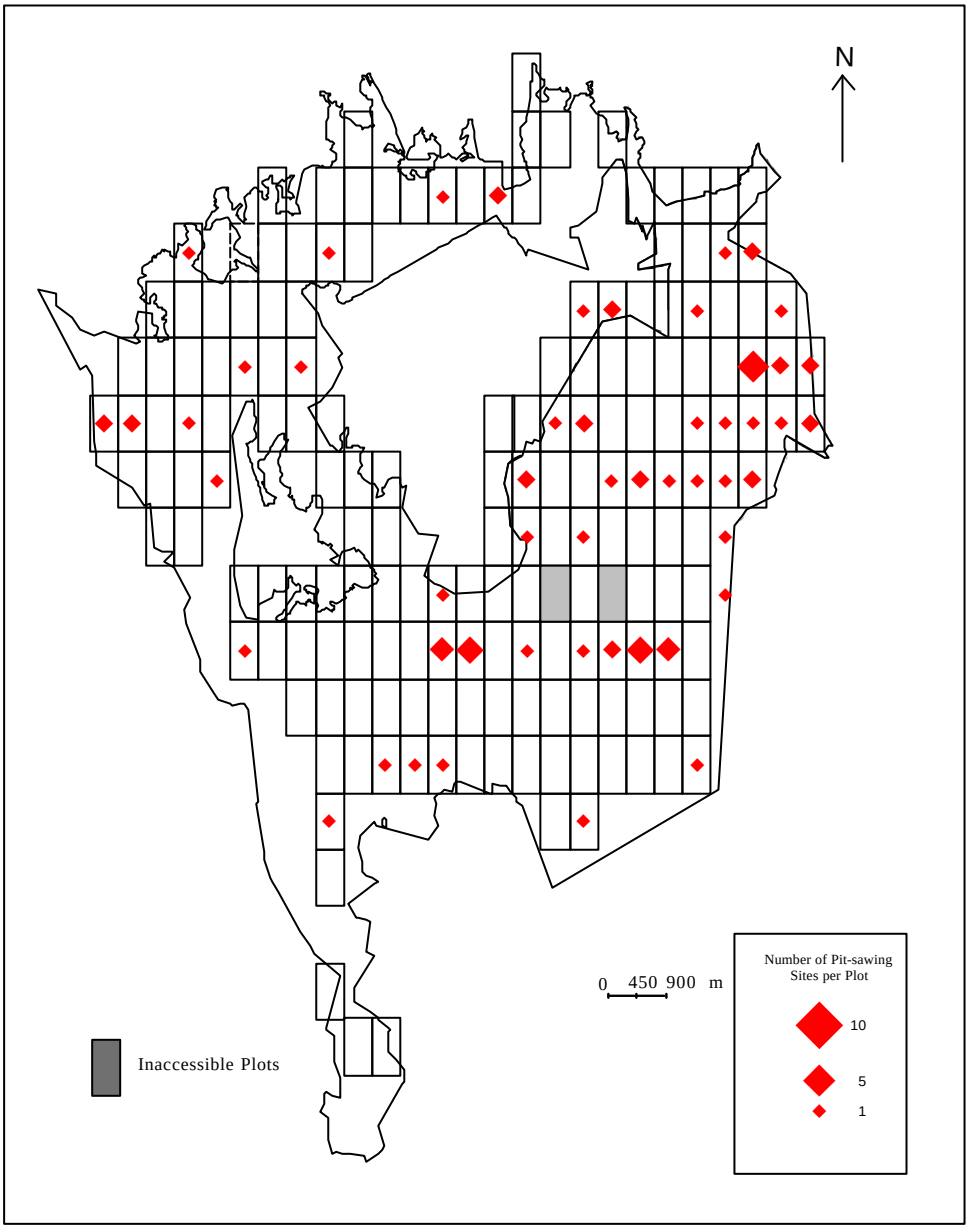

Figure 22 Records of pit-sawing in Amani N. R. (1999 – 2000).

4.3.2.4 Animal Trapping

Animal traps were observed in 39 plots, the traps consisted of active snare traps, and pitfall traps. During the survey period a bush pig was found in a snare trap, in the forest near Kwamkoro substation.

Figure 23 shows the number of animal traps per plot in Amani Nature Reserve.

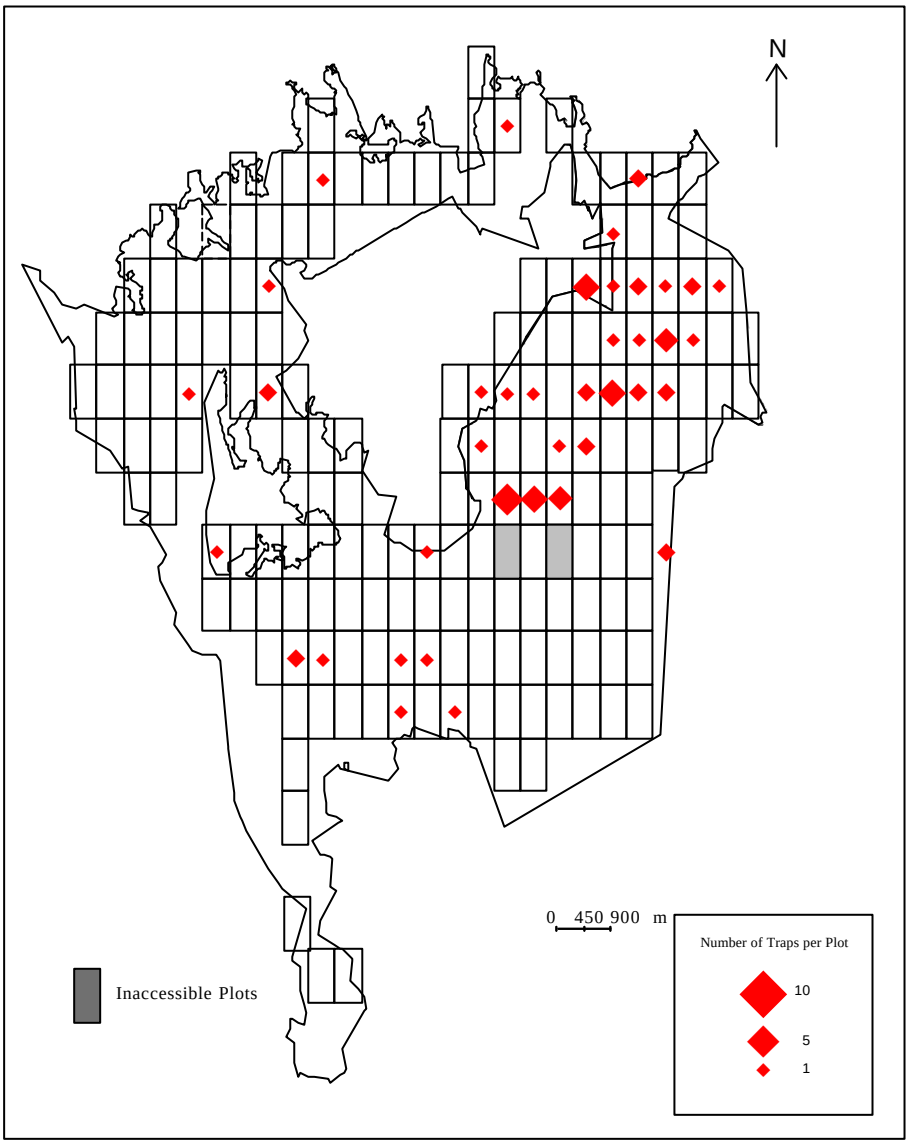

Figure 23 Animal Traps recorded in Amani N. R. (1999 –2000).

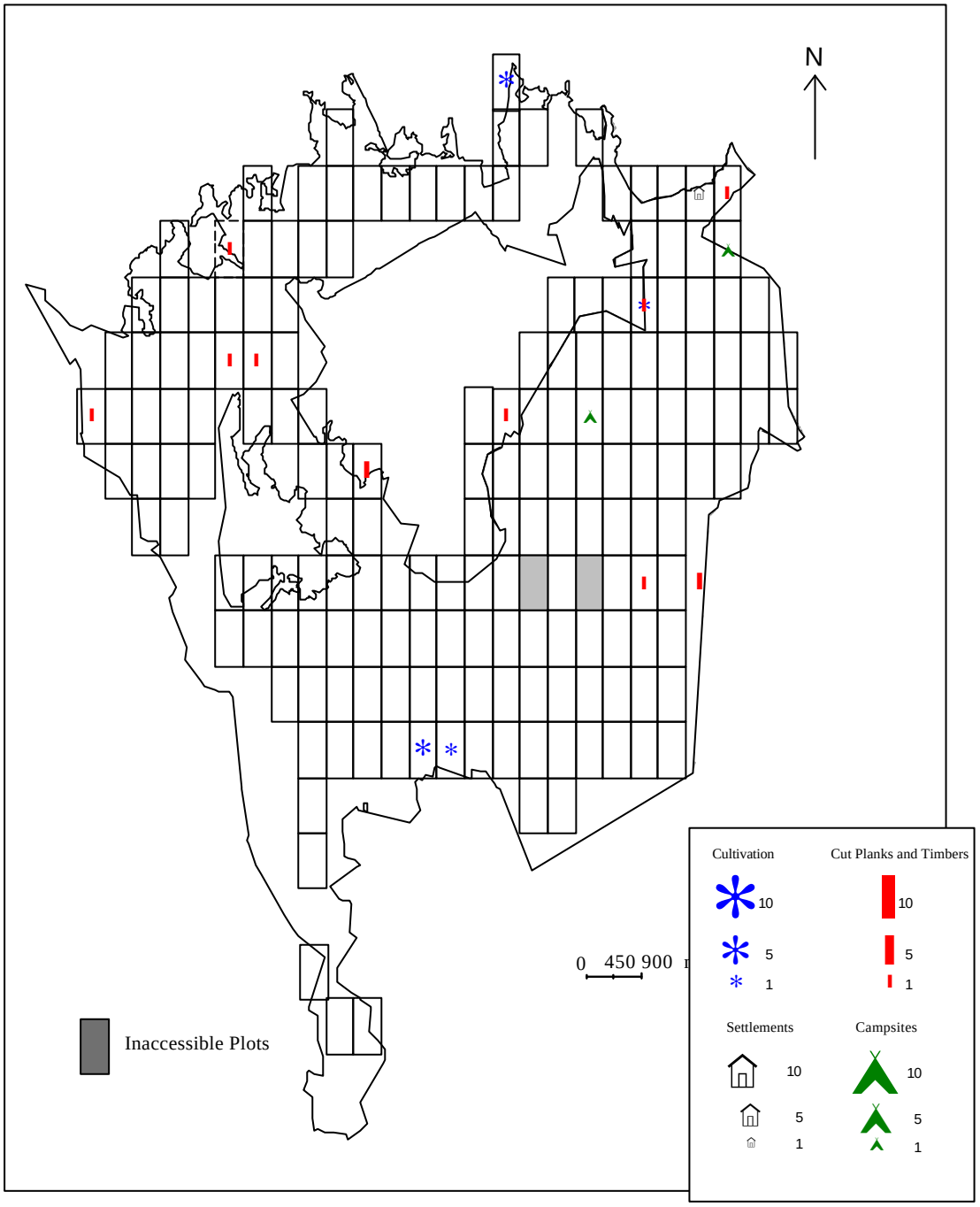

Figure 24 Records of various disturbance types in Amani N. R. (1999 – 2000).

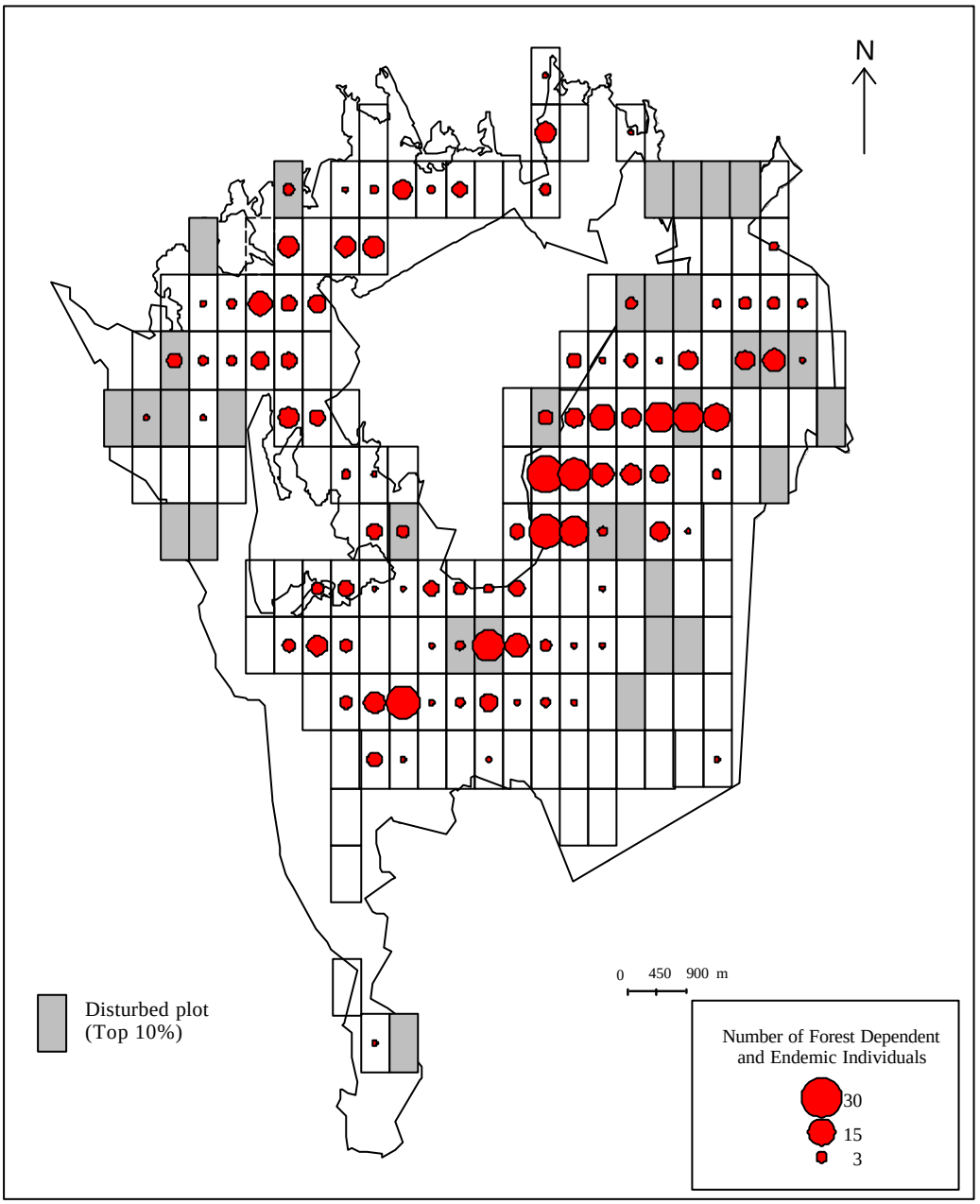

Figure 25 Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic in Amani N.R (1999 – 2000).

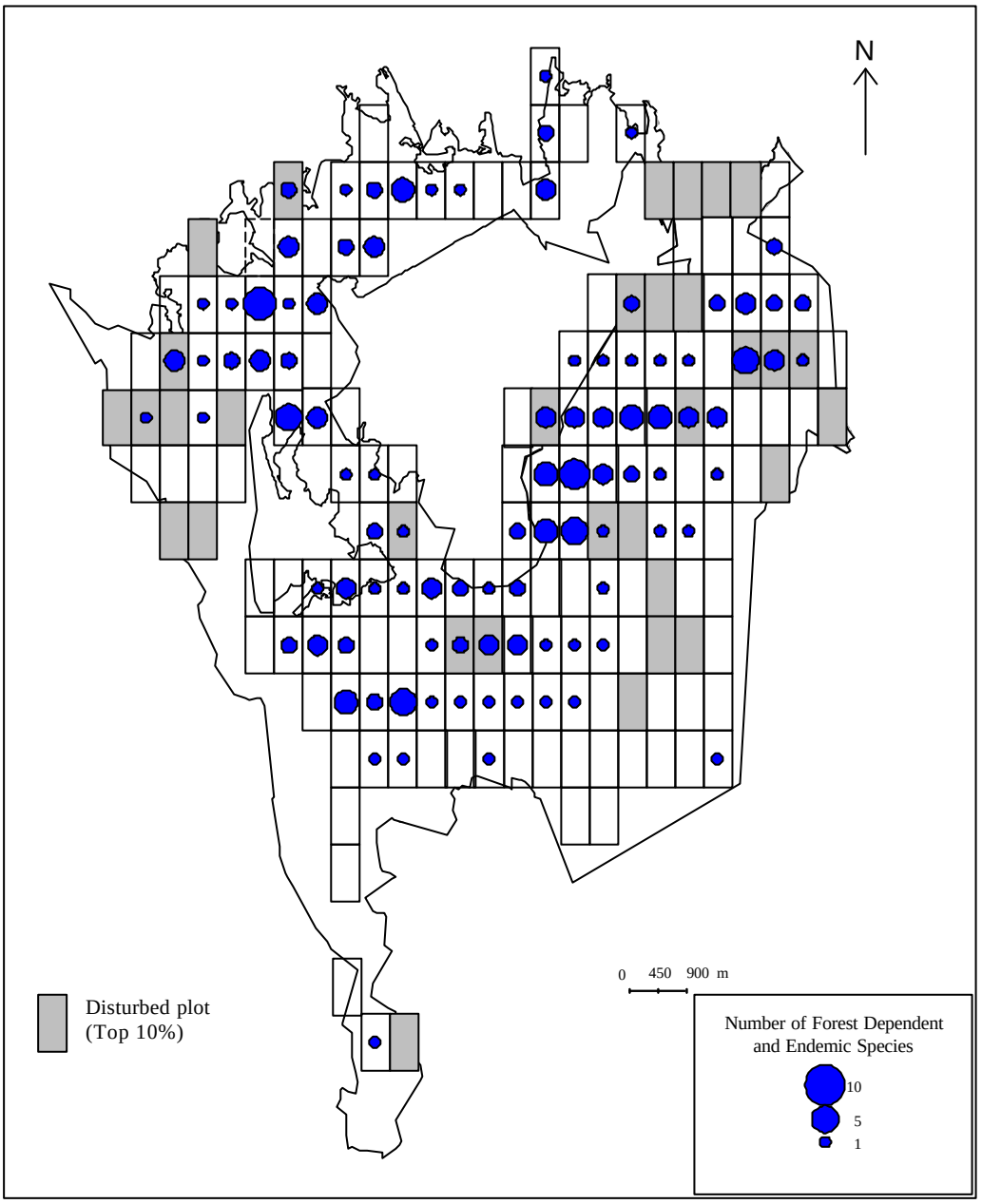

Figure 26 Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and endemic in Amani N.R. (1999 – 2000).

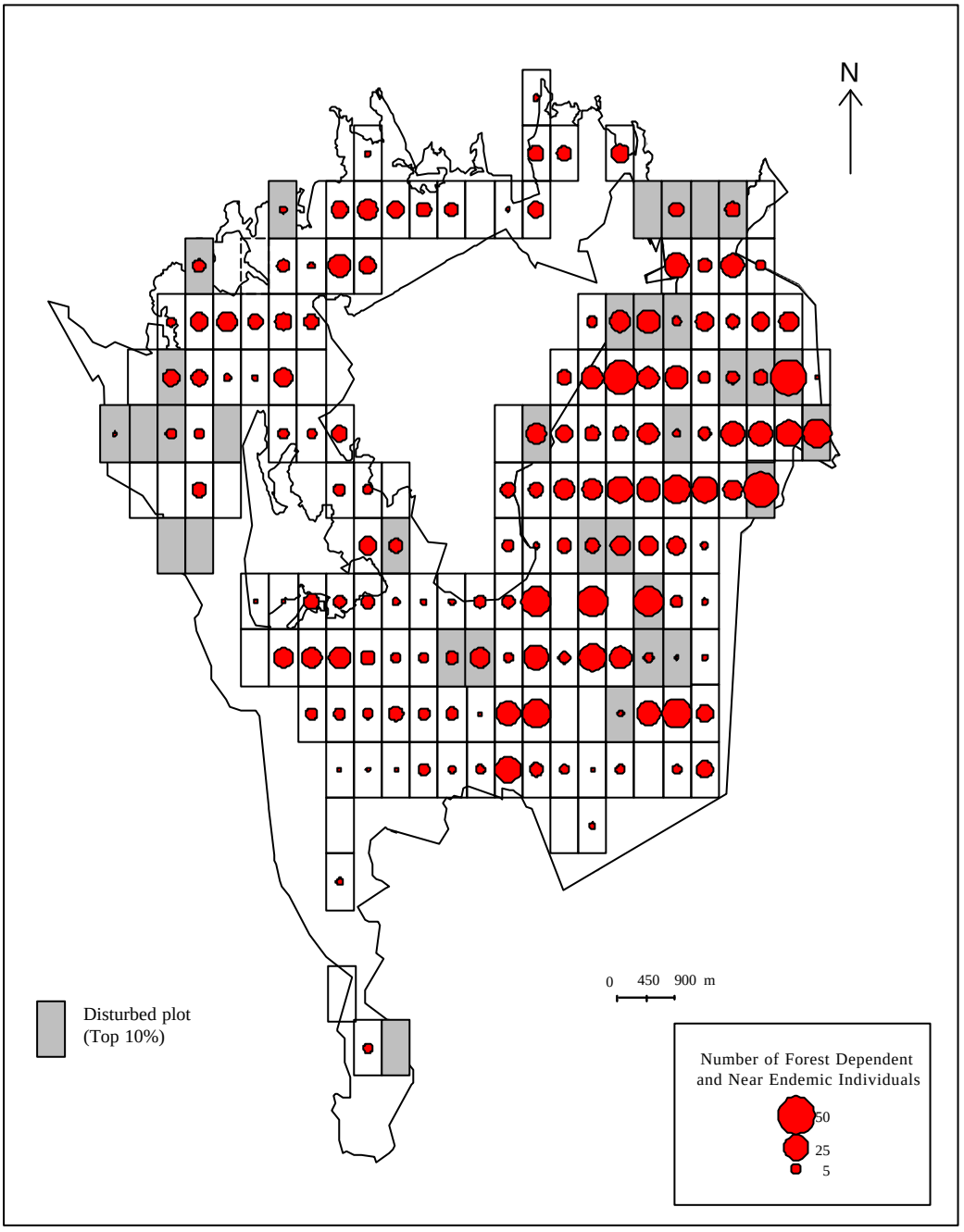

Figure 27 Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic in Amani N.R. (1999 – 2000).

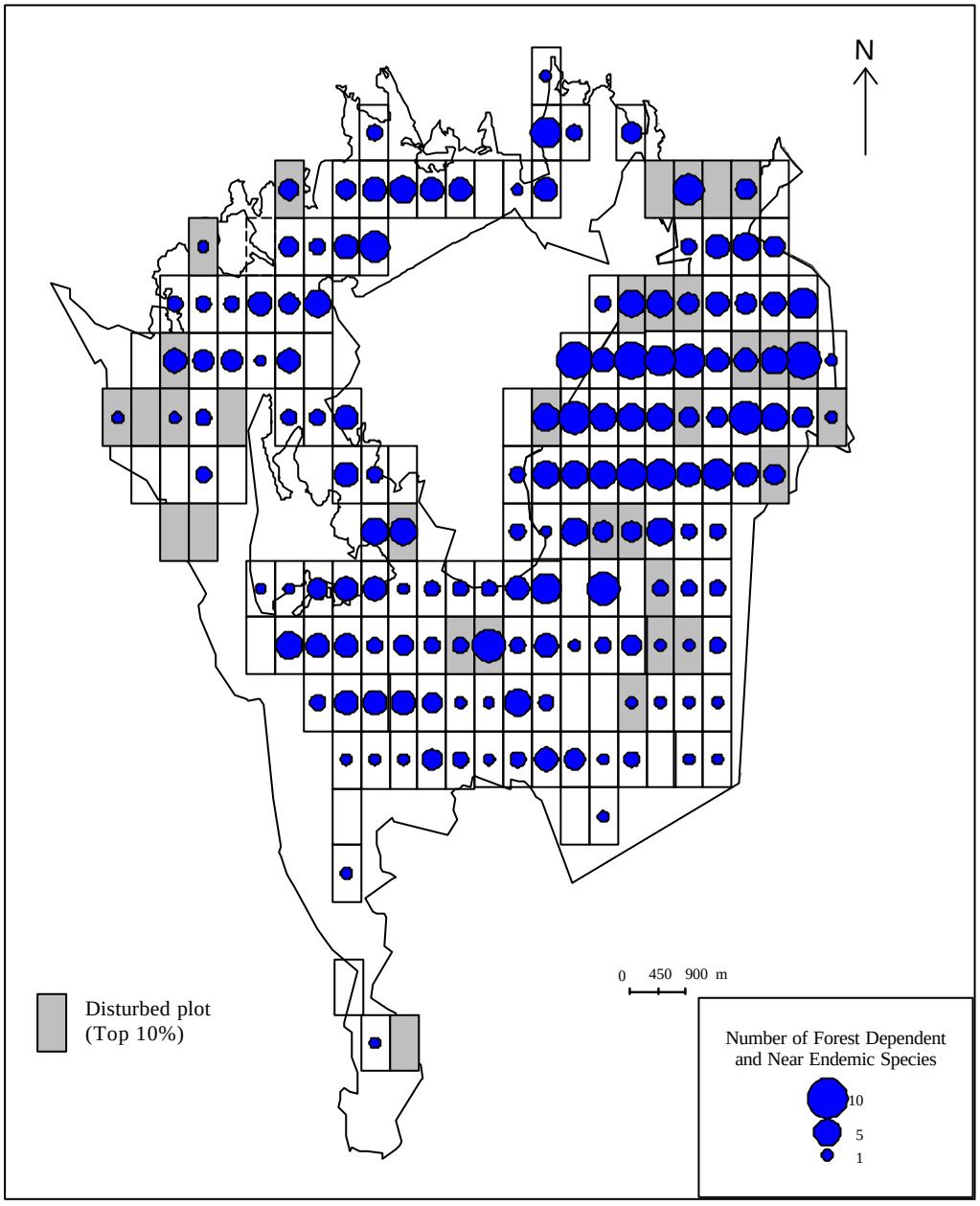

Figure 28 Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic in Amani N. R. (1999 – 2000).

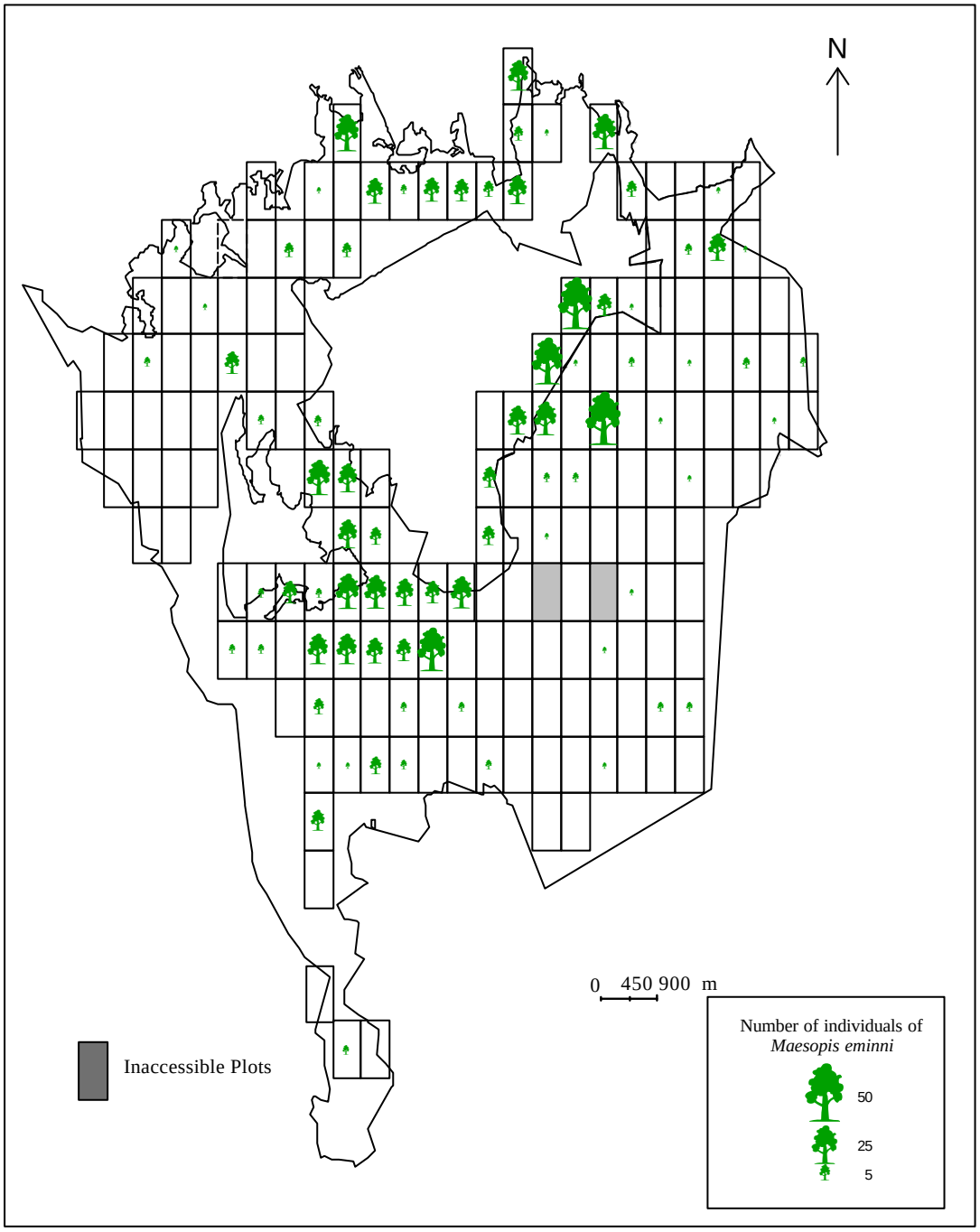

Figure 29 Distribution of *Maesopsis eminii* individuals in Amani N.R.

4.4 Discussion

Amani Nature Reserve covers an area of 8360 ha with altitudes ranging from approximately 190 m to 1130 m asl.

Species richness

In the systematic vegetation plots 7193 trees and shrubs were surveyed, representing 246 species from 53 families. An additional twelve species were recorded in the regeneration plots.

Casual observations from outside of the vegetation plots recorded an additional 367 plant species from 111 families including 71 families not previously recorded.

In total 621 plant species from 124 families were recorded.

Of the 173 vegetation plots surveyed systematically, 101 (58.4%) of the plots analysed were recorded as submontane forest, 58 (33.5%) as lowland forest, 7 (4.0%) as open woodland, 2 (1.2%) as herb/marsh/swamp, 2 (1.2%) as riverine forest, 1 (0.6%) as colonising forest, 1 (0.6%) as plantation forest and 1 (0.6%) as scrub/thicket/bush.

Relative to other forest reserves surveyed in the East Usambara Mountains the botanical diversity of Amani Nature Reserve is very high. This is partly due to the large size, heterogeneous habitat and large altitudinal range.

Species Accumulation Rates

The species accumulation rate for the 50m x 20m vegetation plots increases steadily and then begins to level off. The species accumulation curve does not reach an asymptote indicating that the vegetation plot species list of vascular plants of 10cm dbh and larger is incomplete. The large number of plant species recorded casually outside the vegetation plots may bring the botanical list closer to being complete.

Ecological Type

Forest dependent species defined as 'limited to primary forest only' were recorded 4580 times. This represents 63.7% of all specimens recorded. The most commonly recorded forest dependent tree species were *Maesopsis eminii*, (669 individuals), *Leptonychia usambarensis* (594 individuals) and *Allanblackia stuhlmannii* (316 individuals). 19 (17.8%) of the forest dependent species are endemic to the Usambara Mountains; a further 34 (31.8%) are near-endemic.

22 species characteristic of more open habitats were recorded in 21 of the 173 plots (12.1% of plots). *Cussonia arborea*, (15 individuals), *Lonchocarpus bussei* (14 individuals) and *Dombeya shupangae* (13 individuals) were the most commonly recorded non-forest species.

Habitat

Of the tree species surveyed with known altitude characteristics, 52.8% are considered to be typical of lowland forest and 47.2% are considered typical of submontane forest. Only 33.5 % of the vegetation plots in Amani Nature Reserve occur in lowland forest, a larger proportion 58.4%, occur in submontane forest.

Submontane species occurred in 98.2% of lowland plots surveyed. Lowland species occurred in 94% of submontane plots. This data is indicative of the variability in the ecological requirements and niches of these species, and the large area of transition forest between lowland and submontane zones represented in Amani Nature Reserve.

The most commonly recorded submontane species were: *Maesopsis eminii* (669 individuals), *Sorindeia madagascariensis* (585 individuals), and *Allanblackia stuhlmannii* (316 individuals).

Endemic Status

Of the plant species recorded in the vegetation plots 116 (65%) have widespread distributions. Near-endemics contribute 49 species (20%) from 23 families to the floristic composition of the reserve. These near-endemics were found in 160 of the 173 plots surveyed (92.5%) and account for 1894 or 26.36% of the trees and shrubs sampled in vegetation plots in the reserve. Of the 173 plots surveyed, 78 were found to have more than ten near-endemic individuals. The most commonly recorded near-endemic tree and shrub species in the reserve were: *Leptonychia usambarensis* (594 individuals), *Allanblackia stuhlmannii* (316 individuals) and *Cephalosphaera usambarensis* (221 individuals). Of the 49 near-endemic species, 39 species are also considered to be forest dependent. One near-endemic species, *Dombeya shupangae,* is a non-forest species.

19 of the species recorded are endemic to the Usambara Mountains. Of these seven are endemic to the East and West Usambara Mountains, one species is endemic to the West Usambara Mountains *(Platypterocarpus tanganyikensis*) and 11 are endemic to the East Usambara Mountains.

Regeneration

52% of the species found in the main vegetation plots were recorded within the regeneration subplots, these are indicated in Table 4 with an asterisk (*).

The endemic species *Rinorea albersii, Uvariodendron oligocarpum, Zenkerella grotei, Greenwayodendron suaveolens, Englerodendron usambarense, Magnistipula butayei greenwayi, Cynometra brachyrrachis, Cynometra longipedicellata, Anisophyllea obtusifolia, Cola vercillata, Cola usambarensis* were recorded regenerating.

However, the endemic species *Chrysophyllum zimmermannii, Greenwayodendron suaveolens usambaricum, Cynometra sp. A, Zenkerella capparidaceae grotei, Rytigynia*

xanthotricha, Cola scheffleri, Premna chrysoclada and Platypterocarpus tanganyikensis were not recorded regenerating.

Of the five principle timber species found within the reserve, two species *Newtonia buchananii* and *Cephalosphaera usambarensis,* were recorded regenerating. However the remaining three species *Khaya anthotheica, Ocotea usambarensis* and *Milicia excelsa* were not recorded in the regeneration layer.

Range Extensions

The following 71 species were not recorded by Iversen (1991b):

Spondias lutea, Lettowianthus stellatus, Anysophllea obtusifolia, Tabernaemontana holstii, Myrianthus stuhlmannii, Dracaena usambarensis, Diospyros squarrosa, Sapium armatum, Pentadesma butyraceae, Erythrophleum guineense, Zenkerella grotei, Acacia senegalensis, Senna seingueana, Lonchocarpus capassa, Strychnos innocua, Cedrela odorata, Khaya anthotheica, Castilla elastica, Eucalyptus saligna, Ximenia americana, Chionanthus nilotica, Cocus nucifera, Lasiodiscus mildbraedii, Cinchona succirubra, Coffea robusta, Rytigynia schumannii, Tarenna nigrenscens, Zanthoxylum chalybeum, Allophylus callophylus, Zanha africana, Manilkara densiflora, Manilkara sansibarensis, Pouteria alnifolia, Synsepalum cerasiferum, Quassia undulata, Cola vercillata, Rinorea albersii, Barleria spinisepala, Sclerocarya birrea, Chlorophytum tuberosum, Callopsis volkensii, Ochroma lagopus, Gloriosa minor, Combretum schweinfurthii, Aneilema pedunculosum, Agelaea heterophylla, Agelaea setulosa, Acalypha anata, Micrococca scariosa, Tragia brevipes, Oxtenanthera abyssinica, Ocimum suave, Cinnamomum camphora, Entada pursaetha, Indigoflora volkensii, Plicosepalus meridianus, Tapinanthus oehleri, Tapinanthus pennatulus, Camoemsia scandens, Dissotis speciosa, Bronssonetia papyrifera, Ensete ventricosum, Eucalyptus saligna var. citrodora, Adenia cissampeloides, Polygala paniculata, Gravillea robusta, Hemelia eracta, Cardiospernum grandiflorum, Vitex mombassae, Encephalartos hildebrandtii and *Selaginella myosurus.*

Disturbance

Evidence of fire was observed in 24 plots, clustered into three main areas. The western edge of the nature reserve was severely damaged as fires swept through the area during the survey period. Fires have also affected the most southerly area of the reserve (Mnyuzi Scarp), and the southeastern corner of the reserve. In these areas there is little forest canopy and grassland dominates. It is noticeable from Figure 7 and Figure 8 that these areas have the highest concentrations of non-forest species. Also it is noticeable that there are fewer forest dependent and endemic/near endemic species and individuals (see Figure 25, Figure 26, Figure 27 and Figure 28) in the most severely fire affected areas. It seems likely that fire is limiting the regeneration of forest species thereby limiting forest expansion within the nature reserve.

Pole cutting and timber cutting show similar patterns of extraction, with particular plots (e.g. 29, 30 and 31) having high rates of both pole and timber cutting.

Evidence of pit-sawing was observed on 11 of the 17 transects although no active saw-pits were in use during the survey period. Comparing Figure 20 and Figure 22 shows that there is a similar pattern of pitsawing and areas with high levels of timber cutting. The exception to this is where timber cutting sites are close to roads e.g. plots 30, 31 and 32.

Cultivation was observed in three plots in the reserve, all observations were located on the forest edge. Cut timbers and planks were found in eight plots mostly located near the forest edge.

The invasive tree species *Maesopsis eminii* was recorded in 79 plots across the reserve. 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). The high *Maesopsis eminii* density areas e.g. near the Kwamkoro Nature Trail, are the areas of forest where the species was originally planted, or forest edge plots.

During the survey period Mr Frank Mahenge (EUCAMP) was undertaking a study investigating the regeneration of *Maesopsis eminii.*

Animal traps were found in 39 plots, trapping was highest in the areas formerly known as Amani-Zigi and the northern part of Kwamsambia forests. Human population pressure is relatively high on the inner southeast border as there are several villages and sub-villages in this area including, Chemka, Boom boom, Amani and Mlesa.

Old logging roads were seen throughout the central sections of the reserve, most however are blocked by regenerating trees.

5.0 FAUNA

By Kathryn Doody, Olivia Scholtz, Hanna Siurua and Simon Loader.

5.1 Introduction

The faunal biodiversity of Amani Nature 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 30.

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 Amani Nature Reserve: (1) 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 the Frankfurt Zoological Museum, Germany.

5.2.1.1 Sherman trap lines

Rodents were sampled using one hundred 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, 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 15 litre plastic buckets sunk flush to ground level in linear transects. Each bucket was 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 10 – 15cm lip of plastic sheeting was left flat on the ground onto which soil and leaf litter was placed. Animals were channelled along the plastic into 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 was 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 at 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 the opposite border across the reserve. The transects were 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 the Natural History Museum of Zimbabwe.

5.2.4 Amphibians

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

5.2.5 Invertebrates

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

5.2.5.1 Butterflies

The aim of this study was to compile a species list of the reserve's butterflies. Butterflies were sampled using Blendon-style traps set in the tree canopy. Rotting banana was used as bait. Traps were checked between 12:00 and 14:00hrs. 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 sites with representative microhabitats were selected. At each of these sites a 1m x 1m quadrat was established. In this square, the leaf litter and the first 10cm 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 Copenhagen, c/o Dr N. Scharff.

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 10cm 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 were deposited at the Zoological Museum of Copenhagen, c/o Dr N. Scharff.

5.3 Trapping sites and sampling intensity

17 trapping sites were conducted in representative habitats across the reserve. Table 15 describes the trapping sites. Table 16 and Table 17 summarise the sampling intensity for each site and each trapping method.

Table 15 Summary descriptions of trapping sites in Amani Nature Reserve.

Trapsite Number	Plot Number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
1	3	Lowland Forest	580-600	Gentle/Steep Mid Slope	9-36
2	6	Submontane Forest	890-900	Gentle Upper Slope/ Ridge	2-15
3	20	Submontane Forest	930-950	Gentle / Steep Upper Slope	8-30
4	25	Riverine Lowland Forest	630-650	Steep/Gentle Mid Slope	15-40
5	24	Lowland Forest	500-545	Gentle /Steep Mid Slope	6-33
6	30	Plantation Forest	510-530	Gentle/Steep Lower Slope	0-30
7	44	Submontane Forest	950-970	Gentle Upper Slope	6-25
8	53	Submontane Forest	900	Gentle Upper Slope	6-29
9	60	Lowland Forest	600-640	Ridge/Gentle Mid Slope/Steep Mid Slope	1-36
10	94	Submontane Forest	1128	Peak/Hill Top	0-10
11	75	Lowland Forest	280	Gentle Lower Slope	2-37
12	87	Lowland Forest/ Scrub	210-265	Gentle Lower Slope	2-10
13	99	Plantation Forest	940-960	Gentle Upper Slope/ Valley Floor	0-25
14	122	Lowland Forest	750-780	Gentle Mid Slope/Ridge	8-25
15	133	Submontane/Riverine Forest	980-1000	Gentle Upper Slope/ Valley Floor	2-34
16	150	Submontane Forest	1000-1020	Ridge/Hilltop/ Submontane Forest	3-21
17	172	Submontane Forest	870-890	Gentle Mid Slope	7-25

Table 16 Sampling intensities in Amani Nature Reserve.

Trap nights = number of traps x number of nights.

Trapping Site	Dates	Sherman trap nights	Bucket pitfall*	Butterfly trap nights	Molluscs ** 1x1 m plot	Millipedes ** 3x3m plot
1	21/01/99 - 31/01/99	997	33	50	3	3
2	01/02/99 - 11/02/99	1000	33	50	3	3
3	16/02/99 - 26/02/99	998	33	50	3	3
4	01/03/99 - 01/03/99	1000	33	50	3	3
5	30/03/99 - 09/04/99	1000	33	50	3	3
6	15/03/99 - 30/03/99	1000	33	50	3	3
7	09/07/99 - 19/07/99	996	33	50	3	3
8	19/07/99 - 19/07/99	996	33	50	3	3
9	04/08/99 - 14/08/99	998	33	50	3	3
10	18/08/99 - 28/08/99	999	33	50	3	3
11	30/08/99 - 09/09/99	1000	33	50	3	3
12	16/09/99 - 26/09/99	999	33	50	3	3
13	29/10/99 - 08/11/99	998	33	50	3	3
14	23/11/99 - 02/12/99	1000	33	50	3	3
15	01/02/00 - 11/02/00	989	33	50	3	3
16	23/02/00 - 04/03/00	997	33	50	3	3
17	06/03/00 - 16/03/00	994	33	50	3	3

* Each bucket represents one trap night.

**This represents plots sampled not trap nights.

Table 17 Summary of bat-netting sites in Amani Nature Reserve.

Site Location	Site description	Sampling intensity (m of net x hours)	Altitude (m asl)	Topography
Plot 29	Grassy Lawn outside ANR Visitor Centre.	144	420	Gentle Lower Slope
Plot 20 Trapsite 3	Over Stream, Submontane Forest Canopy Ht 20-30m Canopy Cover >50%	187.5	930	Gentle Upper Slope
Plot 25 Trapsite 4	Over River Lowland Forest, Canopy Ht 20-30m, Canopy Cover >50%	92.75	680	Gentle Lower Slope
Plot 60 Trapsite 9	Over River, Lowland Forest, Gentle Mid Slope, Canopy cover 10 -50% Canopy Ht 20-30 m	29.75	590	Gentle Mid Slope
Plot 60 Trapsite 9	Cave entrance, Lowland Forest, Canopy cover <10%, Canopy Ht <10m	19.5	600	Gentle Mid Slope
Plot 94 Trapsite 10	Submontane Forest, Gully, Canopy cover 10-50%, Canopy Ht 20-30m	18.96	1100	Gully
Plot 94 Trapsite 10	Submontane Forest, Ridge/hill top, Canopy cover 10-50%, Canopy Ht 20-30m	6	1100	Gully
Plot 75 Trapsite 11	Lowland Forest	24	280	Gentle Mid slope
Plot 133 Trapsite 15	Submontane Forest, Canopy cover >50% Canopy Ht 20-30m	156	960-945	Gully / Dry River Bed
	Total of bat net hours	**678.46**		

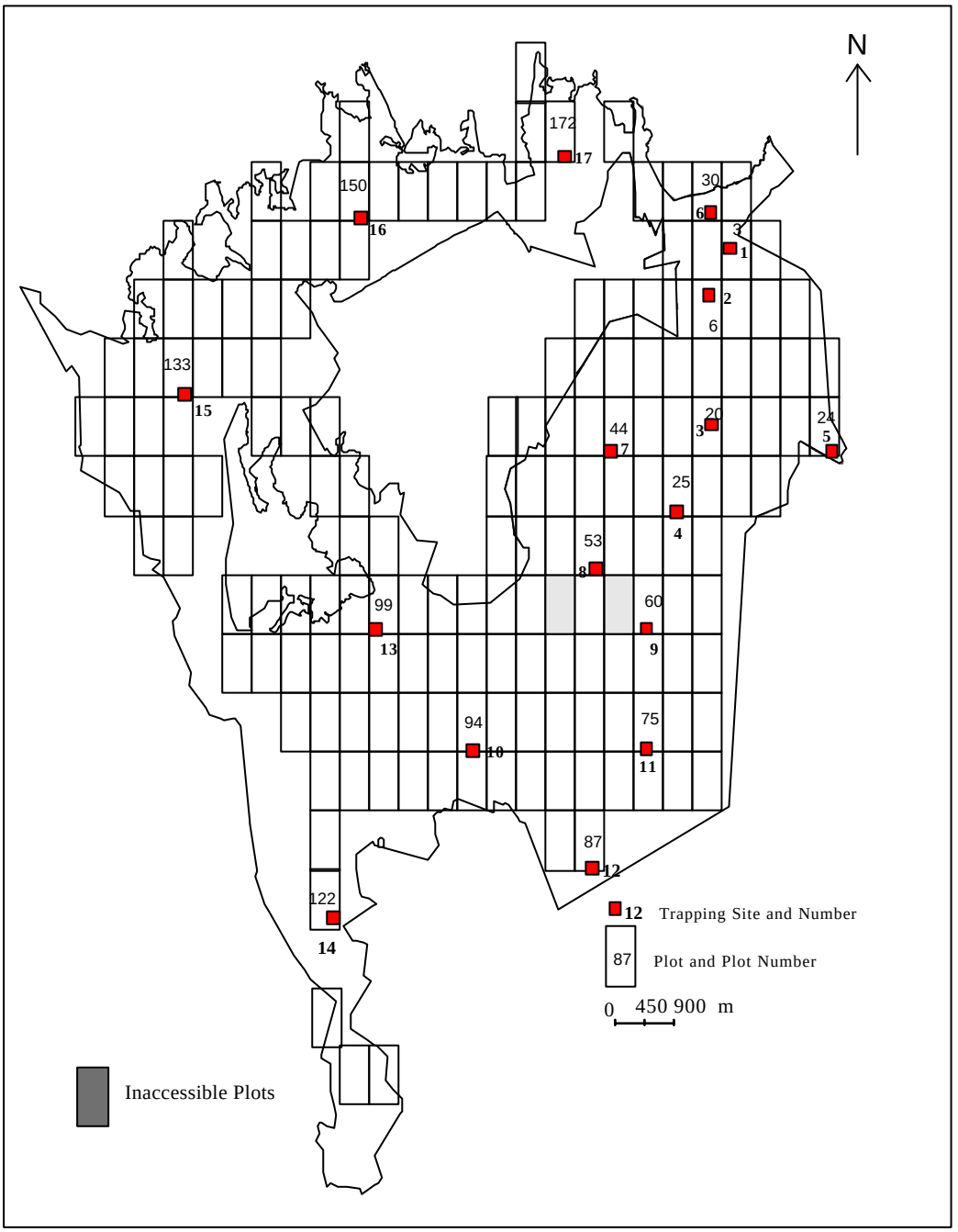

Figure 30 Location of trapping sites in Amani N.R.

5.4 Results

5.4.1 Mammals

5.4.1.1 Small mammals (not bats)

A total of 442 specimens were retained for taxonomic purposes. Mr W. Stanley of the Chicago Field Museum provided tentative determinations for some of the specimens. These specimens represent at least 24 species from seven 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 captured small mammals from Amani Nature Reserve.

Species	Ecological Status	Endemic Status	IUCN Status	Total individuals
SORICIDAE				
Sylvisorex megalura	f	W		1
Crocidura flavescens	f	W		4
Crocidura hildegardeae	f	W		19
Crocidura hildegardeae/elgonius	?	?		4
Crocidura hirta/xantippe morph 1	?	?		2
Crocidura hirta/xantippe morph 2	?	?		2
Crocidura hirta/xantippe morph 3	?	?		2
Crocidura oliveri	?	?		2
Crocidura sp.	?	?		234
SCIURIDAE				
Heliosciurus rufobrachium undulatus	F	W		1
ANOMALURIDAE				
Anomalurus derbianus	f	W		1
MYOXIDAE (Syn. GLIRIDAE)				
Graphiurus sp.	f	W		2
CRICETIDAE				
Beamys hindei	F	N	DD	13
Cricetomys gambianus	O	W		1
MURIDAE				
Acomys sp.	?	?		1
Acomys spinosissimus	f	W		4
Lophuromys flavopunctatus	f	W		13
Lophuromys sp.	?	?		7
Praomys delectorum	F	W		4
Praomys sp.	?	?		95
Hylomyscus sp.	?	?		2
Mastomys sp.	?	?		2
Mus minutoides	f	W		4
Grammomys dolichurus	O	W		3
Grammomys macmillani	O	W		1
Grammomys sp.	?	?		6
Rattus rattus	O	W		9
Unknown rodent	?	?		1
HYRACOIDEA				
Dendrohyrax validus	f	N	EN	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
- EN - Endangered
- DD - Data Deficient

OR - Outside reserve

5.4.1.2 Dung survey

Dung from at least 12 mammal species was 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, hyrax and bushbuck dung in Amani Nature Reserve.

		Duiker		Hyrax		Bush buck	
Transect	**Transect length**	**Dung sightings**	**Rate / ha**	**Dung sightings**	**Rate / ha**	**Dung sightings**	**Rate / ha**
-2	550	2	9.1	0	0.0	0	0
0	6100	3	1.2	0	0.0	0	0
1	4465	0	0.0	2	1.1	0	0
2	5577	1	0.4	0	0.0	0	0
4	8420	0	0.0	1	0.3	0	0
5	7470	3	1.0	1	0.3	0	0
6	5295	1	0.5	5	2.4	0	0
7	7340	2	0.7	8	2.7	0	0
8	7445	1	0.3	1	0.3	0	0
9	6440	2	0.8	9	3.5	0	0

Table 20 Summary of dung survey in Amani Nature Reserve.

Species	Ecol. Type	End. Status	IUCN Status	Times encountered	Altitudinal range (m)
Papio cynocephalus	f	W		3	740-1100
Cercopithecus mitis	f	W		3	490 - 760
Anomalurus derbianus	f	W		1	920
Beamys hindei	F	N		1	605
Cricetomys gambianus	O	W		39	420-1090
Civettictis civetta	f	W		6	620-925
Genetta spp.	?	?		3	590-950
Procavia spp.	?	?		3	700-1020
Dendrohyrax validus	f	N	EN	16	400-1000
Potamochoerus larvatus	f	W		10	400-1000
Cephalophus harveyi	f	W		1	?
Cephalophus monticola	F	W		5	520-1020
Sylvicapra grimmia	f	W		3	475-1005
Unidentified duiker sp.	?	?		7	700-1100

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:

- EN - Endangered
- V - Vulnerable
- LC - Least Concern

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.

5.4.1.3 Mammal observations

A total of 22 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 (Hilton-Taylor, 2000) and Kingdon (1989).

Table 21 Summary of mammal observations in Amani Nature Reserve.

Species	Common Name	Certainty	Ecol. type	Endemic status	IUCN status	Observation location by plot
COLOBIDAE						
Colobus angolensis palliatus	Angola Pied Colobus	Certain	F	W		5, 31, 150
CERCOPITHECIDAE						
Papio cynocephalus	Yellow baboon	Certain	f	W		29, 32, 3
Cercopithecus aethiops	Vervet Monkey	Probable	f	W		87
Cercopithecus mitis	Blue Monkey	Certain	f	W		5, 31, 30, 124, 125
GALAGONIDAE						
Otolemur crassicaudatus	Greater Galago	Certain	f	W		29, 3, 99
Galagoides orinus	Usambara galago	Certain	f	W		101, 111, 102
MACROSCELIDEA						
Rhynchocyon petersi	Zanj Elephant Shrew	Certain	F	N	EN	32, 122, 116, 120
SCIURIDAE						
Paraxerus lucifer byatti	Tanganyika Mountain Squirrel	Certain	F	W	LC	2
ANOMALURIDAE						
Anomalurus derbianus	Lord Derby's Anomalure	Certain	f	W		29
HYSTRICIDAE						
Hystrix cristata	Crested Porcupine	Certain	f	W		83
CRICETIDAE						
Cricetomys gambianus	Giant Pouched Rat	Certain	O	W		29, 125
HERPESTIDAE						
Herpestes ichneumon	Egyptian Mongoose	Certain	O	W		136
Herpestes sanguinea	Slender Mongoose	Certain	f	W		125
Bdeogale crassicauda	Bushy tailed Mongoose	Probable	f	W		123
VIVERRIDAE						
Genetta genetta	Common Genet	Certain	O	W		100, 99
Genetta tigrina	Blotched Genet	Probable	f	W		100
Civettictis civetta	African Civet	Certain	f	W		3
NANDININAE						
Nandinia binotata	African Palm Civet	Probable	f	W		100
HYRACOIDEA						
Dendrohyrax validus	Tree Hyrax	Certain	f	N	EN	30
SUIDAE						
Potamochoerus larvatus	Bush pig	Certain	f	W		66, 110, 106
BOVIDAE						
Cephalophus monticola	Blue Duiker	Probable	F	W		29
Cephalophus harveyi	Harvey's Duiker	Certain	f	W		99

5.4.1.4 Bats

A total of 38 individuals were retained for taxonomic purposes. These represent 16 species from 5 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (Hilton-Taylor, 2000), Kingdon (1974) and Kingdon (1997). Nomenclature follows Kingdon (1974). Dr D. Kock has confirmed all species determinations.

Table 22 Summary of bats.

Species	Common name	Ecol. type	End. status	IUCN status	Plot location and number of individuals captured							
PTEROPODIDAE					20	25	29	60	94	133	O/R	Total
Rousettus (Stenonycteris) lanosus kempi	Mountain fruit bat	F	W					1				1
Lissonycteris angolensis ruwenzorii	Angola fruit bat	f	?							2		2
RHINOLOPHIDAE												0
Rhinolophus eloquens	Horseshoe bat	f	W					1				1
Rhinolophus landeri lobatus	Lander's horseshoe bat	?	?					6		1		7
Rhinolophus hildebrandti	Horseshoe bat	f	W			1				3		4
Rhinolophus deckenii	Horseshoe bat	f	?	LC				1				1
Rhinolophus clivosus keniensis	Horseshoe bat	?	?		1	1						2
NYCTERIDAE												0
Nycteris grandis	Large Slit-faced bat	F	W		1				1			2
HIPPOSIDERIDAE												0
Hipposideros ruber	Leaf-nosed bat	f	W		1		1			2		4
Hipposideros caffer	Leaf-nosed bat	f	W							1		1
Triaenops persicus afer	Persian leaf nose bat	f	W		1							1
VESPERTILIONIDAE												0
Pipistrellus grandidieri grandidieri	Pipistrelle bat	?	?			3		1				4
Pipistrellus africanus	Pipistrelle bat	?	?								1	1
Pipistrellus herperidus (formerly known as *P. kuhlii fuscatus*)	Pipistrelle bat	?	W							1		1
Miniopterus fraterculus	Long fingered Bat	?	?			3		2				5
Miniopterus schreibersii arenarius	Long fingered Bat	?	W								1	1
	Total				**4**	**8**	**1**	**12**	**1**	**10**	**2**	**38**

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

Ecological type:

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

Endemic status:

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

IUCN status:

- LC – Least Concern

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

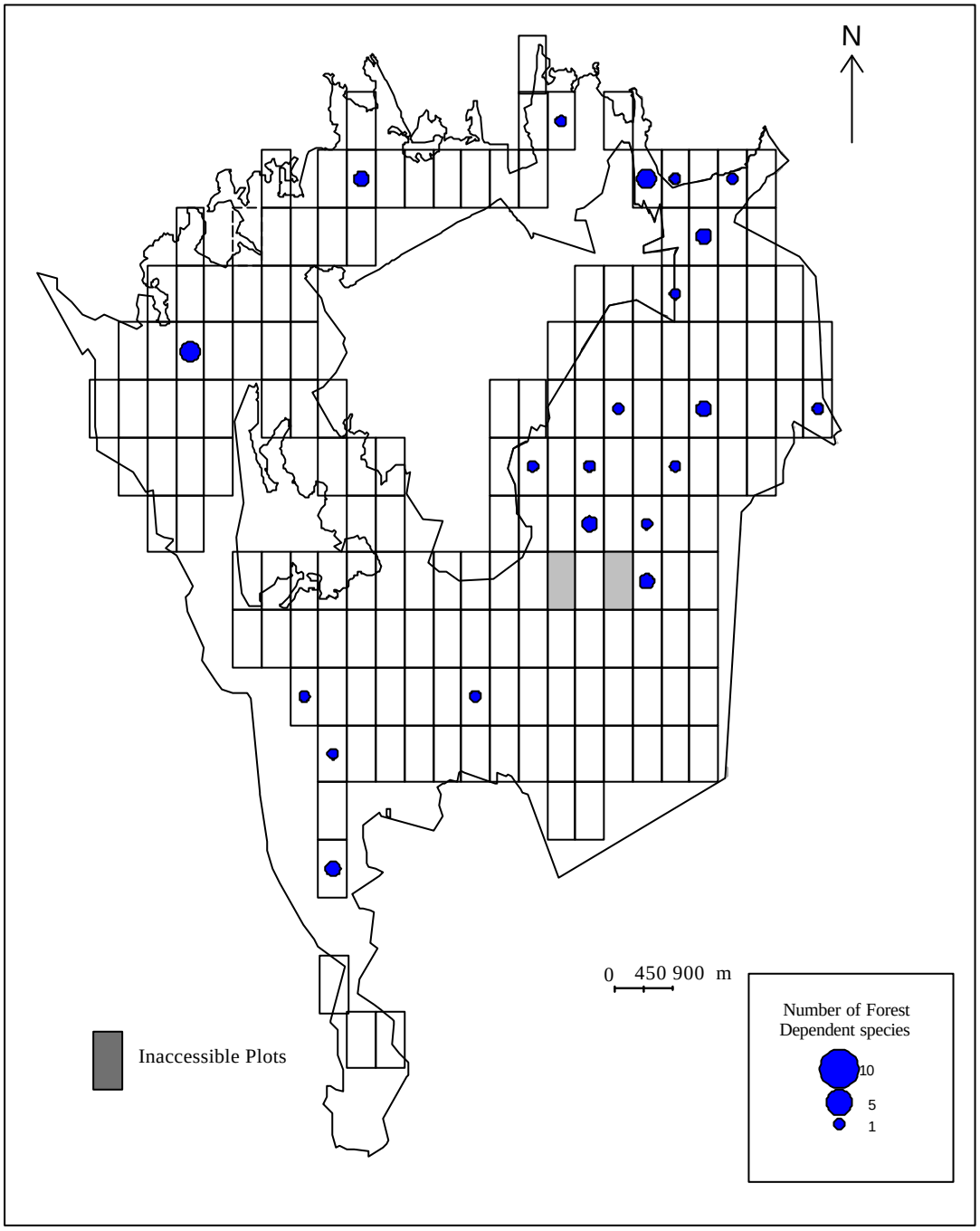

Figure 31 Distribution of forest dependent mammal species in Amani N.R.

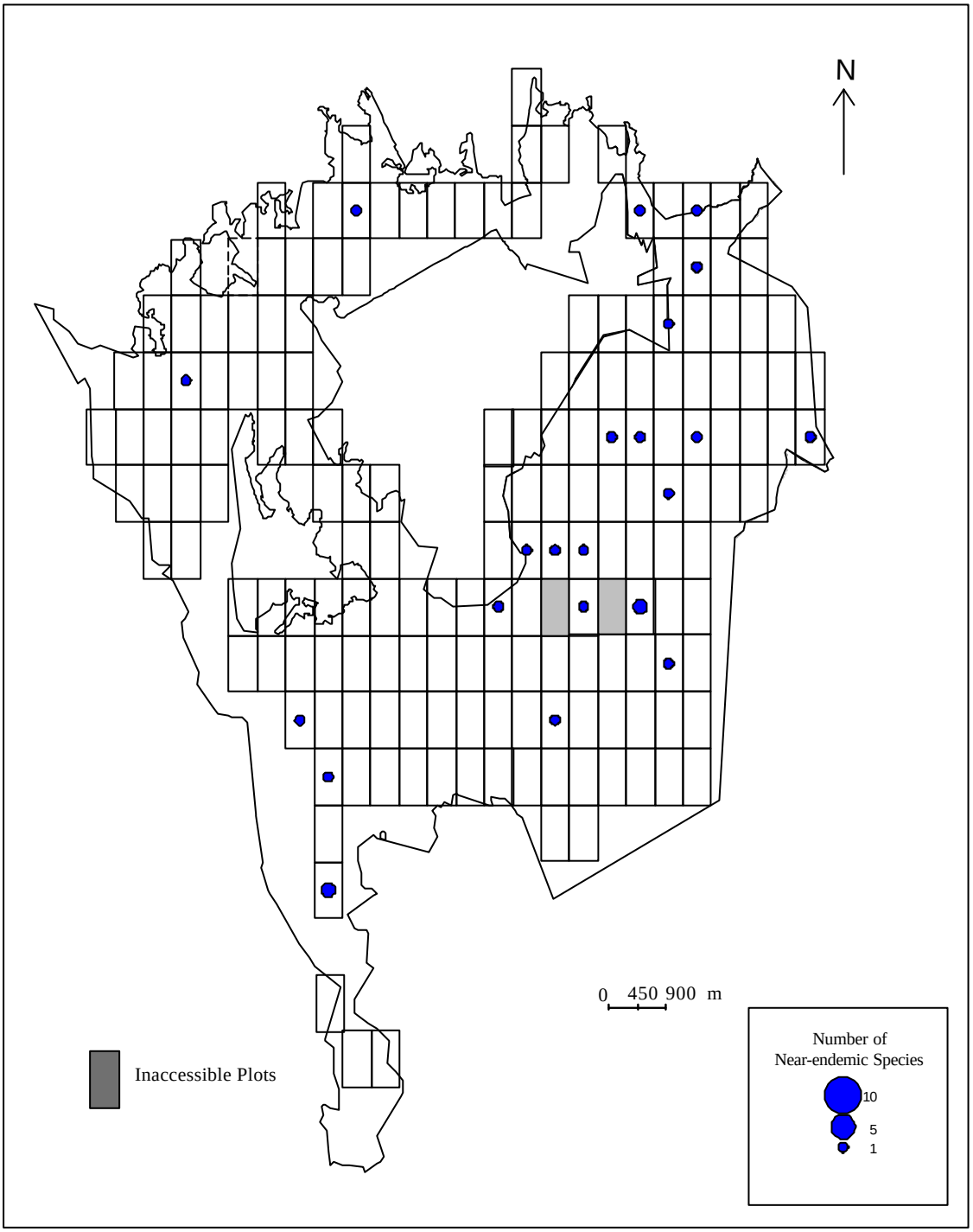

Figure 32 Distribution of near-endemic mammal species in Amani N.R.

5.4.2 Birds

A total of 65 species from 29 families were recorded. No systematic survey of birds was undertaken, therefore this list does not represent a complete bird species inventory. Unless indicated otherwise, ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1997), IUCN (Hilton-Taylor, 2001), Zimmerman *et al.* (1996) and Zimmerman *et al.* (1999).

Table 23 Summary of birds.

Species	Common name	Certainty	Ecol. type	End. status	IUCN status	CITES	Location by plot
ACCIPITRIDAE							
Macheiramphus alcinus	Bat Hawk (Bat-eating Buzzard)	Probable	f	W	LC	II	25
Gypohierax angolensis	Palm-nut Vulture	Certain	O	W	LC	II	60
Lophaetus occipitalis	Long-crested Eagle	Probable	f	W	LC	II	O/R, 99
COLUMBIDAE							
Treron calva	African Green Pigeon	Certain	O	W		II	111
Turtur tympanistria	Tambourine Dove	Certain	F	W		II	31
MUSOPHAGIDAE							
Tauraco fischeri	Fischer's Turaco	Certain	F	W	NT	II	20, 99, 100 numerous sightings
CUCULIDAE							
Cercococcyx montanus patulus	Barred Long-tailed Cuckoo	Probable	F	W			94
Cuculus s. solitarius	Red-chested Cuckoo	Certain	f	W			111
Centropus superciliosus	White-browed Coucal	Certain	O	W			Common at forest edge
STRIGIDAE							
Strix woodfordii	African Wood-owl	Certain	f	W	LC	II	99, 101
Bubo vosseleri	Usambara Eagle Owl	Certain	F	N	VU	II	111
COLIIDAE							
Colius striatus	Speckled Mousebird	Certain	O	W			O/R
TROGONIDAE							
Apaloderma narina	Narina Trogon	Certain	F	W			111
Apaloderma vittatum	Bar -tailed Trogon	Certain	F	W	VU		94, 99, 100, 111
ALCEDINIDAE							
Halcyon albiventris	Brown-hooded Kingfisher		O	W			O/R
Megaceryle m. maxima	Giant Kingfisher	Certain	f	W			O/R
BUCEROTIDAE							
Bycanistes brevis	Silvery Cheeked Hornbill	Certain	F	W			99, 100, 111
Bycanistes bucinator	Trumpeter Hornbill	Certain	F	W			3, 6, 20, 25, 30, 31, 32, 99, 100, 101, 102
CAPITONIDAE							
Stactolaema leucotis	White-eared Barbet	Certain	F	W			30,99, 100, 111
Stactolaema olivacea	Green Barbet	Probable	F	W	NT		99

Table 23 continued

Species	Common name	Certainty	Ecol. type	End. status	IUCN status	CITES	Location by plot
PICIDAE							
Campethera cailliautii	Green-backed Woodpecker	Certain	f	W			118
EURYLAIMIDAE							
Smithornis capensis	African Broadbill	Certain	F	W	NT		99, 100, 101
MOTACILLIDAE							
Motacilla aguimp vidua	African Pied Wagtail	Certain	O	W			O/R, 99, 100, 101
Motacilla clara torrentium	Mountain Wagtail	Certain	f	W			O/R, 99, 100
Motacilla flava	Yellow Wagtail	Certain	O	W			99, 100
HIRUNDINIDAE							
Hirundo abyssinica unitatis	Lesser Striped Swallow	Certain	O	W			O/R
PYCNONOTIDAE							
Pycnonotus barbatus	Common Bulbul	Certain	f	W			3, 30, 99, 100
Andropadus tephrolaemus	Mountain Greenbul	Probable	F	W	NT		99, 100
Phyllastrephus strepitans	Northern Brownbul	Probable	f	W			25
Phyllastrephus fischeri	Fischer's Greenbul	Possible	f	W	NT		100
TURDIDAE							
Cossypha natalensis	Red-capped Robin-chat	Probable	f	W			30
Saxicola torquata axillaris	Common Stonechat	Probable	O	W			O/R
MUSCICAPIDAE							
Melaenornis pammelaina	Southern Black Flycatcher	Probable	f	W			6, 100
Bradornis pallidus	Pale Flycatcher	Certain	f	W			OR
SYLVIIDAE							
Prinia subflava	Tawny-flanked Prinia	Certain	O	W			O/R
Camaroptera brachyura	Common Camaroptera	Certain	f	W			30, 99,100
Phylloscopus ruficapillus minullus	Yellow-throated Woodland Warbler	Certain	F	N	NT		111
ZOSTEROPIDAE							
Zosterops senegalensis	Yellow White-eye	Certain	f	W			111
MONARCHIDAE							
Terpsiphone viridis	African Paradise Flycatcher	Probable	f	W			6, 100
Trochocercus albonotatus	White-tailed Crested Flycatcher	Certain	F	W			100
PLATYSTEIRIDAE							
Batis mixta	Forest Batis	Certain	f	W	NT		94
Batis soror	Pale Batis	Certain	f	N			111
MALACONOTIDAE							
Laniarius aethiopicus	Tropical Boubou	Certain	f	W			99, 100
Malaconotus nigrifrons	Black-fronted Bush-Shrike	Certain	F	W			99, 100
CAMPEPOHAGIDAE							
Campephaga flava	Black Cuckoo-Shrike	Certain	f	W			99, 100
Coracina caesia pura	Grey Cuckoo-Shrike	Certain	F	W	NT		99, 101, 100

Table 23 continued.

Species	Common name	Certainty	Ecol. type	End. status	IUCN status	CITES	Location by plot
DICRURIDAE							
Dicrurus adsimilis	Common Drongo	Certain	f	W			29
Dicrurus ludwigii	Square-tailed Drongo	Certain	f	W			20, 30, 99, 100
ORIOLIDAE							
Oriolus chlorocephalus	Green-headed Oriole	Certain	F	W			30, 100
Oriolus larvatus rolleti	Black-headed Oriole	Certain	F	W			100
Oriolus auratus	African Golden Oriole	Certain	f	W			30, 99
Spermophaga ruficapilla cana	Redheaded Bluebill	Probable	f	E			100
Lagonosticta senegala ruberrima	Red-billed Firefinch	Probable	O	W			155
STURNIDAE							
Onychognathus walleri	Waller's Starling	Probable	F	W			30
Poeoptera kenricki	Kenrick's Starling	Probable	F	W	NT		30
NECTARINIIDAE							
Nectarinia venusta	Variable Sunbird	Certain	O	W			30
Nectarinia olivacea	Olive Sunbird	Certain	f	W			99, 100
Nectarinia amethystina	Amethyst Sunbird	Probable	f	W			150
Anthreptes rubritorques	Banded Green Sunbird	Certain	F	E	VU		99
PLOCEIDAE							
Euplectes nigroventris	Zanzibar Red Bishop	Certain	O	W			O/R
Ploceus baglafecht	Baglafecht Weaver	Certain	O	W			O/R
Ploceus bicolor	Dark-backed Weaver	Certain	F	W			2, 30, 3, 99, 100 frequent sightings
ESTRILDIDAE							
Estrilda astrild	Common Waxbill	Certain	O	W			O/R
Estrilda quartinia kilimensis	Yellow-bellied Waxbill	Probable	f	W			O/R
Mandingoa nitidula chubby	Green-backed Twinspot	Certain	f	W			99,100

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:

- 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.

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

CITES

- I - Listed on CITES Appendix 1
- II – Listed on CITES Appendix II

Table 24 Ranges of endemic and near-endemic bird species (Zimmerman, 1996 and Zimmerman, 1999).

Endemic species	**Range**
Anthreptes rubritorques Banded Green Sunbird	Locally common in Usambara Mountains
Spermophaga ruficapilla cana Redheaded Bluebill	Subspecies *cana* – East Usambara Mountains

Near-endemic species	**Range**
Batis soror Pale Batis	East Usambara Mountains, selected lowland forest in Kenya.
Phylloscopus ruficapillus minullus Yellow-throated Woodland Warbler	Usambara, South Pare Mountains, Taita Hills Kenya
Bubo vosseleri Usambara Eagle Owl	Usambara Mountains, Udzungwa Mountains[1]

[1]**Butynski, T.M. & Ehardt, C.L. (*in press*).**

5.4.3 Reptiles

A total of 256 individuals were retained for taxonomic purposes. These specimens represent 48 species from 13 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1996), IUCN (Hilton-Taylor 2000), Broadley & Howell (unpubl.), Howell (1993), and Branch (1994). For a summary of capture locations of each species please refer to Appendix 3.

Table 25 Summary of reptiles.

Species	Common Name	Ecological Type	Endemic Status	IUCN/ CITES Status	Total individuals
PELOMEDUSIDAE					
Pelomedusa subrufa subrufa	Helmeted Terrapin	O	W	CITES III	1
TESTUDINIDAE	Tropical Leopard Tortoise				
Geochelone pardalis babcocki			W	CITES II	1
GEKKONIDAE					
Lygodactylus capensis grotei	Grote's Dwarf Gecko		W	LC	1
Urocotyledon wolterstorffi		F	N	VU	1
Cnemaspis africana	Usambara Forest Gecko	F	W	NT	26
Cnemaspis barbouri	Uluguru Forest Gecko	F	N	EN	16
Cnemaspis sp.	Forest Gecko sp.	?	?		9
Hemidactylus mabouia	Tropical House Gecko	f	W		2
Hemidactylus platycephalus	Baobab Gecko	f	W		1
AGAMIDAE					
Agama montana	Montane Rock Agama	F	N	VU	1
CHAMAELEONIDAE					
Bradypodion (Chamaeleo) fischeri fischeri	Eastern Usambara Two-horned Chameleon	F	N	VU CITES II	10
Bradypodion spinosum	Rosette-nosed Chameleon	F	E	EN CITES II	2
Bradypodion (Chamaeleo) tenue	Usambara Soft-horned Chameleon	F	N	VU CITES II	3
Chamaeleo dilepis dilepis	Common Flap-necked Chameleon	f	W	CITES II	4
Chamaeleo deremensis	Usambara Three-horned Chameleon	F	E	EN CITES II	6
Rhampholeon brevicaudatus	Bearded Pigmy Chameleon	F	N	VU	4
Rhampholeon temporalis	Pitted Pigmy Chameleon	F	E	EN	4
Rhampholeon sp.	Pigmy Chameleon sp.	?	?		1
SCINCIDAE					
Scelotes ulugurensis	Uluguru Fossorial Skink	F	N	EN	2
Mabuya maculilabris maculilabris	Speckle-lipped Skink	f	W		14
Mabuya varia varia	Variable Skink		W		1
Mabyua striata striata	Common Striped Skink		W		4
Lygosoma afrum	Peter's Writhing Skink	f	W		3

Table 25 continued

Species	Common Name	Ecological Type	Endemic Status	IUCN/ CITES Status	Total individuals
SCINCIDAE continued.					
Leptosiaphos kilimensis	Kilimanjaro Five-toed Skink	F	N	VU	20
CORDYLIDAE					
Cordylus tropidosternum tropidosternum	East African Spiny-tailed Lizard	f	W	CITES II	1
TYPHLOPIDAE					
Typhlops lineolatus lineolatus	Lineolate Blind-Snake		W		1
Typhlops gierrai	Usambara Blind-Snake	F	N	VU	3
Typhlops sp. nov. (*usambaricus*)		?	?		1
Typhlops sp.	Blind-Snake sp.	?	?		3
LEPTOTYPHLOPIDAE					
Leptotyphlops macrops	Worm-snake	F	N	VU	1
BOIDAE					
Python sebae	Northern African Python	O	W	CITES II	3
VIPERIDAE					
Atheris ceratophorus	Horned Bush-Viper		N	NT	3
Bitis gabonica	Eastern Gaboon Viper	F	W		2
ELAPIDAE					
Elapsoidea nigra	Usambara Garter-Snake	F	N	VU	9
Elapsoidea loveridgei	Loveridge's Garter-Snake		W	LC	2
Elapsoidea sp.	Garter Snake sp.	?	?		2
Naja nigricollis nigricollis	Black-necked Spitting Cobra	O	W		1
Dendroaspis angusticeps	Eastern Green Mamba	f	W		3
COLUBRIDAE					
Lamprophis capensis	Common House Snake	f	W		3
Lycophidion meleagre	Speckled Wolf Snake	F	W		2
Lycophidion capense loveridgei	Loverdige's Wolf-Snake	F	W		1
Mehelya capensis capensis	Southern Cape File Snake	f	W		2
Buhoma (Geodipsas) vauerocegae	Usambara Forest Snake	F	N	VU	17
Buhoma sp.	Forest Snake sp.	?	?		1
Aparallactus werneri	Usambara Centipede Eater	F	N		6
Natriciteres olivacea	Olive Marsh Snake	f	W		4
Philothamnus macrops	Usambara Green Snake	F	N	VU	22
Philothamnus hoplogaster	Southeastern Green Snake	f	W		4
Philothamnus punctatus	Spotted Bush Snake	f	W		2
Crotaphopeltis hotambeia	Herald Snake	O	W		2
Crotaphopeltis tornieri	Tornier's Cat-Snake	F	W	VU	8
Dipsadoboa werneri	Werner's Tree-Snake	F	N	VU	2
*Thelotornis capensis mossambicanus**	Mozambique Vine Snake	f	W		8
Total					**256**

KEY TO ABBREVIATIONS FOR Table 25 Table 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:

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

CITES status

- II – Listed on CITES appendix II

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
UK - Unknown capture location
? - No data available

* See section 5.5.1.2 for discussion of this species

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

Endemic Species	**Range**
Chamaeleo deremensis	East and West Usambara Mountains
Bradypodion spinosum	East and West Usambara Mountains
Rhampholeon temporalis	East and West Usambara Mountains
Near-endemic Species	**Range**
Urocotyledon wolterstorffi	East Usambara Mountains and Uluguru Mountains
Cnemaspis barbouri	East Usambara Mountains; Uluguru Mountains
Agama montana	Usambara Mountains; Uluguru Mountains
Bradypodion (Chamaeleo) fischeri fischeri	Usambara Mountains; Nguru Mountains
Bradypodion (Chamaeleo) tenue	Usambara Mountains; Shimba Hills, Kenya
Rhampholeon brevicaudatus	East Usambara Mountains; Uluguru Mountains; Udzungwa Mountains; Coastal forest
Scelotes ulugurensis	Uluguru Mountains
Leptosiaphos kilimensis	Kenya, Northern Tanzania
Typhlops gierrai	Usambara Mountains; Ukaguru Mountains; Uluguru Mountains
Typhlops sp. nov. *(usambaricus)*	?
Leptotyphlops macrops	Coastal forests of Kenya and Tanzania.
Atheris ceratophorus	Usambara; Uluguru and Udzungwa Mountains
Elapsoidea nigra	East Usambara Mountains; West Usambara Mountains; Ulugurus
Buhoma (Geodipsas) vauerocegae	Usambara and Uluguru Mountains
Aparallactus werneri	Usambara and Uluguru Mountains
Philothamnus macrops	Usambara Mountains; Coastal forest
Dipsadoboa werneri	Northeastern Tanzania

Additional casual reptile observations made are listed below, however, only one additional species (*Amblyodipsas polylepis hildebrandtii*) is represented.

Table 27 Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation location
CHAMAELEONIDAE				
Bradypodion (Chamaeleo) fischeri fischeri	Certain	F	N	O/R, Plot 115
Chamaeleo deremensis		F	E	Plot 99, 124, 150
Rhampholeon brevicaudatus		F	N	Plot 75, 122
Rhampholeon temporalis				O/R
BOIDAE				
Python sebae		O	W	Plot 108
ELAPIDAE				
Naja nigricollis nigricollis		O	W	Plot 72
COLUBRIDAE				
Lamprophis capensis		f	W	O/R, Plot 42
Aparallactus werneri		F	N	Plot 44, 51, 53, 150
Amblyodipsas polylepis hildebrandtii		?	W	Plot 32
Philothamnus macrops				Unknown location in forest
Crotaphopeltis tornieri		F	W	Plot 39, 61

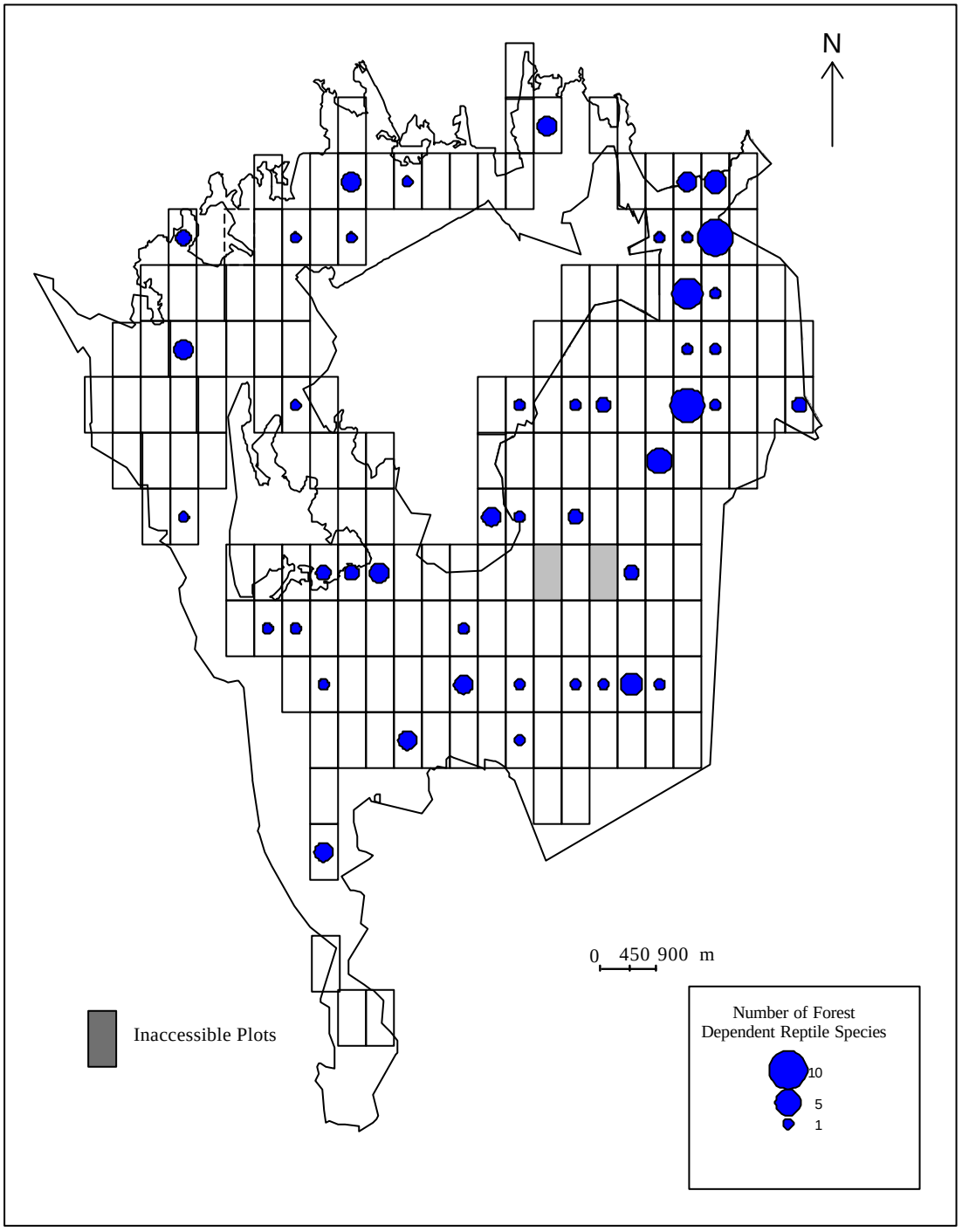

Figure 33 Distribution of forest dependent reptile species in Amani N.R.

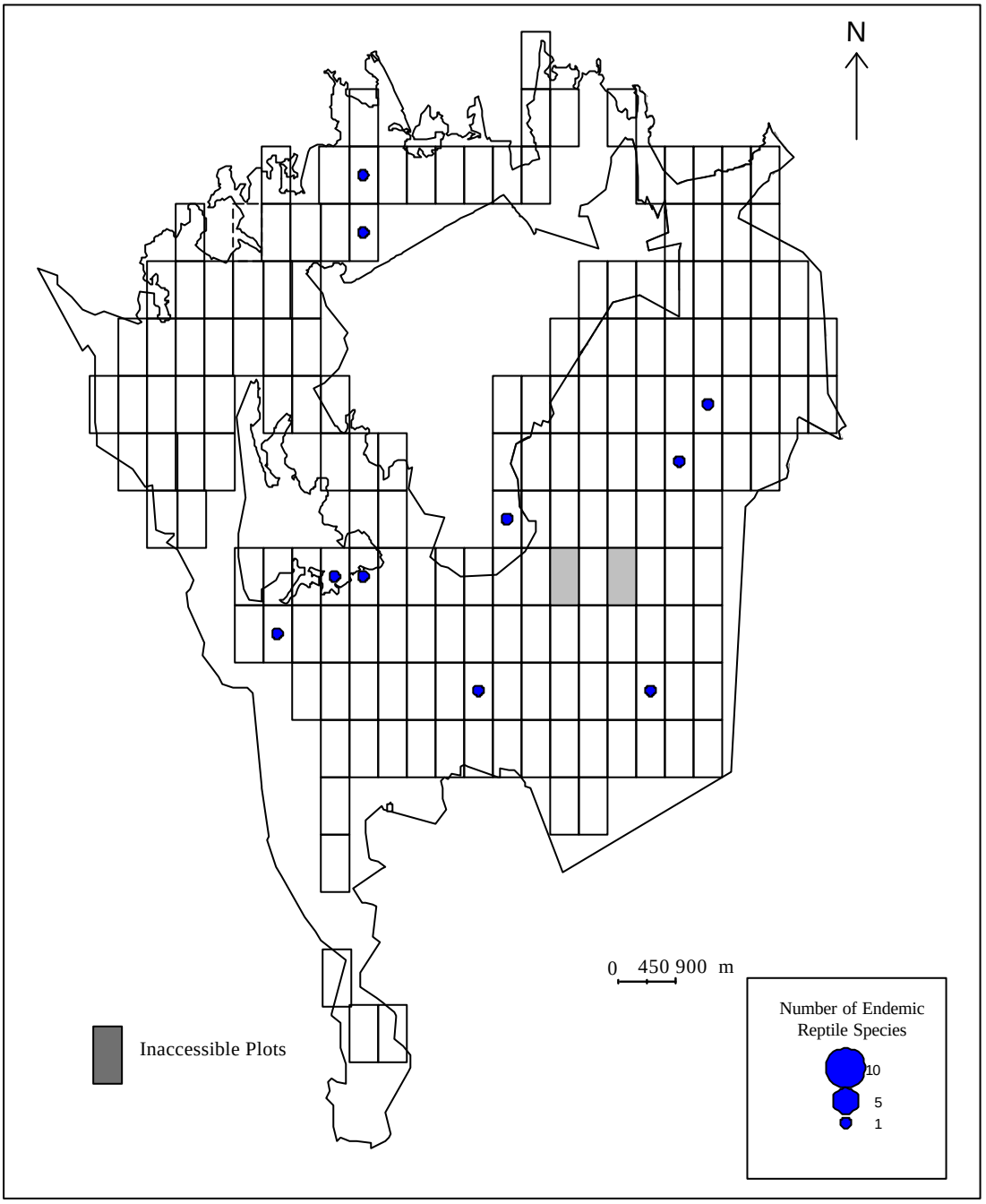

Figure 34 Distribution of endemic reptile species in Amani N.R.

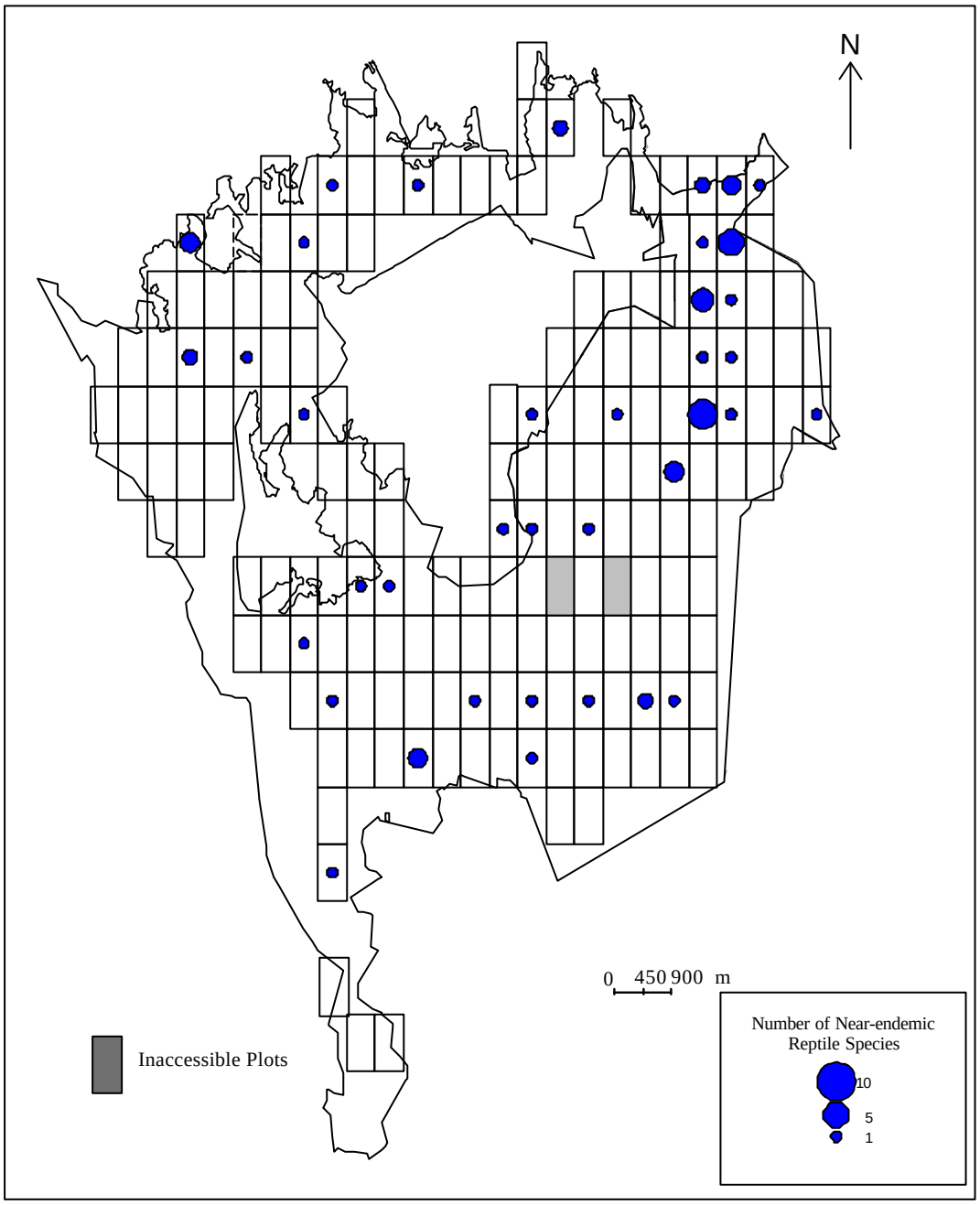

Figure 35 Distribution of near-endemic reptile species in Amani N.R.

5.4.4 Amphibians

A total of 236 individuals were retained for taxonomic purposes. These specimens represent 27 species from 9 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (Hilton-Taylor, 2000) and Poynton & Broadley (1991). Identifications were provided by either, Prof. K. M. Howell or Prof. J. C. Poynton. Common names are from Passmore and Carruthers (1995).

Table 28 Summary of amphibians.

Species	Ecological Type	Endemic Status	IUCN Status	Total
ARTHROLEPTIDAE				
Squeakers				
Arthroleptis affinis	F	N	V	29
Arthroleptis stenodactylus	f	W		9
Arthroleptis xenodactyloides	f	W		5
Arthroleptis xenodactylus	F	N	V	18
Arthroleptis spp.	?	?	?	11
BUFONIDAE				
Dead leaf toad				
Bufo brauni	F	N	V	4
Square-marked toad				
Bufo gutturalis	f	W		4
Bufo spp.	?	?	?	1
Nectophrynoides tornieri	F	N	V	22
Nectophrynoides spp.	?	?	?	2
HEMISIDAE				
Hemisus marmoratus	f	W		2
HYPEROLIIDAE				
Leaf-folding frogs				
Afrixalus fornasini	f	W		1
Afrixalus ulugurensis	F	N		6
Afrixalus spp.	?	?	?	1
Reed Frogs				
Hyperolius punticulatus	F	W		11
Hyperolius mitchelli	F	W		1
Hyperolius mariae	F	N		1
Hyperolius spp.	?	?	?	5
Kassina				
Kassina senegalensis	f	W		2
Tree frogs				
Leptopelis parkeri	F	N	V	4
Leptopelis ulugurensis	F	N	V	15
Leptopelis vermiculatus	F	N	NT	16
MICROHYLIDAE				
Callulina kreffti	F	N	V	5
Hoplophryne rogersi	F	E	V	3
Rain Frog				
Probreviceps macrodactylus	F	N	NT	17

Table 28 continued.

Species	Ecological Type	Endemic Status	IUCN / CITES Status	Total
PIPIDAE				0
Tropical plantanna				
Xenopus muelleri	f	W		3
RANIDAE				
Arthroleptides martiensseni	F	N	V	12
Puddle frogs				
Phrynobatrachus krefftii	F	E	V	9
Phrynobatrachus spp.	?	?	?	1
Grass frog				
Ptychadena anchietae	f	W		3
Common river frog				
Rana angolensis	f	W		3
GYMNOPHONIA – Caecilians				
CAECILIDAE				
Boulengerula boulengeri	F	N		8
SCOLECOMORPHIDAE				
Scolecomorphus vittatus	F	N	V	2
Total individuals				236

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

Table 29 Ranges for endemic and near-endemic amphibian species recorded (Howell, 1993, Vestergaard, 1994, Schiøtz, 1975).

Endemic amphibians	**Range**
Hoplophryne rogersi	Usambara Mountains
Phrynobatrachus krefftii	Usambara Mountains
Boulengerula boulengeri	Usambara Mountains

Near-endemic amphibians	**Range**
Arthroleptis affinis	Usambara and Udzungwa Mountains
Arthroleptis xenodactylus	Usambara and Uluguru Mountains
Bufo brauni	East Usambara Mountains; West Usambara Mountains; Ulugurus; Udzungwas.
Nectophrynoides tornieri	East Usambara, Uluguru, Nguru and Udzungwa Mountains
Afrixalus ulugurensis	Usambara, Uluguru, and Udzungwa Mountains also Taita Hills, Kenya
Hyperolius mariae	Usambara Mountains; Shimba Hills, Kenya
Leptopelis parkeri	Usambara, Uluguru, and Udzungwa Mountains
Leptopelis ulugurensis	Usambara, Uluguru, Nguru and Udzungwa Mountains
Leptopelis vermiculatus	Usambara; Udzungwa; Uluguru and Rungwe Mountains
Callulina kreffti	Usambara, Magarotto, Uluguru, Nguru and Udzungwa Mountains
Probreviceps macrodactylus	Usambara, Uluguru, Udzungwa and Rungwe Mountains
Arthroleptides martiensseni	Usambara, Magarotto, Uluguru, Nguru and Udzungwa Mountains
Boulengerula boulengeri	Usambara Mountains
Scolecomorphus vittatus	Usambara, Magarotto, Uluguru, Mountains

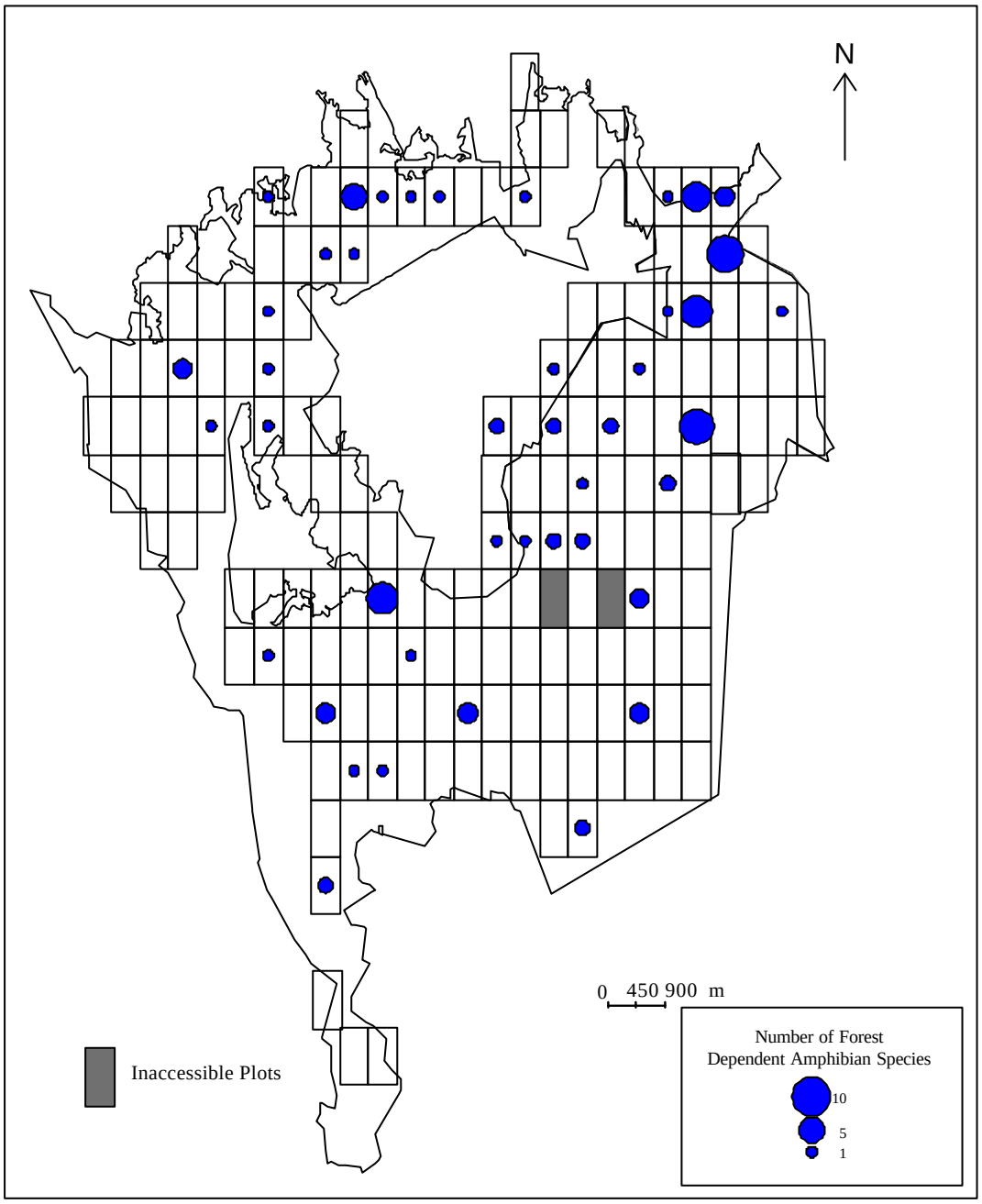

Figure 36 Distribution of forest dependent amphibian species in Amani N.R.

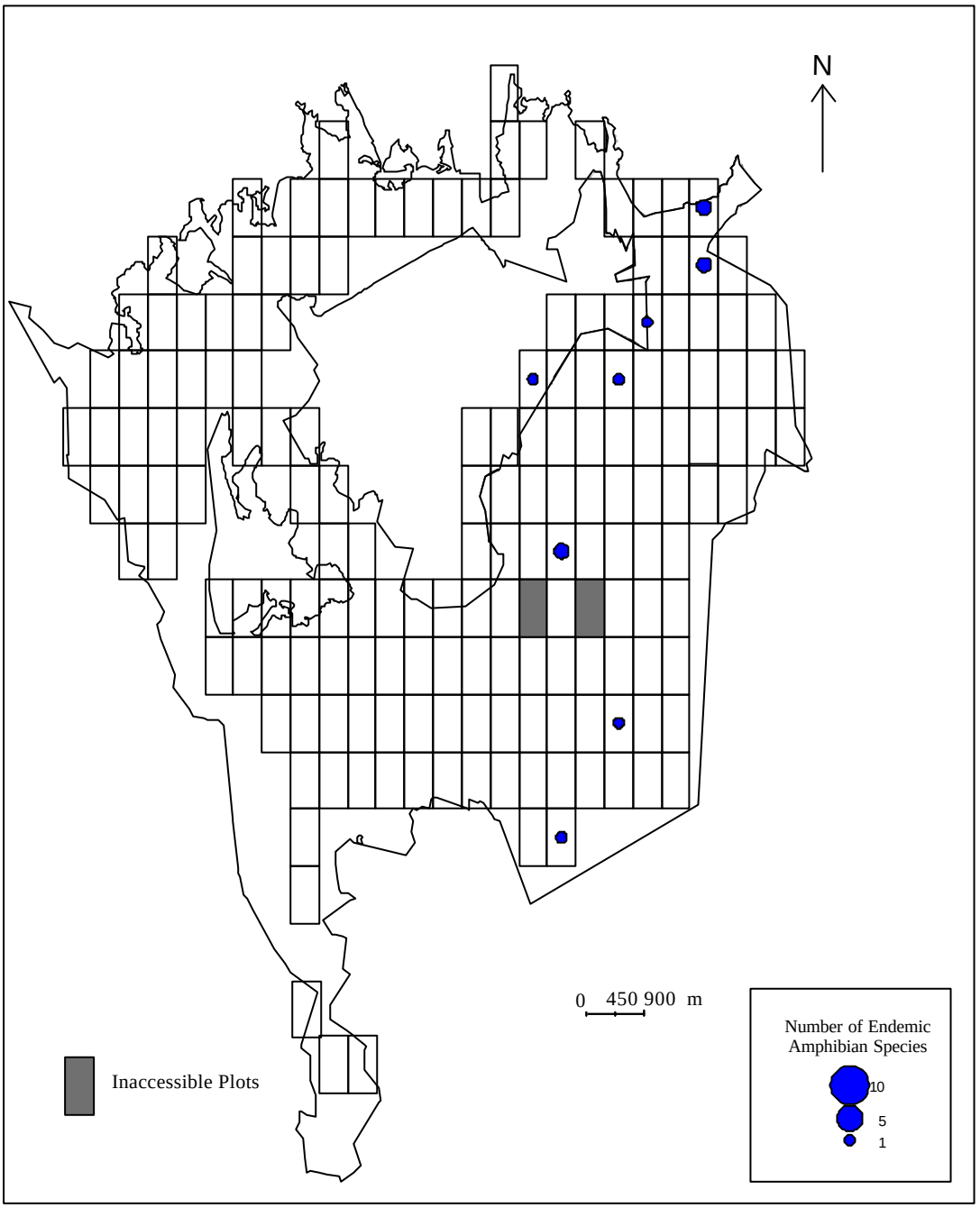

Figure 37 Distribution of endemic amphibian species in Amani N.R.

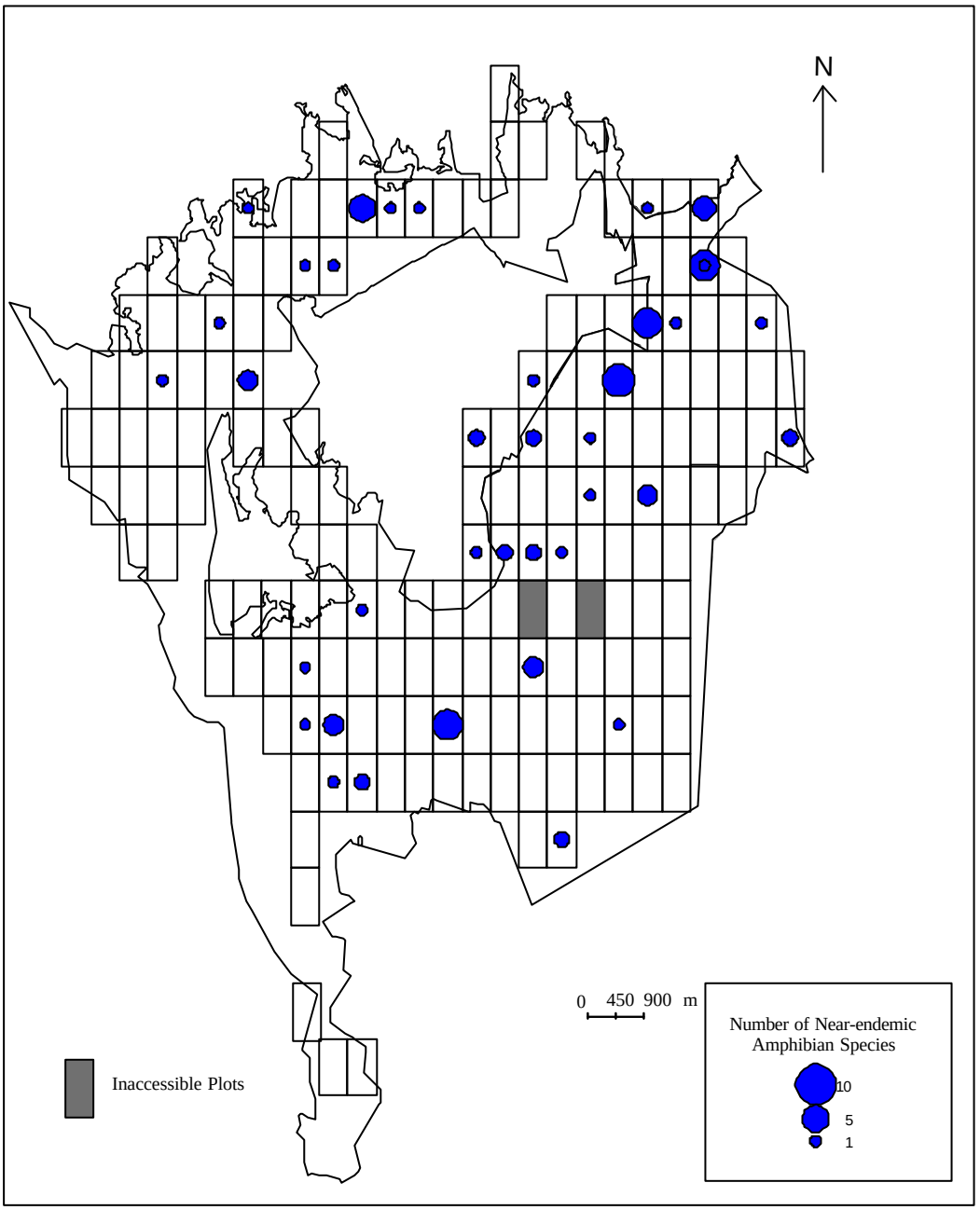

Figure 38 Distribution of near-endemic amphibian species in Amani N.R.

5.4.5 Invertebrates

5.4.5.1 Butterflies

A total of 921 specimens were retained for taxonomic purposes. These represent 112 species from nine families. We are still awaiting confirmation of the tentative determinations presented below. Ecological type and endemic status were compiled from Larsen (1996), and Kielland (1990).

Table 30 Summary of butterflies.

Species	Ecological type	Endemic status
PAPILIONOIIDAE		
Papilio dardanus tibullus	F	W
Papilio echerioides	F	W
Papilio hornimani	F	N
Papilio jacksoni	f	W
Papilio ophidicaphalus ophidicephalus	F	W
Papilio phorcas	F	W
Graphium policenes	F	W
PIERIDAE		
Catopsilia florella	f	W
Eurema floricola floricola	F	W
Eurema hapale	f	W
Eurema hecabe solifera	f	W
Eurema regularis	f	W
Eurema senegalensis	f	W
Nepheronia argia mhondana	f	W
Belenois thysa thysa	f	W
Dixeia pigea	f	W
Appias lasti lasti	f	W
Appias sabina phoebe	F	W
Mylothris rubricosta attenuata	F	W
Mylothris ruppelli rhodesiana	f	W
Leptosia alcesta inalcesta	f	W
DANAIDAE		
Danaus petiverana	f	W
Amauris niavius dominicus	F	W
Amauris ochlea ochlea	f	W
SATYRIDAE		
Gnophodes betsimena diversa	f	W
Melanitis leda africana	f	W
Bicyclus campinus ocelligerus	F	W
Bicyclus dankelmani	F	N
Bicyclus safitza	f	W
Physcaeneura leda	f	N
LIBYTHEIDAE		
Libythea labdaca laius	F	W

Table 30 continued.

Species	Ecological type	Endemic status
NYMPHALIDAE		
Euxanthe tiberius tiberius	F	N
Euxanthe wakefieldi	F	W
Charaxes acuminatus	F	W
Charaxes acuminatus usambarensis	F	W
Charaxes aubyni aubyni	f	W
Charaxes brutus alcyone	f	W
Charaxes candiope candiope	f	W
Charaxes castor flavifasciatus	f	W
Charaxes cithaeron kennethi	F	W
Charaxes etesipe tavetensis	F	W
Charaxes lasti lasti	f	N
Charaxes pollux mirabilis	F	W
Charaxes protoclea azota	f	W
Charaxes usambarae usambarae	F	N (E)
Charaxes varanes vologeses	f	W
Charaxes violetta	F	W
Charaxes violetta melloni	F	W
Charaxes xiphares maudei	F	W
Cymothoe coranus	F	W
Euptera kinungnana	F	W
Euryphura achlys achlys	F	W
Bebearia chriemhilda	F	N
Euphaedra neophron littoralis	F	W
Aterica galene theophanes	f	W
Catuna sikorana	F	W
Pseudacraea dolomena usagara	F	W
Pseudacraea eurytus condrati f. rogersi	F	W
Pseudacraea lucreta expansa	f	W
Neptis alta	O	W
Neptis goochi	F	W
Neptis laeta	f	W
Neptis saclava marpessa	f	W
Neptis serena	f	W
Cyrestis camillus sublineata	f	W
Sallya boisduvali boisduvali	f	W
Sallya moranti	F	W
Sallya natalensis	f	W
Neptidopsis ophione velleda	f	W
Eurytela dryope angulata	f	W
Eurytela hiarbas lita	F	W
Apaturopsis cleochares schulzei	f	W
Hypolimnas antevorta	F	E
Hypolimnas deceptor deceptor	f	W
Salami parhassus	f	W
Juonia terea elgiva	f	W
Precis tugela aurorina	F	W

Table 30 continued.

Species	Ecological type	Endemic status
ACRAEIDAE		
Bematistes adrasta	F	N
Bematistes aganice montana	f	W
Acraea cerasa	F	W
Acraea igola	F	W
Acraea insignis insignis	f	W
Acraea johnstoni johnstoni	f	W
Acraea natalica	O	W
Acraea perenna	f	W
Acraea pharsalus pharsaloides	f	W
Acraea quirina rosa	F	W
Acraea satis	F	W
Acraea servona orientis	F	W
Acraea sotikensis	f	W
Paradopsis punctatissima	O	W
LYCAENIDAE		
Alaena picata picata	F	W
Teriominia micra	F	N
Virachola lorisona	f	W
Anthene kersteni	f	W
Anthene larydas	f	W
Anthene lasti	F	W
Anthene lemnos	F	W
Anthene rubrimaculata rubrimaculata	F	N
Petrelaea sichela	f	W
Uranothauma falkensteini	F	W
Cacyreus virils	f	W
Leptotes sp.		
Leptotes pirithous	f	W
Tuxentius ertli	F	W
Zizula hylax	O	W
Eicochrysops hippocrates	f	W
Thermoniphas micylus colorata	f	W
Oboronia bueronica	F	W
HESPERIIDAE		
Celaeorrhinus galenus	F	W
Eagris sabadius	F	W
Tagiades flesus	f	W

KEY TO ABBREVIATIONS FOR TABLE 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.

5.4.5.2 Molluscs

Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen, c/o Dr N. Scharff.

5.4.5.3 Millipedes

Taxonomic determinations were not available at the time of publication. Specimens were deposited at the Zoological Museum of Copenhagen, c/o Dr N. Scharff.

5.5 Discussion

5.5.5 Species richness and abundance

In this section, species are examined in terms of how frequently they were recorded. Those species which have been captured or observed three or more times during the survey are considered locally common. An assumption is made that the frequency with which an animal is recorded reflects its abundance. It is recognised that some species are highly cryptic and so are easily overlooked. Such cryptic species may therefore be more abundant than is suggested by this survey. However the objective of this discussion is to identify species which may of concern 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)	17	43
Bats	5	16
Birds	29	65
Reptiles	13	49
Amphibians	9	27
Butterflies	9	112

Relative to the other East Usambara forest reserves surveyed by Frontier-Tanzania Amani has above average species richness for mammals, reptiles, butterflies and amphibians.

5.5.1.1 Mammals

The most commonly recorded small mammal species were *Crocidura* sp. and *Praomys* sp.. Other species which appear to be locally common were: *Crocidura flavescens, Crocidura hildegardeae, Crocidura hildegardeae/elgonius, Beamys hindei, Acomys spinosissimus, Lophuromys flavopunctatus*, *Praomys delectorum, Mus minutoides, Grammomys dolichurus, Grammomys* sp., and *Rattus rattus.* However it has not yet been determined whether *Praomys* sp. and *Crocidura* sp. represent multiple species, it is highly likely that several species are represented.

Bat species that appear to be locally common are: *Rhinolophus landeri lobatus, Rhinolophus hildebrandti, Hipposideros ruber, Miniopterus fraterculus* and *Pipistrellus grandidieri grandidieri.*

5.5.1.2 Reptiles

The most commonly recorded reptile species was the gecko *Cnemaspis africana*. Other species which appear to be locally common are: *Cnemaspis barbouri, Bradypodion (Chamaeleo) fischeri fischeri, Bradypodion (Chamaeleo) tenue, Chamaeleo dilepis, Chamaeleo deremensis, Rhampholeon brevicaudatus, Rhampholeon temporalis, Mabuya maculilabris, Mabuya striata striata, Lygosoma afrum, Leptosiaphos kilimensis, Typhlops*

gierrai, Python sebae, Atheris ceratophorus, Elapsoidea nigra, Dendroaspis angusticeps, Lamprophis capensis, Buhoma (Geodipsas) vauerocegae, Aparallactus werneri, Natriciteres olivacea, Philothamnus macrops, Philothamnus hoplogaster, *Crotaphopeltis tornieri*, and *Thelotornis capensis mossambicanus.*

The Usambara Mountain specimens of *Thelotornis capensis mossambicanus* are soon to be reclassified by taxonomists as *Thelotornis usambaricus* (Dr D. Broadley, pers. comm.).
With 7 chameleon species and 26 snake species Amani Nature Reserve has a particularly rich reptilian fauna. Two snake species, *Atheris ceratophorus* and *Amblyodipsas polylepis hildebrandtii* were recorded for the first time by the East Usambara Biodiversity Surveys.

5.5.1.3 Amphibians

The most common amphibian species was *Arthroleptis affinis*. Other species which appear to be locally common are: *Arthroleptis stenodactylus, Arthroleptis xenodactyloides, Arthroleptis xenodactylus, Bufo brauni, Bufo gutturalis, Nectophrynoides tornieri, Afrixalus ulugurensis, Hyperolius punticulatus, Leptopelis parkeri, Leptopelis ulugurensis, Leptopelis vermiculatus, Callulina kreffti, Hoplophryne rogersi, Probreviceps macrodactylus, Xenopus muelleri, Arthroleptides martiensseni, Phrynobatrachus krefftii, Ptychadena anchietae, Rana angolensis* and *Boulengerula boulengeri*.

With 27 amphibian species Amani Nature Reserve has a particularly rich amphibian fauna.

5.5.1.4 Endemics and near-endemics

Of the 37 mammal, reptile and amphibian species which are endemic or near-endemic to the Usambara Mountains and were recorded during this survey, 29 appear to be locally common (as they were recorded at least three times during the survey). These are: *Arthroleptis affinis, Arthroleptis xenodactylus, Bufo brauni, Nectophrynoides tornieri, Boulengerula boulengeri, Afrixalus ulugurensis, Leptopelis parkeri, Leptopelis ulugurensis, Leptopelis vermiculatus, Callulina krefftii, Hoplophryne rogersi, Probreviceps macrodactylus, Arthroleptides martiensseni, Phrynobatrachus krefftii, Beamys hindei, Dendrohyrax validus, Rhynchocyon petersi, Philothamnus macrops, Aparallactus werneri, Elapsoidea nigra, Buhoma (Geodipsas) vauerocegae, Typhlops gierrai, Atheris ceratophorus, Rhampholeon brevicaudatus, Rhampholeon temporalis, Chamaeleo deremensis, Bradypodion (Chamaeleo) fischeri fischeri, Bradypodion (Chamaeleo) tenue* and *Cnemaspis barbouri.*

5.5.1.5 Forest dependent species

Of the 50 mammal, reptile and amphibian species which are dependent on primary forest and were recorded during this survey, 34 appear to be locally common.

The four locally common forest dependent mammal species are: *Colobus angolensis palliatus, Beamys hindei, Rhynchocyon petersi* and *Praomys delectorum*.

The 15 locally common forest dependent reptile species are: *Bradypodion (Chamaeleo) fischeri fischeri, Bradypodion (Chamaeleo) tenue, Chamaeleo deremensis, Rhampholeon brevicaudatus, Rhampholeon temporalis, Aparallactus werneri, Buhoma (Geodipsas) vauerocegae, Crotaphopeltis tornieri, Philothamnus macrops, Elapsoidea nigra, Cnemaspis africana, Cnemaspis barbouri, Leptosiaphos kilimensis, Typhlops gierrai* and *Bitis gabonica.*

The 15 locally common forest dependent amphibian species are: *Arthroleptis affinis, Arthroleptis xenodactylus, Bufo brauni, Nectophrynoides tornieri, Afrixalus ulugurensis, Hyperolius punticulatus, Leptopelis parkeri, Leptopelis ulugurensis, Leptopelis vermiculatus, Callulina kreffti, Hoplophryne rogersi, Probreviceps macrodactylus, Arthroleptides martiensseni, Phrynobatrachus krefftii* and *Boulengerula boulengeri.*

5.5.1.6 ***High risk species:***

Assuming that the number of individuals of a species captured reflects relative population size, the locally uncommon species that are both forest dependent and near-endemic or endemic species should be of conservation concern due to their low population density. There are eight such species, these are: *Bradypodion spinosum, Agama mossambica montana, Urocotyledon wolterstorffi, Scelotes ulugurensis, Leptotyphlops macrops, Dipsadoboa werneri, Hyperolius mariae* and *Scolecomorphus vittatus.*

5.5.2 Ecological type

Of the 125 forest dependent species, 9 are mammals, 53 are butterflies, 22 are birds, 23 are reptiles and 18 are amphibians.

Of the 31 species characteristic of open habitats, 15 are birds and four are butterflies. Of the remaining 12 species, six are reptiles (*Python sebae, Crotaphopeltis hotambeia, Naja nigricollis nigricollis, Pelomedusa subrufa subrufa, Mabuya varia varia and Mabyua striata striata*), and six species are mammals (*Cricetomys gambianus, Herpestes ichneumon, Grammomys dolichurus, Grammomys macmillani, Rattus rattus* and *Genetta genetta*). Many of the observations of species typical of open habitats were recorded from the forest edge or from land adjoining the forest reserve. However *Python sebae, Crotaphopeltis hotambeia, Naja nigricollis nigricollis, Grammomys dolichurus, Grammomys macmillani* and *Rattus rattus* were all recorded inside the forest reserve.

Table 32 Summary of ecological type of mammal, bird, reptile, amphibian and butterfly species.

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	125	40
(f) Forest dwelling but not forest dependent	136	44
(O) Non-forest species	31	10
Unknown	22	6
Total:	**312**	**100**

5.5.3 Endemic Status

Six of the recorded animal species and one subspecies are endemic to the Usambara Mountains these are:

Amphibians: *Hoplophryne rogersi* and *Phrynobatrachus krefftii*.

Reptiles: *Bradypodion spinosum* and *Rhampholeon temporalis*.

Birds: *Anthreptes rubritorques* and *Spermophaga ruficapilla cana* (endemic subspecies).

Butterfly: *Hypolimnas antevorta*.

46 of the animal species recorded are near-endemics, of these 14 are amphibians, 16 are reptiles, three are mammals, ten are butterflies and three are birds.

Table 33 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	7	2
(N) Near-Endemic: ranges in restricted locations	46	15
(W) Widespread	242	78
Unknown	17	5
Total:	**312**	**100**

5.5.4 IUCN Status

According to IUCN criteria the survival of seven species found in Amani Nature Reserve is endangered. These species are: *Dendrohyrax validus, Rhynchocyon petersi, Cnemaspis barbouri, Bradypodion spinosum, Chamaeleo deremensis, Rhampholeon temporalis* and *Scelotes ulugurensis.*

According to IUCN criteria the following 26 species are vulnerable to extinction: *Anthreptes rubritorques, Bubo vosseleri, Apaloderma vittatum, Urocotyledon wolterstorffi, Agama montana, Bradypodion (Chamaeleo) fischeri fischeri, Bradypodion (Chamaeleo) tenue, Rhampholeon brevicaudatus, Leptosiaphos kilimensis, Typhlops gierrai, Leptotyphlops macrops, Elapsoidea nigra, Buhoma (Geodipsas) vauerocegae, Philothamnus macrops, Crotaphopeltis tornieri, Aparallactus werneri, Arthroleptis affinis, Arthroleptis xenodactylus, Bufo brauni, Nectophrynoides tornieri, Leptopelis ulugurensis, Callulina kreffti, Hoplophryne rogersi, Arthroleptides martiensseni, Phrynobatrachus krefftii* and *Scolecomorphus vittatus.*

According to IUCN criteria the following 13 species are Near Threatened with extinction: *Stactolaema olivacea, Smithornis capensis, Tauraco fischeri, Batis mixta, Andropadus tephrolaemus, Phyllastrephus fischeri, Poeoptera kenricki, Phylloscopus ruficapillus minullus, Coracina caesia pura, Cnemaspis africana, Atheris ceratophorus, Leptopelis vermiculatus* and *Probreviceps macrodactylus.*

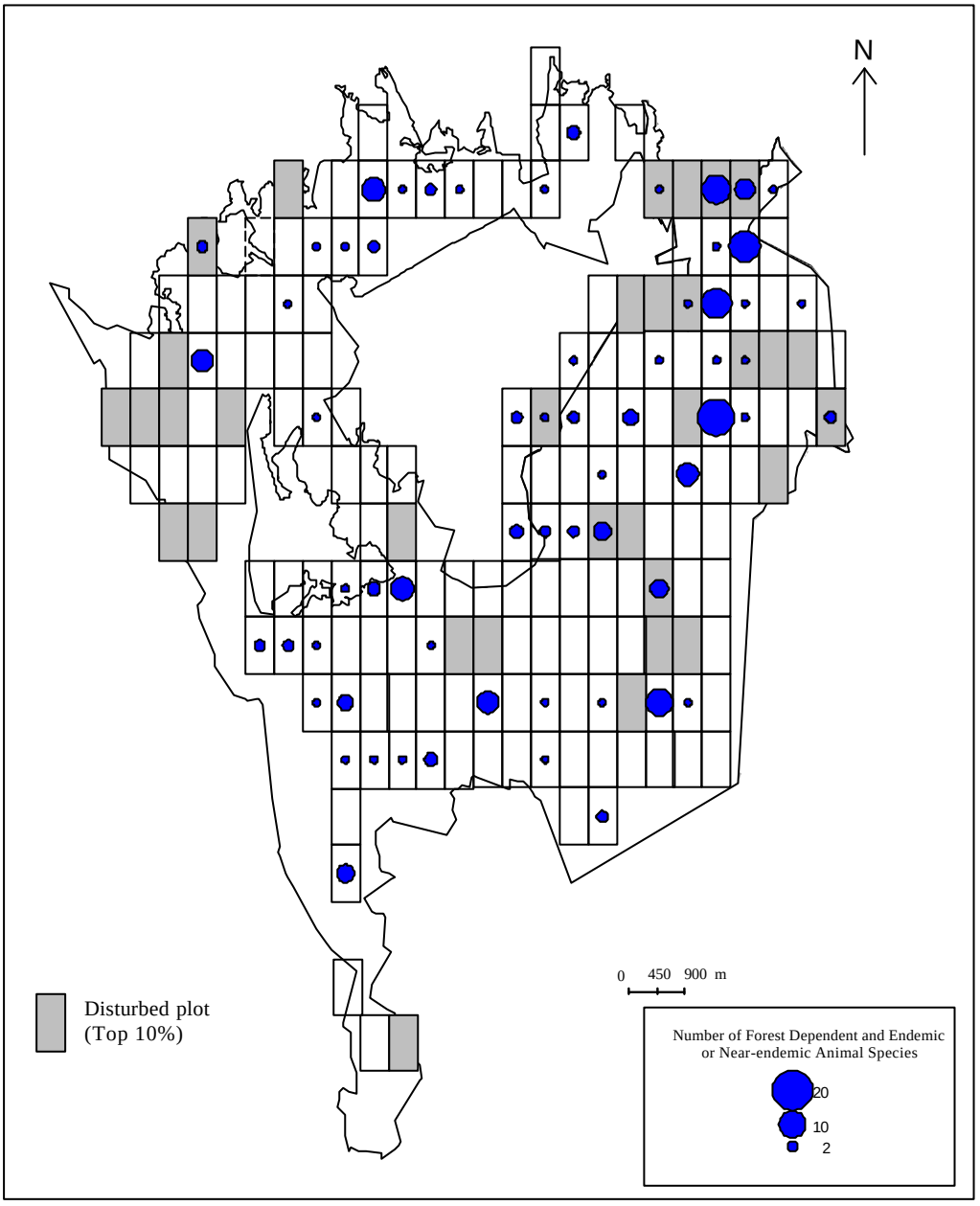

Figure 39 Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent and endemic or near-endemic in Amani N.R. (1999 - 2000).

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.

Amani Nature Reserve was gazetted in 1997. The gazetted forest covers an area of 8360 ha. With altitudes between approximately 190m and 1130m, the former forest reserves consists of approximately 2199 ha of mature dense lowland forest, 4944.5 ha of mature dense submontane forest, 423 ha of poorly stocked lowland and submontane forest, 600 ha of plantation (mostly *Maesopsis eminii*), and small areas of bush, cultivation, barren land and ponds and rivers.

Disturbance

Poles continue to be taken illegally from across the reserve. Areas of particularly high levels of new pole cutting on the eastern side of the reserve are shown in Figure 18.

Evidence of pit-sawing was observed throughout the reserve on 11 of the 17 transects, however no active saw-pits were observed during this survey.

Fire is a threat to specific areas of the forest; extensive patches of forest were burnt during the survey period in 2000. Open grass/bushland habitats dominate in burnt areas. It is possible that the fires are limiting forest expansion with the Nature Reserve.

Animal trapping continues to be undertaken illegally in the reserve.

The invasive species *Maesopsis eminii* was recorded in 79 of the 173 vegetation plots. *Maesopsis eminii* was the most commonly recorded tree in the systematic survey, although this is partly due to extremely high counts in several plots. Not surprisingly the highest densities of *Maesopsis eminii* were recorded in the plantation forest where the species was planted as a nursery species.

Species Richness

The forest reserve was found to contain a minimum of 621 species of trees and shrubs; 43 mammal, 16 bat, 65 bird, 49 reptile, 27 amphibian and 112 butterfly species. Relative to the other ten forest reserves surveyed by Frontier-Tanzania Amani Nature Reserve has an above average species richness for plants, mammals, reptiles and amphibians This is possibly partly due to its large size, heterogeneous habitats and wide altitudinal range.

Flora

19 tree and shrub species were recorded in the vegetation plots that are endemic to the Usambara Mountains and 49 have ranges restricted to the Eastern Arc and/or East African lowland forests. 107 species are dependent on primary forest, and of these species, 19 are endemic and 34 are near endemic to the Usambara Mountains.

22 non-forest tree and shrub species are established within the reserve boundaries.

Fauna

Six animal species and one subspecies were recorded that are endemic to the Usambara Mountains, 46 species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. 125 animal species are dependent on primary forest, and of these species, 7 are endemic and 41 near endemic to the Usambara Mountains. 31 non-forest animal species are established in the nature reserve.

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 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.

The impact of fire is of serious concern on the southern and western borders of Amani Nature Reserve. Hunting continues illegally, the full impact of hunting on the populations of targeted species is unknown.

Severe degradation of Amani Nature Reserve could lead to local extinctions of populations of those species identified as being at high risk. The loss of forested areas in Amani will also reduce the reliability of the water supply to the region.

Amani Nature Reserve being the largest forest block in the East Usambara Mountains, has a lower risk of population extinction than smaller highly fragmented forest reserves. This gives

Amani Nature Reserve a special value as a 'pool' of individuals of species that might be capable of migration to re-colonise other East Usambara forests, or perhaps could be translocated. However, Amani is largely isolated from other forest reserves in the East Usambara Mountains, the only forested connection is the Derma forest corridor. At present no legal status protects the Derema forest, other than basic legislation regarding water catchments and the felling of specific tree species. Recently there has been extensive discussion regarding the type of legislation that should be instated to protect the Derema forest corridor (pers. comm. Dr Veli Pohjonen, Jambiya. 2000.). The proposals range from gazetting the Derema forest corridor as a non-extractive forest reserve, to handing complete control of the forests to the local communities. The outcome has not yet been decided. From a biological perspective, effective protection of this only forested link from the largest block of forest (Amani) to more northerly forests is of up-most importance. However this decision is not purely based on biological considerations, social factors have to be taken into account to ensure the sustainable protection of the Derema forest corridor.

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APPENDIX 1: GENERAL PLOT INFORMATION

Plot Number	Topography	Altitude (m asl)	Slope (degrees)	Aspect	Vegetation Type	Canopy Height (m)
1	VF	690	30	NW	LF	20-30
2	GMS	790	26	NE	LF	20-30
3	SMS	840	31	NW	LF	20-30
4	GMS	700	25	SE	LF	20-30
5	SMS	850	44	W	SMF	20-30
6	GUS	920	20	NE	SMF	20-30
7	GMS	890	22	N	SMF	20-30
8	GMS	840	19	NE	LF	20-30
9	SMS	620	36	E	LF	20-30
10	GUS	830	25	NW	LF	> 30
11	GMS	870	22	NE	SMF	> 30
12	SMS	880	35	N	SMF	> 30
13	R/HT/P	880	25	W	SMF	20-30
14	SMS	820	34	SE	LF	> 30
15	GMS	720	15	E	LF	> 30
16	GLS	560	25	E	LF	10-20
17	GMS	910	14	E	LF	> 30
18	Gully	940	15	SE	SMF	>30
19	GMS	1020	20	S	SMF	20-30
20	GMS	990	14	S	SMF	20-30
21	Gully	940	20	W	SMF	20-30
22	GLS	780	25	E	LF	20-30
23	GMS	640	25	E	LF	20-30
24	GMS/Valley floor	580	18	SW & SE	LF	20-30
25	GLS	760	14	SE	LF	10-20
26	GMS	780	25	W	LF	20-30
27	SMS	700	35	S	LF	>30
28	GMS	680	25	E	LF	10-20
29	GLS	420	26	NW	LF	20-30
30	GLS	450	21	NE	RF	10-20
31	GLS	490	25	S	CF	10-20
32	GLS	540	27	E	LF	10-20
33	GUS	930	20	NW	SMF	20-30
34	R/HT/P	890	10	E	SMF	20-30
35	SLS	800	35	E	SMF	20-30
36	GLS	960	9	E	SMF	20-30
37	SUS	930	35	NW	SMF	20-30
38	SMS	900	35	E	SMF	20-30
39	GUS	810	20	SE	SMF	20-30
40	VF	810	4	NW	H/M/SW	<10
41	SUS	900	30	NW	SMF	20-30
42	GUS	950	10	NE	SMF	>30
43	GUS	950	12	NW	SMF	20-30
44	GMS	910	15	E	SMF	20-30
45	GUS	1000	27	SE	SMF	20-30
46	GUS	1060	27	S	SMF	20-30
47	SLS	985	30	S	SMF	20-30
48	SLS	910	30	SE	SMF	20-30
49	Gully	910	23-30	SE&NW	SMF	10-20

Plot Number	Topography	Altitude (m asl)	Slope (degrees)	Aspect	Vegetation Type	Canopy Height (m)
50	SUS	910	35	W	SMF	20-30
51	SUS	1040	30	E	SMF	20-30
52	GUS	955	18	E	SMF	10-20
53	GUS	800	15	E	RF	10-20
54	GUS	900	15	N	SMF	20-30
55	SMF	780	23	NE	LF	10-20
56	GMS	580	26	SW	LF	20-20
57	GMS	580	24	S	LF	10-20
58	GLS	400	25	E	LF	20-30
59	GLS	500	20	E	LF	10-20
60	SMS	730	37	SW	LF	10-20
61	GUS	920	28	E	SMF	20-30
62	GMS	500	5	SE	LF	10-20
63	GMS	615	25	SE	LF	20-30
64	SUS	1040	38	SE	SMF	20-30
65	SUS	960	35	SW	SMF	10-20
66	GUS	1040	15	NW	SMF	20-30
67	Gully	1040	27	E&W	SMF	10-20
68	SUS	580	37	E	LF	10-20
69	SMS	720	33	E	LF	10-20
70	GLS	450	10	SE	LF	20-30
71	GLS	400	14	E	LF	10-20
72	GLS	240	20	S	LF	20-30
73	GLS	245	7	W	LF	10-20
74	GLS	210	12	NW	LF	10-20
75	GLS	250	3	E	LF	10-20
76	GLS	845	5	S	LF	10-20
77	GLS	375	29	SE	LF	20-30
78	SMS	500	30	SE	LF	20-30
79	GLS	190	14	N	LF	20-30
80	GLS	200	12	NW	LF	>30
81	GLS	230	1	E	LF	10-20
82	GLS	255	4	N	LF	10-20
83	GLS	370	10	E	LF	10-20
84	GMS	450	25	E	LF	10-20
85	GMS	615	20	E	LF	<10
86	SUS	940	40	E	SMF	10-20
87	GMS	320	21	E	LF	10-20
88	SMS	520	37	SE	LF	10-20
89	GUS Cliff in plot	1000	10-40	NE	SMF	10-20
90	GMS	960	8	SW	SMF	20-30
91	GUS	1000	5	NE	SMF	20-30
92	SUS	845	34	E	SMF	20-30
93	SUS	1010	30	SE	SMF	10-20
94	GUS	1130	16	NE	SMF	10-20
95	SUS	1100	35	NW	NW	10-20
96	SMS	765	35	SW	LF	10-20
97	GMS	710	15	E	LF	10-20
98	GUS	940	23	E	SMF	20-30
99	GUS	940	18	NW	SMF	20-30
100	GUS	1000	15	E	SMF	20-30
101	SLS	1050	35	E	SMF	20-30

Plot Number	Topography	Altitude (m asl)	Slope (degrees)	Aspect	Vegetation Type	Canopy Height (m)
102	GUS	1050	12	W	SMF	10-20
103	SUS	1080	37	NW	SMF	10-20
104	GUS	1060	28	W	SMF	10-20
105	GUS	980	27	NW	SMF	20-30
106	GUS	1030	24	SE	SMF	20-30
107	VF	1000	2	E	SMF	20-30
108	GUS	1020	12	S	PF	20-30
109	GUS & Gully	960	15	E & NW	SMF	20-30
110	GUS	1080	25	NE	SMF	20-30
111	GUS	1000	25	SW	SMF	10-20
112	GUS	1000	20	SW	SMF	20-30
113	GUS	1030	20	N	SMF	20-30
114	GUS	1015	20	SW	SMF	10-20
115	GUS & VF	995	25	E	SMF	20-30
116	SUS	840	40	W	SMF	10-20
117	GUS	1140	10	N	SMF	10-20
118	GUS	1020	27	E	SMF	10-20
119	SMS	720	34	E	LF	10-20
120	GLS	960	12	NW	SMF	10-20
121	SUS	900	30	E	SMF	<10
122	R/HT/P	740	17	SE	LF	10-20
123	GMS	960	26	NW	SMF	20-30
124	GMS	1020	15	NE	SMF	10-20
125	GMS	1000	23	W	SMF	20-30
126	GUS	1060	15	NW	SMF	20-30
127	GLS	1000	20	NW	SMF	20-30
128	GLS	1025	15	N	SMF	10-20
129	GUS	1020	14	W	SMF	20-30
130	GLS	1050	5	NE	SMF	>30
131	SLS	1070	35	NW	SMF	20-30
132	GLS	1080	20	NE	SMF	20-30
133	SUS	1050	36	W	SMF	20-30
134	GUS	1080	20	SE	SMF	>30
135	GUS	1025	15	E	SMF	>30
136	GLS	1060	13	SE	SMF	20-30
137	SUS	1180	32	W	SMF	20-30
138	GLS	1080	15	NW	SMF	>30
139	GUS	1140	25	W	SMF	20-30
140	GUS	1090	10	SW	SMF	20-30
141	SUS	900	30	N	SMF	10-20
142	GLS	1025	15	SE	SMF	20-30
143	GMS	980	15	NW	SMF	>30
144	GMS	970	20	E	SMF	20-30
145	GUS	980	10	SW	SW/SMF	20-30
146	GMS	1000	15	SE	SMF	10-20
147	GLS	995	10	NW	SMF	>30
148	VF	1020	13	NW	SMF	>30
149	GMS	1070	26	E	SMF	>30
150	R/HT/P	1055	0	-	SMF	>30
151	GLS	980	20	W	SMF	>30
152	GLS	1020	13	W	SMF	10-20

153	GLS	920	11	SE	SMF	20-30

Plot Number	Topography	Altitude (m asl)	Slope (degrees)	Aspect	Vegetation Type	Canopy Height (m)
154	GLS	1020	15	NE	SMF	10-20
155	GMS	1050	15	SW	S/T/B	20-30
156	GLS	1025	1	E	SMF	10-20
161	GMS	770	18	SW	LF	>30
162	GMS	730	15	SE	SMF	20-30
163	GMS	650	21	W	W	10-20
164	SLS	550	30	W	W	10-20
165	SMS	760	37	W	LF	20-30
166	SMS	710	30	NW	LF	20-30
167	GMS	560	20	W	LF	20-30
168	GMS	480	12	SW	W	<10
169	GMS	640	15	W	W	<10
170	GLS	540	12	E	W	20-30
171	GLS	940	22	E	SMF	>30
172	VF	940	31	N	SMF	>30
173	GMS	970	15	SW	SMF	>30
174	GLS	900	3	NW	SMF	10-20
180	GMS	640	9	NW	W	<10
181	GMS	950	15	E	W	<10
182	GMS	780	20	E	LF	20-30

KEY TO ABBREVIATIONS

Topography

GLS - gentle lower slope
SLS - steep lower slope
GMS – gentle mid-slope
SMS – steep mid slope
GUS - gentle upper slope
SUS – steep upper slope
VF – valley floor
R/HT/P - ridge / hill top / plateau

Vegetation Type

LF - Lowland forest
SF - Submontane forest
H/M/SW – Herb Marsh Swamp
W - Woodland
CF - Colonizing forest
RF - Riverine forest
S/C/T - Scrub / thicket / Bush
PF - Plantation forest

APPENDIX 2: TAXONOMIC VERIFICATION

BOTANY

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

ZOOLOGY - VERTEBRATES

Bats, Rodents, Shrews and other small mammals:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35064, 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. Kim Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35064, Dar es Salaam, Tanzania khowell@twiga.com
Prof. J. Poynton	British Natural History Museum	Cromwell Road, South Kensington, London, UK.

Reptiles:

Prof. Kim Howell	Department of Zoology	University of Dar es Salaam , P.O. Box 35064, 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:

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

Butterflies

Steve Collins	African Butterfly Research Institute	P.O. Box 14308, Nairobi, Kenya collinsabri@iconnect.co.ke

APPENDIX 3 : CAPTURE LOCATION OF REPTILES IN AMANI NATURE RESERVE

Species	**Plot Location and Number of Individuals Captured**																														
	Plots with one ind.	O/R	3	6	20	24	25	29	30	44	50	53	60	75	76	87a	94	99	100	101	109	119	122	133	142	146	150	151	172	**Total ind.**
PELOMEDUSIDAE																														
Pelomedusa subrufa subrufa		1																												**1**
TESTUDINIDAE																														
Geochelone pardalis babcocki		1																												**1**
GEKKONIDAE																														
Lygodactylus capensis grotei			1																											**1**
Urocotyledon wolterstorffi							1																							**1**
Cnemaspis africana			1	4	4		3			1		1	1					7					1				3			**26**
Cnemaspis barbouri		1	5	1		3			2					4																**16**
Cnemaspis sp.			4			1	1			1														1	1					**9**
Hemidactylus mabouia									1														1							**2**
Hemidactylus platycephalus																							1							**1**
AGAMIDAE																														
Agama mossambica montana																										1				**1**
CHAMAELEONIDAE																														
Bradypodion (Chamaeleo) fischeri fischeri		3			1														1		2	2				1				**10**
Bradypodion spinosum	110																1													**2**

Appendix 3 continued

Species	Plot Location and Number of Individuals Captured																														
	Plots with a single ind.	O/R	3	6	20	24	25	29	30	44	50	53	60	75	76	87a	94	99	100	101	109	119	122	133	142	146	150	151	172	**Total ind.**
Bradypodion (Chamaeleo) tenue	21, 115							1																						**3**
Chamaeleo dilepis		1	2						1																					**4**
Chamaeleo deremensis					1		1												2	1					1					**6**
Rhampholeon brevicaudatus								1						3																**4**
Rhampholeon temporalis											1			1													2			**4**
Rhampholeon sp.	102																													**1**
SCINCIDAE																														
Scelotes ulugurensis					2																									**2**
Mabuya maculilabris maculilabris			1			1	1	2	3					1									1	1			1		2	**14**
Mabuya varia varia																											1			**1**
Mabyua striata striata		2						2																						**4**
Lygosoma afrum			1													2														**3**
Leptosiaphos kilimensis			1	3					2				1				1	3					1	3			3		2	**20**
CORDYLIDAE																														
Cordylus tropidosternum																1														**1**
TYPHLOPIDAE																														
Typhlops lineolatus lineolatus									1																					**1**
Typhlops gierrai		3																												**3**

Appendix 3 continued

Species	Plot Location and Number of Individuals Captured																														
	Plots with a single ind.	O/R	3	6	20	24	25	29	30	44	50	53	60	75	76	87a	94	99	100	101	109	119	122	133	142	146	150	151	172	**Total ind.**
Typhlops sp. nov. *usambaricus*									1																					**1**
Typhlops sp.		3																												**3**
LEPTOTYPHLOPIDAE																														
Leptotyphlops macrops		1																												**1**
BOIDAE																														
Python sebae	82	2																												**3**
VIPERIDAE																														
Atheris ceratophorus	131																									1		1		**3**
Bitis gabonica			1																	1										**2**
Elapsoidea nigra	144		1	1	1		1	1										1											2	**9**
Elapsoidea loveridgei		1																											1	**2**
Elapsoidea sp		1													1															**2**
Naja nigricollis nigricollis	59																													**1**
Dendroaspis angusticeps		1						2																						**3**
COLUBRIDAE																														
Lamprophis capensis		2						1																						**3**
Lycophidion meleagre	1			1																										**2**
Lycophidion capense loveridgei								1																						**1**
Mehelya capensis capensis		1	1																											**2**

Appendix 3 continued

Species	**Plot Location and Number of Individuals Captured**																													
	Plots with a single ind.	O/R	3	6	20	24	25	29	30	44	50	53	60	75	76	87a	94	99	100	101	109	119	122	133	142	146	150	151	172	**Total ind.**
COLUBRIDAE cont.																														
Buhoma (Geodipsas) vauerocegae	7, 13		2	3	1		1			2		1					1					1		3						**17**
Buhoma sp.																													1	**1**
Aparallactus werneri	51		1		2																			1					1	**6**
Natriciteres olivacea		1									1							1								1				**4**
Philothamnus macrops	2, 29a, 41, 74, 77, 85, 92, 128,148	2	4	1					3		1											1	1							**22**
Philothamnus hoplogaster	89	3																												**4**
Philothamnus punctatus		1																										1		**2**
Crotaphopeltis hotambeia	79a															1														**2**
Crotaphopeltis tornieri	43, 169		1			1					1			2	1															**8**
Dipsadoboa werneri	12				1																									**2**
Thelotornis capensis mossambicanus	84, 134, 160	2	1					1	1																					**8**
Total		**33**	**31**	**20**	**33**	**30**	**34**	**41**	**45**	**48**	**54**	**55**	**62**	**86**	**78**	**4**	**97**	**111**	**103**	**103**	**111**	**123**	**128**	**142**	**144**	**150**	**160**	**153**	**181**	**256**

APPENDIX 4 : CAPTURE LOCATION OF AMPHIBIANS IN AMANI NATURE RESERVE

Genus	**Ecol. Type**	**End. Status**	**IUCN / CITES Status**	**Plots with one individual**	0	3	6	20	25	29	30	36	40	42	44	50	51	52	53	60	75	87	94	99	115	122	129	133	148	150	160	**Total**
ARTHROLEPTIDAE																																
Arthroleptis affinis	F	N	Vu	9		4	7	3	1		1	2		1			3				1		4	1								**29**
Arthroleptis stenodactylus	f	W		68, 114, 137, 161							2						1							1		1						**9**
Arthroleptis xenodactyloides	f	W									4												1									**5**
Arthroleptis xenodactylus	F	N	Vu			6	10	2																								**18**
Arthroleptis spp.	?	?	?								1		1										1	2		5	1					**11**
BUFONIDAE																																
Bufo brauni	F	N	Vu							1	1		2																			**4**
Bufo gutturalis	f	W		24														1								2						**4**
Bufo spp.	?	?	?																							1						**1**
Nectophrynoides tornieri	F	N	Vu	105		1	3	6			1								6					3						1		**22**
Nectophrynoides spp.	?	?	?					2																								**2**
HEMISIDAE																																
Hemisus marmoratus	f	W																				1				1						**2**
HYPEROLIIDAE																																**0**
Afrixalus fornasini	f	W																											1			**1**
Afrixalus ulugurensis	F	N		118, 153																				1					1	2		**6**
Afrixalus spp.	?	?	?																							1						**1**
Hyperolius punticulatus	F	W		31, 130, 152	1	2																		4			1					**11**
Hyperolius mitchelli	F	W																													1	**1**
Hyperolius mariae	F	N		142																												**1**
Hyperolius spp.	?	?	?	108	1																					1					2	**5**
Kassina senegalensis	f	W																								2						**2**
Leptopelis parkeri	F	N	Vu	48			2											1														**4**
Leptopelis ulugurensis	F	N	Vu	5, 10, 147		1	1	1						1				1						2	1	1		2		1		**15**
Leptopelis vermiculatus	F	N	NT	110, 117, 143				4			1					1					1	1		3	2							**16**

Appendix 4 continued.

Genus	Ecol. Type	End. Status	IUCN / CITES Status	Plots with one individual	0	3	6	20	25	29	30	36	40	42	44	50	51	52	53	60	75	87	94	99	115	122	129	133	148	150	160	Total
MICROHYLIDAE																																
Callulina kreffti	F	N	Vu					2		1									1		1											**5**
Hoplophryne rogersi	F	E	Vu			1					1									1												**3**
Probreviceps macrodactylus	F	N	NT	149		1	4	2	1						4								1	1				2				**17**
PIPIDAE																																**0**
Xenopus muelleri	f	W																						3								**3**
RANIDAE																																**0**
Arthroleptides martiensseni	F	N	Vu	136		1				1										2					2	2		2		1		**12**
Phrynobatrachus krefftii	F	E	Vu			1		8																								**9**
Phrynobatrachus spp.	?	?	?					1																								**1**
Ptychadena anchietae	f	W			1					1											1											**3**
Rana angolensis	f	W		49, 127												1																**3**
GYMNOPHONIA – Caecilians																																
CAECILIDAE																																
Boulengerula boulengeri	F	N			2		1				1		1							1		1	1									**8**
SCOLECOMORPHIDAE																																
Scolecomorphus vittatus	F	N	Vu												1															1		**2**
Total individuals					**5**	**18**	**28**	**31**	**2**	**4**	**13**	**2**	**4**	**2**	**5**	**2**	**4**	**3**	**7**	**4**	**4**	**3**	**8**	**21**	**5**	**17**	**2**	**6**	**2**	**6**	**3**	**236**

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