TECHNICAL PAPER 40

Kwamgumi Forest Reserve

A biodiversity survey

Nike Doggart,
Michael S. Dilger, Pamela Cunneyworth
and Eibleis Fanning
1999

East Usambara Conservation Area Management Programme

Technical Paper 40

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A biodiversity survey

Nike Doggart, Michael S. Dilger, Pamela Cunneyworth and Eibleis Fanning

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

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

Frontier-Tanzania
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Society for Environmental Exploration

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East Usambara Conservation Area Management Programme (EUCAMP)
The East Usambara rain forests are one of the most important areas for biodiversity conservation in Africa. Several plant and animals 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 Amani Nature Reserve and aims at protecting water sources; establishing and protecting forest reserves; sustaining villager's benefits from the forest; and rehabilitating the Amani Botanical Garden. The programme is implemented by the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism with financial support from the Government of Finland, and implementation support from the Finnish Forest and Park Service. To monitor the impact of the project, both baseline biodiversity assessments and development of a monitoring system are needed. The present activity is aimed at establishing baseline information on biological diversity in selected East Usambara forests.

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

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

Frontier Tanzania Forest Research Programme (FT FRP)
The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of the Frontier Tanzania Forest Research Programme (FT FRP). Since July 1994, the FT FRP has been working in the forests of the East Usambara mountains in collaboration with the East Usambara Conservation Area Management Programme (EUCAMP). This survey of selected forests collects baseline biodiversity data and assists the EUCAMP in the management of the East Usambara forests.

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EXECUTIVE SUMMARY

Kwamgumi Forest Reserve, in the East Usambara Mountains of north-east Tanzania was gazetted in 1905. It is situated in Muheza District, Tanga Region and covers 1708 ha between 150 - 915 m asl, encompassing lowland and submontane forest.

As part of the East Usambara Conservation Area Management Programme (from 1999 East Usambara Conservation Area Management Programme, EUCAMP) Frontier-Tanzania conducted a biological survey of Kwamgumi Forest Reserve between January - March 1995 and a follow-up survey was conducted between October - December 1996 for a total of 106 research-days. The survey covered systematically all parts of the reserve with a sampling intensity of 0.25% for the vegetation survey and five zoological trapping sites. This report provides an inventory of the trees, shrubs, herbs, mammals, reptiles, amphibians, birds, butterflies, millipedes and molluscs recorded during the survey. The report also describes disturbance within the reserve and presents the results of a socio-economic study. The species richness, endemism and ecological affinities of the taxa recorded are summarised as Table 1.

Table 1. Summary of biodiversity of taxa surveyed.

Taxon	Total no. of species	% forest dependent	No. of non-forest species	No. of endemics	No. of near-endemics	No. of forest dependent endemics and near-endemics
trees and shrubs	192	35	15	7	47	**29**
Mammals	47	9	4	0	3	**1**
Birds	68	28	8	1	2	**2**
Reptiles	27	44	4	1	8	**9**
Amphibians	24	63	0	1	10	**11**
Butterflies	31	68	0	0	3	**3**
Total	**389**		**31**	**10**	**73**	**55**

Kwamgumi Forest Reserve is part of a larger forest block that includes Segoma and Bamba Ridge Forest Reserves. In terms of conservation it is a significant area of lowland forest providing habitat for endemic and threatened species including the East Usambara endemic plants *Cynometra longipedicellata* and *Cola usambarensis*.

In terms of fauna, the reserve is home to one critically endangered, three endangered and 17 vulnerable species. This includes the recently described snake *Prosymna semifasciata* which was first discovered in Kwamgumi. The reserve has a high diversity of mammals and molluscs relative to other Usambara forests.

Timber cutting was found to occur at low levels throughout the reserve, pole cutting was concentrated near the reserve border although at lower levels than in neighbouring private forest. Fire has affected the forest around Muhinduro Peak and near Kwamtili.

The information collected will be used for management planning by the EUCAMP. The survey results are also available as a baseline for monitoring. The data is stored

on a Microsoft Access database and is available on the Internet at the address: www.usambara.com

FOREWORD

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

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

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

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

Evarast Nashanda
Project Manager

Veli Pohjonen
Chief Technical Adviser

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Project Manager: Mr Katigula (until 1997, now deceased) and Mr E. Nashanda (from 1998)

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UDSM: Professor K. M. Howell, Department of Zoology and Marine Biology.
Phil Kihaule, formerly Chief Technician, Department of Zoology.
Henry Kamwela, Technician, Department of Botany and Microbiolgoy.
Mike Fundi, Soil Technician
TAFORI: Ahmud Mndolwa, botanist.

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

REPORT WRITING

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

1.0 INTRODUCTION

1.1 The East Usambara Mountains and forest diversity

The East Usambara Mountains support ancient and unique forests rich in endemic species (Hamilton, 1989). Their old age, isolation and role as condensers of the moisture from the Indian Ocean make them an important conservation resource. The mountains are situated in north-east Tanzania within 40 km of the coastal town of Tanga between $4^{O}48'$-$5^{O}13'$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 south-east of the mountains, increasing from 1,200 mm annually in the foothills to over 2,200 mm at higher altitudes. Because of the topographical and climatic interactions, the west-facing slopes of the mountains are drier compared to the east-facing slopes.

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

The East Usambara forests have been likened to the African equivalent of the Galapagos Islands in terms of their endemism and biodiversity (Rodgers & Homewood, 1982; Howell, 1989). They are considered to be one of the most important forest blocks in Africa, if not the most important (Tye, 1994). Currently, at least 3450 species of vascular plants have been recorded in the Usambaras of which it is suggested that over one quarter are endemic or near-endemic (Iversen, 1991a). Many are threatened (Rodgers, 1996).

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

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

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

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

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

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

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

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

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

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

1.2 Report structure

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

Ecological requirements are defined in terms of:

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

Levels of endemism are defined in terms of:

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

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

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

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

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

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

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

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

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

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

1.3 Maps

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

1.4 Data and monitoring

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

1.4 Survey period and personnel

The survey of Kwamgumi Forest Reserve was conducted between January and March 1995 and between October and December 1996 for a total of 106 research-days. The survey was conducted by Frontier-Tanzania staff and voluntary Research Assistants, Catchment Forest Officers, and local people from Maramba and Semdoe.

2.0 AIMS OF THE SURVEY

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

- to conduct biological baseline surveys in selected gazetted forests and in forests which are proposed for 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 forests in the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.25% of the area of each Forest Reserve;
- to assess levels of disturbance by systematically sampling the incidence of tree cutting, animal trapping and other illegal activities along the vegetation transects;
- to use standardised and repeatable methods to record biodiversity values of the forest in terms of small mammal, reptile, amphibian, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists will be compared against IUCN categories of threat and other conservation criteria in order to assess the overall biodiversity values of each forest;
- to undertake a socio-economic appraisal of the impact of resource-use activities by human communities in the vicinity of each forest and produce a brief assessment of how these activities affect the integrity of the forests.

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: Kwamgumi Forest Reserve
Muheza District, Tanga Region, Tanzania.

Area: 1708.4; 17.1 km^2; 6 sq. miles

Status: Central Area Forest Reserve
Gazetted 1905, Gazettement notice GN 195

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742
Sheet 110/3 'Hemagoma' of 1988 and Sheet 110/4 'Gombero' of 1989

Forest Division map: Jb 204

3.1.2 Location

Grid reference: 38°44'E to 38° 47'E, 4° 55'S to 4°57'S

Elevation 150 - 915 m a.s.l.

Kwamgumi Forest Reserve is situated in the central area of the East Usambara Mountains (Figure 1). The reserve is part of a forest continuum with the adjoining Segoma and Bamba Ridge Forest Reserves. Segoma F.R. is continuous along the entire southern boundary of Kwamgumi and Bamba Rige F.R is continuous along the entire eastern boundary. The area north of the reserve is owned by the Kwamtili Estate. The forest in this part of the estate is in the process being gazetted as an extension of Kwamgumi Forest Reserve.

3.1.3 Land use

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

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

Kwamgumi Forest Reserve	**Area (ha)**	**Percent (%)**
Dense lowland forest	1,071.6	94.9
Dense submontane forest	16.9	1.5
Cultivation	3.1	0.3
Barren land	37.2	3.3
Total for the reserve:	**1128.8**	**100.0**

3.1.4 Topography

The reserve encompasses the catchment basin for tributaries of the Muzi river. The Muzi is a subsidiary of the Sigi river, which is the main catchment river of the East Usambara Mountains. The reserve consists of a ridge running in an arc around a number of small valleys. The ridge rises to three peaks. To the west the Kwachawe Range runs north-south linked by a lower ridge to Segoma Peak in the centre of the reserve. On the eastern border lies Muhinduro Peak of Bamba Ridge Forest Reserve. The Muzi River marks some of the western border of the reserve (Figure 2).

3.1.5 History and Status

The reserve was gazetted during the German colonial period. During the 1950s the primary access road to Tanga ran through the reserve along the Muzi. This road is no longer in use and is impassable. During the late 1980s Sikh Saw Mills logged the forest and logging tracks are still evident. These tracks reach up to 500m asl.

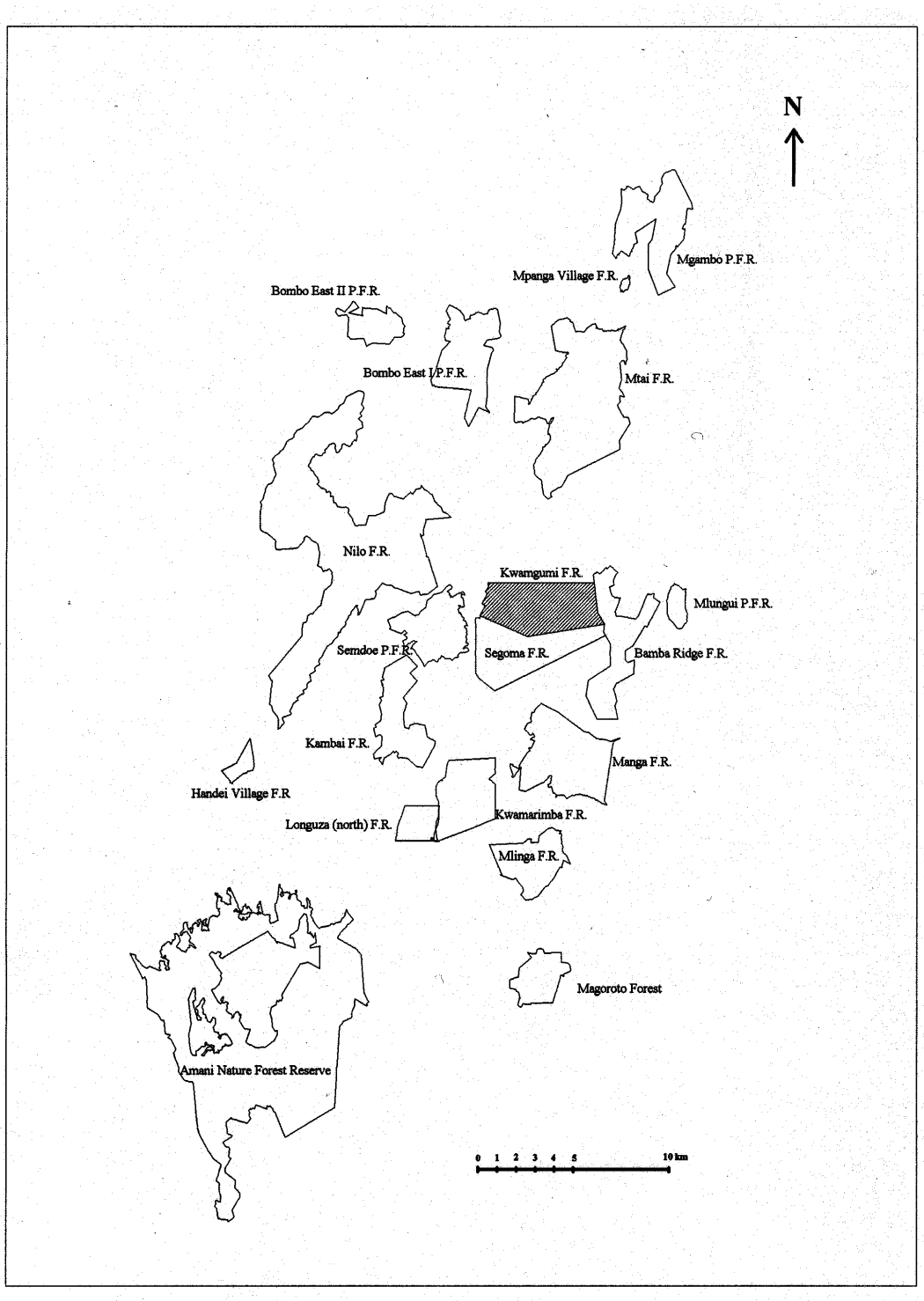

Figure 1. The location of Kwamgumi Forest Reserve in relation to other East Usambara forests.

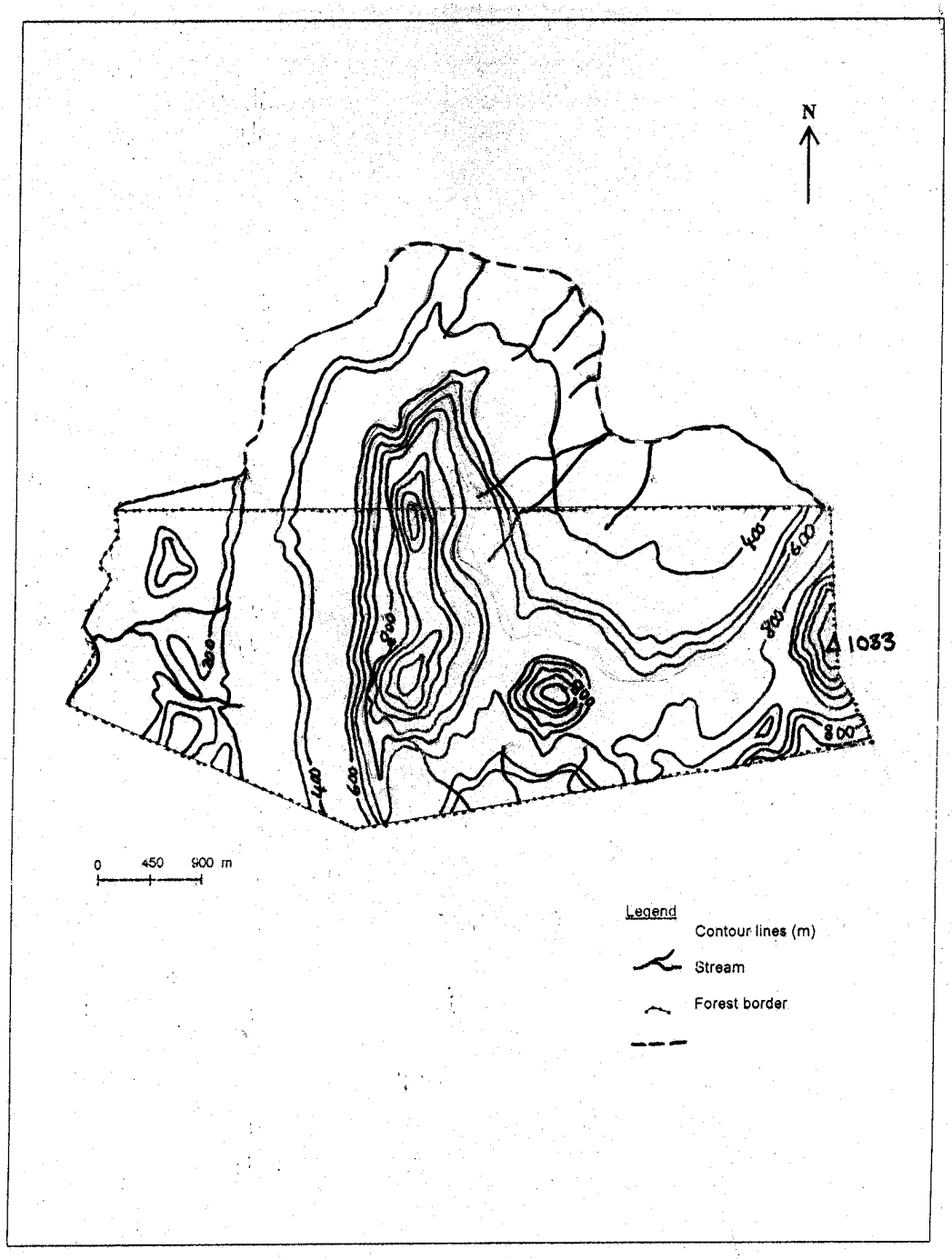

Figure 2. Topographical map.

4.0 SOILS

By Mike Fundi

4.1 Aims

- To describe the soil underlying Kwamgumi Forest Reserve;
- to assess the relationship between vegetation type, slope, altitude and human activities on the reserve's soil characteristics.

4.2 Methods

Transects 800 m long, were located to include a gradation of vegetation types, slope and altitude. The first transect began at an altitude of around 150 m asl and continued across a lower slope with secondary lowland forest, through riverine forest and into the Kwamtilli cocoa plantation. Soil was sampled in the lowland forest, riverine forest and in the plantation.

A second transect ran from the ridge top down into the valley bottom. The starting point for the transect was randomly located on the ridge top. Soil was sampled at the ridge top, at a mid-slope point and in the valley bottom. The transect line ran on a direct bearing between the valley bottom and the ridge top sample sites. The mid-slope sample site was located along this transect line in a representative area.

In order to analyse the soil profile a pit was dug at three or four sample points along each transect. The pits extended to the bedrock or to a maximum depth of 100 cm. Soil samples were taken at 20cm intervals down the profile. Soil horizons were described in terms of colour, texture, structure, root distribution and size and stoniness. Notes were made altitude, aspect slope, biological activity and signs of erosion. Samples were dried and then tested for pH. Data were recorded on standardised sheets for each soil profile (SEE, 1996).

4.3 Results

4.3.1 Soil structure and colour

The results from the soil profiles in Kwamgumi Forest Reserve show a gradation in colour with decreasing altitude from brown to increasingly red and orange. Within a profile the upper layer was darker brown due to an abundance of organic matter. The soils were generally sandy. There was a gradual increase in the sand content of the soils with decreased altitude, and down the profiles. This progressive increase in the sand content and decrease in cohesiveness of the particles was reflected in the progressive weakening of the soil structure moving down the transect and down the profile. All of the samples were weak or structureless with the exception of the mid-slope site that had a higher clay content than any other site. Here the clay content increased with depth to form a platy structure at 100 cm.

4.3.2 Soil pH

The pH values reflect the acidity of the parent material, gneiss. The exception is the soil at the higher altitude site which had a pH of 6.5-7.0. At the mid-altitude site, pH decreased down the profile from 6.0 to 5.5. Further down the slope the pH was

consistently 5.5. At the site in the cocoa plantation pH decreased from 6.5 to 5.5 but increased at 100cm to 6.0.

4.3.3 Soil profiles

In the cocoa plantation the profile had a thicker A horizon than any of the forest sites however there were no obvious differences in soil colour, texture or pH. The litter layer of all soil profiles analysed were of similar depth and the percentage leaf litter cover was above 85%.

4.3.4 Soil erosion

There were no signs of accelerated soil erosion at any of the sample sites in Kwamgumi even on the steeper slopes. This is probably due to the protection given by the dense vegetation cover.

4.4 Discussion

4.4.1 AFIMP Soil Survey

The soils of Kwamgumi were investigated during the 1986-7 AFIMP survey by the National Soil Service, Mlingano Agricultural Research Institute. Three soil profiles were examined in relatively undisturbed lowland forest at altitudes of between 210 - 260 m a.s.l.. The soil profiles were located along a catenary sequence. Soil samples were taken from the top 20 cm of each soil profile for chemical analysis. The three sample sites were found to have similar soil characeristics and all were considered to be Rhodic Ferralsols (FAO, 1988). All soils were dark reddish-brown, sandy clays grading to clays at depth. In general organic carbon content was low (0.7 - 2.0%). Total nitrogen was found to be low to medium (0.09 - 0.27%) (Hamilton, 1989b). The soils were all weakly acidic (pH 6.2 - 6.7). Cation exchange capacity was medium to low and was strongly related to organic matter content. Calcium levels were high, magnesium levels were medium, potassium levels were low and phosphorus content was very low (Hamilton, 1989b).

4.4.2 Comparisons with the AFIMP soil survey

The soil analysis carried out in this study was limited to simple field tests and, therefore, detailed chemical analysis was not possible. However, it is possible to compare soil reaction, colour, texture and structure with the AFIMP survey. The soils sampled in both surveys were of similar colour, reddish brown becoming more red down the profile. This is typical of tropical forest soils, particularly the Rhodic Ferralsols, which are sedentary soils formed *in situ* and subject to heavy weathering. These are characterised by a red colour due to high levels of aluminium and iron sesquioxides since other more soluble bases are washed down the profile (Holmes, 1995), and the inorganic fraction is consequently low in available nutrients. As recorded in the AFIMP survey, the nutrient holding capacity of these soils is directly related to the organic matter content (Hamilton, 1989b).

The soils of Kwamgumi were found to be predominantly sandy by both surveys, although the increasing clay content recorded in sub-soils by the AFIMP survey was only observed on the mid-slope site during this study. The soil catena examined

during this survey was located at a lower altitude than that of the AFIMP study, and was typical of the overbank floodplain of the Muzi River. This may account for the coarser sediments which characterised the Kwamgumi soils sampled during this survey.

The pH of soils was found to be relatively acidic in both surveys, though soils were recorded as having slightly lower pH during this survey. This may be due to testing errors. The acidity of the soil shows the importance of the gneiss parent material, a rock type with a high quartz component which results in relatively acid soils. On the Kwamgumi transect, a correlation between slope angle and soil depth was observed: as the slope angle increased, the depth of the soil decreased and stoniness increased. Therefore, the parent material is probably more influential on slopes than on gentle terrain, which were characterised by sandier soils.

As is typical of many tropical soils, the soils of Kwaumgumi have a small A horizon due to the rapid rate of organic matter breakdown and nutrient cycling (Holmes, 1995). Given that nutrient retention is directly related to organic matter content, the loss of the A horizon would result in rapid soil impoverishment. Such a scenario could occur if the natural forest were cleared (Hamilton, 1989b).

5.0 VEGETATION

5.1 Introduction

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

5.2 Methods

The forest block is divided into a grid of numbered rectangles marked in the field by tagged transects. All methods are based on this grid system and are detailed in the FT FRP methodologies report (SEE, 1998). A brief description is presented below. The location of vegetation plots and disturbance transects are illustrated in Figure 3.

5.2.1 Forest composition

Two methods were used to analyse forest composition: (1) quantitative vegetation analysis; (2) disturbance transects.

5.2.1.1 Quantitative vegetation analysis

The botanical survey was based on a 450 m x 900 m grid marked in the field using tagged transect lines. One plot 50 m x 20 m was sampled in each grid square, giving an approximate sampling intensity of 0.25%. Within each sample plot, every tree with a dbh (diameter at breast height) of 10 cm and over was recorded, labelled and identified. The regeneration layer was recorded within a 3 m x 3 m plot at the centre of each vegetation plot. All plants with a dbh below 10 cm were recorded in these plots including herbs. Botanists from the Tanzanian Forestry Research Institute (TAFORI) provided the field identification of plant species.

5.2.1.2 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 450 m x 900 m grid prepared for the vegetation plots. Each transect running east-west was sampled from border to border. Disturbance was recorded by 50 m section along the transect.

Every self-standing tree and sapling (i.e. not lianas or creepers) above 5 cm dbh was measured within an area 5 m either side of each transect line. Each plant was recorded under one of three categories: live, cut or naturally fallen. Within these categories a distinction is made between poles and timbers. Poles are classified as having a dbh between 5 and 15 cm and a minimum of 2 m long relatively straight trunk. Timber is classified as having a dbh > 15 cm with a minimum 3 m long relatively straight trunk. These divisions are based on differences in use. Data are presented as a total and as an average per hectare.

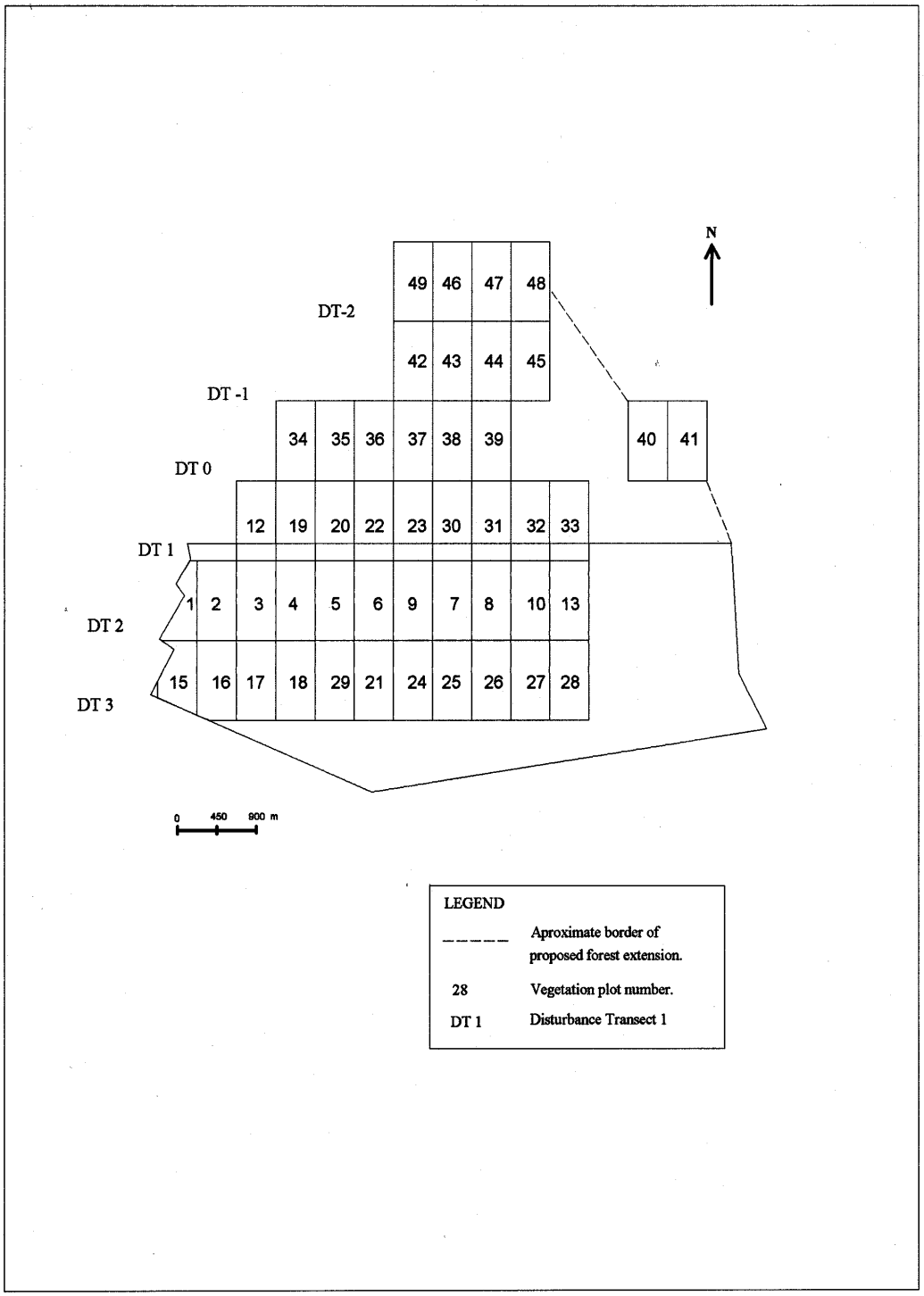

Figure 3. Location of vegetation plots and disturbance transects.

5.3 Results

5.3.1 Quantitative vegetation analysis

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

Table 4. Checklist of trees and shrubs.

Species	Ecological type	Habitat[2]	Endemic status
ANACARDIACEAE			
Lannea schweinfurthii ssp. *stuhlmannii*	f	L&S	W
Lannea welwitschii	F	L	N
**Sorindeia madagascariensis*	f	S&L	W
ANNONACEAE			
**Enantia kummeriae*	F	S	N
**Lettowianthus stellatus*	f	S&L	N
**Mkilua fragrans*	F	S	N
**Monodora grandidieri*	f	L&S	N
Polyceratocarpus scheffleri	F	S	N
Uvariodendron gorgonis	f	S	N
Uvariodendron pycnophyllum	F	S	E (EU&WU)
Uvariodendron sp.			
Xylopia parviflora	f	L	W
APOCYNACEAE			
Funtumia africana	F	L&S	W
Tabernaemontana holtsii	F	L	W
**Tabernaemontana pachysiphon*	F	S	W
**Tabernaemontana ventricosa*	F	L	W
ARALIACEAE			
Cussonia arborea	O	L&S	W
Cussonia zimmermannii	f	L	N
BIGNONIACEAE			
**Fernandoa magnifica*	f	L	N
Kigelia africana	f	L	W
**Markhamia lutea*	f	L & S	W
BOMBACACEAE			
Bombax rhodognaphalon	f	L	W
Ceiba pentandra	f	S	W (cultivated)
BORAGINACEAE			
Cordia ovalis	f	L&S	W
Ehretia cymosa	f	(L)&S	W
BURSERACEAE			
**Commiphora eminii zimermanii*	f	L	N
CAPPARIDACEAE			
Maerua sp.			
CELASTRACEAE			
Gymnosporria sp.			
Maytenus acuminata	F	S	W
Maytenus undata	f	S	W

Species	Ecological type	Habitat[2]	Endemic status
Mystroxylon aethiopicum	f	L&S	W
CELASTRACEAE cont.			
**Salacia lehmbachii*	F	L&S	N
CHRYSOBALANACEAE			
Parinari excelsa	f	S	W
COMBRETACEAE			
Combretum volkensii	f	L	N
Combretum schumannii	f	L	N
Pteleopsis myrtifolia	f	L	W
**Terminalia sambesiaca*	f	L	W
COMPOSITAE			
Brachylaena huillensis	O	L	W
DRACAENACEAE			
**Dracaena steudneri*	f	S (forest gaps)	W
Dracaena usambarensis	f	L	W
EBENACEAE			
Diospyros abyssinica	f	S	W
**Diospyros kabuyeana*	f	S	N
Diospyros mespiliformis	f	L	W
**Diospyros natalensis*	f	L	W
Diospyros sp.			
**Diospyros squarrosa*	F	L	W
EUPHORBIACEAE			
Antidesma membranaceum	f	L&S	W
Bridelia cathartica melanthesoides	f	L&S	W
Bridelia micrantha	f	L&S	W
Clutia abyssinica	f	(L&)S	W
Cleistanthus polystachyus	f	L&S	W
Croton sylvaticus	f	L	W
Drypetes gerrardii	F	S	W
Drypetes natalensis	f	L	W
**Drypetes usambarica*	f	S	N
Drypetes sp.		?	
Euphorbia candelabrum	O	(L&)S	W
Flueggea virosa	f	L&S	W
Macaranga capensis	F	L&S (forest gaps)	W
Margaritaria discoidea	f	S	W
Ricinodendron heudelotii	f	L	W
Sapium ellipticum	f	L & S	W
Suregada zanzibarense	f	L	W
FLACOURTIACEAE			
Dasylepis integra	F	S	N
Oncoba spinosa	f	L&S	W
Rawsonia lucida	F	S	W
GUTTIFERAE			
Allanblackia stuhlmannii	F	S	N
Harungana madagascariensis	F	S	W
**Symphonia globulifera*	f	S	W
HERNANDIACEAE			
Gyrocarpus americanus	f	L	W

Species	Ecological type	Habitat[2]	Endemic status
ICACINACEAE			
Alsodeiopsis schumannii	F	S	N
**Apodytes dimidiata*	f	S	W
LECYTHIDACEAE			
Barringtonia racemosa	f	L	W
LEGUMINOSAE - CAESALPINIOIDEAE			
Cynometra longipedicellata	F	L&S	E (EU)
**Cynometra webberi*	f	L	N
**Dialium holtzii*	f	L	N
Englerodendron usambarense	F	S	E (EU)
Erythrophleum suaveolens	F	L	W
Isoberlinia scheffleri	F	S&L	N
Julbernardia magnistipulata	f	L	N
Julbernardia globiflora	O	S&L	N
Julbernardia sp.			
**Scorodophloeus fischeri*	f	L	N
LEGUMINOSAE - MIMOSOIDEAE			
Albizia glaberrima	f	L	W
Albizia gummifera	f	S (& L)	W
**Albizia schimperiana*	F	S	N
Albizia zimmermanni	f	L	W
Newtonia buchananii	F	S	W
Newtonia paucijuga	F	L	N
Parkia filicoidea	F	L&S	W
LEGUMINOSAE - PAPILIONOIDEAE			
**Angylocalyx braunii*	F	L	N
Craibia brevicaudata	f	L	N
Erythrina lysistemon	O	S	W
Millettia stuhlmannii[1]	O	L&S	W
Millettia usaramensis	O	L	N
Pterocarpus mildbraedii	F	L	N
* *Pterocarpus tinctorius*	F	S(&L)	W
Swarzia sp.			
Schefflerodendron usambarense	F	S	W
MELIACEAE			
Entandrophragma excelsum	F	S	W
Khaya anthotheica	F	L&S	W
Lepidotrichilia volkensii	F	L&S	W
Trichilia emetica	f	L	W
MORACEAE			
Antiaris toxicaria	f	L&S	W
Artocarpus heterophyllus	O		W (Introduced species)
**Dorstenia* sp.			
Dorstenia kameruniana	f	L	W
Ficus exasperata	f	L&S	W
Ficus ingens	O	L&S	W
Ficus sp.			
Ficus sur	f	L&S	W
Ficus sycomorus[1]	f	L	W
**Ficus vallis-choudae*	f	L	W
**Mesogyne insignis*	F	S	W

Species	Ecological type	Habitat[2]	Endemic status
MORACEAE (Cont.)			
Milicia excelsa	f	L&S	W
Myrianthus holstii	F	S	W
Treculia africana	F	S&L	W
**Trilepsium madagascariensis*	f	L&S	W
MYRISTICACEAE			
**Cephalosphaera usambarensis*	F	S	N
MYRTACEAE			
Syzygium guineense	F	S	W
Syzygium sp.			
OCHNACEAE			
Brackenridgea zanguebarica	F		W
Ochna holstii	f	S	W
**Ochna sp.*			
OLACACEAE			
**Strombosia scheffleri*	F	S	W
PANDANACEAE			
**Pandanus stuhlmannii*	O	S	W
PITTOSPORACEAE			
Pittosporum viridiflorum	f	S	W
RHAMNACEAE			
Ziziphus mucronata	O	L	W
RHIZOPHORACEAE			
Anisophyllea obtusifolia	F	S	N
RUBIACEAE			
Cremaspora triflora	f	S	N
Leptactina platyphylla	f	S	W
Oxyanthus pyriformis	f	S	N
**Oxyanthus speciosus*	F	S (forest gaps)	W
Psychotria brevicaulis	F	S	E (EU)
Psychotria capensis	?	L&S	W
**Rothmannia manganjae*	F	L&S	W
Rothmannia urcelliformis	F	L	W
Rytigynia bugoyensis	f	S	W
**Rytigynia flavida*	F	S	W
Rytigynia sp.			
**Sericanthe odoratissima var.odoratissima*	F	L&S	N
Tarenna pavettoides	F	L&S	W
**Tricalysia anomala*	F	S	N
**Tricalysia pallens*	f	S	W
Tricalysia sp.			
RUTACEAE			
Citrus aurantium	O	?	W
Teclea nobilis	f	S	W
Teclea simplicifolia	f	S	W
Zanthoxylum usambarense	F	S	W
SAPINDACEAE			
Allophylus melliodorus	F	S	N
**Blighia unijugata*	f	L&S	W
**Chytranthus obliquinervis*	f	L (forest gaps)	N
**Deinbolia sp.*			
**Lecaniodiscus fraxinifolius*	F	L	W

Species	Ecological type	Habitat[2]	Endemic status
SAPINDACEAE (Cont.)			
Placodiscus amaniensis	F	S	N
**Zanha golungensis*	F	L&S	W
SAPOTACEAE			
Afrosersalisia cerasifera	F	L&S	W
Chrysophyllum perpulchrum	F	S	W
Englerophytum natalense	f	L&S	W
Manilkara obovata	f	S	W
Manilkara sulcata	f	L	W
Pouteria alnifolia	f	L&S	W
Synsepalum msolo	F	L&S	W
Synsepalum passargei	f	L	W
SIMAROUBACEAE			
Odyndea zimmermannii	F	S	N
STERCULIACEAE			
**Cola clavata*[1]	F	L	W
**Cola greenwayi*	F	S	N
Cola microcarpa	F	S	N
**Cola scheffleri*	F	L	E
**Cola usambarensis*	F	S	E (EU)
Dombeya acutangula	f		W
Dombeya shupangae	f		N
**Leptonychia usambarensis*	F	L	W
Mansonia diatomanthera			
Sterculia appendiculata	f	L	W
TILIACEAE			
Carpodiptera africana	O		W
Grewia bicolor	O	L&S	W
Grewia goetzeana	f	L	W
Grewia holstii	f		W
Grewia sp.			
Nersogordonia holtzii[1]		L	N
ULMACEAE			
Celtis africana	F	L	W
Celtis gerrardii			
Celtis mildbraedii	F	L&S	W
Celtis wightii	f	S	W
Trema orientalis	f	L&S	W
VERBENACEAE			
Premna chrysoclada	O	L	N
Vitex amaniensis	f	S&L	N
VIOLACEAE			
**Rinorea angustifolia* var *albersii*	F	S	E (EU&WU)
**Rinorea ilicifolia*	F	L&S	W
Rinorea sp.			

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

KEY TO ABBREVIATIONS FOR TABLE 4

Ecological type: (based on Iversen, 1991a)

- F - Forest dependent species: This is defined as primary forest only. It does not include forest edge or secondary forest;

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

Habitat: (based on Hamilton, 1989)
- L - Lowland: Species occurring at altitudes of <850 m;
- S - Submontane: Species occurring at altitudes of >850 m.

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

Endemic status: (based on Iversen, 1991a):
- E - Endemic: Occurring only in the Usambara mountains;
- N - Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution.

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

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

In Table 5, four 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
EUPHORBIACEAE			
Alchornea hirtella	f	S	W
RHAMNACEAE			
Maesopsis eminii	F	S&L	W
SAPINDACEAE			
Deinbollia borbonica	O		W
Deinbollia kilimandscharica	f	S	W

Additional species were recorded through opportunistic observations. These are listed in Table 6.

Table 6. Summary of opportunistic botanical records.

Species	Ecological type	Habitat	Endemic status
Pteridophyta			
DENNSTAEDTIACEAE			
Blotiella glabra	f		W
Pteridium aquilinum	f		W
LYCOPODIACEAE			
Lycopodium clavatum	f		W
Angiospermae			
ACANTHACEAE			
Sclerochiton boivinii	F		N
ALANGIACEAE			
Alangium chinense	f	S	W
APOCYNACEAE			
Rauvolfia caffra	F		W
BIGNONACEAE			
Markhamia obtusifolia	O		W
CHRYSOBALANACEAE			
Maranthes goetzeniana	f	S	N

Table 6. Cont.

Species	Ecological type	Habitat	Endemic status
COMPOSITAE			
Senecio mannii			
EBENACEAE			
Diospyros amaniensis	F		N
EUPHORBIACEAE			
Mildbraedia carpinifolia	f	L&S	N
FLACOURTIACEAE			
Grandidiera boivinii	F	L&S	N
Ludia mauritiana	f	L&S	W
GUTTIFERAE			
Garcinia volkensii	F	L&S	W
ICACINACEAE			
Leptaulus holstii	F	L&S	W
LEGUMINOSAE-CAESALPINIOIDEAE			
Afzelia quanzensis	f	L	W
LEGUMINOSAE MIMOSOIDEAE			
Albizia versicolor	f		W
LEGUMINOSAE PAPILIONOIDEAE			
Crotalaria sp.			
Erythrina caffra			
Lonchocarpus bussei	O	L&S	W
Millettia oblata	N	S	F
LILIACEAE			
Aloe sp.			
LOBELIACEAE			
Lobelia giberroa	f	S	W
LOGANIACEAE			
Anthocleista grandiflora	f		W
MELASTOMATACEAE			
Memecylon brenanii	F	S	N
MORACEAE			
Ficus scasselattii	f	S	W
MYRSINACEAE			
Maesa lanceolata	f	L&S	W
Rapanea melanophleas	f	S(&L)	W
RUBIACEAE			
Keetia venosa	f		W
Ixora scheffleri	f	S	W
Pavetta amaniensis	f	L&S	N
RUTACEAE			
Harrisonia abyssinica			
STERCULIACEAE			
Cola sp.			
ULMACEAE			
Celtis gomphopylla	F		W
ZAMIACEAE			
Encephalartos hildebrandtii	f	L	N

Species accumulation rates:

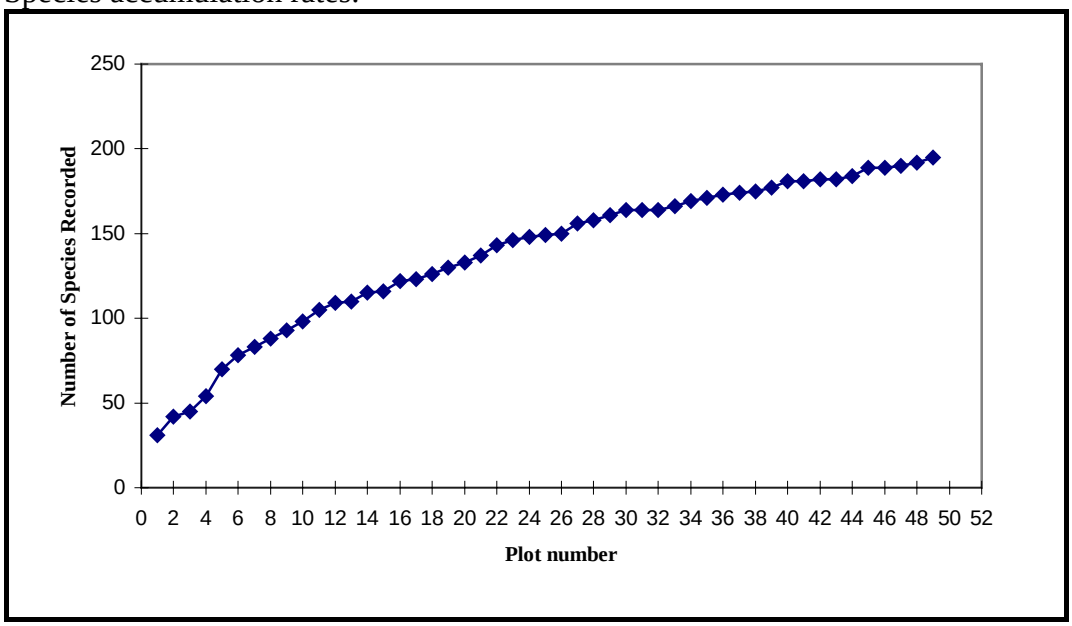

Figure 4. Species accumulation rates of recorded species by vegetation plot.

In 1986 - 1987 a botanical survey was conducted in the East Usambaras (Ruffo et al. 1989). A comparison is made below between the species recorded during the current survey of Kwamgumi and their East Usambaran range as listed by Ruffo et al (1989). Only those species listed by Ruffo et al. (1989) are included in this comparison.

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

Species	**Location as previously recorded**[1]
Albizia glaberrima	Kwamsambia, Lutindi, Longuza, Mlinga and Mtai
Allanblackia stuhlmannii	Northern and southern part of main range, Mlinga and Mtai
Allophylus melliodorus	Lutindi and Mtai
Alsodeiopsis schumannii	Northern and southern part of main range, Marimba, Mlinga and Mtai
Apodytes dimidiata	Kwamkoro and Lutindi
Bridelia micrantha	Northern and southern part of main range, Longuza and Mlinga
Cephalosphaera usambarensis	Northern and southern part of main range, Longuza and Mtai
Chrysophyllum perpulchrum	Southern part of main range and Mtai
Cleistanthus polystachyus	Mtai
Cola greenwayi	Kwamkoro and Lutindi
Cola microcarpa	Mtai
Commiphora eminii zimmermannii	Lutindi and Mtai
Cynometra webberi	Marimba
Dasylepis integra	Amani-Zigi and Mtai
Diospyros abyssinica	Bulwa and Kwamkoro
Dorstenia kameruniana	Kwamsambia, nothern part of main range
Drypetes gerrardii	Southern part of main range and Lutindi.
Drypetes usambarica	Northern and southern part of main range, Marimba, Mlinga and Mtai

Table 7. Cont.

Species	Location as previously recorded[1]
Englerodendron usambarense	Southern part of main range
Entandrophragma excelsum	Southern part of main range, Lutindi and Mtai
Erythrophleum suaveolens	Kwamsambia, Longuza and Mtai
Ficus vallis-choudae	Kwamsambia and Mlinga
Harungana madagascariensis	Nothern and southern part of main range, Marimba and Mlinga
Isoberlinia scheffleri	Southern part of main range, Lutindi, Longuza, Mlinga and Mtai
Julbernardia magnistipulata	Southern part of main range and Lutindi
Manilkara obovata	Kwamkoro
Manilkara sulcata	Lutindi and Longuza
Maytenus acuminata	Southern part of main range
Maytenus undata	Northern part of main range
Myrianthus holstii	Northern and southern part of main range, Mlinga and Mtai
Newtonia buchananii	Southern and northern part of main range, Longuza, Mlinga and Mtai
Odyndea zimmermannii	Northern and southern part of main range, Longuza, Marimba, Mlinga and Mtai
Oxyanthus speciosus	Southern part of main range, Longuza and Mlinga
Pandanus stuhlmannii	Southern part of main range, Mlinga and Mtai
Parinari excelsa	Northern and southern part of main range, Mlinga and Mtai
Parkia filicoidea	Southern part of main range, Lutindi, Longuza, Marimba and Mtai
Psychotria capensis	Lutindi
Rawsonia lucida	Nothern and southern part of main range, Longuza and Marimba
Rothmannia manganjae	Southern and northern part of main range, Longuza and Mtai
Symphonia globulifera	Kizara
Syzgium guineense	Southern part of main range, Lutindi and Mtai
Tabernaemontana pachysiphon	Northern and southern part of main range and Mtai
Teclea simplicifolia	Lutindi and Mtai
Vincentella passargei	Mtai
Ziziphus mucronata	Mtai

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

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

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

Ecological type	Number of species	% of total number of species	Number if individuals	% of total number of individuals
(F) Forest dependent species	68	35.4	851	39.8
(f) Non-forest dependent species	86	44.8	1026	47.9
(O) Non-forest species	15	7.8	132	6.2
Unknown	23	12.0	131	6.1
Total:	**192**	**100.0**	**2140**	**100.0**

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

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

Habitat	Number of species	% of total number of species	Number of individuals	% of total number of individuals
(L) Lowland Species	97	50.5	1445	68.2
(S) Submontane Species	70	36.5	552	25.8
Unknown	25	13.0	144	6.8
Total:	**192**	**100.0**	**2140**	**100.0**

Table 10. Submontane species occurring in lowland areas and the lowest altitude at which they were recorded.

Species	Altitude (metres)
Albizia schimperiana	300
Allanblackia stuhlmannii	600
Allophylus melliodorus	500
Alsodeiopsis schumannii	750
Anisophyllea obtusifolia	750
Apodytes dimidiata	350
Ceiba pentandra	350
Celtis wightii	150
Cephalosphaera usambarensis	500
Chrysophyllum perpulchrum	600
Cola greenwayi	160
Cola microcarpa	700
Cola usambarensis	160
Cremaspora triflora	500
Dasylepis integra	450
Diospyros kabuyeana	160
Drypetes gerrardii	200
Drypetes usambarica	150
Enantia kummeriae	450
Englerodendron usambariensis	750
Erythrina lysistemon	450
Leptactina platyphylla	500

Table 10. Cont.

Species	Altitude (metres)
Manilkara obovata	420
Margaritaria discoidea	170
Maytenus undata	160
Mesogyne insignis	750
Mkilua fragrans	160
Newtonia buchananii	760
Odyndea zimmermannii	500
Oxyanthus pyriformis	160
Pandanus stuhlmannii	200
Parinari excelsa	750
Placodiscus amaniensis	750
Polyceratocarpus scheffleri	200
Psychotria brevicaulis	760
Rawsonia lucida	600
Rinorea angustifolia var albersii	450
Rytignia flavida	480
Rytignia uhligii	160
Schefflerodendron usambarense	750
Strombosia scheffleri	200
Symphonia globulifera	560
Syzgium guineense	760
Tabernaemontana pachysiphon	200
Teclea nobilis	200
Teclea simplicifolia	150
Tricalysia anomala	170
Tricalysia pallens	150
Uvariodendron gorgonis	450
Uvariodendron pycnophyllum	150
Zanthoxylum usambarense	170

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

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

Endemic status	Number of species	% of total number of species	Number of individuals	% of total number of species
(E) Endemic	7 (5-EU; 2 EU&WU)*	3.6	95	4.4
(N) Near Endemic	47	24.5	616	28.7
(W) Widespread	117	61.0	1311	61.3
Unknown	21	10.9	118	5.6
Total:	**192**	**100.0**	**2140**	**100.0**

* EU - East Usambara mountains
WU - West Usambara mountains

Timber value

Formerly logging was permitted in Kwamgumi Forest Reserve. Table 12 lists the most commonly extracted trees (Ruffo 1989) to give an indication of the remaining populations of these species.

Table 12. The abundance of selected timber species.

Species	Number of plots in which present	% of plots in which present	Total individuals	% of all stems
Milicia excelsa	7	3	13	0.6
Cephalosphaera usambarensis	5	2	9	0.4
Khaya anthotheica	9	4	11	0.5
Newtonia buchananii	2	1	3	0.1
Ocotea usambarensis	0	0	0	0.0

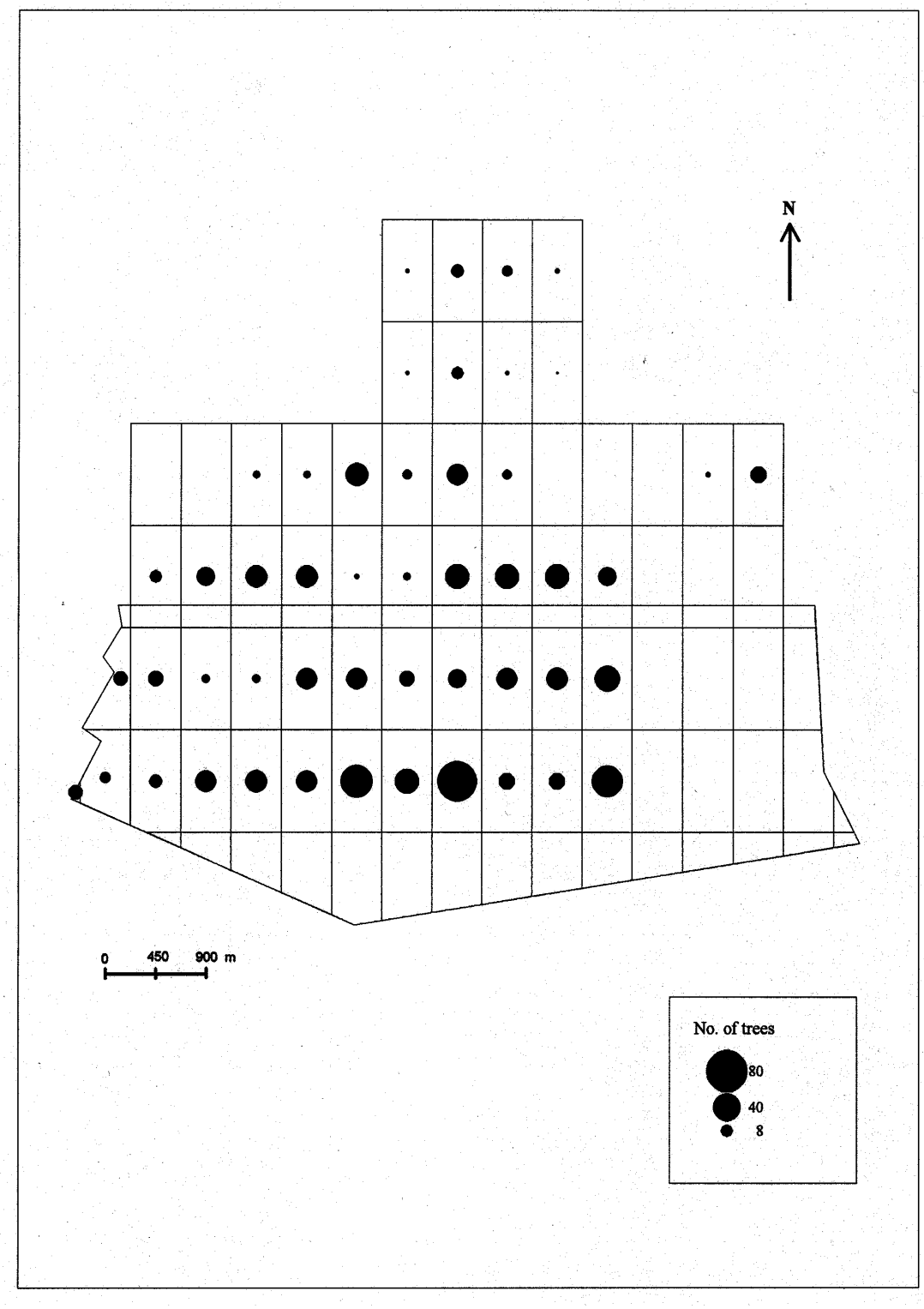

Figure 5. Distribution of forest dependent tree and shrub individuals.

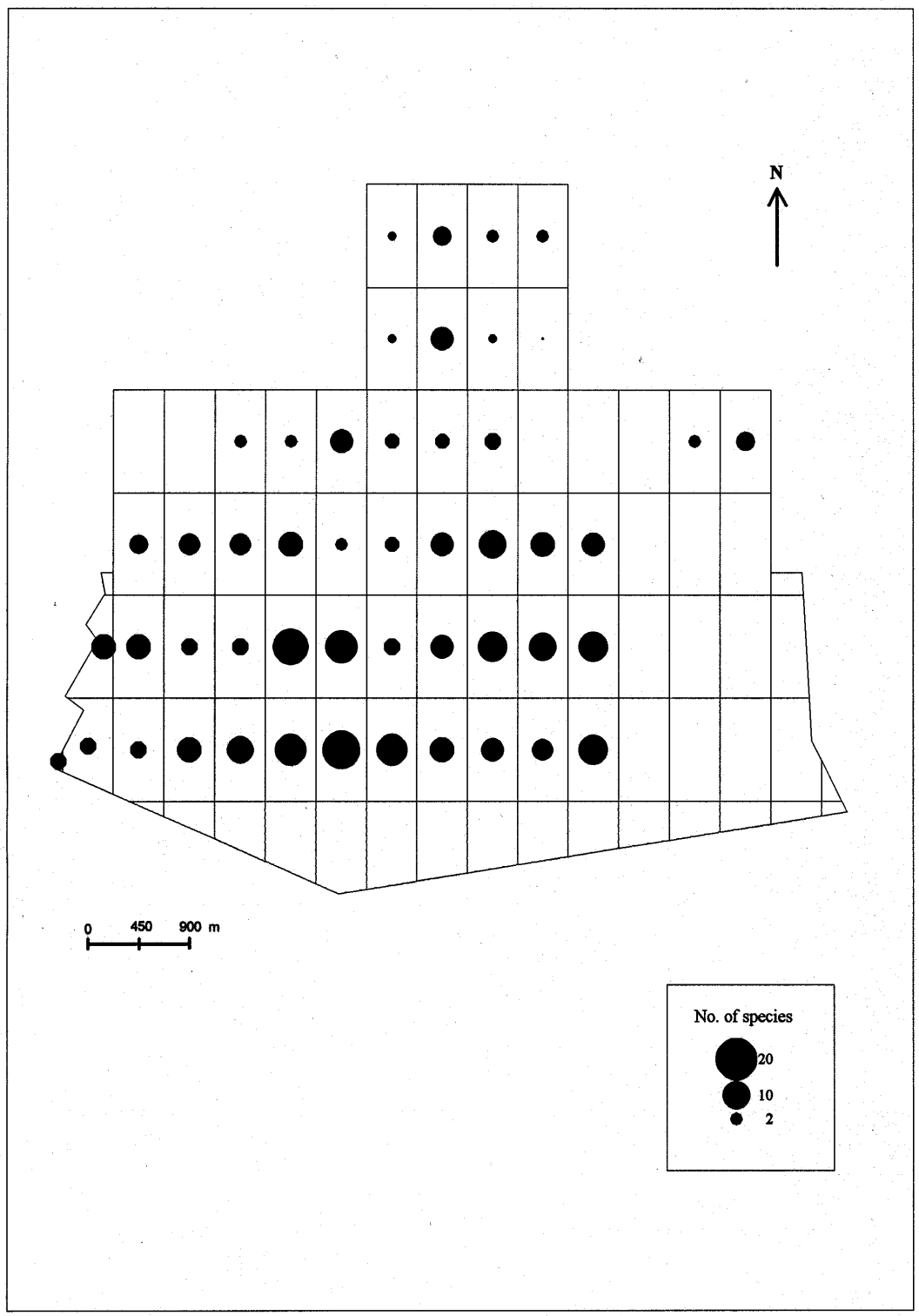

Figure 6. Distribution of forest dependent tree and shrub species.

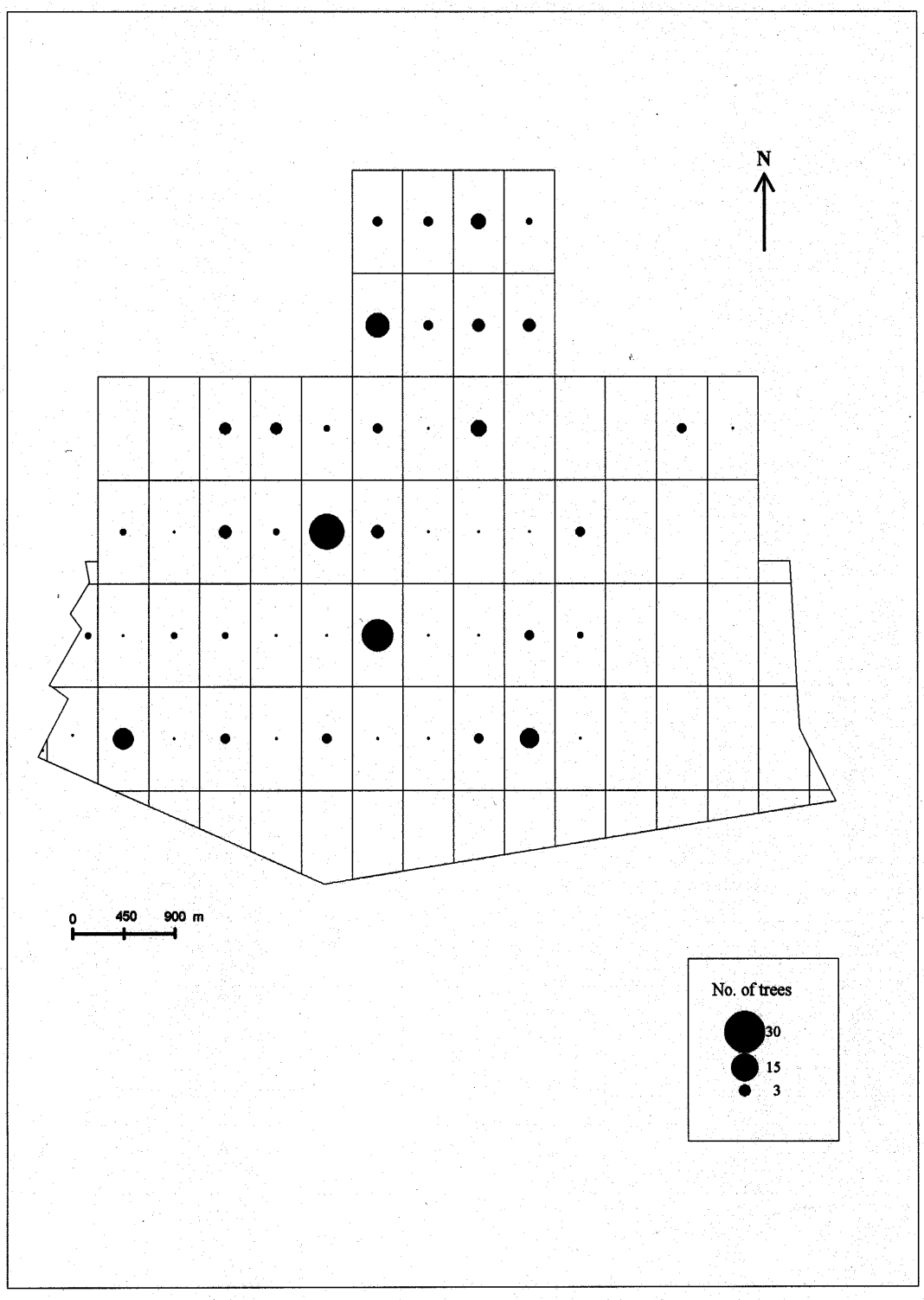

Figure 7. Distribution of non-forest tree and shrub individuals.

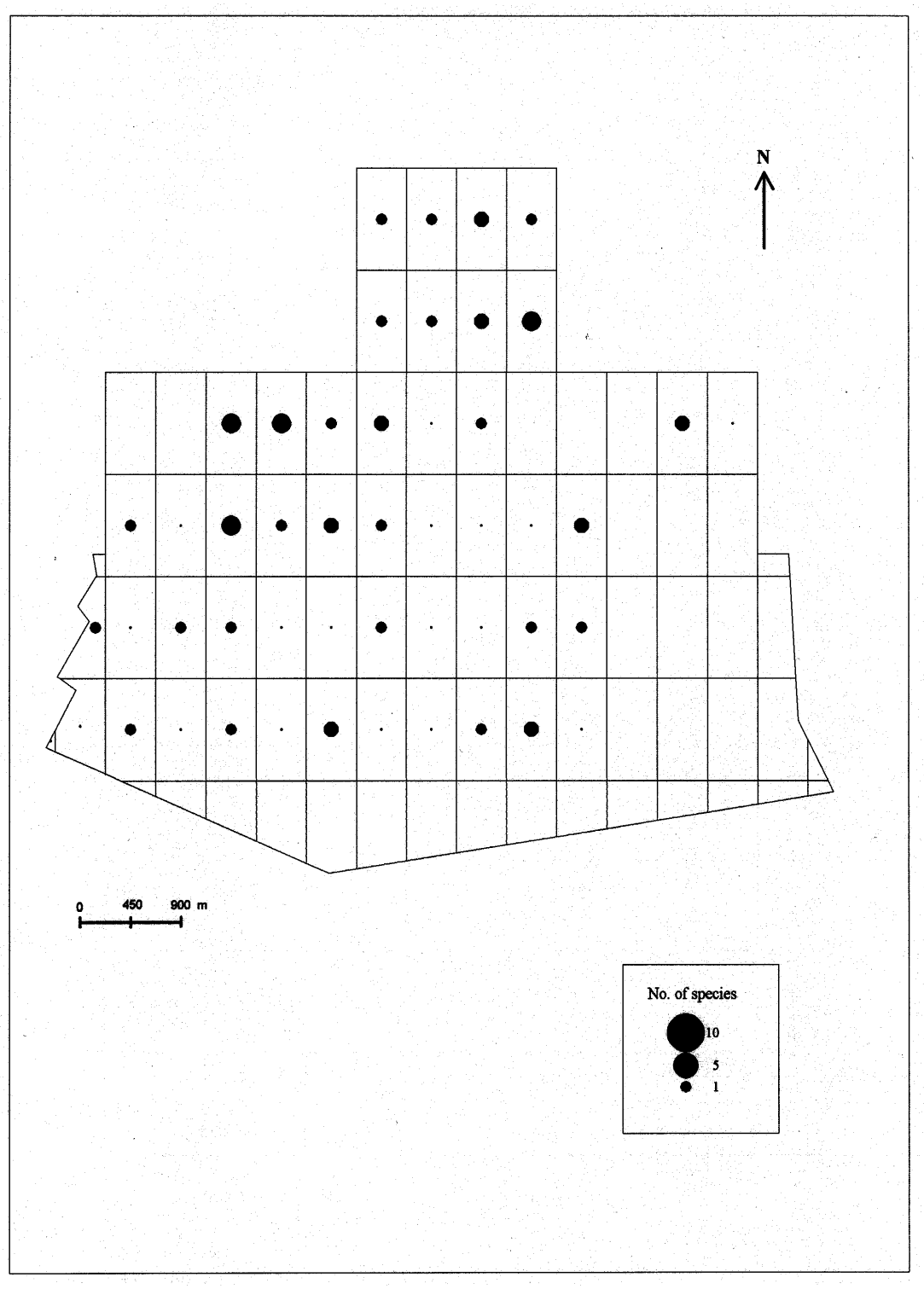

Figure 8. Distribution of non-forest tree and shrub species.

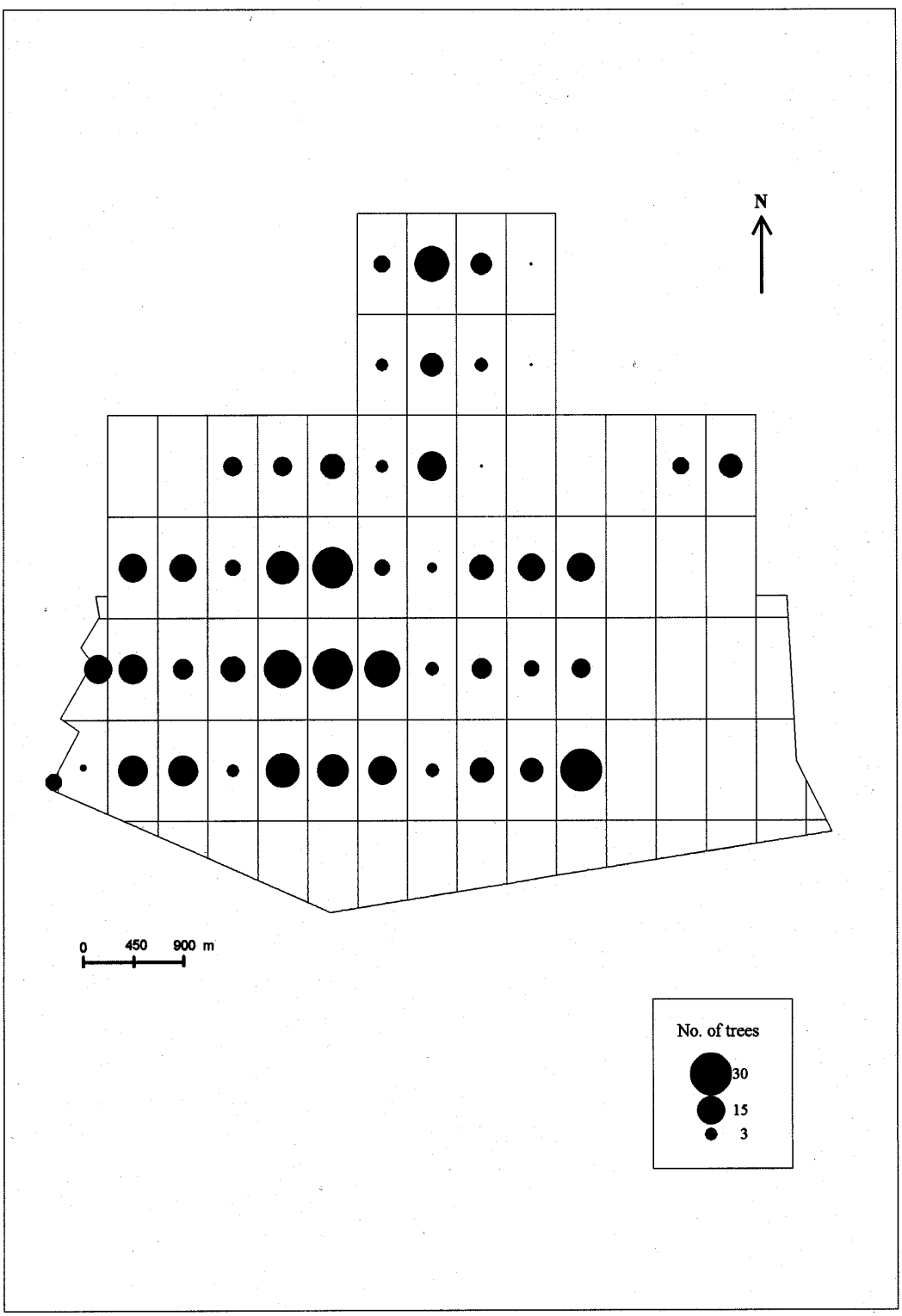

Figure 9. Distribution of submontane tree and shrub individuals.

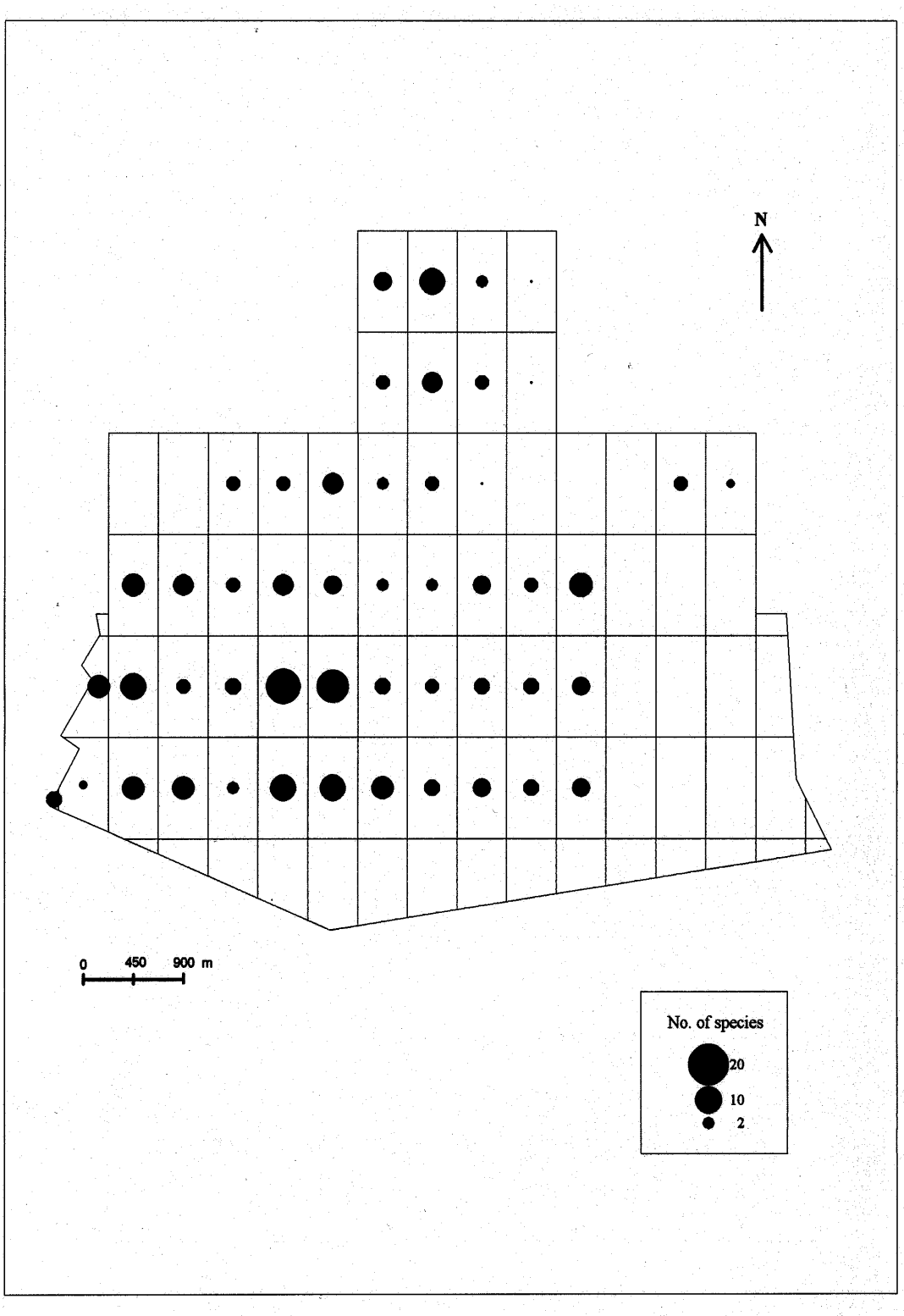

Figure 10. Distribution of submontane tree and shrub species.

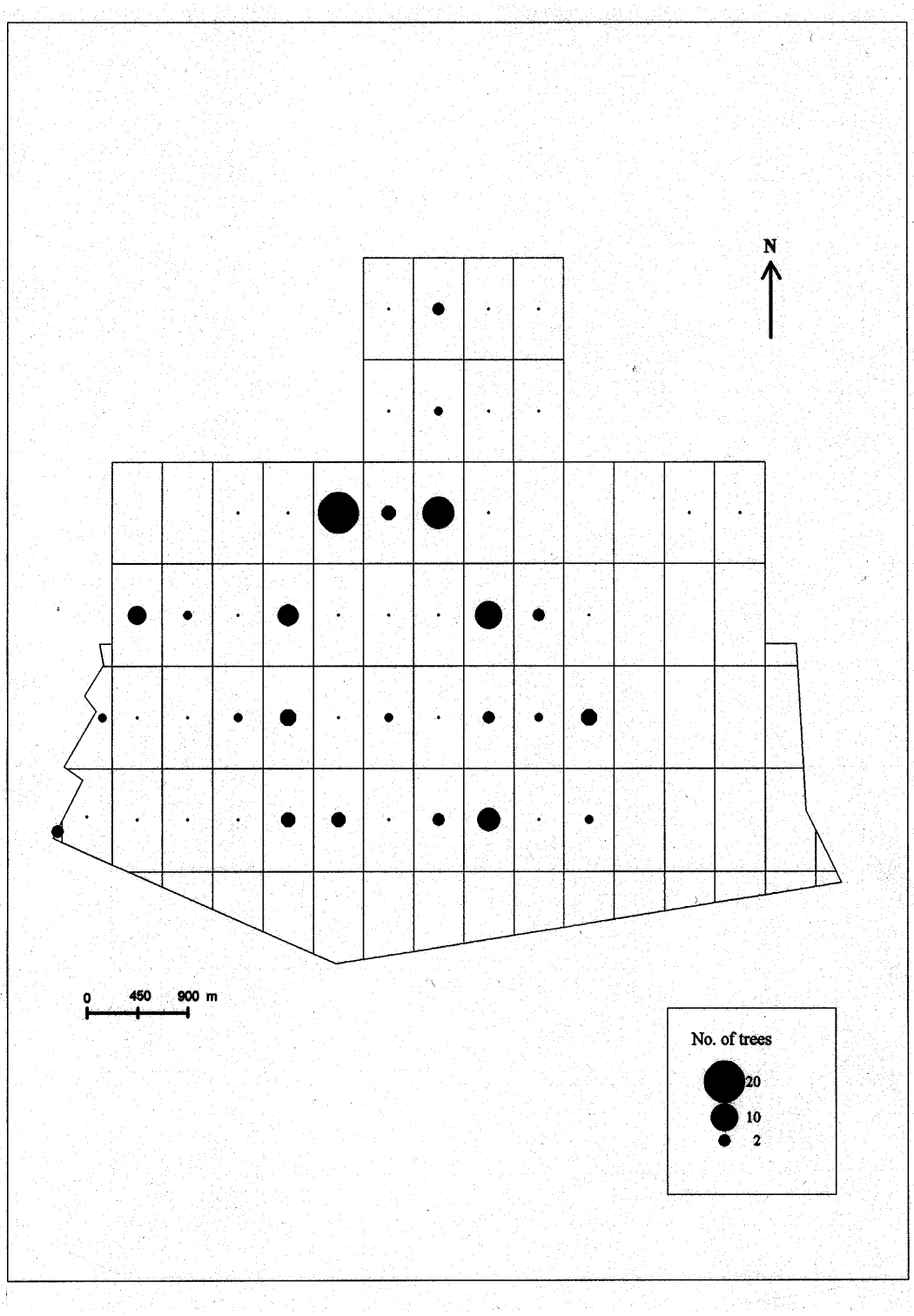

Figure 11. Distribution of endemic tree and shrub individuals.

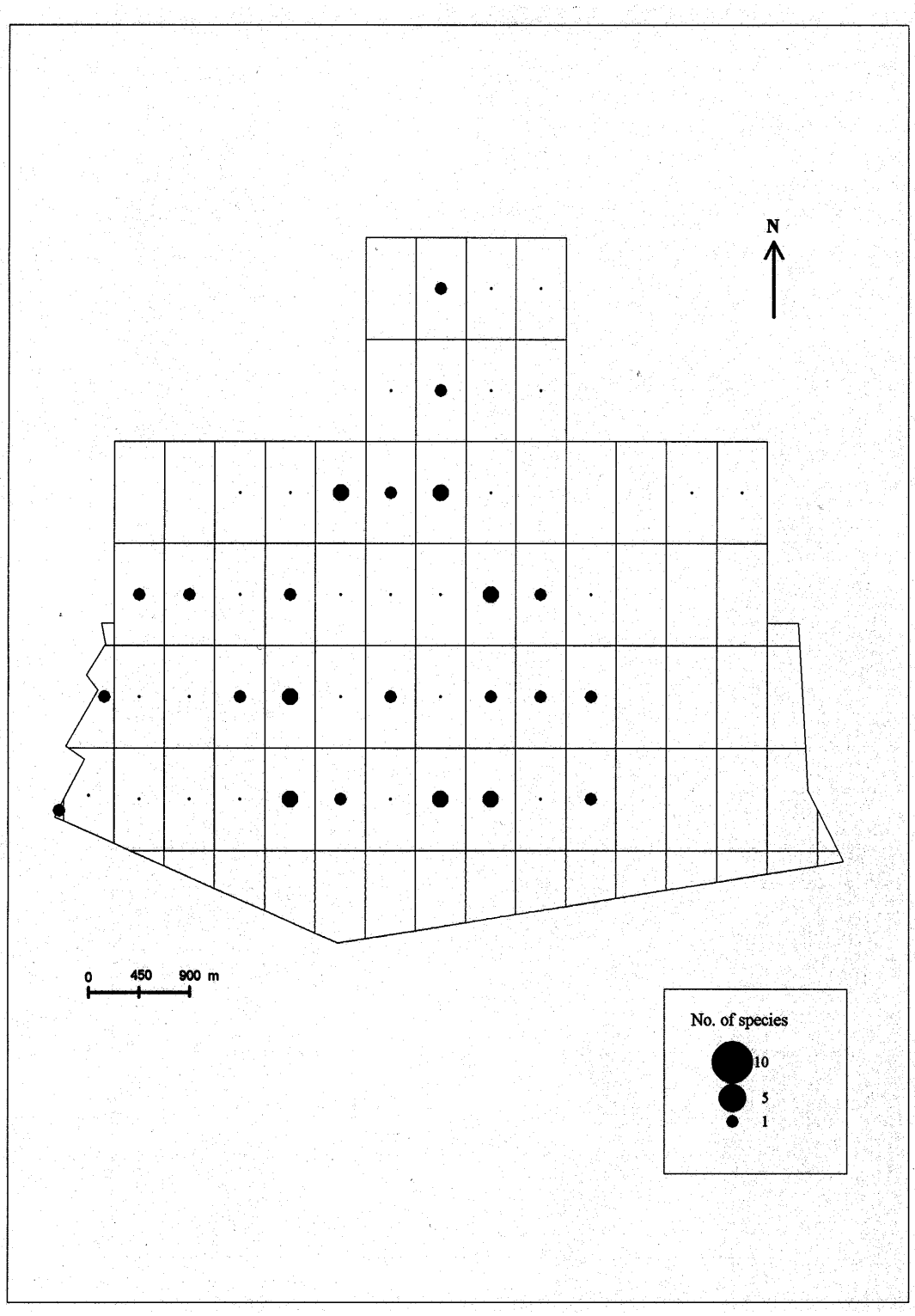

Figure 12. Distribution of endemic tree and shrub species.

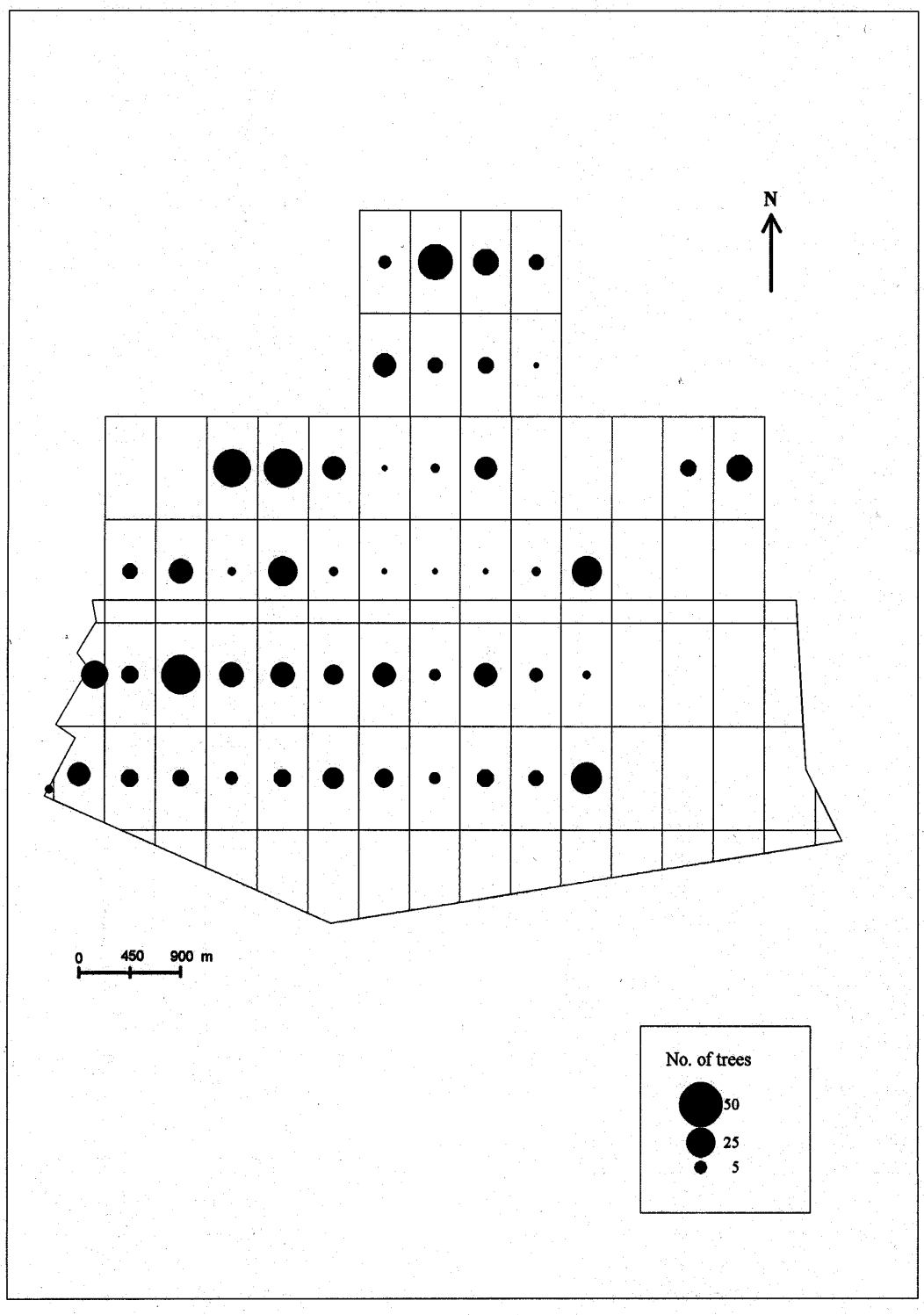

Figure 13. Distribution of near-endemic tree and shrub individuals.

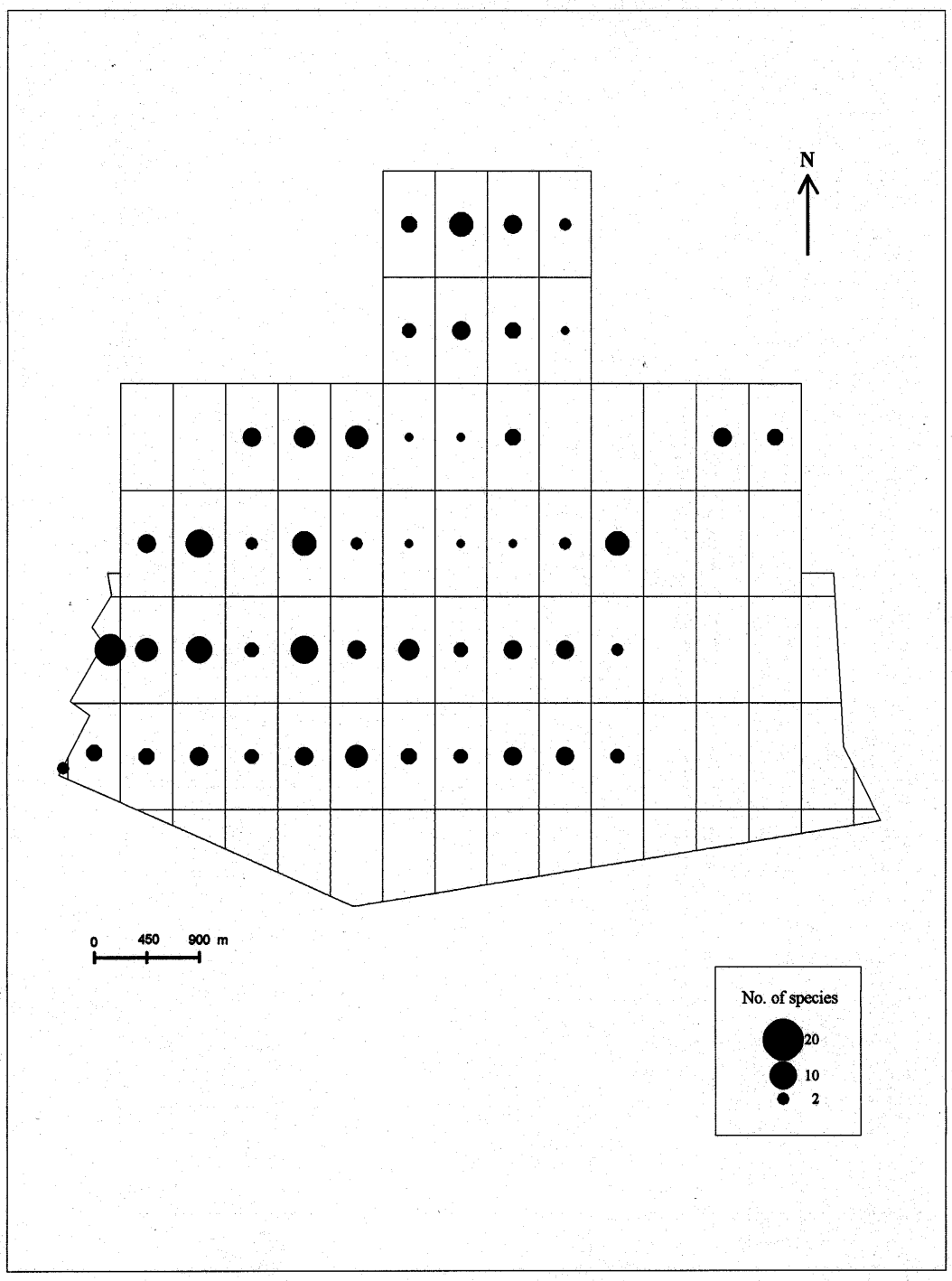

Figure 14. Distribution of near-endemic tree and shrub species.

5.3.2 Disturbance transects

Pole and timber extraction was recorded along all transects. The results of the disturbance transects are summarised in Table 13 for poles and Table 14 for timber.

Table 13. Disturbance transect results for pole counts.

Transect number	Length of transect (m)	Total poles sampled	Standing poles	Cut poles	Average per ha	Naturally fallen poles	Average per ha
-1	1850	1371	1191	67	**36**	113	**61**
0	2800	1986	1730	105	**38**	151	**54**
1	3900	2557	2355	125	**32**	77	**20**
2	4950	3432	3193	48	**10**	191	**39**
3	4500	2812	2649	31	**7**	132	**29**

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

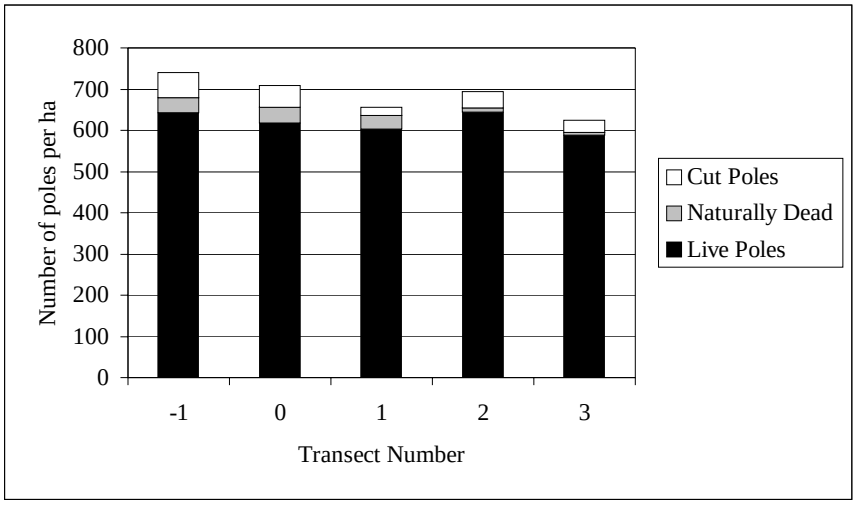

Figure 15. Cut and naturally fallen poles recorded by transect.

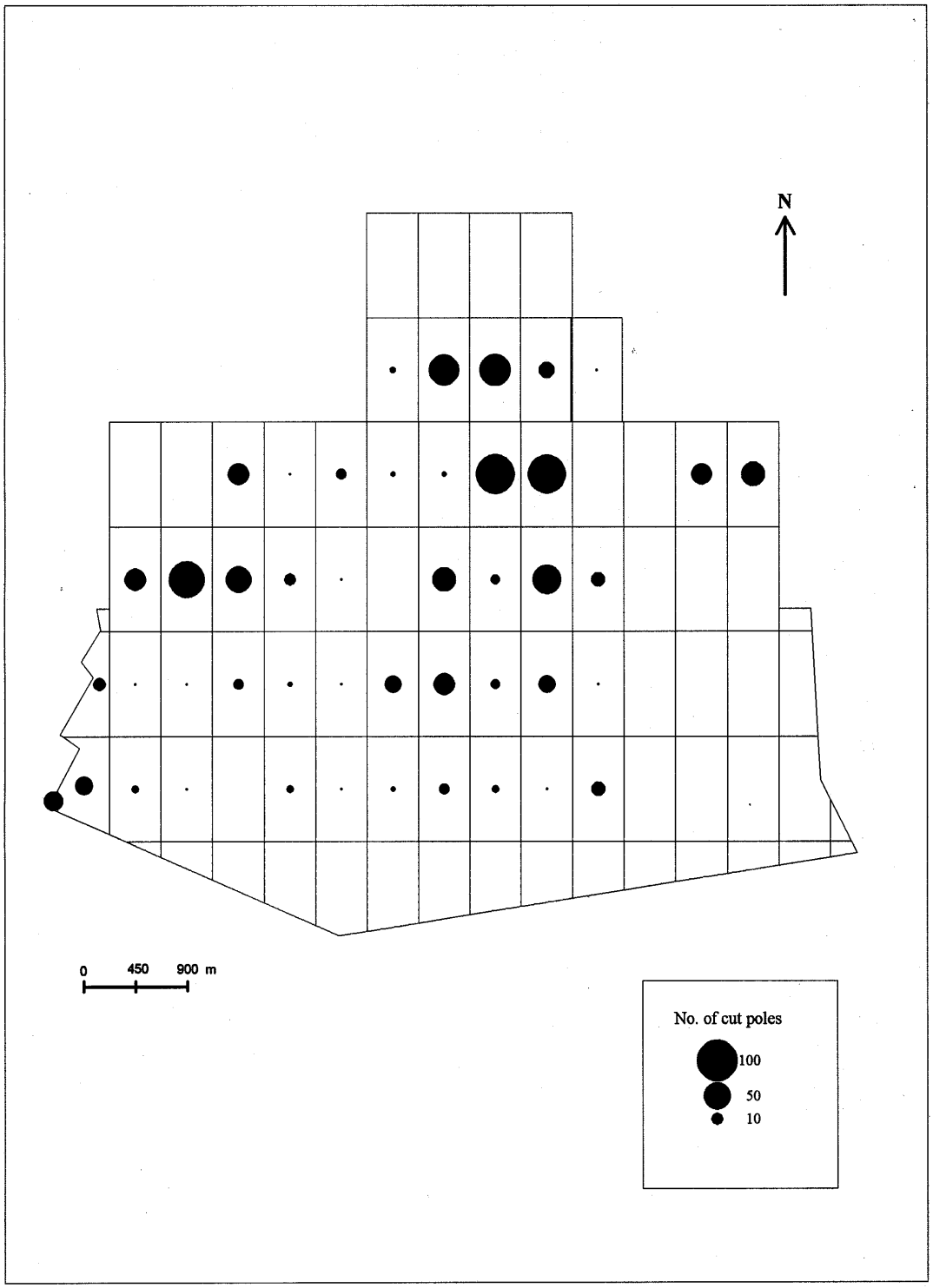

Figure 16. Distribution of pole extraction in the reserve.

Table 14. Disturbance transect results for timber counts.

Transect number	Length of transect (m)	Total timber sampled	Standing timber	Cut timber	Average per ha	Naturally fallen timber	Average per ha
-1	1850	535	435	14	**8**	86	**46**
0	2800	1065	900	30	**11**	135	**48**
1	3900	1350	1186	19	**5**	145	**37**
2	4950	1769	1551	22	**4**	196	**40**
3	4500	1187	1045	16	**4**	126	**28**

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

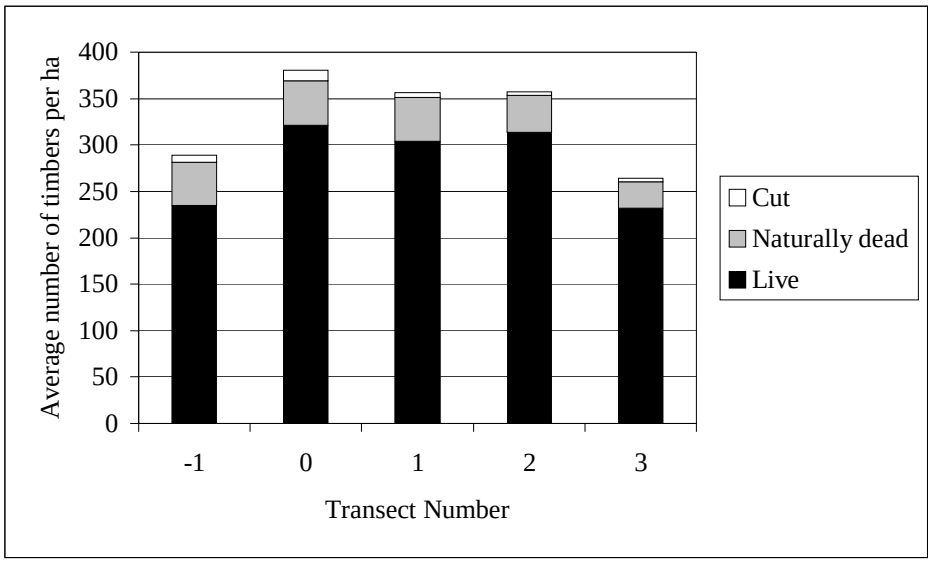

Figure 17. Cut and naturally fallen timber recorded per hectare.

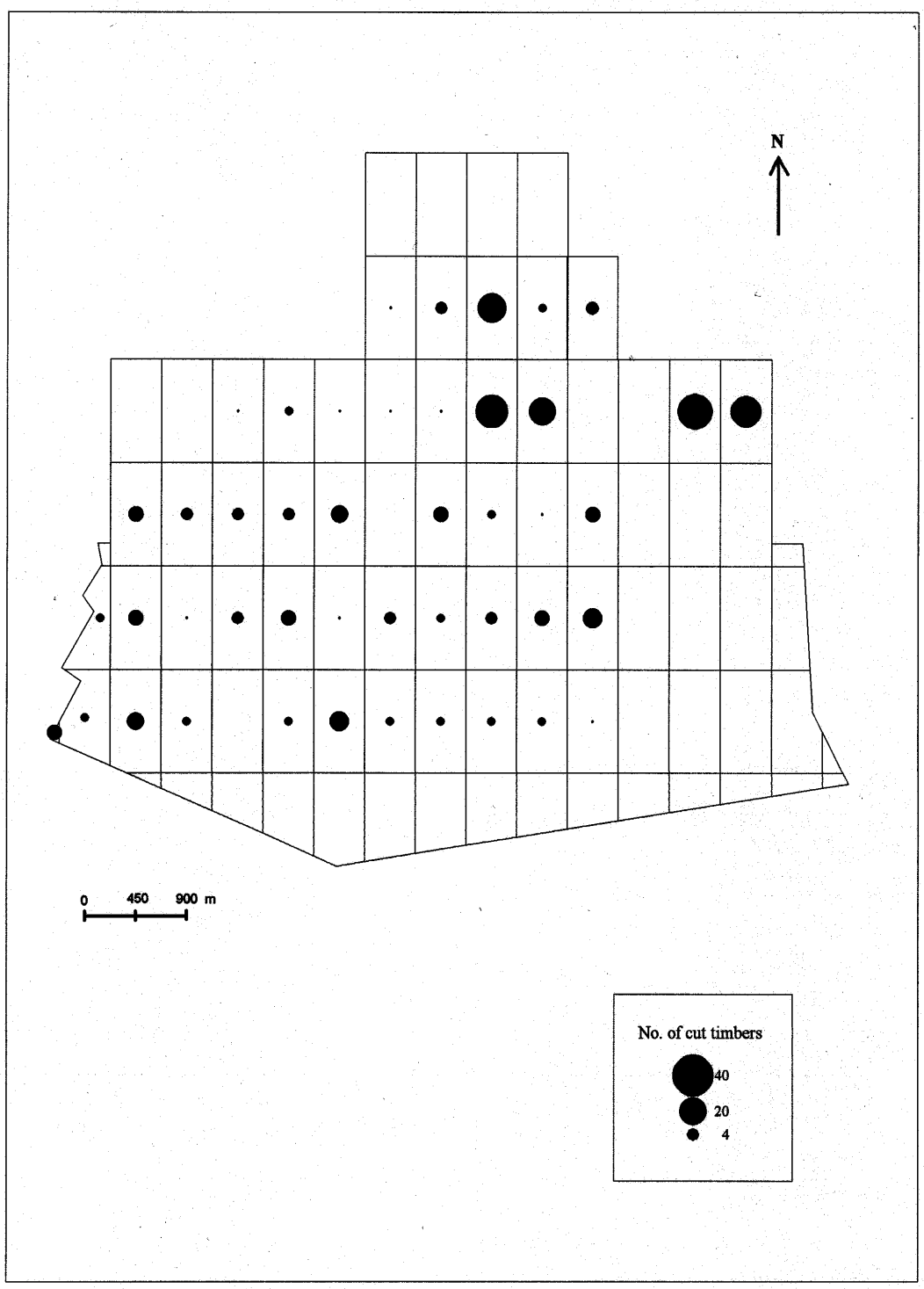

Figure 18. Distribution of timber extraction in the reserve.

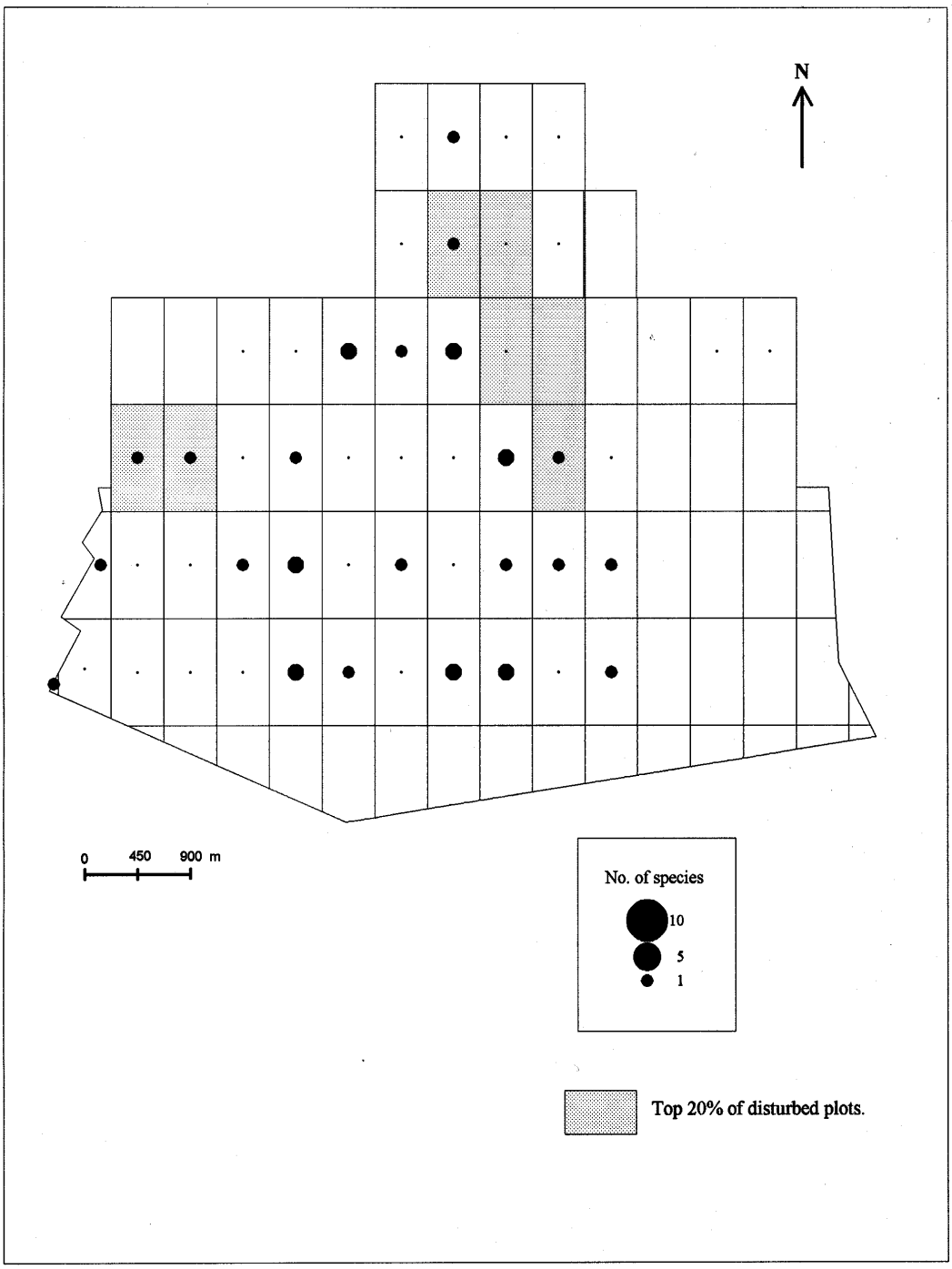

Figure 19. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.

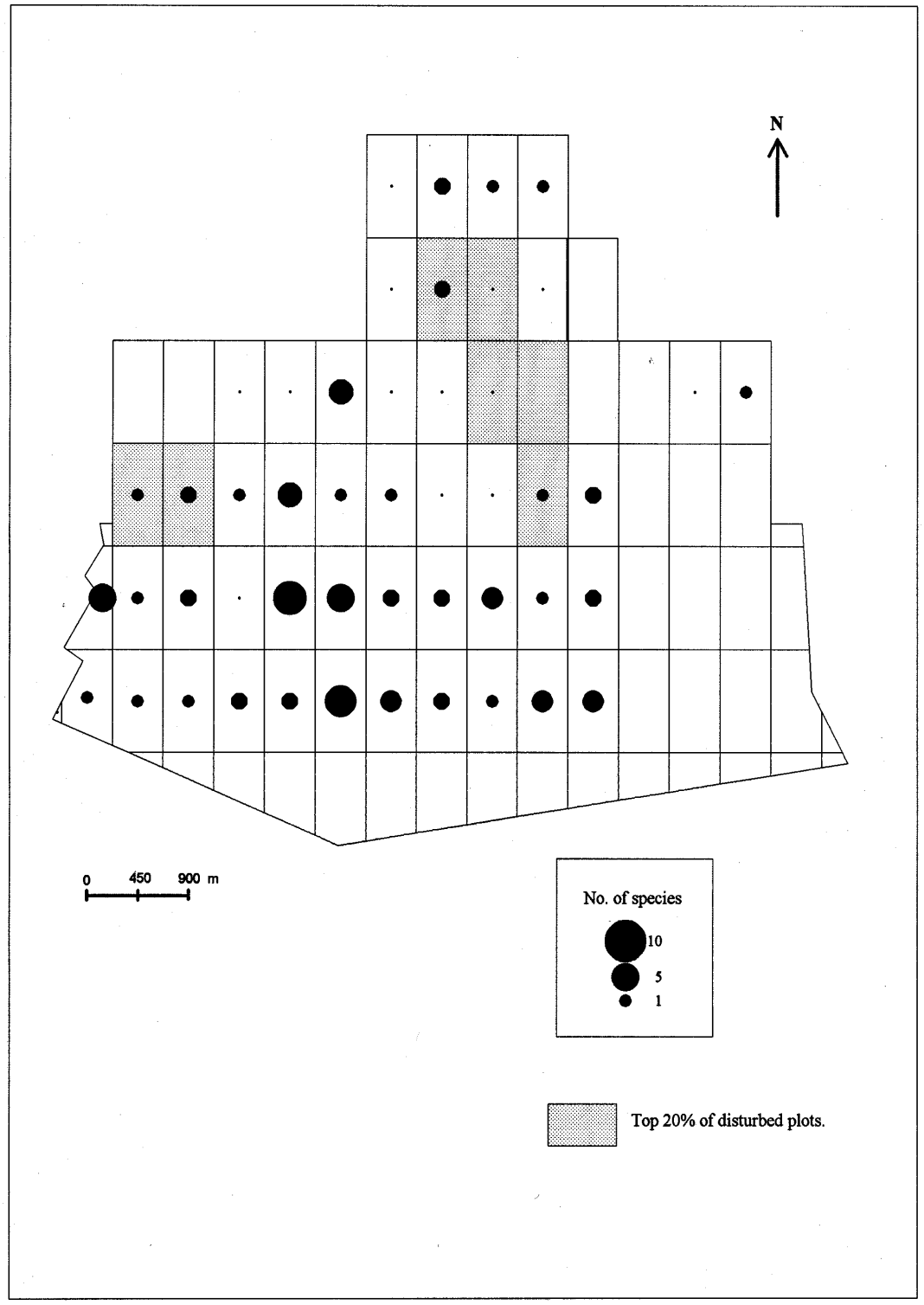

Figure 20. Areas of highest disturbance in relation to the distribution of tree and shrub species that are both forest dependent and near-endemic.

5.4 Discussion

Kwamgumi Forest Reserve covers an area of 1708.4 ha with altitudes ranging from 150 to 915 m.

Species richness

In the systematic vegetation plots 2140 trees and shrubs were surveyed, representing 192 species from 44 families. An additional four species were recorded in the regeneration plots. Casual observations from outside of the vegetation plots recorded an additional 35 species from 25 families including 10 families not previously recorded. In total 231 species from 69 families were recorded.

Of the 49 plots systematically surveyed, 34 (69.4%) of the plots analysed were recorded as mature mixed forest, 14 (28.6%) as previously disturbed or poorly mixed forest, and 1 (2.0%) as scrub under open canopy.

Species Accumulation Rates

The species accumulation rate for the 50 m x 20 m subplots increases rapidly initially and then begins to decline. The accumulation curve does not reach an asymptote indicating that the list of vascular plants of 10 cm dbh and larger is incomplete based on the systematic vegetation plots.

Ecological Type

Forest dependent species, defined as limited to primary forest only, were recorded 851 times. This represents 39.7% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve but were most abundant at higher altitude in the south. The most common forest dependent tree is *Leptonychia usambarensis*. Twenty-nine of the forest dependent species are also endemic or near-endemic to the Usambaras.

Fifteen non-forest species were recorded in 31 of the 49 plots. *Pandanus stuhlmannii* is the most common non-forest species.

Habitat

Of the tree species surveyed with known altitude characteristics, 49.5% were considered to be typical of lowland forest and 36.5% are considered typical of submontane forest. Submontane species occur in 94% of the plots surveyed in the lowland forest. This data indicates the variability in the ecological requirements and niches of these submontane species and that in the East Usambaras they are found at lower altitudes than in other areas. The most common submontane species is *Pandanus stuhlmannii*.

Endemic Status

Of the plant species recorded, 117 (61%) have widespread distributions. Near-endemics contribute 47 species (24.5%) from 22 families to the floristic composition of the reserve. These near-endemics are found in all plots and account for 616 of the surveyed specimens or 28.7% of all recorded trees and shrubs in the reserve. Of the 49 plots surveyed, 24 were found to have more than ten near-endemic trees. The most common near-endemic in the reserve is *Scorodophloeus fischeri*. Of the 47 near-endemic species, 21 species are also considered to be forest dependent. Three near-endemics are non-forest species *Julbernardia globiflora, Millettia usaramensis* and *Premna chrysoclada*.

Seven of the species surveyed are endemic to the East and West Usambaras. *Cola scheffleri, C. usambarensis, Cynometra longipedicellata, Englerodendron usambarensis* and *Psychotria brevicaulis* are endemic to the East Usambaras. *Uvariodendron pycnophyllum* and *Rinorea angustifolia* var. *albersii* are endemic to the East and West Usambaras.

Range Extensions

The following three species, recorded from Kwamgumi Forest Reserve, were listed by Iversen (1991a) as being present in the West but not East Usambara Mountains: *Albizia schimperana, Lobelia gibberoa* and *Lycopodium clavatum*. Specimens from the East Usambaras are now held at the TAFORI herbarium in Lushoto.

For the first time *Senecio mannii* was also recorded in the East Usambara Mountains. A specimen is held at the TAFORI Herbarium in Lushoto.

Regeneration

26% of the species found in the main vegetation plots were also recorded in the regeneration layer. The endemic species *Cola scheffleri, Cola usambarensis* and *Rinorea angustifolia* var. *albersii* were recorded regenerating. Four endemic species *Uvariodendron pycnophyllum, Cynometra longipedicellata, Englerodendron usambarensis* and *Psychotria brevicaulis* were not recorded regenerating.

Only one of the four principal timber species found within the reserve, *Cephalopshaera usambarensis,* was recorded as regenerating. The remaining three species *Khaya anthotheica, Milicia excelsa* and *Newtonia buchananii* were not recorded in the regneration layer.

Disturbance

In January and February 1997, subsequent to this survey, extensive fires damaged large areas of Kwamgumi Forest Reserve. The fires were associated with the failure of the short rains between September and December 1996. Areas affected include the forest around Muhinduro Peak and the forest close to Kwamtili village in the north of the reserve (Kilenga pers. comm.). Fire fighting attempts around the peak were not successful and the fires burned for many days.

Several fresh pit saw workings were observed during the survey. These were located in the east of the reserve close to Plot 13. Species being cut included *Afzelia quanzensis* and pitsawyers were know to come from Chilwa. This species was only recorded in the casual botanical surveys suggesting that it is not abundant within Kwamgumi.

The invasive species *Maesopsis eminii* was recorded in Plot 4 in the west of Kwamgumi. 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). It remains rare in Kwamgumi Forest Reserve.

6.0 FAUNA

6.1 Introduction

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

6.2 Methods

Methods used during the survey are described in detail in the FT FRP methodology report (SEE¸1996). A brief description is presented below. The locations of trap sites are presented in Figure 22.

6.2.1 Mammals

The aim of this survey was to compile a species list of the reserve's mammals. Five different methods are used to sample mammals within Kwamgumi Forest Reserve: (1) snap trap lines, (2) bucket pitfalls, (3) bat netting (4) dung surveys and (5) opportunistic observations. Unless otherwise indicated, specimens were identified by Prof. K. M. Howell or by Dr. D. Kock (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the Frankfurt Zoological Museum.

6.2.1.1 Snap-trap lines

Rodents were sampled using large break-back traps (snap-traps). Typically the traps were set out in three lines of approximately 33, with traps positioned at least 2 m apart. The traps were set each evening and checked early the following morning. Fifty percent of the traps were baited with fried coconut rolled in peanut butter, 25% with fish and 25% with oatmeal and peanut butter. Each mammal caught was weighed and measured and detailed habitat notes were recorded. Trapping and biometric data was recorded on standardised data sheets.

6.2.1.2 Bucket pitfall trapping

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

6.2.1.3 Bat netting

Nocturnal mist netting was used to sample the forest's bats. Mist nets were placed near potential roost sites and across flight "corridors", such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed shortly

before dawn for 11 nights. Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets

6.2.1.4 Dung survey

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

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

6.2.1.5 Mammal observations

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

6.2.2 Birds

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

6.2.3 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 6.2.1.2 above). Opportunistic captures were also made by hand, or with a snake stick where necessary. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or Dr. D. Broadley (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the Natural History Museum of Zimbabwe.

6.2.4 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 6.2.1.2 above). Opportunistic captures were also made, particularly of tree frogs. After rain, typical amphibian habitats were targeted for sampling. Unless otherwise indicated, taxonomic identifications were made by Prof. K. Howell or by Prof. J. Poynton (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the British Natural History Museum.

6.2.5 Invertebrates

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

6.2.5.1 Butterflies

The aim of this study was to compile a species list of the reserve's butterflies. Butterflies were sampled using Blendon-style traps set in the tree canopy. Rotting banana was

used as bait. Traps were checked at midday. Five traps are set for 10 nights in each of the five trapping sites. Unless otherwise indicated, taxonomic identifications were provided by Steve Collins (see Appendix 2). Specimens are deposited at the African Butterfly Research Institute.

6.2.5.2 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 3 cm of soil was searched carefully for molluscs. All specimens were collected. Unless otherwise indicated, taxonomic identifications were made by Dr. B. Verdcourt (see Appendix 3).

6.2.5.3 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 3 cm of soil was searched carefully for millipedes. All specimens were collected. Unless otherwise indicated, taxonomic identifications were made by Dr. R. Hoffman (see Appendix 3). Specimens are deposited at the Virginia Museum of Natural History.

6.3 Trapping sites and sampling intensity

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

Table 15. Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
1	secondary forest near overgrown road; overbank flood plain	160	gentle lower slope	0
3	lowland forest	300	gentle mid-slope	0
13	lowland forest	500	gentle mid-slope	0
28	transitional forest	910	ridge top	5
39	lowland forest within 200 m of farmland	220	gentle lower slope	15

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

Trapping method	Plot 1	Plot 3	Plot 13	Plot 28	Plot 39
Date	Jan 28 - Mar 20 1995	Oct 18 - 27 1996	Oct 30-Nov 8 1996	Nov 15 - 24 1996	Nov 28-Dec 7 1996
snap traps	425	991	965	994	997
Bucket pitfall*	91**	330	330	330	330
Butterfly traps	50	50	50	50	50
Molluscs***	3	3	3	3	3
Millipedes***	3	3	3	3	3

* Each bucket represents one trap night.
** Unknown number of buckets. This number represents number of trap nights only.
***This represents plots sampled not trap nights.

Table 17. Summary of bat-netting sites.

Site description	Sampling intensity (hours)	Altitude	Topography
Over Muzi River; riverine forest; 200 m north of north-west corner of reserve; forest edge	20	150	bottom of hill (riverine)
Plot 9: Forest near top of Mt. Kwachawa	12	900	ridge top
Plot 11: Forest edge; secondary forest; overbank flood plain; overgrown road	18	150	gentle lower slope

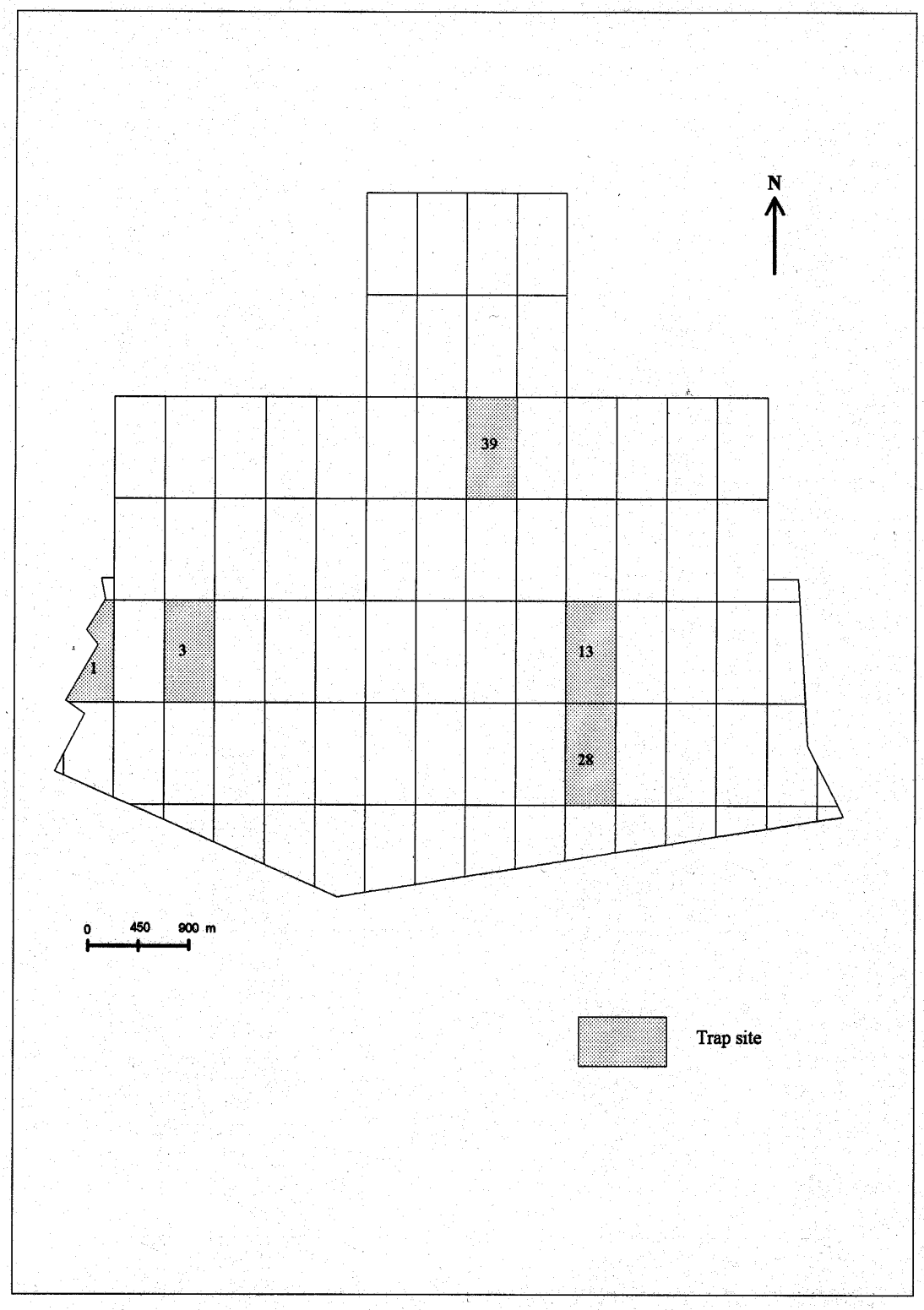

Figure 21. Location of trapping sites.

6.4 Results

6.4.1 Mammals

6.4.1.1 Small mammals

A total of 68 specimens were retained for taxonomic purposes. These represent at least 14 species from five families. Many have yet to be identified to species level. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996), Kingdon (1989) and Kingdon (1997). Nomenclature follows Kingdon (1997).

Table 18. Summary of small mammals.

Species	**Ecol. type**	**End. status**	**End. status**	**Capture location by plot and number collected**							**Total**
				1	3	4	13	28	39	OR	
CRICETIDAE											
Lesser pouched rat											
Beamys hindei	f	N	V	2	1		5	4			**12**
MURIDAE											
Black rat											
*Rattus rattus**	O	W								2	**2**
Brush-furred mice											
Lophuromys flavopunctatus	f	W		1							**1**
Lophuromys sp.	?	?		1				1			**2**
Narrow-footed woodland mice											
Grammomys sp.	?	?		4			1				**5**
Spiny mice											
Acomys sp.	?	?		1							**1**
Soft-furred mice											
Praomys sp.	?	?					1	10			**11**
African dormice											
Graphiurus sp.	?	?						3		1	**4**
Zebra mice											
Lemniscomys sp.**	?	?								1	**1**
Rodents not yet identified.							1	1			**2**
MACROSCELIDIDAE											
Four-toed elephant shrew											
Petrodromus tetradactylus	f	W		1	1						**2**
Zanj elephant shrew											
Rhynchocyon petersi	F	N	EN							1	**1**
SORICIDAE											
White-toothed shrews											
Crocidura sp.	?	?		3	1		3	11			**18**
PROCAVIDAE											
Tree hyrax											
Dendrohyrax sp.	?	?				1					**1**

* Found in the adjoining Segoma Forest Reserve.

KEY TO ABBREVIATIONS FOR TABLE 18 (Definitions based on those described in Section 1.2).

Ecological (ecol.) type:

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

Endemic (end.) status:
- 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

* Captured in cocoa plantation approximately 200 m from the north-west corner of the reserve.
** Found in the adjoining Segoma Forest Reserve.
OR Outside reserve
? – No data available.

6.4.1.2 Dung survey

Dung from at least six 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 *Cephalophus monticola* and other duiker species may not be reliable.

Table 19. Abundance of duiker, bushbuck and hyrax dung.

		Duiker		Bushbuck		Hyrax	
Transect	**Transect length**	**Dung sitings**	**Rate / ha**	**Dung sitings**	**Rate / ha**	**Dung sitings**	**Rate / ha**
-1	1850	0	0.0	0	0	0	0.0
0	2800	2	1.8	0	0	0	0.0
1	3900	15	9.6	0	0	1	0.6
2	4950	16	8.1	0	0	3	1.5
3	4500	9	5.0	0	0	0	0.0

Table 20. Summary of dung survey.

Species	**Ecol. type**	**End. status**	**IUCN status**	**Times encountered**	**Altitudinal range (m)**
GALAGONIDAE					
Small-eared galago					
Otolemur crassicaudatus	f	W		**1**	300
THRYONOMYIDAE					
Cane rat					
Thryonomys sp.				**4**	300 - 770
VIVERRIDAE					
Unidentified sp.				**1**	300
PROCAVIDAE					
Eastern tree hyrax					
Dendrohyrax validus	f	N	V	**4**	300 - 525
BOVIDAE					
Blue duiker					
Cephalophus monticola	f	W		**9**	300 - 460
Unidentifiable duiker				**32**	165 - 770

KEY TO ABBREVIATIONS FOR TABLE 19 (Definitions based on those described in Section 1.2).

Ecological (ecol.) type:

- 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

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

6.4.1.3 Mammal observations

A total of 12 species from seven families were observed but not retained for taxonomic purposes. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Kingdon (1989). Nomenclature follows Kingdon (1997).

Table 21. Summary of mammal observations.

Species	Certainty	Ecological type	Endemic status	IUCN status	Observation location
COLOBIDAE					
Angola pied colobus					
Colobus angolensis	definite	F	W		Plot 10, 14
CERCOPITHECIDAE					
Yellow baboon					
Papio cynocephalus	definite	f	W		forest edge
Gentle monkey					
Cercopithecus mitis	definite	f	W		Plot 1
GALAGONIDAE					
Matundu galago					
Galagoides sp. nov. '*udzungwensis*'	definite	f	N		Unknown
SCIURIDAE					
Red-legged sun squirrel					
Heliosciurus rufobrachium	probable	f	W		Unknown
Red-bellied coast squirrel					
Paraxerus palliatus	probable	f	W		Unknown
ANOMALURIDAE					
Lord Derby's anomalure					
Anomalurus derbianus	probable	f	W		Outside reserve on forest edge
VIVERRIDAE					
Genet					
Genneta sp.	probable				Cocoa plantation
African civet					
Civettictis civetta	probable	f	W		Cocoa plantation
African palm civet					
Nandinia binotata	definite	f	W		Forest and Cocoa plantation
BOVIDAE					
Blue duiker					
Cephalophus monticola	probable	f	W		Unknown
Bush pig					
Potamochoerus larvatus	definite	f	W		Cocoa plantation

KEY TO ABBREVIATIONS FOR TABLE 21 (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

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

IUCN status:
- NT - Near-threatened

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.

6.4.1.4 Bats

A total of 28 individuals were retained for taxonomic purposes. These represent 17 species from six families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Kingdon (1974). Nomenclature follows Kingdon (1997) and Kingdon (1974).

Table 22. Summary of bats.

Species	Ecol. type	End. status	IUCN status	Capture location by plot and number collected					Total
				9	11	OR*	OR **	OR ***	
Megachiroptera									
PTEROPODIDAE									
Egyptian rousette bat									
Rousettus aegyptiacus leachi	f	W						4	**4**
Angola fruit bat									
Lissonycteris angolensis	F	W		2					**2**
Epauletted fruit bat									
Epomophorus wahlbergi	f	W						3	**3**
Microchiroptera									
NYCTERIDAE									
Slit-faced bat									
Nycteris hispida	O	W						1	**1**
Nycteris grandis	F	W			1			1	**2**
EMBALLONURIDAE									
Tomb bat									
Taphozous (t.) mauritianus	O	W					1		**1**
MOLOSSIDAE									
Guano bat									
Tadarida (Mops) brachyptera	f	W				1			**1**
Tadarida (Chaerophon) ansorgei	?	W						2	**2**
HIPPOSIDERIDAE									
Leaf-nosed bat									
Hipposideros ruber	f	W						1	**1**
VESPERTILIONIDAE									
Persian leaf-nosed bat									
Triaenops persicus	f	W						3	**3**
Butterfly bat									
Chalinolobus argentata	f	W						1	**1**
Serotine bat									
Eptesicus flavescens	?	?						1	**1**
Hairy bat									
Myotis bocagei	f	W						2	**2**
Evening bat									
Scotoecus hirundo	O	W						1	**1**
Scotoecus hindei	?	W						1	**1**
House bat									
Scotophilus nucella	?	W						1	**1**
Pipistrelle									
Pipistrellus nanus	f	W						1	**1**

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

Ecological (Ecol.) type:

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

Endemic (End.) status:

- W - Widespread distribution.

OR - Refers to observations outside but in proximity to the reserve to be considered associated to it.
* Inside house on a cocoa plantation
** Over overgrown road
*** Over Muzi river
? - No data available

6.4.2 Birds

A total of 68 species from 31 families were recorded. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1997), IUCN (1996) and Zimmerman *et al.* (1996). Nomenclature follows Zimmerman et al. (1996).

Table 23. Summary of birds.

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
ACCIPITRIDAE					
Gypohierax angolensis	Palm-nut vulture	f	W	LC	II
Polyboroides typus	African harrier hawk	f	W	LC	II
Stephanoaetus coronatus	African crowned eagle	f	W	LC	II
NUMIDIDAE					
Guttera pucherani	Crested guineafowl	f	W		
COLUMBIDAE					
Columba delegorguei	Eastern bronze naped pigeon	F	W		
Turtur tympanistria	Tambourine dove	f	W		
MUSOPHAGIDAE					
Tauraco fischeri	Fischer's turaco	f	W	NT	II
CUCULIDAE					
Centropus superciliosus	White-browed coucal	O	W		
Cercococcyx montanus	Barred long-tailed cuckoo	F	W		
Chrysococcyx klaas	Klaas's cuckoo	f	W		
Chrysococcyx cupreus	African emerald cuckoo	f	W		
Ceuthmochares aereus	Yellowbill	f	W		
STRIGIDAE					
Otus ireneae	Sokoke scops owl	f	N		
Bubo vosseleri	Usambara eagle-owl	F	E (E&W)		
APODIDAE					
Cypsiurus parvus	African palm-swift	O	W		
Neafrapus boehmi	Bohm's spintetail	f	W		
Telacanthura ussheri	Mottled spinetail	f	W		
TROGONIDAE					
Apaloderma narina	Narina trogon	f	W		
ALCEDINIDAE					
Halcyon albiventris	Brown-hooded kingfisher	f	W		
PHOENICULIDAE					
Phoeniculus purpureus	Green wood-hoopoe	f	W		
BUCEROTIDAE					
Bycanistes brevis	Silvery-cheeked hornbill	f	W		
Bycanistes bucinator	Trumpeter hornbill	f	W		
Tockus alboterminatus	Crowned hornbill	f	W		
CAPITONIDAE					
Stactolaema leucotis	White-eared barbet	f	W		
Stactolaema olivacea	Green barbet	F	W	LC	
PICIDAE					
Campethera mombassica	Mombasa woodpecker	f	W		
Campethera cailliautii	Green-backed woodpecker	f	W		
Dendropicos fuscescens	Cardinal woodpecker	f	W		
EURYLAIMIDAE					
Smithornis capensis	African broadbill	F	W	LC	

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
HIRUNDINIDAE					
Hirundo abyssinica	Lesser striped swallow	f	W		
PYCNONOTIDAE					
Chlorocichla flaviventris	Yellow-bellied greenbul	f	W		
Nicator gularis	Eastern nicator	f	W		
Phyllastrephus debilis	Tiny greenbul	F	W		
Phyllastrephus flavostriatus	Yellow-streaked greenbul	F	W		
Pycnonotus barbatus	Common bulbul	f	W		
TIMALIIDAE					
Illadopsis rufipennis	Pale-breasted illadopsis	F	W		
TURDIDAE					
Swynnertonia swynnertoni	Swynnerton's robin	F	N	V	
Cossypha natalensis	Red-capped robin-chat	f	W		
Neocossyphus rufus	Red-tailed ant thrush	f	W		
Sheppardia gunningi	East Coast akalat	F	W	V	
MUSCICAPIDAE					
Muscicapa caerulescens	Ashy flycatcher	f	W		
Myioparus plumbeus	Lead-coloured flycatcher	f	W		
SYLVIIDAE					
Camaroptera brachyura	Grey-backed camaroptera	f	W		
Apalis melanocephala	Black-headed apalis	F	W		
Macrosphenus kretschmeri	Kretschmer's longbill	F	W		
Prinia subflava	Tawny flanked prinia	O	W		
MONARCHIDAE					
Erythrocercus holochlorus	Little yellow flycatcher	f	W		
Terpsiphone viridis	African paradise flycatcher	f	W		
Trochocercus cyanomelas	Blue-mantled crested flycatcher	F	W		
PLATYSTEIRIDAE					
Batis mixta	Forest batis	f	W		
Bias musicus	Crested shrike-flycatcher	F	W		
PRIONOPIDAE					
Prionops retzii	Retz's helmet-shrike	f	W		
Prionops scopifrons	Chestnut helmet-shrike	f	W		
MALACONOTIDAE					
Dryoscopus cubla	Black-backed puffback	f	W		
Laniarius aethiopicus	Tropical boubou	f	W		
CAMPEPHAGIDAE					
Coracina caesia	Grey cuckoo-shrike	F	W	LC	
DICRURIDAE					
Dicrurus ludwigii	Square-tailed drongo	f	W		
ORIOLIDAE					
Oriolus auratus	African golden oriole	f	W		
Oriolus chlorocephalus	Green-headed oriole	F	W		
STURNIDAE					
Lamprotornis corruscus	Black-bellied starling	f	W		
Onychognathus walleri	Waller's starling	F	W		
NECTARINIIDAE					
Anthreptes collaris	Collared sunbird	f	W		
Anthreptes neglectus	Uluguru violet-backed sunbird	F	W		
Anthreptes reichenowi	Plain-backed sunbird	F	W	NT	
Nectarinia olivacea	Olive sunbird	f	W		

Species	Common name	Ecological type	Endemic status	IUCN status	CITES
PLOCEIDAE					
Ploceus bicolor	Dark-backed weaver	f	W		
ESTRILDIDAE					
Hypargos niveoguttatus	Peter's twinspot	f	W		
Spermophaga ruficapilla	Red-headed bluebill	F	W		

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

Ecological (Ecol.) type:

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

Endemic (End.) status:

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

6.4.3 Reptiles

A total of 72 individuals were retained for taxonomic purposes. These specimens represent 28 species from 12 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1996), IUCN (1996), Broadley & Howell (unpubl.), Howell (1993), and Branch (1994). Nomenclature follows Broadley and Howell (1991).

Table 24. Summary of reptiles.

Species	Ecol. Type	End. Status	IUCN status	Capture location by plot and number collected									Total
				1	3	13	28	38	39	Plots with a single specimen	OR	UK	
TESTUDINIDAE													
Southeastern hinge-back tortoise													
Kinixys sp. (juv)		W									1		**1**
GEKKONIDAE													
Usambara forest gecko													
Cnemaspis africana	F	W	NT			2	5						**7**
Uluguru forest gecko													
Cnemaspis barbouri	F	N	EN							11		2	**3**
Baobab gecko													
Hemidactylus platycephalus	f	W									1		**1**
Tropical house gecko													
Hemidactylus mabouia	f	W			4						2	1	**7**
CHAMAELEONIDAE													
Bearded pigmy-chameleon													
Rhampholeon brevicaudatus	F	N	V		2				1*	24		1	**5**
Common flap-necked chameleon													
Chamaeleo dilepis	f	W								11	2	3	**6**
SCINCIDAE													
Speckle-lipped skink													
Mabuya maculilabris	f	W				3			1		1		**5**
Kilimanjaro five-toed skink													
Leptosiaphos kilimensis	F	N	V			1	2						**3**
LACERTIDAE													
East African spiny-tailed lizard													
Cordylus t. tropidosternum	f	W		1	1				1		1		**4**
CORDYLIDAE													
Southern tawny plated-lizard													
Gerrhosaurus m. major	f	W								20			**1**
VARANIDAE													
Nile monitor													
Varanus niloticus	f	W									1		**1**
TYPHLOPIDAE													
Usambara blind-snake													
Typhlops gierrai	F	N	V				1						**1**
LEPTOTYPHLOPIDAE													
Worm-snake													
Leptotyphlops macrops	F	N	V							23			**1**
BOIDAE													
Northern African python													
Python sebae	O	W									1		**1**

Species	Ecol. Type	End. Status	IUCN status	Capture location by plot and number collected									Total
				1	3	13	28	38	39	Plots with a single specimen	OR	UK	
ELAPIDAE													
Forest cobra													
Naja melanoleuca	F	W									1	1	**2**
Eastern green mamba													
Dendroaspis angusticeps	f	W										1	**1**
Usambara garter-snake													
Elapsoidea nigra	F	N	V							5			**1**
COLUBRIDAE													
Half-banded shovel-snout													
Prosymna semifasciata	F	E	CR							11			**1**
Spotted bush-snake													
Philothamnus punctatus	f	W								45	1		**2**
Usambara green-snake													
Philothamnus macrops	F	N	V							10, 34	1		**3**
Speckled wolf-snake													
Lycophidion meleagre	F	W								5			**1**
Olive marsh-snake													
Natriciteres olivacea	F	W									3		**3**
Tornier's cat snake													
Crotaphopeltis tornieri	F	W	V			1			1		2		**4**
Herald snake													
Crotaphopeltis hotamboeia	O	W		1						5	1		**3**
Mozambique vine-snake													
Thelotornis capensis	F	W									1		**1**
Brown house-snake													
Lamprophis capensis mossambicanus	F	W						1					**1**
Boomslang													
Dispholidus typus	O	W									2		**2**

KEY TO ABBREVIATIONS FOR TABLE 24 (Definitions based on those described in Section 1.2).

Ecological type:

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

Endemic status:

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

IUCN status:

- CR - Critical Risk
- EN - Endangered
- V - Vulnerable
- NT - Near-threatened

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

Table 25. Ranges for endemic and near-endemic reptile species recorded (Howell, 1993).

Endemic Species	**Range**
Prosymna semifasciata sp. nov.	East Usambaras
Near-endemic Species	**Range**
Typhlops gierrai	Usambaras; Ulugurus; Uzungwas; Ukinga
Leptotyphlops macrops	?
Philothamnus macrops	Usambaras; Coastal forest
Elapsoidea nigra	East Usambaras; West Usambaras; Ulugurus
Leptosiaphos kilimensis	Kenya, Northern Tanzania
Rhampholeon brevicaudatus	East Usambaras; Ulugurus; Uzungwas; Coastal forest
Cnemaspis barbouri	East Usambaras; Ulugurus

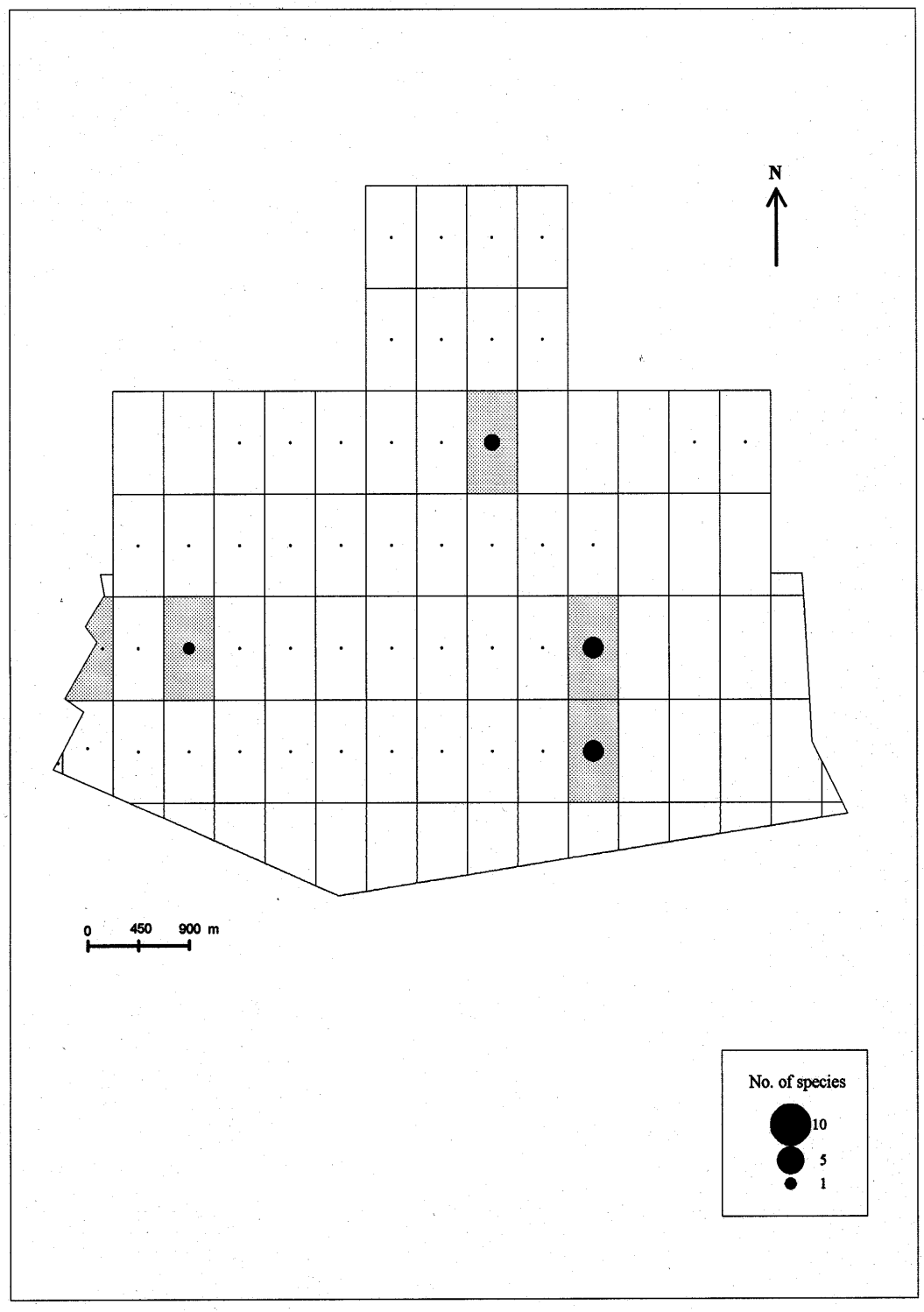

Figure 22. Distribution of forest dependent reptile species.

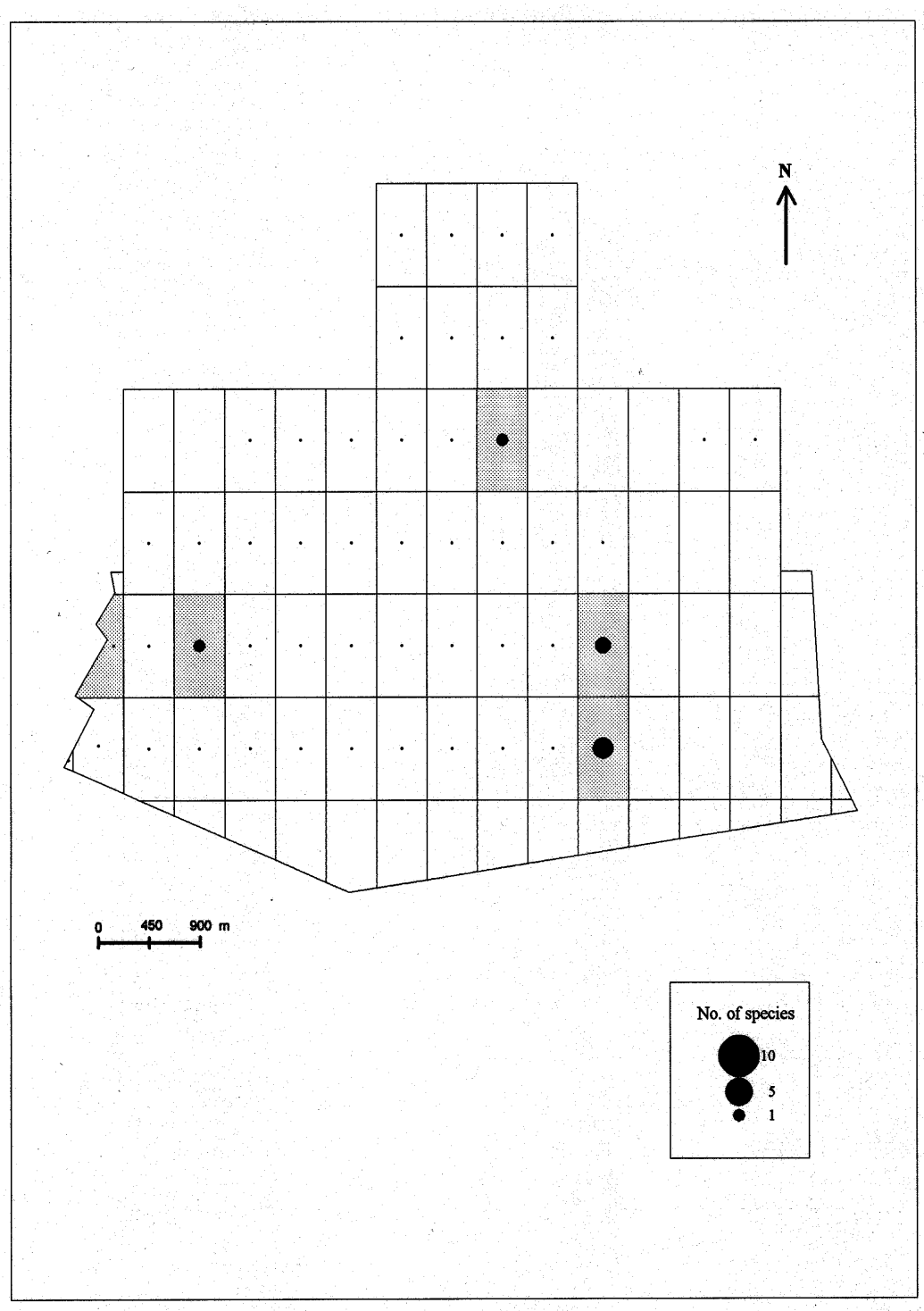

Figure 23. Distribution of near-endemic reptile species.

6.4.4 Amphibians

A total of 147 individuals were retained for taxonomic purposes. These specimens represent 24 species from 7 families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), IUCN (1996) and Poynton & Broadley (1991). Identifications were provided by either Professor K. M. Howell or Professor J. C. Poynton. Common names are taken from Passmore and Carruthers (1995).

Table 26. Summary of amphibians.

Species	**Ecol. type**	**End. status**	**IUCN status**	**Capture site and number collected**							**Total**
				UK	0R	1	3	28	39	Plots with a single specimen	
ARTHROLEPTIDAE											
Arthroleptis xenodactyloides	f	W		12		1	1		1	2	**16**
Shovel-footed squeaker											
Arthroleptis stenodactylus	f	W		2		1	3	1	1	13	**9**
Arthroleptis sp.				12			2	6	1		**20**
BUFONIDAE											
Bufo brauni	F	N	V	5			1				**6**
Bufo sp.				2							**2**
Stephopaedes sp. nov.				2		1					**3**
Nectophrynoides tornieri	F	N	V					7			**7**
Nectophrynoides sp.								1			**1**
Mertensophryne micranotis	F	N	EN	1			1				**2**
HYPEROLIDAE											
Leptopelis flavomaculatus	F	W		5							**5**
Leptopelis uluguruensis	F	N	V					1		9, 20	**3**
Leptopelis parkeri	F	N	V	3							**3**
Leptopelis vermiculatus	F	N	NT	2							**2**
Hyperolius mitchelli	F	W		1							**1**
Hyperolius puncticulatus	F	W		2							**2**
Afrixalus brachycnemis?				1							**1**
Afrixalus sp.				3							**3**
MICROHYLIDAE											
Probreviceps macrodactylus	F	N	NT					2			**2**
Probreviceps sp.								21			**21**
Callulina kreffti	F	N	V				1	1	1		**3**
Hoplophryne rogersi	F	E (E&W)	V			1					**1**
RANIDAE											
East African puddle frog											
Phrynobatrachus acridoides	f	W		1	1						**2**
Phrynobatrachus mababiensis	f	W				1					**1**
Phrynobatrachus ?*ukingensis*	F	Range?								2	**1**
Arthroleptides martiensseni	F	N	V	1							**1**
Plain grass frog											
Ptychadena anchietae	f	W		1	1						**2**
Common river frog											
Rana angolensis										2	**1**

Table 25 Cont.

Species	Ecol. type	End. status	IUCN status	Capture site and number collected							Total
				UK	0R	1	3	28	39	Plots with a single specimen	
RHACOPHORIDAE											
Foam-nest treefrog											
Chiromantis xerampelina	f	W		3	1	1					**5**
SCOLECOMORPHIDAE											
Scolecomorphus vittatus	F	N	V				2				**2**
Unidentified				15					2	29	**18**

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

Ecological type:

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

Endemic status:

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

IUCN status:

- CR - Critical Risk
- EN - Endangered
- V - Vulnerable
- NT - Near-threatened

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

Table 27. Ranges for endemic and near-endemic amphibian species recorded (Howell, 1993).

Endemic species	
Hoplophryne rogersi	Usambara and Magrotto Mountains
Near-endemic species	**Range**
Bufo brauni	East Usambaras; West Usambaras; Ulugurus; Uzungwas;
Nectophrynoides tornieri	East Usambara, Uluguru, Nguru and Udzungwa Mountains
Mertensophryne micranotis	Coastal Forests and E. Usambaras
Leptopelis uluguruensis	Usambara, Uluguru, Nguru and Udzungwa Mountains
Leptopelis parkeri	East Usambaras; West Usambaras; Ulugurus
Leptopelis vermiculatus	East Usambaras; West Usambaras; Shimba Hills, Kenya
Arthroleptides martiensseni	Usambara, Magrotto, Uluguru, Nguru and Udzungwa Mountains
Probreviceps macrodactylus	Usambara, Ulguru, Rungwe and Udzungwa Mountains, Nguru Mts? and Pare Mts?
Callulina kreffti	Usambara, Magrotto, Uluguru, Nguru and Udzungwa Mountains also Taita Hills, Kenya
Scolecomorphus vittatus	Usambara, Uluguru, N. Pare, Magrotto Mountains and lowlands near the Usambara Mountains

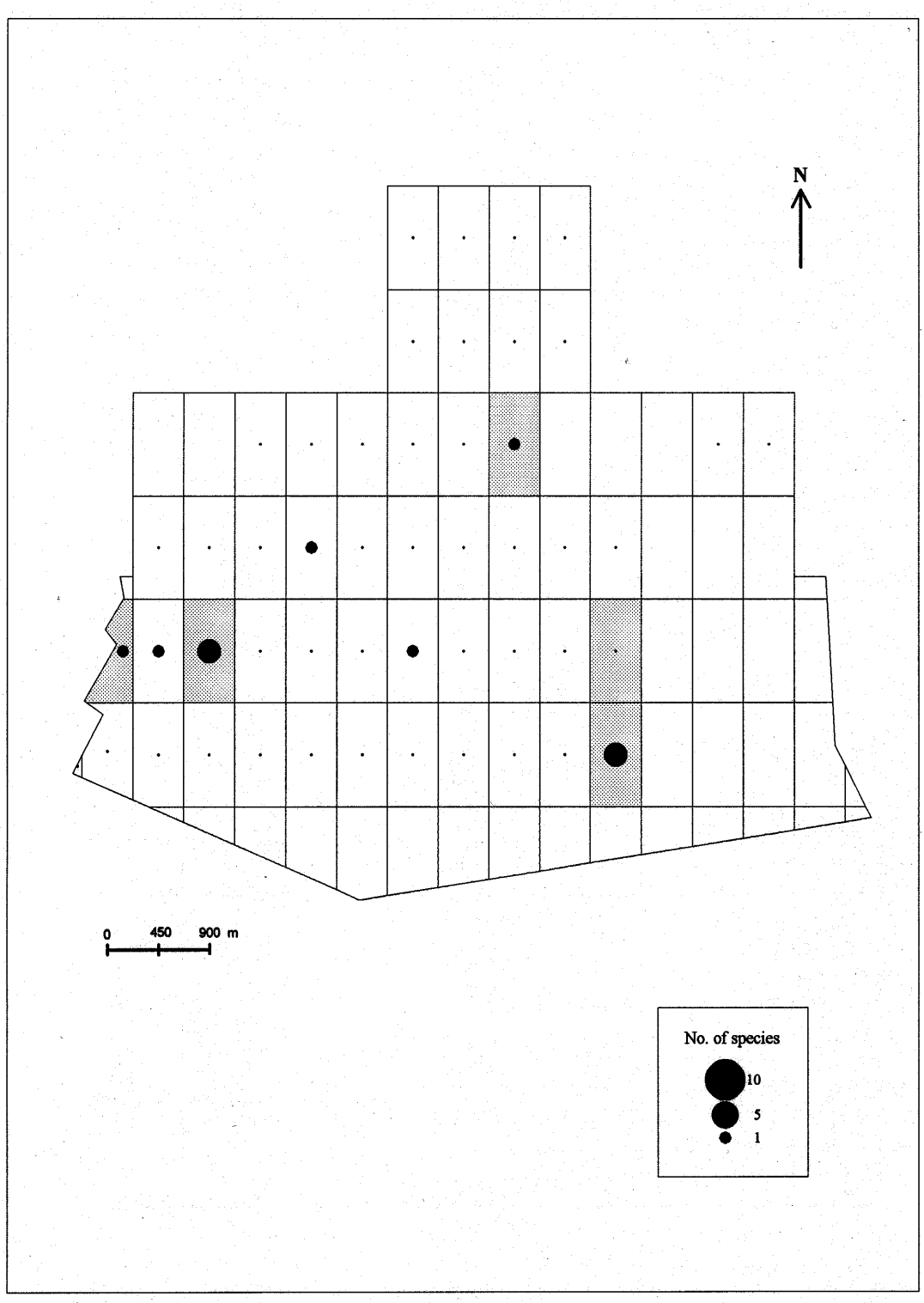

Figure 24. Distribution of forest dependent amphibian species.

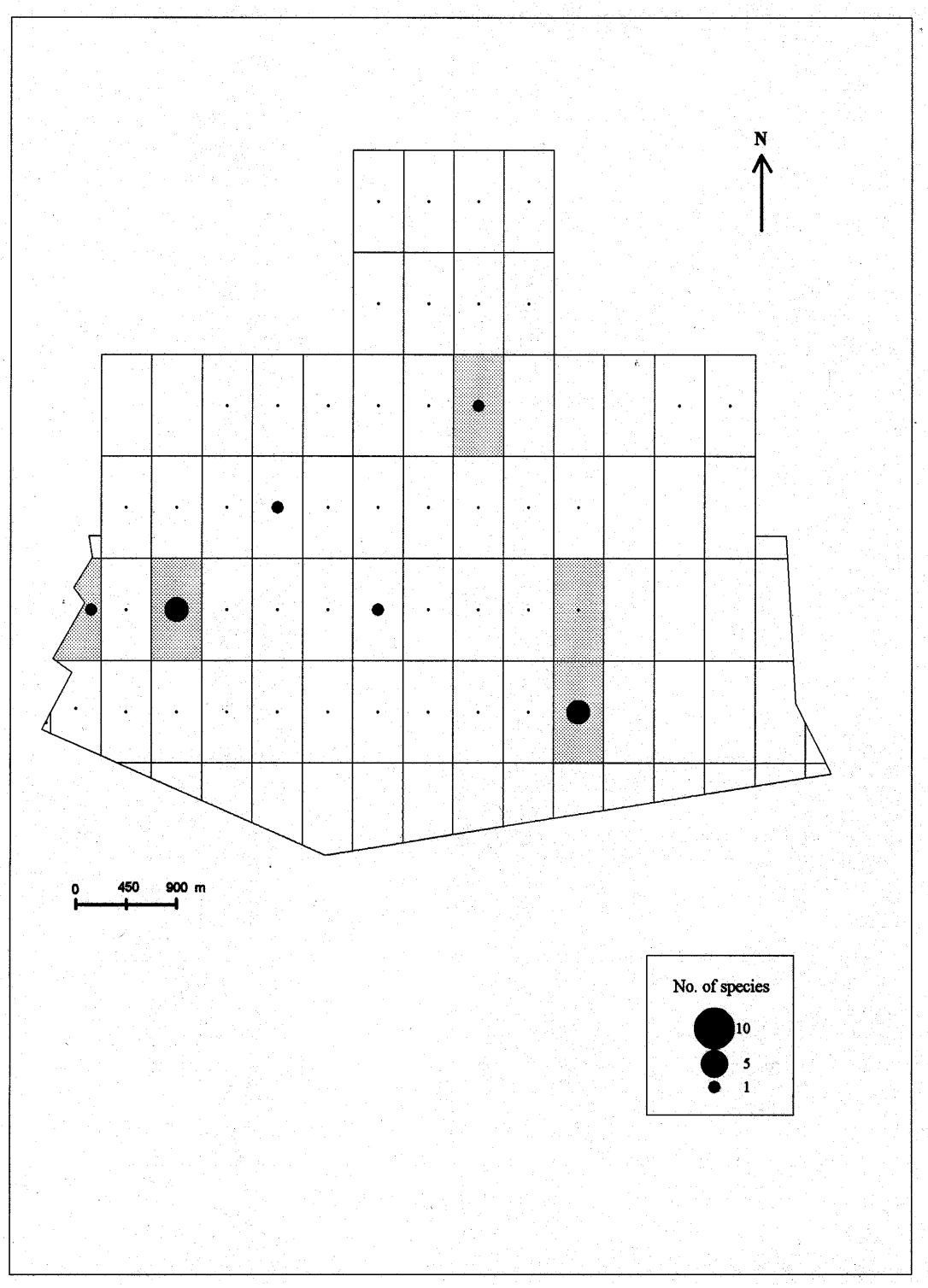

Figure 25. Distribution of near-endemic amphibian species.

6.4.5 Invertebrates

6.4.5.1 Butterflies

A total of 59 specimens were retained for taxonomic purposes. These represent 31 species from five families. Ecological type and endemic status were compiled from Kielland (1990) and Larsen (1996). Identifications were provided by Steve Collins from the African Butterfly Research Institute.

Table 28. Summary of butterflies.

Species	**Ecol. Type**	**Endemic status**	**Capture location by plot and number collected**				**Total**
			1	3	28	39	
PAPILIONIDAE							
Graphium policenes	F	W	1				**1**
PIERIDAE							
Eurema hecabe	f	W	1	3			**4**
DANAIDAE							
Amauris niavius	f	W	1	1			**2**
NYMPHALIDAE							
Apaturopsis cleochares schultzei	F	W				1	**1**
Aterica galene	F	W		1			**1**
Catuna sikorana	F	W	1	1			**2**
Ch. Acuminatus usambarensis	F	W				2	**2**
Charaxes cithaeron kennethi	f	W				1	**1**
Charaxes lasti	F	N				1	**1**
Charaxes pleione oriens	F	W		1			**1**
Charaxes pollux	F	W			1		**1**
Euxanthe tiberius	F	N				1	**1**
Euxanthe wakefieldi	F	W				1	**1**
Neptis carcassoni	F	W	1	1			**2**
Neptis saclava	f	W	1				**1**
Precis octavia	f	W			1		**1**
Pseudacraea eurytus	F	W	1	1			**2**
Pseudacraea lucretia	F	W		1			**1**
ACRAEIDAE							
Acraea quirina	F	W			1		**1**
Acraea satis	F	W	1				**1**
Bematistes (Acraea) aganice	f	W		1			**1**
LYCAENIDAE							
Anthene kersteni	f	W		8			**8**
Eicochrysops hippocrates	f	W		2			**2**
Leptotes pirithous	f	W		1	1		**2**
Oboronia bueronica	F	W	2	9			**11**
Pentila tropicalis mombasae	F	W	1				**1**
Thermoniphas micylus colorata	F	W			1		**1**
HESPERIIDAE							
Acada biseriatus	f	W		1			**1**
Ceratrichia bonga	F	N	1				**1**
Gorgyra subfacatus vosseleri	F	W			1		**1**
Pardaleodes incerta	F	W		2			**2**

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.

6.4.5.2 Molluscs

A total of 148 specimens were retained for taxonomic purposes. These represent 54 species from 11 families. Identifications and remarks were provided by Prof. B. Verdcourt.

Table 29. Summary of molluscs.

Species	**Endemic status**	**Catpure site by plot number and number collected**						**Total**
		1	**3**	**13**	**28**	**39**	**Casual**	
ACHATINIDAE								
Achatina albopicta						1		**1**
Achatina grandidieriana						1		**1**
Achatina sp. (very juv.)		4						**4**
AMPULLARIIDAE								
Lanistes farleri						1		**1**
Lanistes sp. (juv.)		1						**1**
ARIOPHANTIDAE								
Sitala leroyi		1						**1**
ENIDAE								
Rhachis braunii						1		**1**
Rhachistia sp. (juv.)		1						**1**
EUCONULIDAE								
Afroguppya rumrutiensis		4						**4**
HELICARIONIDAE								
Kaliella barrakpoorensis			1					**1**
MAIZANIIDAE								
Maizania sp. (juv.)		2	1		3			**6**
Maizania sp.		2	1			1		**4**
STREPTAXIDAE								
Edentulina ovoidea				1		1		**2**
Gonaxis ? *craveni* (juv.)			1					**1**
Gonaxis craveni						1		**1**
Gonaxis vosseleri						1		**1**
Gonaxis denticulatus	E	4	3		4			**11**
Gonaxis sp. (juv.)		4			1			**5**
Gulella ? *radius*			1					**1**
Gulella aenigmatica					2			**2**
Gulella gouldi globulosa	E				1			**1**
Gulella grossa	E				1	1		**2**
Gulella juv. *Aenigmatica*			1					**1**
Gulella usambarica						1		**1**
Gulella lornae					1			**1**
Gulella sp. (allied to G. unidentata variety or new?)						1		**1**
Gulella sp. nov(also collected by Tattersfield)		2						**2**
Gulella habibui			1					**1**
Gulella sp. nov (near a Tattersfield specimen)		1						**1**
Gulella sp. very juv.		1						**1**
Tayloria sp. juv.			1		1			**1**
Tayloria usambarica					2			**2**

Species	Endemic status	Catpure site by plot number and number collected						Total
		1	**3**	**13**	**28**	**39**	**Casual**	
SUBULINIDAE								
Ceras ordinarius			1					**1**
?*Subulina* sp. (juv.)			1					**1**
Curvella sp. (probably nov.)						5		**5**
Curvella sp. (juv.)		1						**1**
Curvella sp. (juv.)		1						**1**
Curvella sp. (perhaps C. delicata (Taylor))		1						
?*Homorus* juv			5					**5**
Pseudoglessula ?leroyi (very juv.)		5		1				**5**
Pseudoglessula leroyi			2		9	9		**20**
Pseudoglessula sp. nov.		1						**1**
Pseudoglessula sp.		1						**1**
Pseudoglessula sp.		2						**2**
Subulina ? lasti		8						**8**
Subulina sp.					2			**2**
Opeas sp.					3			**3**
THIARIDAE								
Cleopatra sp.								**1**
UROCYCLIDAE								
Arichotoxon ?							1	**1**
Leptichnus bernardi							1	**1**
Thapsia leroyi		5	4		11			**20**
Thapsia sp.				1				**1**
Thapsia sp. (very juv.)			2					**2**
Trichotoxon heynemanni							1	**1**

KEY TO ABBREVIATIONS FOR TABLE 29 (Definitions based on those described in the botanical section of this report).

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.

6.4.5.3 Millipedes

A total of 86 specimens were retained for taxonomic purposes. These represent at least 18 species from nine families. At least three genera and four new species were discovered during this survey. The most abundant mollusc was *Stemmiulus* sp.

Table 30. Summary of millipedes.

Taxon	Capture site by plot and number collected					Total	Remarks
	1	**3**	**13**	**28**	**39**		
Order Stemmiulida							
STEMMIULIDAE							
Stemmiulus sp.		14		1	9	**24**	Possibly two species one may be *S. howelli*
Order Spirostreptida							
HARPAGOPHORIDAE							
Apoctenophora sp. (?astricta Karsch)	1					**1**	
ODONTOPYGIDAE							
Unknown gen. & sp.	1					**1**	
Unknown gen. & sp.	1			1	13	**15**	
Xystopyge sp.			2			**2**	
Xystopyge sp. nov.			3			**3**	
SPIROSTREPTIDAE							
Archispirostreptus ?*gigas* (Peters)	1					**1**	
Unknown gen. & sp.	4					**4**	
Order Spirobolida							
PACHYBOLIDAE							
Epibolus ?*pulchripes* (Gerst.)	3					**3**	
Order Polydesmida							
PARADOXOSOMATIDAE							
Gen. & sp. nov.	14			1	6	**21**	
CHELODESMIDAE							
Callistocilla sp. nov			1			**1**	
OXYDESMIDAE							
Ceratodesmus cristatus	2		2	1		**5**	
Rhodesmus mastophorus (Gerst.)					1		
Unknown gen and species	1					**1**	
GOMPHDESMIDAE							
?*Astrodesmus* (juv.)					3	**3**	
Astrodesmus laxus (Gerst.)	1					**1**	
gen. & sp. nov.	3		4	2		**9**	
gen. & sp. nov.					1	**1**	

6.5 Discussion

6.5.1 Species Richness and abundance

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

Table 31. Summary of faunal families and species.

Taxon	Number of families	Number of species
Mammals	11	47
Birds	31	68
Reptiles	12	28
Amphibians	7	29
Butterflies	5	31
Molluscs	11	54
Millipedes	9	18

6.5.1.1 Mammals

The most common small mammal species is the lesser pouched rat *Beamys hindei*. Other species which appear to be locally common are: *Grammomys* sp., *Praomys* sp. *Graphiurus* sp. and *Crocidura* sp. however it has not yet been determined whether these represent multiple species. Bats which appear to be locally common are: *Rousettus aegyptiacus leachi* and *Triaenops persicus*.

6.5.1.2 Reptiles

The most common reptile species are the geckos *Cnemaspis africana* and *Hemidactylus mabouia*. Other species which appear to be locally common are: *Philothamnus macrops*, *Natriciteres olivacea*, *Crotaphopeltis tornieri*, *Crotaphopeltis hotamboeia*, *Cordylus t. tropidosternum*, *Rhampholeon brevicaudatus*, *Chamaeleo dilepis*, *Cnemaspis barbouri*, *Mabuya maculilabris* and *Leptosiaphos kilimensis*. With 15 species Kwamgumi has a particularly rich snake fauna including the East Usambara endemic *Prosymna semifasciata*.

6.5.1.3 Amphibians

The most commonly caught amphibian species was *Arthroleptis xenodactyloides* which was recorded 16 times. Other species which appear to be locally common are *Arthroleptis stenodactylus*, *Bufo brauni*, *Stephopaedes* sp., *Nectophrynoides tornieri*, *Leptopelis flavomaculatus*, *Leptopelis uluguruensis*, *Leptopelis parkeri*, *Afrixalus* sp., *Probreviceps* sp., *Callulina kreffti* and *Chiromantis xerampelina*.

6.5.1.4 Butterflies

The most commonly caught butterfly species was *Oboronia bueronica*. Other species which appear to be locally common are *Anthene kersteni* and *Eurema hecabe*.

6.5.1.5 Molluscs

The most commonly collected species were *Thapsia leroyi* and *Pseudoglessula leroyi*. Three new species were identified during this survey two, possibly three, from the genus *Gullella* and one from the genus *Curvella*.

6.5.1.6 Millipedes

The most commonly caught species was *Stemmiulus* sp. although this may represent two species. Other locally common millipede species are *Xystopyge* sp., *Epibolus ?pulchripes*, *Ceratodesmus cristatus* and *Astrodesmus* sp.

6.5.1.7 Endemics and near-endemics

Of the 23 mammal, reptile and amphibian species which are endemic or near-endemic to the Usambaras and were recorded during this survy, 11 appear to be locally common as they were recorded at least three times during the survey. These are: *Beamys hindei*, *Philothamnus macrops*, *Rhampholeon brevicaudatus*, *Cnemaspis africana*, *Cnemaspis barbouri*, *Leptosiaphos kilimensis*, *Bufo brauni*, *Nectophrynoides tornieri*, *Leptopelis uluguruensis*, *Leptopelis parkeri* and *Callulina kreffti*.

6.5.1.8 Forest dependent species

Of the 31 mammal, reptile and amphibian species which are dependent on primary forest and were recorded during the survey 12 appear to be locally common. These are: *Philothamnus macrops*, *Crotaphopeltis tornieri*, *Rhampholeon brevicaudatus*, *Cnemaspis africana*, *Cnemaspis barbouri*, *Leptosiaphos kilimensis*, *Bufo brauni*, *Nectophrynoides tornieri*, *Leptopelis flavomaculatus*, *Leptopelis uluguruensis*, *Leptopelis parkeri* and *Callulina kreffti*.

6.5.1.9 High risk species

The locally uncommon species that are both forest dependent and near-endemic or endemic should be of conservation concern due to their low poulation density and restricted range. These species are: *Typhlops gierrai*, *Leptotyphlops macrops*, *Prosymna semifasciata*, *Elapsoidea nigra*, *Mertensophryne micranotis*, *Scolecomorphus vittatus*, *Leptopelis vermiculatus*, *Arthroleptides martiensseni*, *Probreviceps macrodactylus* and *Hoplophryne rogersi*.

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

Taxon	1	3	5	10	11	13	23	24	28	39	Other plots	Out-side reserve	Unknown capture location
small mammal*	7	3				5			6	4	1	4	
reptile	2	7	3	1	4	7	1	1	8	4	2	22	9
amphibian	6	7				1			9	5	6	3	19
butterfly	11	15							6	6			
molluscs	21	15				3			13	13	3		
millipede	11	1				5			5	6			

*primates excluded due to their large ranges.

6.5.2 Ecological type

Of the forest dependent species, four are mammals, 19 are birds, 12 are reptiles and 15 are amphibians.

Of the 16 non-forest species, eight are birds many of which were recorded from the forest edge. Of the remaining eight species three are mammals: *Rattus rattus*, *Nycteris hispida*, *Taphozous (t.) mauritianus* and five are reptiles: *Python sebae*, *Natriciteres olivacea*, *Crotaphopeltis hotamboeia*, *Dispholidus typus* and *Varanus niloticus*. With the exception of the *Crotaphopeltis hotamboeia* all of these species were recorded from the forest edge or from land adjoining the Forest Reserve.

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

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	71	35
(f) Forest dwelling but not forest dependent	88	43
(O) Non-forest species	16	8
Unknown	28	14
Total:	**203**	

6.5.3 Endemic Status

The three species which are endemic to the Usambara Mountains are: *Bubo vosseleri, Prosymna semifasciata* and *Hoplophryne rogersi*. The latter species were recorded from forest to the west of the reserve.

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

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	3	1
(N) Near-Endemic: ranges in restricted locations	26	13
(W) Widespread	147	72
Unknown	27	13
Total:	**203**	

6.5.4 Range Extensions

Phrynobatrachus ukingensis from Misuku Hills, Malawi.

Phrynobatrachus mababiensis, a widespread species typical of open habitats.

Tadarida brachyptera, a wrinkle-lipped bat. This is the fourth record in Tanzania and the first in the East Usambara Mountains.

Scotophilus nucella, a house bat, is the second specimen identified from Tanzania. This represents a range extension (Kock, pers. comm. 1997);

6.5.5 IUCN Status

According to IUCN criteria (see Section 1.2), four species found in Kwamgumi Forest Reserve are endangered. These are: *Rhynchocyon petersi*, *Mertensophryne micranotis, Cnemaspis barbouri* and *Lanistes farleri.* The snake *Prosymna semifasciata* is considered to be critically at risk.

According to IUCN criteria (see Section 1.2), the following 18 species are vulnerable to extinction: *Dendrohyrax validus, Sheppardia gunningi, Typhlops gierrai, Leptotyphlops macrops, Philothamnus macrops, Crotaphopeltis tornieri, Elapsoidea nigra, Rhampholeon brevicaudatus, Cnemaspis africana, Cnemaspis barbouri, Bufo brauni, Nectophrynoides tornieri, Scolecomorphus vittatus, Leptopelis uluguruensis, Leptopelis parkeri, Arthroleptides martiensseni, Callulina kreffti* and *Hoplophryne rogersi,*

7.0 CONCLUSIONS

This report presents the raw data of the survey with preliminary descriptions and analyses 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.

Kwamgumi Forest, gazetted as a Forest Reserve in 1905, covers an area of 1129 ha in the central area of the East Usambara range. With altitudes between 150 m and 915 m, it consists of approximately 1088.5 ha mature forest and 40.3 ha of previously disturbed, colonising or poorly stocked forest.

Disturbance

Pole cutting within the reserve was found at higher levels close to the forest edge. Timber extraction was recorded at low levels throughout the reserve but was most abundant in the north-east of the reserve.

In the private forest to the north of the reserve pole and timber cutting was recorded at higher levels than that found inside the reserve and was more localised. Active pitsaws were recorded during the survey period in the east of the reserve.

Subsequent to the surveys, fire damaged forest around Muhinduro Peak and near Kwamtili. The full impact of these fires is not known. Trapping was also recorded.

The invasive species *Maesopsis eminii* was recorded, but only in the regeneration layer.

Species Richness

The Forest Reserve was found to contain a minimum of 231 species of trees and shrubs; 47 mammal, 68 bird, 27 reptile and 24 species of amphibian.

Flora

Seven tree species were recorded which are endemic to the Usambara mountains and 47 have ranges restricted to the Eastern Arc and/or East African lowland forests. Sixty-eight species are dependent on primary forest, and of these species, 29 are also endemic or near endemic to the Usambara mountains. Fifteen non-forest tree and shrub species are established within the reserve boundaries.

Fauna

Three species were recorded which are endemic to the Usambara mountains and 23 species were recorded as near-endemics, having restricted ranges limited to the Eastern Arc and/or East African lowland forests. Ninety-three species are dependent

only on primary forest, and of these species, 23 are also endemic or near endemic to the Usambara mountains. Sixteen species typical of open habitats are established in the reserve.

Conservation

The forests of the East Usambara Mountains are recognised as being a biodiversity hotspot of global significance. 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 fuelwood 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.

Kwamgumi Forest Reserve has one of the highest species richness recorded by the Frontier-Tanzania surveys in the East Usambaras. It has the highest number of mammals so far recorded and is second only to Mtai Forest Reserve in terms of botanical species richness. It is home to the critically endangered *Prosymna semifasciata* as well as the endangered toad *Mertensophryne micranotis* and the endangered gecko *Cnemaspis barbouri*. Other authors have recognised the reserves importance in terms of the avifauna particularly as being home to the endemic Usambara eagle owl *Bubo vosseleri* the near-endemic Sokoke scops owl, *Otus ireneae*, and Swynnerton's robin, *Swynnertonia swynnertoni*.

Damage to the forest from fire and illegal timber extraction is of serious concern particularly where it has damaged the restricted submontane forest. Degradation and further fragmentation of Kwamgumi forest may lead to local extinctions of populations of those species identified as being at high risk. The loss of the forest will also reduce the reliability of the water supply to the region.

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Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
1	GL	160	15	LF	20 - 30
2	GL	200		LF	20 - 30
3	SM	320	41	LF	10 - 20
4	SF	420	43	LF	10 - 20
5	SU	750	20	LF	20 - 30
6	SU	850	17	SF	20 - 30
7	SM	600	30	W	10 - 20
8	SM	650	35	SF	20 - 30
9	SM	650	20	LF	10 - 20
10	GM	450	17	LF	10 - 20
11	GL	150	2	LF	20 - 30
12	GL	220	22	LF	10 - 20
13	GM	500	1	LF	10 - 20
14	VF	160	5	LF	10 - 20
15	GM	210	33	SF	10 - 20
16	GL	170	3	LF	20 - 30
17	GM	200	21	SF	20 - 30
18	GM	525	25	SF	20 - 30
19	GM	400	25	LF	<10
20	SU	550	35	LF	10 - 20
21	GM	560	39	LF	>30
22	SU	1000	45	SF	10 - 20
23	SU	650	30	LF	10 - 20
24	GM	500	23	LF	20 - 30
25	GL	500	10	LF	10 - 20
26	GM	550	20	LF	20 - 30
27	SM	700	40	LF	20 - 30
28	SM	600	18	LF	20 - 30
29	SM	760	35	SF	20 - 30
30	GM	400	25	LF	20 - 30
31	SL	355	25	LF	20 - 30
32	GL	400	10	RF	10 - 20
33	SM	480	25	LF	20 - 30
34	GL	350	33	LF	10 - 20
35	VF	420	14	LF	10 - 20
36	SM	450	24	LF	10 - 20
37	GL	630	34	LF	<10
38	SM	480	21	LF	10 - 20
39	GL	220	15	LF	20 - 30
40	VF	200	2	LF	20 - 30
41	VF	350	10	LF	20 - 30
42	SM	350	35	LF	10 - 20
43	GL	300	12	LF	20 - 30
44	SL	330	30	LF	20 - 30
45	GL	250	20	S	<10
46	GL	280	15	LF	20 - 30
47	GM	250	10	LF	10 - 20

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Condition	Canopy Height (metres)
48	GL	200	10	LF	20 - 30
49	RT	200	5	LF	10 - 20

KEY TO ABBREVIATIONS

Topography

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

Vegetation Condition

LF - Lowland forest
SF - Submontane forest
CF - Colonizing forest
RF - Riverine forest
PF - Plantation forest
S - Scrub / thicket / Bush
W - Woodland

Appendix 2:

Taxonomic Verification

BOTANY

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Bats and small mammals:

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