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

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12. Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara Mountains.
13. Hall, J.B. 1995. *Maesopsis eminii* and its status in the East Usambara Mountains.
14. Heinonen, P. 1995. PSPs in East Usambara Mountains: present findings and future recommendations.
15. Munuyku, F.C.N. 1995. Report on an inventory of selected proposed forest reserves in Muheza District, Tanga Region.
16. Kamugisha, S.M. & Materu, E.M.A. 1995. Preliminary results from a study on water flow and in Sigi and Bombo rivers in the East Usambara mountains.
17. Ellman, A., Tye, A., Rwamugira, S., Mallya, B., Mahenge, F. and Mndolwa, A. 1995. Development of forest trails and drive routes in the Amani Nature Reserve.
18. Ellman, A.E. 1996. Handing over the stick? Report of a village forest management and farm forestry consultancy
19. Katigula, M.I.L., Mmasi, S.E., Matiko, W., Mshana, L., Kijazi, M.S., Rwamugira, S. 1995. Planning ourselves. Evaluation report on the participatory planning of the EUCAMP Phase II project document.
20. Fowler, S. & Nyambo, B. 1996. Invasive species and biodiversity - Report of a short consultancy on the potential of biological control of invasive species in Amani Nature Reserve. International Institute for Biological Control & EUCAMP.
21 Howard, P.C. 1996. Baseline biological surveys in selected East Usambara forest reserves and forests, 1995-96 - project evaluation report
22. Woodcock, K. 1995. Indigenous knowledge and forest use: two case studies from the East Usambaras, Tanzania.
23. Shaka, J.M. & A. Msangi. 1996. Soils and vegetation of Bamba Ridge Forest Reserve, Maramba Division, Muheza District, Tanga.

Appendix 2:

Taxonomic Verification

BOTANY

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ZOOLOGY - VERTEBRATES

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ZOOLOGY - INVERTEBRATES

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Appendix 1:

General Plot Information

Plot Number	Topography	Altitude (metres)	Slope (degrees)	Vegetation Type	Canopy Height (metres)
1	LP	128	10	B	<10
2	FV	138	12	B	<10
3	GM	130	18	G	10-20
4	GM	-	9	LF	10-20
5	GM	230	21	LF	10-20
6	SL	273	28	LF	10-20
7	GL	198	15	LF	10-20
8	GL	198	13	LF	10-20
9	no vegetation plot				
10	GL	122	13	RF	10-20
11	GU	162	11	LF	20-30
12	GM	160	9	LF	10-20
13	GL	360	10	B	10-20
14	GL	360	14	B	10-20
15	GL	110	5	LF	>30
16	GM	110	14	LF	20-30
17	no vegetation plot				
18	GM	120	21	G	<10
19	GL	190	5	B	10-20
20	GL	210	12	LF	20-30
21	GM	175	22	LF	10-20
22	GL	150	20	G/W	<10
23	no vegetation plot				
24	FV	150	0	OW	<10
25	GL	180	16	LF	10-20
26	no vegetation plot				
27	GM	120	21	LF	20-30
28	GU	110	22	LF	20-30
29	GM	165	-2	LF	10-20
30	GU	278	8	LF	10-20
31	FV	160	3	LF	20-30
32	GL	140	10	LF	10-20
33	GL	140	10	G	<10
34	no vegetation plot				
35	GM	175	16	G	<10
36	GU	205	10	LF/G	10-20
37	GM	120	17	LF	20-30
38	GL	150	15	LF	<10
46	GL	145	3	G	-

KEY TO ABBREVIATIONS

Topography	Vegetation Type
GL - gentle lower slope	LF - lowland forest
SL - steep lower slope	RF - riverine forest
GM - gentle mid-slope	G - grassland
GU - gentle upper slope	B - bushland and/or thicket
SU - steep upper slope	W - woodland
FV - flat valley floor	OW - open woodland
LP - lowland plain	

Rodgers, W.A. 1996. Biodiversity values of Tanzanian forests: A training and awareness manual for forest managers and conservationists. FAO, Dar es Salaam.

Rodgers, W.A. & Homewood, K.M. 1982. The conservation of the East Usambara Mountains, Tanzania: a review of biological values and land use pressures. *Biol. J. Linn. Soc.* 24: 285-304.

Ruffo .K.; Mmari, C.; Kibuwa, S.P.; Lovett, J.; Iversen, S. & Hamilton, A.C. 1989. A preliminary list of the plant species recorded from the East Usambara forests. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania*. IUCN, Gland. Pp 157-179.

Schmidt, P. 1989. Early exploitation and settlement in the Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 357-361.

SEE, 1998. Methodology Report. Frontier Tanzania Forest Research Programme. Technical paper of the Society for Environmental Exploration, London.

Stuart, S.N. 1989. The avifauna of the East Usambara mountains. Chapter 35 - Forest conservation in the East Usambara mountains Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 357-361.

Tye, A. 1994. Magoroto rainforest conservation - Proposal for establishment of a new reserve. *EUCDP, IUCN, Amani, Tanzania (unpubl.).*

Zimmerman, D.A., Turner, D.A. & Pearson, D.J. 1996. *Birds of Kenya and Northern Tanzania*. Russel Friedman Books, South Africa.

Hyytiäinen, K. 1995. Land use classification and mapping for the East Usambara mountains. *East Usambara Conservation Area Management Programme.*

IUCN 1996. 1996 IUCN Red list of threatened animals. IUCN, Gland, Switzerland.

Iversen, S.T. 1991a. The Usambara mountains, NE Tanzania: History, Vegetation and conservation. Uppsala University, Uppsala.

Iversen, S.T. 1991b. The Usambara mountains, NE Tanzania: Phytogeography of the vascular plant flora. Uppsala University, Uppsala.

Johansson S. & Sandy R. 1996. Updated Forest area information in the Usambara mountains. East Usambara Conservation Area Management Programme, working paper 19.

Kielland, J. 1990 Butterflies of Tanzania. Hill House, Melbourne/London.

Kikula, I.S. 1989. Spatial changes in forest cover on the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 79 - 86.

Kingdon, J. 1974. East African Mammals. An atlas of evoluntion in Africa. Vol. 2B: Hares and rodents. University Chicago Press, Chicago.

Kingdon, J. 1989. East African mammals. An atlas of evolution in Africa. Vol. 2A: Insectivores and bats. University of Chicago Press, Chicago.

Kingdon, J. 1997. The Kingdon field guide to African Mammals. Academic Press, London.

Kingdon, J & Howell, K. M. 1993 Mammals in the forests of Eastern Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. Pp 229-241.

Larsen, T. B. 1996 The butterflies of Kenya and their natural history. Oxford University Press, Oxford.

Litterick, M. 1989. Assessment of water quality of the Sigi river. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 141-155.

Lovett, J.C. 1993. Eastern Arc moist forest flora. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. Pp 33-56.

Lovett, J.C. 1989. The botanical importance of the East Usambara forests in relation to other forests in Tanzania. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 207-212.

National biodiversity database (1996). Unpubl. Department of Zoology and Marine Biology, UDSM, Dar es Salaam.

Passmore, N. I. And V. C. Carruthers 1995 South African frogs: a complete guide.Southern book publishers.

Poynton, J.C. 1997. Amphibians. In N.D. Burgess & G.P. Clarke (eds.), *The coastal forests of eastern Africa: status, history, biodiversity & conservation.*

Poynton J.C. & Broadley, D.G. 1991. Amphibia zambesiaca 5. Zoogeography. *Ann. Natal Mus.* Vol 32:221-277.

8.0 REFERENCES

Binggeli, P. 1989. The ecology of Maesopsis invasion and dynamics of the evergreen forest of the East Usambaras, and their implications for forest conservation and forestry practices. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 269-300.

Branch, B. 1994. Field guide to the snakes and other reptiles of Southern Africa. Struik Publ., Cape Town.

Broadley, D. G. 1995 A new species of *Prosymna* Gray (Serpentes: COLUBRIDAE) from coastal forest in northeastern Tanzania. *Arnoldia Zimbabwe* 10 (4): 29 – 32.

Broadley, D.G. & Howell, K.M., in press. Reptiles. In N.D. Burgess & G.P. Clarke (eds). *The coastal forests of eastern Africa: status, history, biodiversity & conservation.*

Broadley, D.G. & Howell, K. M. 1991 A check list of the reptiles of Tanzania, with synoptic keys. Syntarsus 1: 1 – 70.

Bruen, M. 1989. Hydrological considerations of development in the East Usambara mountains. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 117-139.

Cambridge Tanzania Rainforest Project. 1994. A biological and human impact survey of the lowland forests, East Usambara Mountains, Tanzania. Birdlife Study Report No. 59. Birdlife International, Cambridge.

Collar, N.J.; Crosby, M.J. & Stattersfield, A.J. 1994. Birds to watch 2. The world list of threatened birds. Birdlife International, Cambridge.

Collar, N.J. & Stuart, S.N. 1987. Priorities for conservation action. ICBP Monograph No. 3. 1988. Cambridge.

Cunneyworth, P. & Stubblefield, L 1996b. Bamba Ridge Forest Reserve: A biodiversity survey - East Usambara Conservation Area Management Programme Technical Paper No. 31. Forestry and Beekeeping Division & Finnish Forest and Park Service & Society for Environmental Exploration, Dar es Salaam, Vantaa & London.

Cunneyworth, P. & Stubblefield, L. 1996c. Mlungui Proposed Forest Reserve: A biodiversity survey - East Usambara Conservation Area Management Programme Technical Paper No. 32. The Society for Environmental Exploration, London; Forestry & Beekeeping Division, Dar es Salaam; & Finnish Forest & Park Service, Vantaa.

Griffiths, C.J. 1993. The geological evolution of East Africa. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. Pp 9-22.

Groombridge (ed.) 1993. 1994 IUCN red list of threatened animals. Cambridge IUCN.

Hamilton, A.C. 1989. The place and the problem. a survey of forest types on the East Usambaras using the variable-area tree plot method. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 213-226.

Howell, K.M. 1989. The East Usambara Fauna. In A.C. Hamilton & R. Bensted-Smith (eds.). *Forest conservation in the East Usambara Mountains Tanzania.* IUCN, Gland. Pp 315-355.

Howell, K.M. 1993. Herpetofauna of the eastern African forests. In J.C. Lovett, & S.K. Wasser (eds.). *Biogeography and ecology of the rain forests of eastern Africa.* Cambridge University Press, Cambridge. Pp 173-201.

extracted by villagers include building poles, bush meat, fuel wood and edible plant leaves.

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 principal 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.

As a Catchment Forest Reserve, Manga Forest Reserve is legally protected from deforestation however the law does not specify that the reserve's biodiversity be conserved. It is therefore theoretically possible to replace the natural forest with plantation. A higher level of protection aimed specifically at the conservation of the forest's biodiversity would provide greater security for the fauna and flora of the reserve.

Fire is a serious threat to the integrity of Manga Forest Reserve as it affects both forest structure and species composition. Forest dependent species will be affected disproportionately by fires. This includes many of the endemic and near-endemic species.

Manga Forest Reserve is home to a number of species of particular conservation concern including the new species of butterfly found during this survey which appears to be endemic to the reserve. The protection of Manga Forest Reserve will increase the chances that these species have of surviving for future generations to admire and study.

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 main aspects of biodiversity and conservation:

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

Manga forest, gazetted as a Forest Reserve in 1955, covers an area of 1616 ha in the central area of the East Usambara range. With altitudes between 120 m and 360 m, it consists of lowland forest, grassland and patches of woodland.

Species Richness

The Forest Reserve was found to contain a minimum of 329 species of trees and shrubs; 30 mammal, 82 bird, 26 reptile, 22 amphibian, 94 butterfly, 12 millipede and 16 mollusc species.

Flora

Three species were recorded which are endemic to the Usambara Mountains. Twenty-two species have ranges restricted to the Eastern Arc and/or East African lowland forests. Twenty-six species are dependent only on primary forest, and of these species ten are also endemic or near endemic to the Usambara mountains. Nineteen non-forest tree and shrub species are established within the reserve boundaries.

Fauna

Two butterfly species were recorded which are endemic to the Usambara Mountains and 22 animal species were recorded as near-endemics, having ranges restricted to the Eastern Arc and/or East African lowland forests. Fifty-four species are considered dependent only on primary forest, and of these species, 17 are also endemic or near endemic to the Usambara mountains. Twenty-three non-forest species are established in the reserve.

Disturbance

Timber was extracted commercially from Manga in the 1980s and the impact on the forest is still visible. Timber extraction at a commercial scale has now largely stopped however pole and timber continue to be collected by local villagers throughout the reserve. The highest rates of pole and timber cutting were in the north-west of the reserve. Fire has affected large areas of Manga and 37% of the plots had been affected by fire. In some areas, particularly in the north of the reserve there is no forest only woodland and grassland dominated by the invasive grass *Rottboellia exaltata.* It is clear from the mango and banana trees within the reserve, that cultivation occurred in some of these open areas. Forest products commonly

exist and would appear to be in a reasonable condition; a water collection tank would provide the water required for tourists.

At present tourists are limited to a few visiting biologists. The presence of a number of rare bird and butterfly species and the area's high biodiversity also attracts a few specialist tourists. However the forest is not of a high enough quality to attract a non-specialist tourist particularly if it were in competition with Amani Nature Reserve. This situation will, of course, change if the forest is left to regenerate particularly around the Mruka River and in the south-west of the reserve. The basic visitors requirements would be a safe and fairly comfortable place to stay, and a knowledgeable guide of the Forest Reserve. The old Lanzoni managers house could possibly be renovated to provide accomodation for visitors, and the local Catchment Forest Officer could act as a guide, if given training.

Mkwajuni villagers expressed favour for *Brachylaena hutchinsii* (*mkarambati*) which was once in abundance in the area but is now unavailable due to overuse. People say they are finding it increasingly difficult to obtain good quality building materials from public forest and some say that they have no choice but to take from the forest reserve.

Pitsawing has been banned in the area since January 1993, however recent signs of pitsawing were discovered in the reserve. Carpenters expressed concern over the pitsawing ban and said that they would be forced to stop production when their stocks are depleted and return to farming. Many households own planks which they obtained before the ban and they use these when they require furniture.

Millicia excelsa (*mvule*) is the preferred tree species for furniture making because it is hard and resistant to termite attack.

6.3.5 Peoples attitudes to conservation

In general, most villagers feel that the forest reserve should be for their use and livelihood, in terms of agricultural land and forest products. They are well aware of the restrictions on the use of the forest reserve and who officially controls it. They feel that the restrictions make their daily activities unnecessarily difficult and therefore continue to use the reserve. They also feel that the forest guards, by protecting the forest also protect the crop pests which most farmers spend considerable time trying to prevent from attacking their crops. A few farmers see the forest as important for the prevention of soil erosion.

6.4 Eco-tourism potential

6.4.1 Aim

- To assess the eco-tourism potential of Manga Forest Reserve and the surrounding land.
- To determine the extent of the present facilities available to tourists and their use by them.
- To identify the requirements of tourists not presently met, and provide suggestions for the development of these facilities.

6.4.2 Existing tourist facilities

Existing tourist facilities are poor. The old Lanzoni Estate Managers house (built at the turn of the century by the German company, Meyer brothers) is structurally sound and impressive enough to be considered as a possible base for tourists. The architecture has Arabic influences and there are large doors carved in Zanzibarian style. It could potentially house up to twenty or more people, and has an impressive view of the surrounding mountains. Manga Forest Reserve is also bordered by the Sigi River, which adds to the scenic value of the area and there are crocodiles present. There are two roads leading into Mkwajuni, the village neighbouring the forest. Both are dirt roads in a bad condition. In the wet season a four wheel drive vehicle is required. There are electricity lines installed to Mkwajuni. However the old Lanzoni Estate managers house does not have electricity, but installation would not require much work. There is also no running water at the house however water pipes still

The forest is not a significant source of fruit for most members of the household. For most people it seems more convenient to obtain fruit from trees on their own farmland.

There are a few individuals in each village who have experience in collecting honey from wild tree hives. Hives are most often found in forest

Hunting of forest dwelling animals is an activity undertaken both in forest and on shamba. Hunting appears to fall into three categories; scaring, trapping and sometimes killing animals from shamba; hunting in groups in the forest and hunting alone in the forest using traps and guns. Immigrants who live in Vumba (sub-village of Kwatango) have an organised hunt once a week into the forest with the sole purpose of reducing populations of wild animals which may attack their crops. They do not utilise the carcasses.

The most commonly hunted animals are bush pig (*Potamochoerus lavatus*), blue monkey (*Cercopithecus mitis*), vervet monkey (*Cercopitheus aethiops*), Harvey's duiker (*Cephalophus harveyi*), bushbuck (*Tragelaphus scriptus*), and African civet (*Civettictis civetta*). Other animals hunted include banded mongoose (*Mungos mungo*), tree hyrax (*Dendrohyrax validus*), colobus monkey (*Colobus angolensis*) and baboon (*Papio cynocephalus*). Bushmeat tends to be for domestic consumption. Communities do not depend on hunting as a source of protein or income. Rather than a necessity, bush meat is perceived as an occasional luxury. It is also an important male social event.

The fronds of the wild date palm, *Phoenix reclinata* are used by women for weaving baskets and mats for household use and for wedding gifts

Collection of medicinal plants within the forest is minimal since many species are collected from bushland and shamba. There does not appear to be any commercial exploitation of plants for medicinal purposes.

In all communities, areas of traditional spiritual value are known. These have a number of characteristics in common, such as they were all found on hills and under the cover of forest. In Kwatango and Mkwajuni many people know of the significance of Mlinga Peak and Kweukindo in Segoma forest.

Communities adjacent to the reserve usually collect fuelwood from their shambas and bushland, and admit to collecting occasionally from the reserve. The reason given for collecting from the reserve was that the alternative source is up to two hours walk away. Kwatango women who are surrounded by public forest say that they are required to penetrate deeper into the forest now to find the best firewood, suggesting a reduction in availability of good quality firewood.

Poles are collected from the forest for the construction and repair of houses. Building poles are collected exclusively by men. Live trees are most commonly utilised for building construction, replacement and repair. Poles are cut from saplings for the withies (diameter 2cm, length 2.53m) and larger trees are often taken and split for the vertical poles (diameter 10-15cm, length 2.5-3m) and beams.

6.3.3 Land tenure

The majority of households acquired their land through family inheritance, with land inheritance being patriarchal. Women do not own land but are given shambas by their fathers, husbands or brothers on which to farm. Mkwajuni villagers have moved from their fathers land (known as Chambangwe) due to soil infertility. In 1981 Kibaranga Sisal Estate returned a portion of estate land to the public. Each household head was given eight to ten acres on which to farm, depending on the number of sons and the extent to which farmers were able-bodied.

Immigrants to the area apply for land through the village government or are given land by friends or family with excess. Land is rarely bought and if it is not given it is often lent for an extensive period of time. Villagers perceive the forest as agricultural land for the next generation. Hence, when forest was gazetted, the local community often felt that 'their' land and livelihood had been stolen from them.

The traditional farming method is shifting cultivation. Traditionally farmers work an area of land for two to five years and then move to other land when crop yields decline. Cleared forest land is the preference for new farmland. The area is slashed and burned before planting. In this way agriculture exerts pressure on the natural forests. They will return to farm the same land after approximately five years.

6.3.4 Forest Resource utilisation

All households in both Kwatango and Mkwajuni said that they collect and eat wild plants. In the dry season between January and Febrary, and between July and September when there is reduced crop availability from the shamba, villagers are required out of necessity to supplement their diet more frequently from the wild resource. Mkwajuni villagers collect and eat wild plant leaves on a daily basis throughout the year. Through discussion with Mkwajuni villagers it was suggested that daily dependency on wild plant resources was due to lack of access to alternative food sources such as bush meat, the distance to market and low ownership of poultry and goats.

It was discovered that those communities, such as Kwatango living adjacent to public forests collected and ate forest derived plants more frequently than those communities adjacent to forest reserves who ate more bushland and shamba derived wild plants. Those communities adjacent to forest reserves do not collect forest derived plants due to lack of access and availability.

Few vegetables are cultivated close to the home, however since many are abundant around the shamba, along paths this does not appear to have been necessary. It would seem however that those communities without access to the forest have adapted by using edible plants from the shamba.

Edible mushrooms are utilised by the majority of households from forest, bushland and shamba. Communities adjacent to the forest reserve do not use forest derived mushrooms again due to a lack of access. Collection is based on seasonal availability, with the majority of collection and utilisation in the short (vuli) and long (mwaka) rains.

Over the last ten years, Kwatango Village has allowed approximately ten families from Lushoto District to settle on public forest land, immediately adjacent to the reserve. The immigrants were advised by their own village government to migrate to the Kwatango area because it was perceived that there was plenty of fertile land.

6.3.2 Economic activity

The main source of income is the sale of cash crops. There are also sales of local alcohol, baskets and mats. Women rank crop sales as the largest source of family income, followed by alcohol production, mat and basket weaving and shamba cleaning.

Off-farm employment may running a small shop for food and household goods, tea houses (selling tea, doughnuts, chapatis and occasionally ugali and beans), tailors, carpenters and teachers.

The main cash crops are maize, cassava, coconuts, oranges, sugarcane and groundnuts. The main markets are Muheza and Tanga. Mkwajuni and Kwatango villagers often join together to hire a vehicle to transport crops at harvest time. Kwatango villagers complain severely about the condition of their road and some even say that their harvests are simply rotting in the village due to difficulty in transporting them to market.

The most commonly grown tree crops are bananas, coconuts, oranges, limes, mangoes, jack-fruit, papaya and cashew nuts. Few non-fruit trees are found on shambas in Mkwajuni, this is probably due to the fact that most of the land was previously under sisal cultivation. Non-fruit trees are rarely planted, however during land clearance specific timber species are often retained.

The main subsistence crops are maize, cassava, beans (kidney, pigeon-peas and mung), coconuts and bananas, with sugar cane, sweet potatoes, yams, pineapples, oranges, cashew and groundnuts also common, plus small quantities of vegetables such as spinach, okra, tomatoes and ngogwe (a kind of green tomato) grown in gardens close to the home.

Almost all households own chickens and ducks, which are managed by the women, and approximately fifty percent of households own goats and sheep, which are managed by the men and boys. Other livestock owned are pigs, rabbits and guinea pigs. It is not usual to eat meat regularly from these animals, goats and sheep in particular are reserved for ceremonies and in exceptional circumstances will be sold in times of severe hardship. Cattle are not traditionally owned in this area, however in Mwarimba village there was one farmer who owned dairy cows. Dairy cows were introduced into the area in 1985 by the Tanga Smallholder's Dairy Development Programme (TSDDP) and these are zero grazed for the majority of the time. All other grazing animals are forest and bushland grazed. Only Kivuleni (sub-village of Mkwajuni) was noted as having a specifically designated area for goat grazing (nine acres) which is communally owned.

6.0 SOCIO-ECONOMICS

By Kerry A. Woodcock

6.1 Introduction

A socio-economic study was conducted in two villages Mkwajuni and Kwatango, on the boundary of Manga Forest Reserve between October and December 1994. The aim of the study was:

- to describe resource use in the reserve;
- to assess the extent of forest-related activities;
- to record local people's attitudes and problems concerning the reserve.

6.2 Methods

A multidisciplinary case study approach was used for the socio-economic study. Two villages on the boundary of Manga Forest Reserve, Mkwajuni and Kwatango, were studied in depth. Mwarimba village was also visited on two occasions. Three approaches were combined to triangulate data rapidly and progressively: rapid rural appraisal (RRA), household interviews and ethnography.

The study used various RRA methods including formal and informal group meetings, key informant interviews, participatory social mapping, transect walks and seasonal calendars. Household interviews were carried out in all sub-villages of Mkwajuni and Kwatango. Households were specifically selected to cover a wide range of socio-economic circumstances, taking into account religion, gender of head of household, ethnic group and wealth. The ethnographic element involved the researcher Kerry A. Woodcock working closely with one woman in Mkwajuni village. The researcher learnt and practised typical daily activities, such as collecting firewood, water, and vegetables; farming, weaving and cooking.

6.3 Results

6.3.1 The villages and the population

Manga Forest Reserve has two settlements in close proximity to its boundary; Mkwajuni, on its north-eastern corner and Kwatango on its north-western corner. Mkwajuni village is five minutes walk from the reserve whereas Kwatango is approximately one hour's walk from the reserve boundary and is also surrounded by public forest. These two settlements fall under Misozwe Ward, Muheza District, Tanga Region.

The total population of the two villages is estimated at around 1600. The majority of families originate from Muheza District and are of the Wasambaa and Wabondei tribes. There is a small proportion of the population who originates from other areas of Tanzania and who initially moved into the area for employment on the sisal estates (Kibaranga, Lanzoni, Sigi- Miembeni) or with Sikh Sawmills (1988-1992).

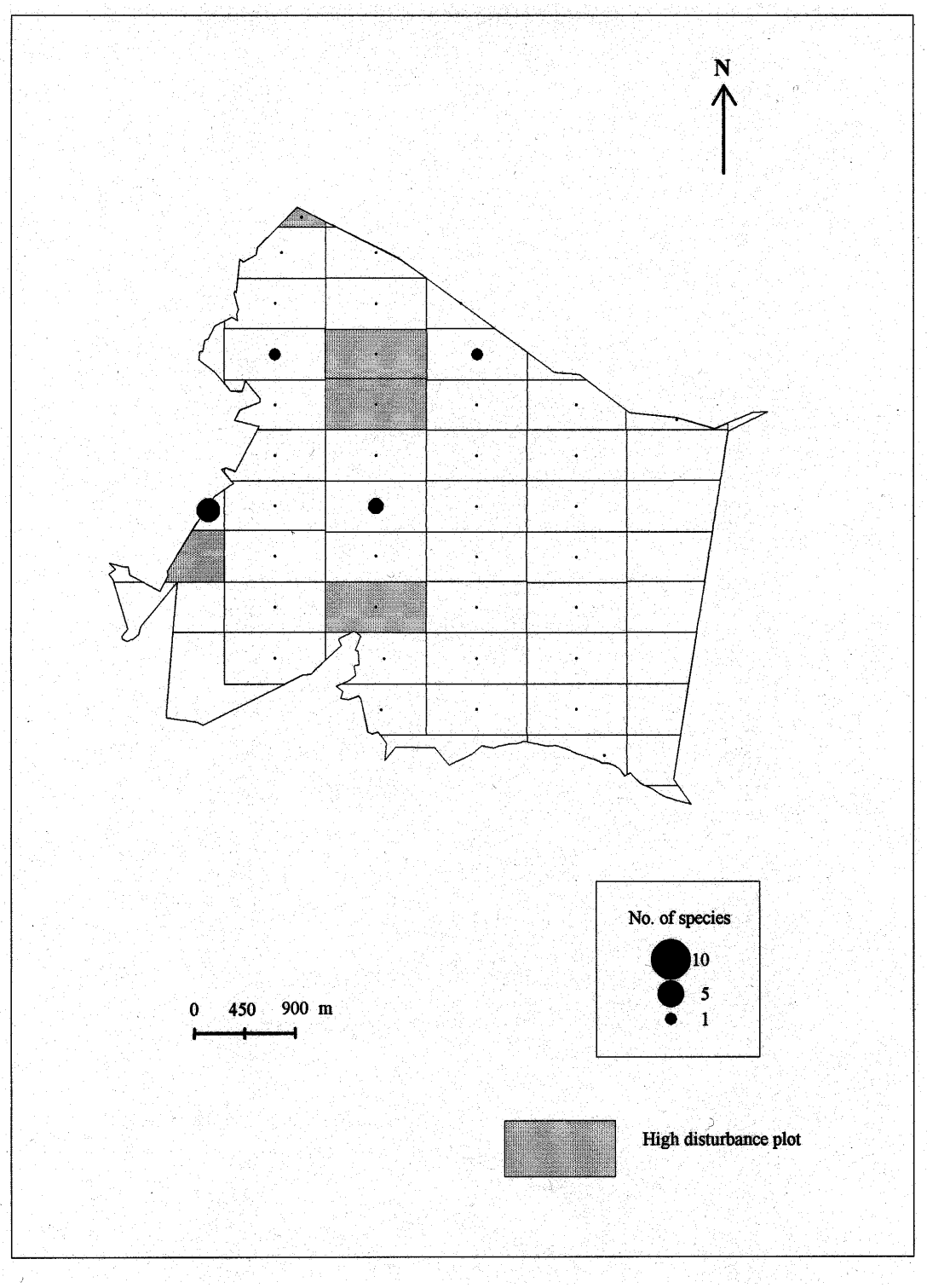


Figure 30. Areas of highest disturbance in relation to the distribution of animal species that are both forest dependent and near-endemic.

5.5.6 CITES

All the birds from the families ACCIPITIRIDAE and STRIGIDAE, *Tauraco fischeri, Tyto alba, Chamaeleo dilepis, Kinixys belliana, Cordylus t. tropidosternum, Varanus niloticus* and *Crocodylus niloticus* are listed under Appendix II of CITES.

5.5.7 IUCN Status

According to IUCN criteria (see Section 1.2), the survival of three species found in Manga Forest Reserve is endangered. These species are: *Rhynchocyon petersi, Lygodactylus kimhowelli* and *Mertensophryne micranotis*. There has been insufficient data on the skink *Melanoseps longicauda* to categorise it however it seems likely that given its apparent rarity it will also be categorised as a threatened species.

According to IUCN criteria the following species, found in Manga Forest Reserve, are vulnerable to extinction: *Otus ireneae, Sheppardia gunningi, Agama montana* and *Scolecomorphus vittatus*.

creona, Colotis regina, Eurema brigitta, Eurema floricola, Eurema hecabe and *Axiocerses tjoane*.

Table 36. Summary of ecological type of faunal species (excluding molluscs and millipedes).

Ecological type	No. of species	% of total species recorded
(F) Forest dependent	58	22
(f) Forest dwelling but not forest dependent	171	64
(O) Non-forest species	24	9
Unknown	13	5
Total:	**254**	

5.5.3 Endemic Status

Two butterfly species endemic to the Usambara Mountains were recorded during this survey. These are *Charaxes usambarae* and *Euthecta* sp. nov.

Table 37. Summary of endemic status of faunal species (excluding molluscs and millipedes).

Endemic status	No. of species	% of total species recorded
(E) Endemic to the Usambara Mountains	2	1
(N) Near-Endemic: ranges in restricted locations	21	8
(W) Widespread	233	89
Unknown	6	2
Total:	**254**	

5.5.4 New Species

- The butterfly *Euthecta* sp. nov. was first recorded in Manga during the preliminary survey in 1994. The late Jan Kielland started to describe this species and had proposed that it be called *Euthecta baylissi*.
- Two new genera of millipede were recorded from Manga.

5.5.5 Range Extensions

- *Melanoseps longicauda* has previously only been recorded from Pangani and was known from only two specimens (Broadley and Howell 1991).
- *Bufo lindneri* has not previously been recorded north of the Coastal Region of Tanzania.
- *Afrixalus sylvaticus* was formerly known only from Kazimzumbwi F.R. and the Shimba Hills, Kenya.
- The butterfly *Charaxes etesipe* is listed as being a western Tanzanian species by Kielland (1990).

5.5.1.1 Amphibians

The most commonly caught amphibian was *Arthroleptis stenodactylus*. It was recorded 125 times. Other species which appear to be locally common are *Hemisus marmoratus, Bufo gutturalis, Leptopelis flavomaculatus* and *Afrixalus sylvaticus*. It is notable that *Bufo brauni* was not recorded in Manga. This is common in most other Usambara forests.

5.5.1.1 Butterflies

The most commonly caught butterfly was *Bicyclus safitza*. It was recorded 79 times. Another forty one species are locally common. Relative to other forest reserves in the East Usambaras, Manga Forest Reserve has the highest diversity of butterflies.

5.5.1.1 Molluscs

The most commonly recorded molluscs were *Maizania* sp and unidentified urocyclids.

5.5.1.1 Endemics and near-endemics

Of the 24 faunal Usambara endemics and near-endemics found in Manga, four species, the rodent, *Beamys hindei* and the butterflies *Charaxes contrarius, Charaxes lasti* and *Charaxes usambarae* appear to be locally common as they were recorded at least three times during the survey.

5.5.1.1 Forest dependent species

Of the 53 forest dependent species, eight appear to be locally common. These are: *Mertensophryne micranotis, Leptopelis flavomaculatus* and six butterfly species. This does not include birds as abundance was not systematically recorded for birds nor molluscs and millipedes as insufficient information is known on their ecological requirements.

5.5.1.1 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: *Rhynchocyon petersi*, *Leptotyphlops macrops, Lygodactylus kimhowelli, Aparallactus werneri, Bebearia chriemhilda* and *Euthecta* sp. nov. *Melanoseps longicauda* may also be at high risk although it is unclear whether the reason for it being recorded so rarely is due to its scarcity or to it being highly cryptic.

5.5.2 Ecological type

Of the forest dependent species, four are mammals, 18 are birds, four are reptiles, five are amphibians and 22 are butterflies.

Twenty-one non-forest species are established in the reserve. These non-forest species are: *Streptopelia semitorquata, Centropus superciliosus, Caprimulgus pectoralis, Phoeniculus purpureus, Pycononotus barbatus, Apalis flavida, Mabuya boulengeri, Bitis arietans, Panaspis wahlbergii* and *Bufo maculatus, Acraea neobule, Charaxes jahlusa, Charaxes zoolina, Junonia hierta, Junonia oenone, Belenois*

5.5 Discussion

5.5.1 Species richness and abundance

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

Table 34. Summary of faunal families and species.

Taxon	Number of families	Number of species
Mammals	16	30
Bird	35	82
Reptiles	13	26
Amphibians	8	22
Butterflies	8	102
Millipedes	7	12
Molluscs	8	16

Relative to other forest reserves in the East Usambaras the species richness of Manga FR is above average for mammals (24), reptiles (21), amphibians (16) and butterflies (50).

Table 35. Summary of capture locations of faunal species by plot number.

Taxon	1*	2	5	10*	12*	30*	42*	32	Unknown capture location
Mammal**	3	1	1	8	5	5	0		
Reptile	6	2	1	5	4	4	1		10
Amphibian	7			6	8	2	2	1	20
Butterflies	42			38	36	21	27		

* Trap site.
**primates and bats excluded due to their large ranges.

5.5.1.1 Mammals

The most commonly recorded small mammal (excluding bats) was *Crocidura* sp.. Other animals which appear to be common locally are *Beamys hindei, Grammomys* sp., *Acomys* sp., and *Mus* sp.. The most commonly caught bat was *Hipposideros ruber*. Two other species, *Epomophorus wahlbergi* and *Rhinolophus deckenii* are also locally common.

5.5.1.1 Reptiles

The most commonly caught reptile species was *Hemidactylus mabouia*. It was recorded eleven times. The other species which appear to be locally common are *Mabuya m. maculilabris, Leptotyphlops scutifrons merkeri, Philothamnus punctatus, Thelotornis capensis mossambicanus* and *Cordylus t. tropidosternum*.

5.4.6.3 Millipedes

A total of 12 species from seven families were collected during casual collections. At least three genera and four new species were discovered during this survey. The identification of those millipedes collected during the systematic collections has not been completed.

Table 33. Summary of millipedes.

Species
SPIROBOLIDA
PACHYBOLIDAE
Gen & Sp. Nov.
SPIROSTREPTIDA
SPIROSTREPTIDAE
Otostreptus stylifer
Lophostreptus aff. Armatus (Pocock)
HARPAGOPHORIDAE
Apoctenophora sp. indet.
ODONTOPYGIDAE
Xystopyge ?*robusta* (Attems)
Xystopyge sp. indet.
Gen. & Sp. Nov.
POLYDESMIDA
PARADOXOSOMATIDAE
Aklerobunus sp.?
OXYDESMIDAE
Ctenodesus pectinatus
Rhododesmus mastophorus
GOMPHODESMIDAE
Astrodesmus laxus
Marptodesminae gen. & sp. nov.

5.4.6.2 Molluscs

A total of 208 specimens were retained for taxonomic purposes. Only those specimens collected casually have been identified. These represent 16 species from 8 families. Remaining specimens are held at the Zoological Museum of Copenhagen and await identification.

Table 32. Summary of molluscs.

Species	Total
ACHATINIDAE	
Achatina albopicta ? (half grown)	1
ARIOPHANTIDAE	
Sitala leroyi	2
Sitala jenynsi	1
ENIDAE	
Rhachistia picturata	2
Rhacidina braunsi	2
MAIZANIIDAE	
Maizania sp.	3
POMATIASIDAE	
Tropidophora calcarea	2
STREPTAXIDAE	
Edentulina ovoidea	2
Tayloria usambarica	1
Streptaxis sp.	2
Streptaxis craveni	1
SUBULINIDAE	
Pseudoglessula sp.	1
Eunyma magilensis	2
UROCYCLIDAE	
Atoxon sp.	1
Elisolimax sp.	1
Urocyclos kirkii / elegans	1
Unidentified Urocyclid	6

Species	Ecological type	Endemic status	Capture location by plot and number collected						Total
			1	42	30	12	10	Other	
LYCAENIDAE									
Anthene lemnos	f	W						1	**1**
Anthene sp.							1		**1**
Axiocerses tjoane	O	W						1	**1**
Baliochila latimarginata	F	N						1	**1**
Eicochrysops hippocrates	f	W	1						**1**
Euthecta sp. nov.		E						1	**1**
Leptotes pirithous	f	W	1					1	**1**
Pentila rogersi	F	N						1	**1**
Pentila tropicalis	F	W	1				1		**2**
Spalgis lemolea	f	W						1	**1**
Teriomima subpunctata	F	N				1			**1**
HESPERIDAE									
Acada biseriatus	f	W	1		1				**2**
Ampittia parva	f	W			1	1			**2**
Andronymus neander	f	W				1			**1**
Asticoptrerus stellatus	f	W	1						**1**
Astictopterus tura	f	N						1	**1**
Borbo fatuellus	f	W						1	**1**
Borbo lugens	f	W						1	**1**
Celaenorrhinus galenus	F	W				1			**1**
Coeliades chalybe	f	W						1	**1**
Pardaleodes incerta	f	W						1	**1**
Tagiades flesus	f	W			1				**1**

KEY TO ABBREVIATIONS FOR TABLE 31 (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.

Species	Ecological type	Endemic status	Capture location by plot and number collected						Total
			1	42	30	12	10	Other	
NYMPHALIDAE cont.									
Charaxes contrarius	f	N		4					**4**
Charaxes etesipe	F	W					1		**1**
Charaxes ethalion	f	W	1						**1**
Charaxes jahlusa	O	W		9	1				**10**
Charaxes lasti	F	N	1	9	27	5	1		**43**
Charaxes macclounii	f	W	1						**1**
Charaxes protoclea	F	W		4		1			**5**
Charaxes usambarae	F	E				3			**3**
Charaxes varanes	f	W		1		1			**2**
Charaxes violetta	f	W	13	3	2	5			**23**
Charaxes xiphares	F	W	2		1				**3**
Charaxes zoolina	f	W		2		1			**3**
Euphaedra neophron	F	W					2		**2**
Euptera kinungnana	F	W	2						**2**
Euryphura achlys	F	W			3	3			**6**
Eurytela dryope	f	W	1		1	1	6		**9**
Euxanthe wakefieldi	f	W	1	1	3	1			**6**
Hamanumida daedalus	f	W					3		**3**
Hypolimnas anthedon	f	W	1	1	2	1	6		**11**
Hypolimnas deceptor	f	W	1			4			**5**
Hypolimnas misippus	f	W	4	1			1	1	**6**
Junonia natalica	f	W					2		**2**
Junonia oenone	O	W	4				5	1	**9**
Libythea labdaca	f	W	2	1	2				**5**
Neptidopsis ophione	f	W				1			**1**
Neptis carcassoni	f	W				3			**3**
Neptis goochi	f	W	1	1					**2**
Neptis melicerta	F	W		1					**1**
Neptis saclava	f	W	3			2			**5**
Neptis serena	f	W					1		**1**
Neptis sp.				1					**1**
Neptis trigonophora	F	W	1						**1**
Pseudacrea boisduvali	f	W				3			**3**
Pseudacrea dolomena	f	W				1			**1**
Pseudacrea eurytus	F	W			1				**1**
Pseudacrea lucretia	F	W	4	1		27			**32**
Tirumala petiverana	f	W			2	1			**3**
ACRAEIDAE									
Acraea encedon	O	W	1						**1**
Acraea eponina	f	W	1				2	1	**3**
Acraea esebria	f	W				2			**2**
Acraea insignis	f	W	1						**1**
Acraea johnstoni	f	W		1					**1**
Acraea natalica	O	W					1		**1**
Acraea neobule	O	W			1		1		**2**
Acraea rabbaiae	f	W						1	**1**
Acraea servona	F	W				1			**1**
Acraea zonata	F	W				1			**1**
Bematistes adrasta	f	W					1		**1**

5.4.6 Invertebrates

5.4.6.1.1 Butterflies

A total of 515 individuals were retained for taxonomic purposes. These specimens represent 102 species from eight families. Ecological type and endemic status were compiled from Kielland (1990) and Larsen (1996). Identifications were made by Steve Collins and the late Jan Kielland. Specimens are held at the African Butterfly Research Institute in Nairobi.

Table 31. Summary of butterflies.

Species	Ecological type	Endemic status	Capture location by plot and number collected						Total
			1	42	30	12	10	Other	
PAPILIONIDAE									
Papilio constantinus	f	W						1	**1**
Papilio dardanus	f	W	2	2			1		**5**
Papilio demodocus	f	W	1				1		**2**
PIERIDAE									
Appias lasti	f	W				1	1		**2**
Appias sabina	f	W	1						**1**
Belenois aurota	f	W					1		**1**
Belenois creona	O	W	7	3			4		**14**
Belenois thysa	f	W		1		1	13		**15**
Catopsilia florella	f	W	4	2					**6**
Colotis evippe	f	W	2				4		**6**
Colotis ione	O	W	1						**1**
Eurema brigitta	O	W					1		**1**
Eurema floricola	O	W			1	9	2		**12**
Eurema senegalensis	F	W	1				4		**5**
Leptosia alcesta	f	W		2			1		**3**
Nepheronia argia	F	W					2		**2**
DANAIDAE									
Danaus chrysippus	f	W	5						**5**
Danaus petiverana	f	W	1					1	**1**
SATYRIDAE									
Bicyclus campinus	f	W		6		1	4		**11**
Bicyclus safitza	f	W	16	15	3	5	40		**79**
Melanitis leda	f	W	3	6	4	4	12		**29**
Ypthimomorpha itonia	O	W					1		**1**
NYMPHALIDAE									
Amauris niavius	f	W	1			1		1	**2**
Amauris ochlea	f	W			1	1			**2**
Apaturopsis cleochares	F	W	2		4	1			**7**
Aterica galene	F	W					1		**1**
Bebearia chriemhilda	F	N		1					**1**
Byblia ilithyia	f	W					3		**3**
Charaxes acuminatus	F	W	4				2		**6**
Charaxes aubyni	F	W					1		**1**
Charaxes brutus	f	W	4	1		6	2		**13**
Charaxes candiope	f	W	1						**1**
Charaxes castor	f	W					2		**2**
Charaxes cithaeron	f	W		1	6	6			**13**

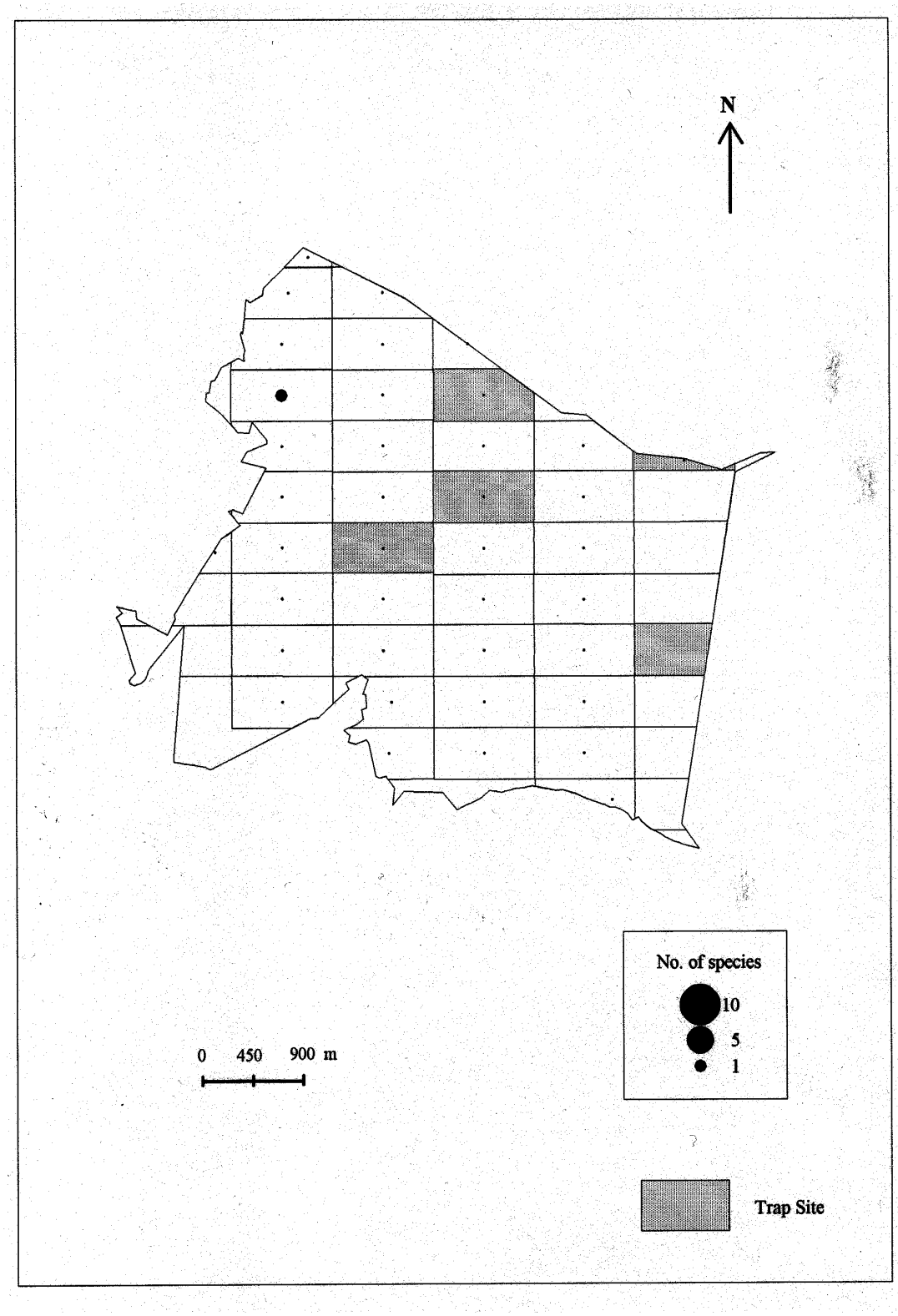


Figure 29. Distribution of near-endemic amphibian species.

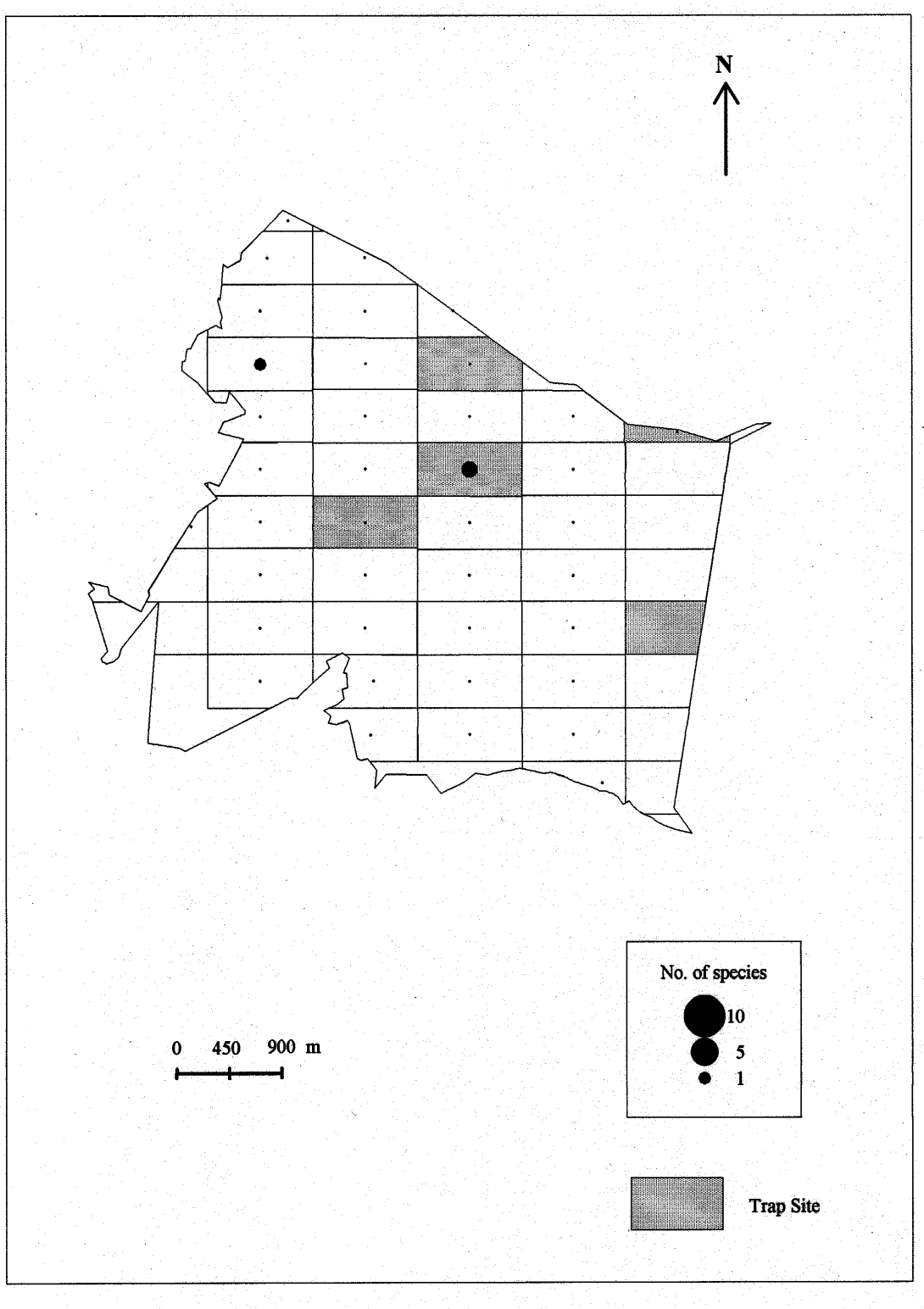


Figure 28. Distribution of forest dependent amphibian species.

	Ecol. type	End. status	IUCN status	Capture site by plot and number collected								Total
				1	**30**	**12**	**10**	**42**	**32**	**35**	**UK**	
PIPIDAE												
Tropical platanna												
Xenopus muelleri	f	W									2	**2**
SCOLECOMORPHIDAE												
Scolecomorphus vittatus	F	N	V								1	**1**
Unknown				5		6						**11**

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

Ecological type:

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

Endemic status:

- 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

Table 30. Ranges for near-endemic amphibian species recorded (Howell, 1993).

Species	Range
Hyperolius mariae	Coastal lowlands of NE Tanzania, S.E. Kenya, also Zanzibar and Mafia.
Leptopelis parkeri	Usambara, Uluguru and Udzungwa Mountains.
Afrixalus sylvaticus	Kwale, Kenya.
Scolecomorphus vittatus	Usambara, Uluguru, N. Pare Mountains.
Mertensophryne micranotis	Coastal forests including Sokoke Forest in Kenya, E. Usambaras including Kilulu Hill, Zanzibar and Songo-Songo Island (Kilwa District).

5.4.5 Amphibians

A total of 332 individuals were retained for taxonomic purposes. These specimens represent 22 species from eight families. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (UDSM, 1996), Poynton & Broadley (1991). Common names are from Passmore & Carruthers (1995).

Table 29. Summary of amphibians.

	Ecol. type	End. status	IUCN status	Capture site by plot and number collected								Total
				1	**30**	**12**	**10**	**42**	**32**	**35**	**UK**	
ARTHROLEPTIDAE												
Common squeaker												
Arthroleptis stenodactylus	f	W		13	33	27	31	2			19	**125**
Arthroleptis xenodactyloides	f	W		4							10	**14**
Arthroleptis sp.				5		26	2					**33**
BUFONIDAE												
Guttural toad												
Bufo gutturalis	f	W		22			7	1			2	**32**
Bufo lindneri	f	W									2	**2**
Flat-backed toad												
Bufo maculatus	O	W		1			1				1	**3**
Bufo sp.				6								**6**
Bunty's dwarf toad												
Mertensophryne micranotis	F	N	EN							1	2	**3**
HEMISIDAE												
Marbled shovel-nose												
Hemisus marmoratus	f	W			6	11	25					**42**
HYPEROLIDAE												
Argus reed frog												
Hyperolius argus	f	W									3	**3**
Coast reed frog												
Hyperolius mariae	f	N									2	**2**
Hyperolius puncticulatus (?)	F	W				1						**1**
Tinker reed frog												
Hyperolius tuberilinguis	f	W									4	**4**
Ornate treefrog												
Leptopelis flavomaculatus	F	W				4			2		6	**12**
Glade treefrog												
Leptopelis argenteus	O	W									3	**3**
Glass tree frog												
Leptopelis parkeri	F	N									1	**1**
Leptopelis sp.						1						**1**
Afrixalus brachycnemis	O	W									2	**2**
Afrixalus sylvaticus	F	N									3	**3**
Afrixalus sp.											10	**10**
RANIDAE												
Zanzibar puddle frog												
Phrynobatrachus acridoides	f	W									10	**10**
Plain grass frog												
Ptychadena anchietae	f	W		1			1				1	**3**
Sharp-nosed grass frog												
Ptychadena oxyrhynchus	f	W									1	**1**
RHACOPHORIDAE												
Foam-nest treefrog												
Chiromantis xerampelina	f	W				1					1	**2**

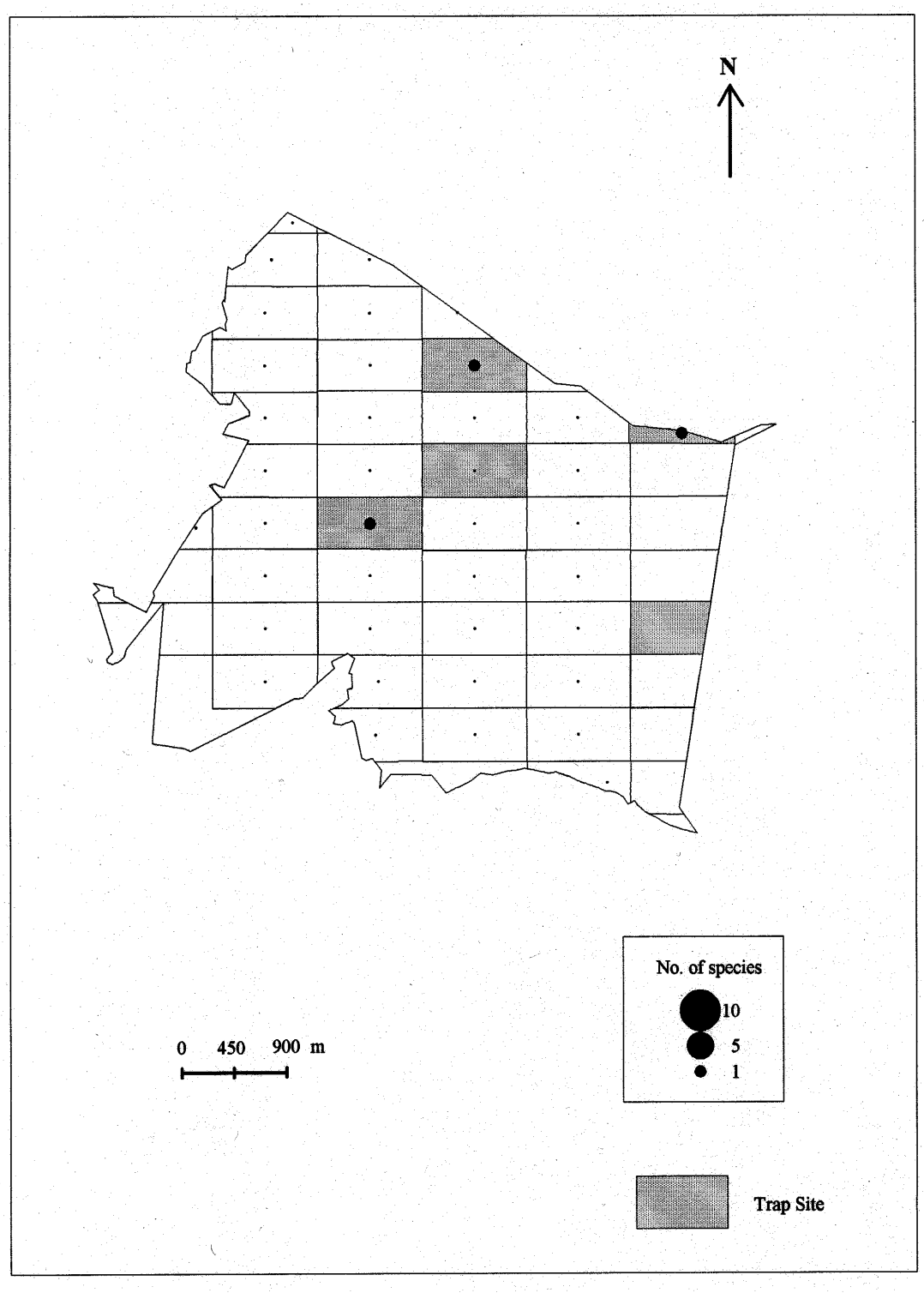


Figure 27. Distribution of near-endemic reptile species.

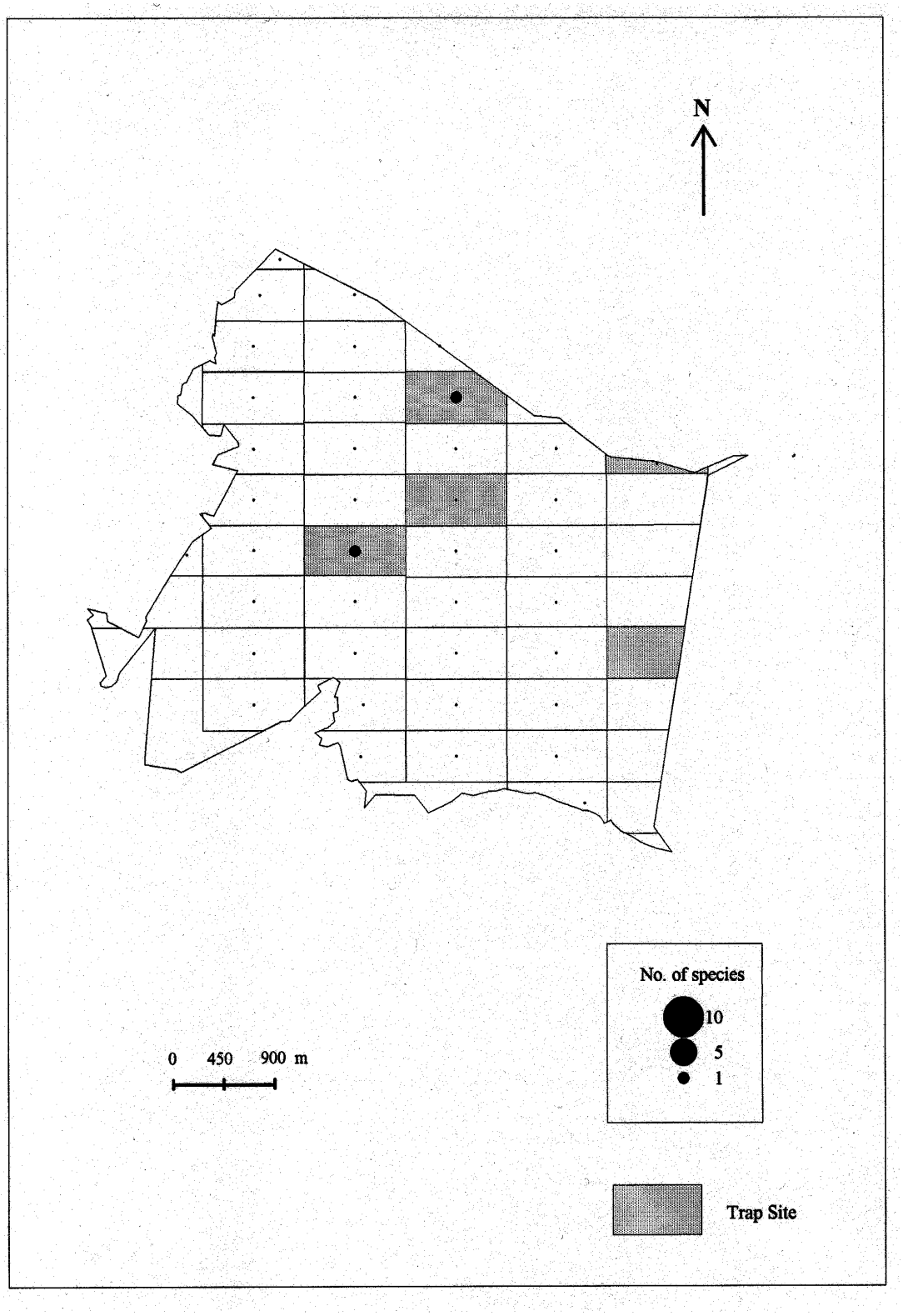


Figure 26. Distribution of forest dependent reptile species.

- LC – Least concern

UK - Unknown capture location

Table 28. Ranges for endemic and near-endemic reptile species recorded (Howell, 1993).

Near-endemic Species	**Range**
Lygodactylus kimhowelli	Amboni Caves Forest and E. Usambara Mountains.
Melanoseps longicauda	Northeastern Tanzania (also S.E. Kenya?).
Leptotyphlops macrops	E. Usambaras, coastal forests of NE Tanzania and SE Kenya.
Aparallactus werneri	Usambara and Uluguru Mountains.

Species	Ecol. type	End. status	IUCN status	Capture location by plot and number collected								Total
				1	2	5	10	12	30	42	UK	
COLUBRIDAE cont.												
Olive marsh-snake												
Natriciteres olivacea	f	W							1			**1**
East African shovel-snout												
Prosymna ambigua stuhlmanni	f	W							1			**1**
South-eastern green-snake												
Philothamnus hoplogaster	f	W		1								**1**
Spotted bush-snake												
Philothamnus punctatus	f	W		1				1			1	**3**
Herald snake												
Crotaphopeltis hotamboeia	F	W		1								**1**
Northern marbled tree-snake												
Dipsadoboa flavida broadleyi	f	W									2	**2**
Brown house snake												
Lamprophis capensis	f	W					1					**1**
Mozambique vine-snake												
Thelotornis capensis mossambicanus	f	W			1	1					1	**3**

Table 27. Summary of reptile observations.

Species	Certainty	Ecological type	Endemic status	Observation location
LACERTIDAE				
Eastern serrate-toed tree-lizard				
Holaspis guentheri	Definite	f	W	UK
ELAPIDAE				
Forest cobra				
Naja melanoleuca	Definite	f	W	UK
VARANIDAE				
Nile monitor				
Varanus niloticus	Definite	f	W	Near Sigi River
CROCODYLIDAE				
Nile crocodile				
Crocodylus niloticus	Definite	f	W	Sigi River

KEY TO ABBREVIATIONS FOR TABLE 26 & 27 (Definitions based on those described in Section 1.2).

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

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

IUCN status:
- EN - Endangered
- V - Vulnerable
- NT - Near-threatened

5.4.4 Reptiles

A total of 46 individuals were retained for taxonomic purposes. These specimens represent 22 species from 9 families. An additional four species from four families were observed but not collected. Ecological type, endemic status and IUCN status were compiled from the National Biodiversity Database (1996), Broadley & Howell (unpubl.), Howell (1993), and Branch (1994). Nomenclature follows Broadley and Howell (1991).

Table 26. Summary of reptiles.

Species	**Ecol. type**	**End. status**	**IUCN status**	**Capture location by plot and number collected**								**Total**
				1	**2**	**5**	**10**	**12**	**30**	**42**	**UK**	
TESTUDINIDAE												
Southeastern hinge-back tortoise												
Kinixys belliana	f	W					1					**1**
GEKKONIDAE												
Tropical house gecko												
Hemidactylus mabouia	f	W						1	1	1	8	**11**
Lygodactylus kimhowelli	F	N	EN				1					**1**
AGAMIDAE												
Montane rock agama												
Agama montana	F	N	V								1	**1**
CHAMAELEONIDAE												
Common flap-necked chameleon												
Chamaeleo dilepis	f	W			1							**1**
SCINCIDAE												
Long-tailed limbless skink												
Melanoseps longicauda	f	N	DD	1								**1**
Boulenger's skink												
Mabuya boulengeri	O	W									1	**1**
Speckle-lipped skink												
Mabuya maculilabris Maculilabris	f	W		3				1				**4**
Savanna snake-eyed skink												
Panaspis wahlbergii	O	W					1	1				**2**
CORDYLIDAE												
East African spiny-tailed lizard												
Cordylus t. tropidosternum	f	W		1			1				1	**3**
LEPTOTYPHLOPIDAE												
Worm-snake												
Leptotyphlops macrops	F	N									1	**1**
Merker's worm-snake												
Leptotyphlops scutifrons merkeri	f	W	LC	1							3	**4**
VIPERIDAE												
Puff adder												
Bitis arietans arietans	O	W									1	**1**
COLUBRIDAE												
Usambara centipede-eater												
Aparallactus werneri	F	N	V						1			**1**

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:
- V – Vulnerable
- LC – Least concern
- NT – Near Threatened

Species	English Name	Ecological type	Endemic status	IUCN status
TYTONIDAE				
Tyto alba	Barn owl	O	W	LC
APODIDAE				
Cypsiurus parvus	African palm swift	O	W	
Apus affinis	Little swift	O	W	
COLIIDAE				
Colius striatus	Speckled mousebird	O	W	
ALCEDINIDAE				
Alcedo semitorquata	Half-collared kingfisher	O	W	
Ceryle rudis	Pied kingfisher	O	W	
Megaceryle maxima	Giant kingfisher	O	W	
MEROPIDAE				
Merops apiaster	Eurasian bee-eater	O	W	
CORACIIDAE				
Eurystomus glaucurus	Broad-billed roller	O	W	
INDICATORIDAE				
Indicator indicator	Black-throated honeyguide	O	W	
Indicator minor	Lesser honeyguide	O	W	
HIRUNDINIDAE				
Hirundo abyssinica	Lesser striped swallow	O	W	
Hirundo smithii	Wire-tailed swallow	O	W	
PICNONOTIDAE				
Andropardus importunus	Zanzibar sombre greenbul	O	W	
TURDIDAE				
Cossypha caffra	Cape robin-chat	O	W	
MUSCICAPIDAE				
Muscicapa striata	Spotted flycatcher	O	W	
SYLVIIDAE				
Prinia subflava	Tawny-flanked prinia	O	W	
MALACONOTIDAE				
Tchagra australis	Brown-crowned tchagra	O	W	
ORIOLIDAE				
Oriolus larvatus	Black-headed oriole	O	W	
CORVIDAE				
Corvus albicollis	White-naped raven	f	W	
NECTARINIIDAE				
Nectarinia bifasciata	Purple-banded sunbird	O	W	
PLOCEIDAE				
Amblyospiza albifrons	Grosbeak-weaver	O	W	
Ploceus ocularis	Spectacled weaver	O	W	
Ploceus cucullatus	Black-headed weaver	O	W	
Euplectes nigroventris	Zanzibar red bishop	O	W	
Euplectes capensis	Yellow bishop	O	W	
ESTRILDIDAE				
Estrilda astrild	Common waxbill	O	W	

KEY TO ABBREVIATIONS FOR TABLE 24 and 25 (Definitions based on those described in Section 1.2).

Ecological type:

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

Species	English Name	Ecological type	Endemic status	IUCN status
PLATYSTEIRIDAE				
Batis mixta	Forest batis	f	W	LC
Bias musicus	Black-and-white flycatcher	F	W	
PRIONOPIDAE				
Prionops retzii	Retz's helmet-shrike	f	W	
Prionops scopifrons	Chestnut-fronted helmet-shrike	f	W	
MALACONOTIDAE				
Dryoscopus cubla	Black-backed puffback	f	W	
Laniarius aethiopicus	Tropical boubou	f	W	
CAMPEPHAGIDAE				
Campephaga flava	Black cuckoo-shrike	f	W	
DICRURIDAE				
Dicrurus adsimilis	Common drongo	f	W	
Dicrurus ludwigii	Square-tailed drongo	f	W	
ORIOLIDAE				
Oriolus auratus	African golden oriole	f	W	
Oriolus chlorocephauls	Green-headed oriole	f	W	
STURNIDAE				
Lamprotornis corruscus	Black-breasted glossy starling	f	W	
NECTARINIIDAE				
Anthreptes collaris	Collared sunbird	f	W	
Anthreptes neglectus	Uluguru violet-backed sunbird	F	W	
Anthreptes pallidigaster	Amani sunbird	F	N	
Nectarinia olivacea	Olive sunbird	f	W	
PLOCEIDAE				
Ploceus bicolor	Dark-backed weaver	f	W	
ESTRILDIDAE				
Hypargos niveoguttatus	Peter's twinspot	f	W	
Mandingoa nitidula	Green-backed twinspot	f	W	
Spermophaga ruficapilla	Red-headed bluebill	F	W	

An additional 34 species were recorded from agricultural land adjacent to the forest reserve and from the Sigi River. These records are not included in the summary statistics.

Table 25. Birds recorded from adjacent public land.

Species	English Name	Ecological type	Endemic status	IUCN status
SCOPIDAE				
Scopus umbretta	Hamerkop	O	W	
ACCIPITRIDAE				
Buteo sp.	Buzzard		W	
Hieraaetus pennatus	Booted eagle	O	W	LC
HELIORNITHIDAE				
Podica senegalensis	African finfoot	O	W	
SCOLOPACIDAE				
Actitis hypoleucos	Common sandpiper	f	W	
COLUMBIDAE				
Turtur afer	Blue-spotted wood dove	f	W	
CUCULIDAE				
Oxylopus levaillantii	Levaillant's cuckoo	f	W	

Species	English Name	Ecological type	Endemic status	IUCN status
BUCEROTIDAE				
Bycanistes bucinator	Trumpeter hornbill	f	W	
Tockus alboterminatus	Crowned hornbill	f	W	
CAPITONIDAE				
Pogoniulus simplex	Eastern green tinkerbird	F	W	LC
Stactolaema leucotis	White-eared barbet	f	W	
Stactolaema olivacea	Green barbet	F	W	LC
INDICATORIDAE				
Indicator meliphilus	Pallid honeyguide	f	W	
Indicator variegatus	Scaly-throated honeyguide	f	W	
PICIDAE				
Campethera mombassica	Mombasa woodpecker	f	W	LC
Campethera cailliautii	Little spotted woodpecker	f	W	
Dendropicos fuscescens	Cardinal woodpecker	f	W	
EURYLAIMIDAE				
Smithornis capensis	African broadbill	F	W	LC
MOTACILLIDAE				
Motacilla clara	Mountain wagtail	f	W	
HIRUNDINIDAE				
Psalidoprocne holomelas	Black saw-wing	f	W	
PYCNONOTIDAE				
Andropadus virens	Little greenbul	f	W	
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				
Cercotrichas quadrivirgata	Eastern bearded scrub robin	f	W	
Cossypha natalensis	Red-capped robin-chat	f	W	
Neocossyphus rufus	Red-tailed ant thrush	f	W	LC
Sheppardia gunningi	East Coast akalat	F	N	V
MUSCICAPIDAE				
Muscicapa caerulescens	Ashy flycatcher	f	W	
Myioparus plumbeus	Lead-coloured flycatcher	f	W	
CERTHIIDAE				
Erythrocercus holochlorus	Little yellow flycatcher	f	W	
MONARCHIDAE				
Terpsiphone viridis	African paradise flycatcher	f	W	
Trochocercus cyanomelas	Blue-mantled crested flycatcher	F	W	
SYLVIIDAE				
Apalis flavida	Yellow-breasted apalis	f	W	
Apalis melanocephala	Black-headed apalis	F	W	
Camaroptera brachyura	Grey-backed camaroptera	f	W	
Hyliota australis	Southern hyliota	f	W	
Macrosphenus kretschmeri	Kretschmer's longbill	F	W	LC

5.4.3 Birds

A total of 82 species from 35 families were recorded within the reserve. An additional 34 species and seven families not recorded within the reserve were recorded from outside of the reserve along the Sigi River and in neighbouring agricultural land. These additional species are not included in the summary information. 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 24. Summary of birds.

Species	English Name	Ecological type	Endemic status	IUCN status
ACCIPITIRIDAE				
Accipiter melanoleucus	Great sparrowhawk	f	W	LC
Accipiter minullus	Little sparrowhawk	f	W	LC
Accipiter tachiro	African goshawk	f	W	LC
Circaetus fasciolatus	Southern banded snake eagle	F	W	LC
Gypohierax angolensis	Palm-nut vulture	f	W	LC
Hiraaetus ayresii	Ayres's hawk-eagle	f	W	LC
Lophaetus occipitalis	Long-crested eagle	f	W	LC
Polyboroiodes typus	African harrier hawk	f	W	LC
Stephanoaetus coronatus	African crowned eagle	f	W	LC
NUMIDIDAE				
Gutter pucherani	Crested guineafowl	f	W	
COLUMBIDAE				
Columba delegorguei	Eastern bronze-naped pigeon	F	W	
Streptopelia semitorquata	Red-eyed dove	f	W	
Treron calva	African green pigeon	F	W	
Turtur tympanistria	Tambourine dove	f	W	
MUSOPHAGIDAE				
Tauraco fischeri	Fischer's turaco	f	W	NT
CUCULIDAE				
Centropus superciliosus	White-browed coucal	O	W	
Cercococcyx montanus patulus	Barred long-tailed cuckoo	F	W	
Ceuthmochares aereus	Yellowbill	f	W	
Chrysococcyx klaas	Klaas's cuckoo	f	W	
STRIGIDAE				
Otus ireneae	Sokoke scops owl	f	N	V
Strix woodfordii	African wood owl	f	W	LC
CAPRIMULGIDAE				
Caprimulgus pectoralis	Fiery-necked nightjar	O	W	
APODIDAE				
Telacanthura ussheri	Mottled spinetail	f	W	
TROGONIDAE				
Apaloderma narina	Narina trogon	f	W	
Apaloderma vittatum	Bar-tailed trogon	F	W	LC
ALCEDINIDAE				
Halcyon albiventris	Brown-hooded kingfisher	f	W	
PHOENICULIDAE				
Phoeniculus purpureus	Green wood-hoopoe	f	W	

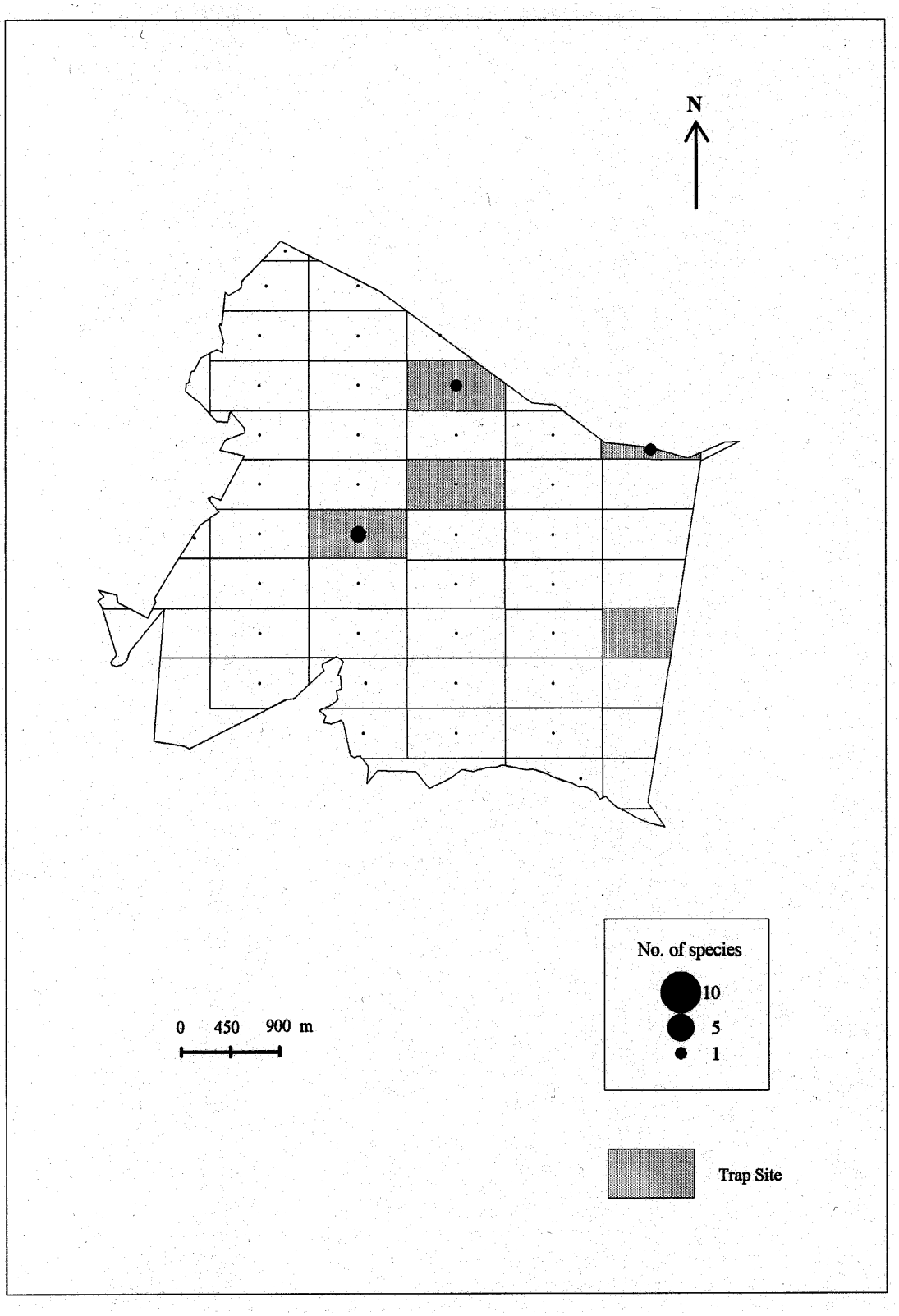


Figure 25. Distribution of near-endemic mammal species.

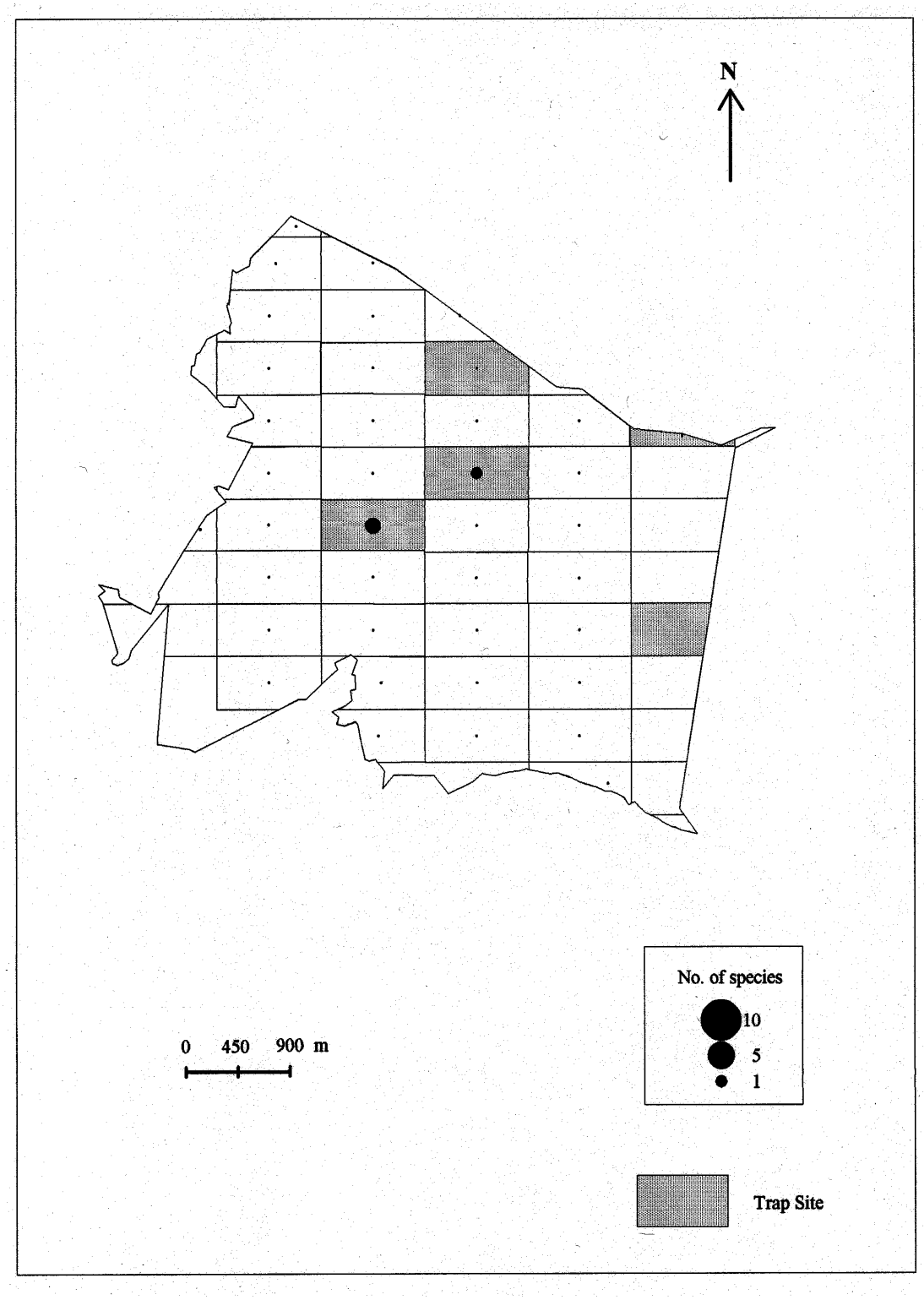


Figure 24. Distribution of forest dependent mammal species.

5.4.2 Bats

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

Table 23. Summary of bats.

Species	Common name	Ecological type	Endemic status	Number collected
PTEROPODIDAE				
Rousettus aegyptiacus	Egyptian rousette bat	f	W	2
Epomophorus wahlbergi	Epauletted fruit bat	f	W	3
Myonycteris relicta	Collared fruit bat		W	2
Microchiroptera				
HIPPOSIDERIDAE				
Hipposideros ruber	Leaf-nosed bat	f	W	4
Triaenops persicus afer	Persian leaf-nosed bat	f	W	1
RHINOLOPHIDAE				
Rhinolophus landeri	Horseshoe bat	f	W	1
Rhinolophus deckenii	Horseshoe bat	f	W	3
VESPERTILIONIDAE				
Myotis bocagei hildegardeae	Hairy bat	f	W	2
Miniopterus fraterculus	Long-fingered bat	f	W	1
MOLOSSIDAE				
Tadarida (Chaerephon) *pumila*	Guano bat	f	W	1 (in barn owl pellets)

KEY TO ABBREVIATIONS FOR TABLE 23 (Definitions based 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:

- W - Widespread distribution.

6.4.1.3 Mammal observations

A total of 10 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) and Kingdon (1989).

Table 22. Summary of mammal observations.

Species	Certainty	Ecol. type	End. status	IUCN status	Observation location by plot
COLOBIDAE					
Angola pied colobus					
Colobus angolensis	definite	F	W		2, 30
CERCOPITHECIDAE					
Yellow baboon					
Papio cynocephalus	definite	f	W		
Vervet monkey					
Cercopithecus aethiops	definite	f	W		
Gentle monkey					
Cercopithecus mitis	definite	f	W		
GALAGONIDAE					
Small-eared galago					
Otolemur garnetti	definite	f	W		
Matundu galago					
Galago sp. nov. *'udzungwensis'*	probable	f	W		
MACROSCELIDIDAE					
Zanj elephant shrew					
Rhynchocyon petersi	definite	F	N	EN	30
VIVERRIDAE					
African palm civet					
Nandinia binotata	probable	f	W		UK
SUIDAE					
Bush pig					
Potamochoerus larvatus	definite	f	W		
BOVIDAE					
Blue duiker					
Cephalophus monticola	definite	F	W		15, 43

KEY TO ABBREVIATIONS FOR TABLE 21 and 22 (Definitions based on those described in Section 1.2).

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

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

IUCN status:
- EN - Endangered

u/k: Unknown capture location

Certainty: Indicates the probability of the correctness of the identity of the species observed;
- Definite: Can be regarded as occurring in the reserve.
- Probable: Identification is likely but requires further information before being considered on the reserve's species list.
- Possible: Species identification is may not be accurate.

6.4.1.2 Dung survey

Dung from at least seven 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 the *Sylvicapra grimmia* may be unreliable.

Table 20. 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	100	0	0	0	0	0	0
2	3128	24	19	4	3	0	0
3	3484	20	14	1	1	0	0
4	4050	15	9	2	1	0	0
5	3036	16	13	0	0	0	0
6	650	0	0	0	0	0	0

Table 21. Summary of dung survey.

Species	**Ecol. Type**	**End. Status**	**IUCN status**	**Times encountered**
THRYONOMYIDAE				
Cane rat				
Thryonomys sp.		W		**1**
MURIDAE				
Common mouse				
Mus sp.		W		**4**
MACROSCELIDIDAE				
Four-toed elephant shrew				
Petrodromus tetradactylus	f	W		
SUIDAE				**12**
Bush pig				
Potamochoerus larvatus	f	W		**1**
BOVIDAE				
Bushbuck				
Tragelaphus scriptus	f	W		**7**
Bush duiker				
Sylvicapra grimmia	O	W		**9**
Blue duiker				
Cephalophus monticola	f	W		**55**

5.4 Results

5.4.1 Small mammals (non-bat)

A total of 69 specimens were retained for taxonomic purposes. These specimens represent at least ten species from six 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), Kingdon (1989), Kingdon (1997) and IUCN (1996). Nomenclature follows Kingdon (1997) and Kingdon (1989).

Table 19. Summary of mammals.

Species	**Ecol. type**	**Endemic status**	**IUCN status**	**Capture location and number collected**						**Total**
				1	2	5	10	12	30	
CRICETIDAE										
Lesser pouched rat										
Beamys hindei	f	N	V	6			4		1	**11**
MURIDAE										
Narrow-footed woodland mice										
Grammomys sp.				1			1	6	10	**18**
Soft-furred rats										
Praomys sp.							2			**2**
Spiny mice										
Acomys sp.							3			**3**
Common mice										
Mus sp.							6	2		**8**
Multimammate rats										
Mastomys sp.							2			**2**
Rodents not yet identified.							1		1	**2**
SCIURIDAE										
Red-bellied coast squirrel										
Paraxerus palliatus	F	W						1		**1**
MACROSCELIDINAE										
Four-toed elephant shrew										
Petrodromus tetradactylus	f	W				1				**1**
SORICIDAE										
White-toothed shrews										
Crocidura sp.				3	1		14	1		**19**
VIVERRIDAE										
African civet										
Civettictis civetta	f	W						1	1	**2**

KEY TO ABBREVIATIONS FOR TABLE 19 (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

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

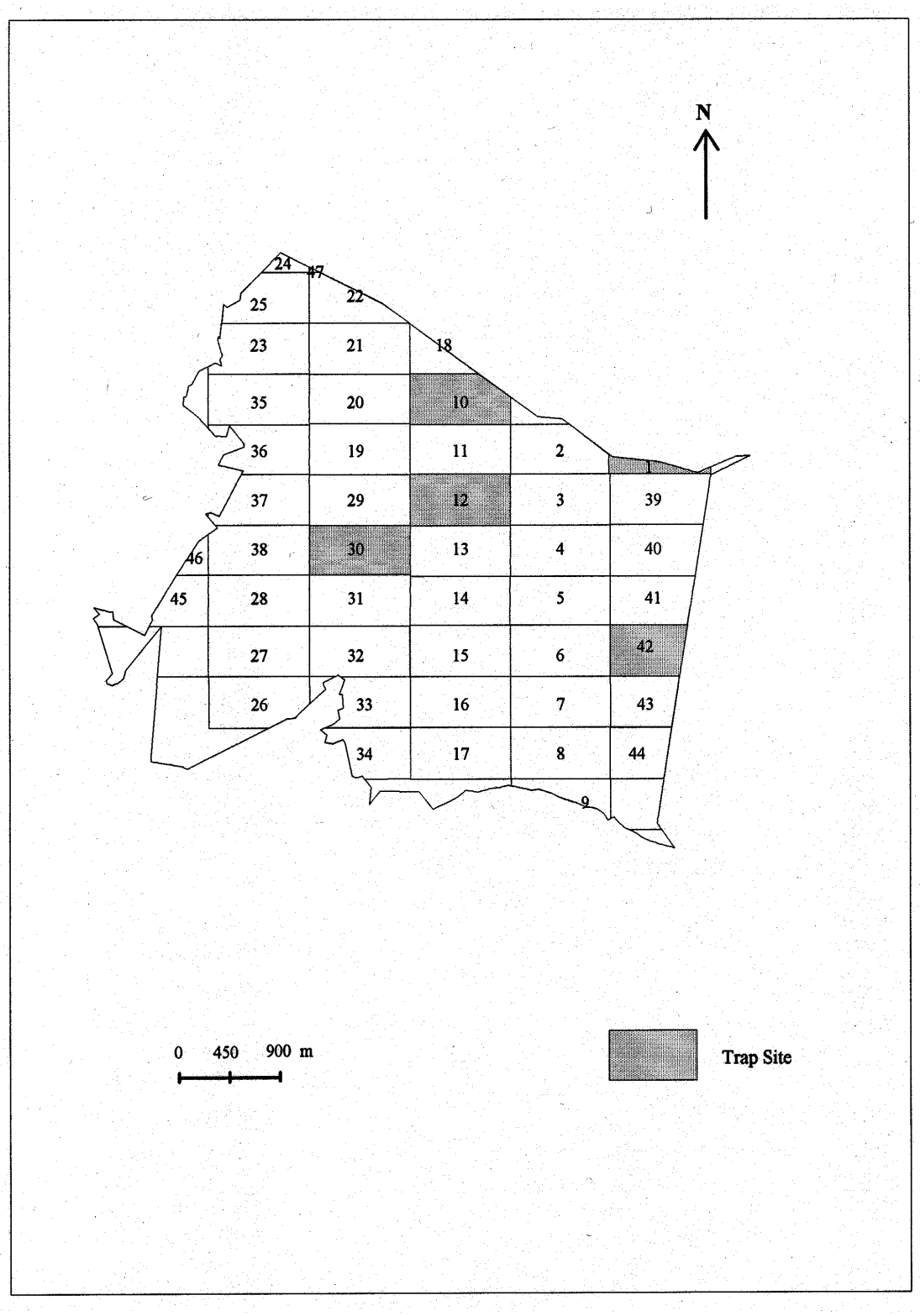


Figure 23. Location of trapping sites.

5.3 Trapping sites and sampling intensity

Five trapping sites were conducted in various habitats. Table 16 describes the sites and Tables 17 and 18 summarise the sampling intensity for each site and for each trapping method.

Table 16. Summary descriptions of trapping sites.

Plot number	Vegetation type	Altitude (m)	Topography	Slope (degrees)
10	grassland / open woodland	145	gentle mid-slope	13
12	lowland forest	115	gentle lower slope	11
30	lowland forest	150	gentle lower slope	12
42	lowland forest	318	ridge / hill top / peak	15
1	riverine forest	120	steep lower slope	29

Table 17. Sampling intensity by trap night (number of nights x number of traps).

Trapping method	Plot 10	Plot 12	Plot 30	Plot 42	Plot 1
Date	7th-16th July	18th-26th July	29th July - 7th August	10th-19th August	20th-29th August
Snap traps	926	989	938	965	979
Bucket pitfall*	330	330	330	330	330
Butterfly traps	50	50	50	50	50
Molluscs**	3	3	3	3	3
Millipedes**	3	3	3	3	3

* Each bucket represents one trap night.
**This represents plots sampled not trap nights.

Table 18. Summary of bat-netting sites.

Site description	Sampling intensity (hours)	Altitude	Topography
Across Mruka River	12	110	Valley floor
Across Manga access road	12	128	Gentle lower slope
Manga Peak	12	320	Hill top

5.2.5.1 Butterflies

The aim of this study was to collect and identify a representative sample of the reserve's butterfly community. The community of butterflies was sampled using 'Blendon' styled traps set in the tree canopy. Rotting bananas were used for bait. Traps were checked every morning. Five traps are set for 10 nights in each of the five trapping sites. Identifications were made by Steve Collins of the African Butterfly Research Institute and the late Jan Kielland. Specimens are deposited at the African Butterfly Research Institute.

5.2.5.2 Molluscs

The aim of this study was to collect and identify a representative sample of the reserve's mollusc community. The community of molluscs was sampled within three 1 m x 1 m plots at each trapping site. Plots were measured and string laid out along the boundaries. Leaf litter and the upper layers of soil were searched. All specimens were collected. Unless otherwise indicated, taxonomic identifications were made by Dr. B. Verdcourt (see Appendix 2).

5.2.5.3 Millipedes

The aim of this study was to collect and identify a representative sample of the reserve's millipede community. The community of milllipedes was sampled within three 3 m x 3 m plots at each trapping site. Plots were measured and string laid out along the boundaries. Leaf litter and the upper layers of soil were searched. All specimens were collected. Unless otherwise indicated, taxonomic identifications were made by Dr. R. Hoffman (see Appendix 2). Specimens are deposited at the Virginia Museum of Natural History.

shortly before dawn for 420 hours (number of hours x number of nets). Each bat caught was weighed and measured at the netting site. Trapping and biometric information was recorded on standardised data sheets.

5.2.1.4 Duiker dung survey

The aim of this study is to provide base line information of the population size of duiker in the reserve. Because duiker respond quickly to conservation activity, repeating this method through time will give an indication as to how well conservation activities are actually working.

The disturbance transects are surveyed for duiker dung from reserve border to border. 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.

5.2.1.5 Mammal observations

Other mammals including primates were recorded opportunistically throughout the survey.

5.2.2 Birds

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

5.2.3 Reptiles

The aim of this study was to collect and identify a representative sample of the forest reptile community. The community of ground-dwelling reptiles was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted by hand, and 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.

5.2.4 Amphibians

The aim of this study was to collect and identify a representative sample of the forest amphibian community. The community of ground-dwelling amphibians was sampled using the bucket pitfall method (see 6.2.1.2 above). Opportunistic captures were also conducted, especially in reference to tree frog collections since they are often beyond capture with the bucket pitfalls. 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.

5.2.5 Invertebrates

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

5.0 FAUNA

5.1 Introduction

The faunal biodiversity of Manga forest reserve was investigated using standard, repeatable, survey methods. Studies on small mammals, bats, reptiles, amphibians and various invertebrate groups were carried out. An inventory of all fauna encountered was compiled. This data was analysed to assess the biodiversity value of the area.

5.2 Methods

All methods used during the expedition survey are outlined in detail in the FT FRP methodologies report (SEE¸1998). A brief description is presented below. The location of trap sites are presented in Figure 23.

5.2.1 Mammals

Four different methods are used to sample the mammal community within Manga 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. Howell or by Dr. D. Kock (see Appendix 2). Specimens are deposited at the Department of Zoology and Marine Biology, University of Dar es Salaam and at the Frankfurt Zoological Museum.

5.2.1.1 Snap-trap lines

In order to sample the community of rodents, large break-back traps (snap-traps) were used. Typically the traps were set out in three lines of approximately 33, with traps positioned at least 2 m apart. The traps were set each evening and checked early the following morning. Half of traps were baited with fried coconut rolled in peanut butter, one quarter with fish and one quarter with oatmeal and peanut butter. Each mammal caught was weighed and measured. Trapping, habitat and biometric data were recorded on standardised data sheets.

5.2.1.2 Bucket pitfall trapping

The bucket pitfall traps consist 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 on to which soil and leaf litter was placed. An animal was, therefore, channelled along the plastic to one of the buckets. The bucket pitfalls, acting as live traps, were designed for sampling shrews and small mice within the forest. Each mammal captured was weighed and measured. Trapping and biometric information was recorded on standardised data sheets.

5.2.1.3 Bat netting

Bat mist netting was used to collect and study a representative sample of the forest bat community, and also provide data on species’ ranges. Mist nets were placed near potential roost sites and across obvious flight “corridors”, such as paths and rivers. Nets were set up at dusk, observed continuously throughout the night and closed

Endemic Status

Of the plant species recorded in the vegetation plots, 80 have widespread distributions. Near-endemics contribute 22 species from 14 families to the floristic composition of the reserve. These near-endemics are most abundant in the centre of the reserve and account for 208 of the surveyed specimens or 19.7% of all recorded trees and shrubs in the reserve. Of the 36 plots surveyed, seven were found to have greater than ten near-endemic trees. The most common near-endemics in the reserve are *Scorodophloeus fischeri* and *Dombeya shupangae.* Of these near-endemic species, seven species are also considered to be forest dependent. Two near-endemics are non-forest species

Three of the species surveyed in the vegetation plots are endemic to the Usambaras. All three are found in both the East and West Usambaras and are *Chassalia albiflora*, *Sericanthe odoratissima* and *Uvariodendron oligocarpum*. All three species are considered to be forest dependent species, restricted to wet evergreen forest (Iversen, 1991b). An additional two endemic species were recorded through casual collections, *Psychotria triclada*, and *Tricalysia* sp. H.

Disturbance

Pole and timber cutting is spread throughout the reserve although it was not recorded from all plots. It is most prevalent in the north-east and around the edges of the reserve. In 26% of the plots no pole cutting was recorded and in 50% no timber cutting was recorded. In almost 96% of plots, the natural rate of tree fall is higher than the rate of timber cutting. Similarly in 93% of plots the natural rate of sapling fall is higher than the rate of pole cutting. Between plots the highest rate of timber extraction was in Plot 20 at 60 timbers cut / ha. Pole cutting was also highest in this plot, at a rate of 80 poles / ha. There is access to this plot along an abandoned logging road.

Fire was recorded from 37% of the plots. Recurrence of fire seems to be prolonging areas dominated by *Rottboellia exaltata* and *Lantana camara*.

The forest has been disturbed by commercial timber extraction in the past and this is still evident from the network of abandoned logging trails and from the areas dominated by grass and disturbed secondary forest.

A number of introduced species are established within the reserve particularly in areas previously inhabited by people. Introduced species recorded within the reserve include the fruit trees *Mangifera indica*, *Citrus limonia*, *C. sinensis* and *Psidium guajava* and the weed *Olyra latifolia.*

The invasive species *Maesopsis eminii* was not recorded within the reserve. Since its introduction into the area this species has spread rapidly in the Usambara Mountains particularly around Amani where there is concern that it may begin to dominate the forest (Binggeli 1989). In 1997 it did not appear to be a problem in Manga.

There was evidence of encroachment of agricultural land along the southern border of the reserve. At the time of the survey the position of the border was being clarified and clearly marked.

4.4 Discussion

Manga forest reserve covers an area of 1616 ha with altitudes ranging from 120 to 320 m asl.

Species Richness

In the systematic vegetation plots 1054 trees and shrubs were surveyed, representing 115 species from 29 families. An additional one family and 10 species were recorded in the regeneration layer but not in the larger plots. Casual observations recorded a further 204 species from 24 families not previously recorded. In total 329 species of vascular plants from 54 families were recorded.

Of the 36 plots systematically surveyed, 20 plots were in lowland forest, five plots in grassland, five plots in scrub/thicket, three in woodland and one in riverine forest.

Relative to the other ten forest reserves so far surveyed by Frontier-Tanzania in the East Usambaras, Manga has a below average species richness (115/139) in the systematic vegetation plots. However when the casual collections made by the Missouri Botanical Gardens collectors are included the reserve has the highest species richness. Collecting effort is a significant factor in obtaining this result.

Species Accumulation Rates

After approximately 36 plots the species accumulation curve for the 50 m x 20 m subplots reaches an asymptote. Although this suggests that the majority of trees had been recorded by the systematic survey, numerous trees were only recorded through casual collections.

Ecological Type

Forest dependent species defined as limited to primary forest only were recorded 147 times. This represents 14% of all specimens recorded. Forest dependent individuals are distributed throughout the reserve. They are most abundant in the south. The most common forest dependent tree *Ehretia cymosa*. Ten of the forest dependent species are also endemic or near-endemic to the Usambaras.

Nineteen non-forest species were recorded. They were recorded throughout the reserve but were most abundant close to the northern grassland. *Leucaena leucocephala* is the most common non-forest species. It was recorded 34 times in a single plot. *Dombeya shupangae* was also abundant and was recorded 29 times from seven plots.

Habitat

Of the tree species surveyed in the vegetation plots with known altitude characteristics, 53% are considered to be typical of lowland forest and 32.2% are considered typical of submontane forest. Submontane species occur in 19 plots, all of which are in lowland forest. This data indicates the variability in the ecological requirements and niches of these submontane species. The most common submontane species is *Cola greenwayi*.

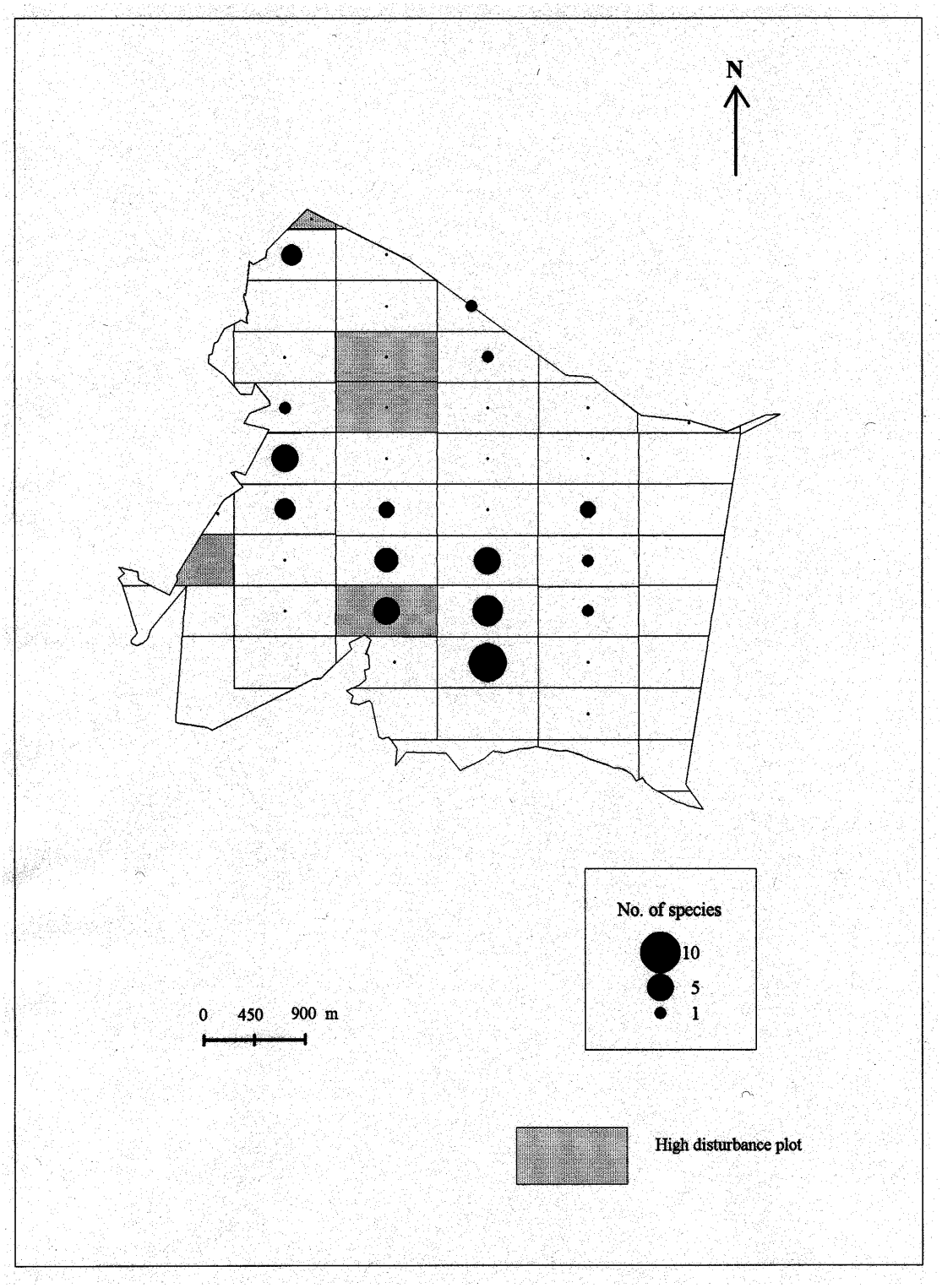


Figure 22. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and near-endemic.

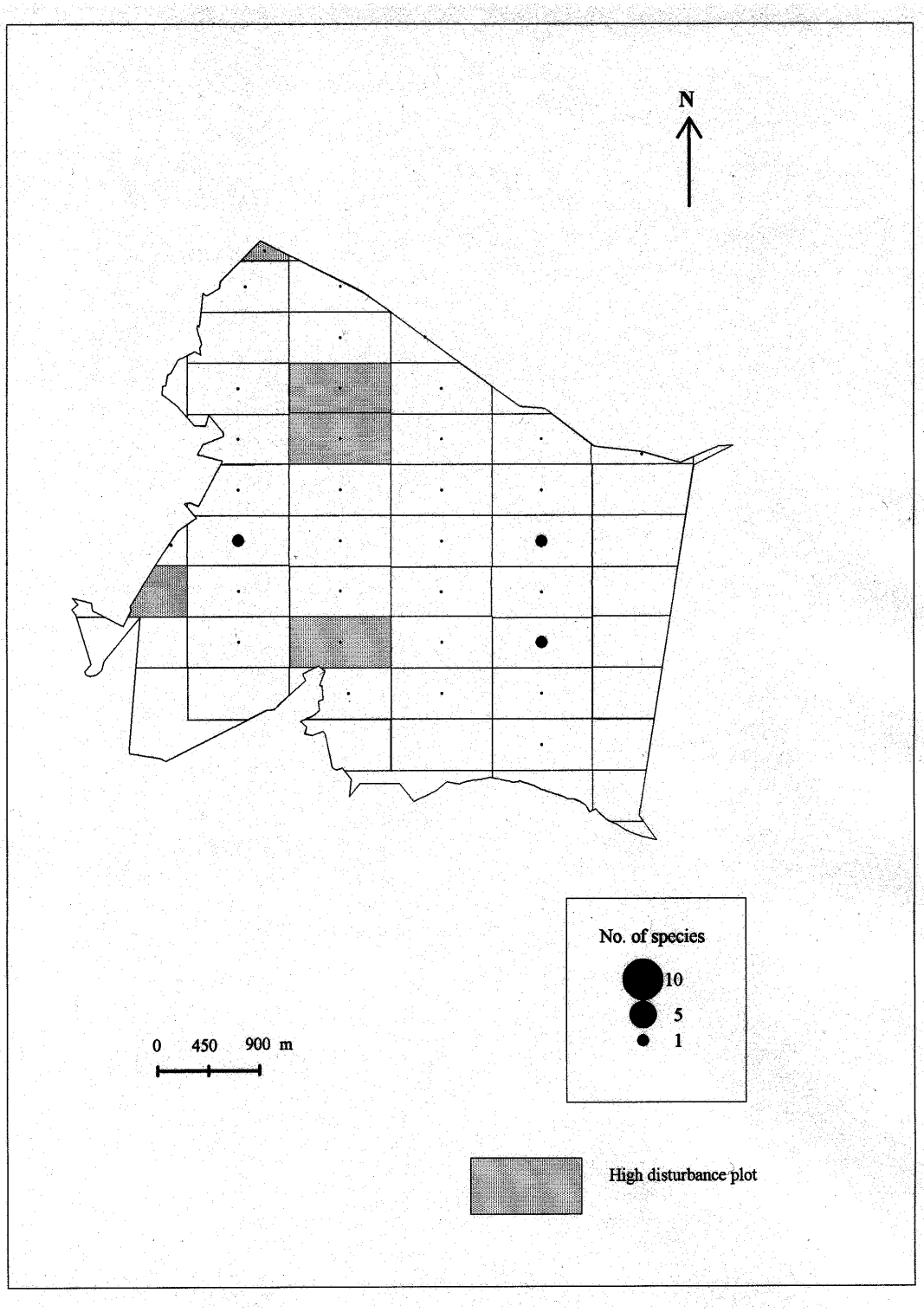


Figure 21. Areas of highest disturbance in relation to the distribution of tree and shrub individuals that are both forest dependent and endemic.

Table 15. Frequency of selected human disturbances recorded in the forest in vegetation plots and along disturbance transects.

Disturbance	Total number of plots in which disturbance was recorded	Percentage of plots in which disturbance was recorded (n=34)
Pole cutting	26	76
Timber cutting	22	65
Fire Damage	17	50
Cultivation	3	9
Pit saw workings	1	3
Road	1	3
Animal remains	1	3
Old campsite	1	3
Settlement	1	3

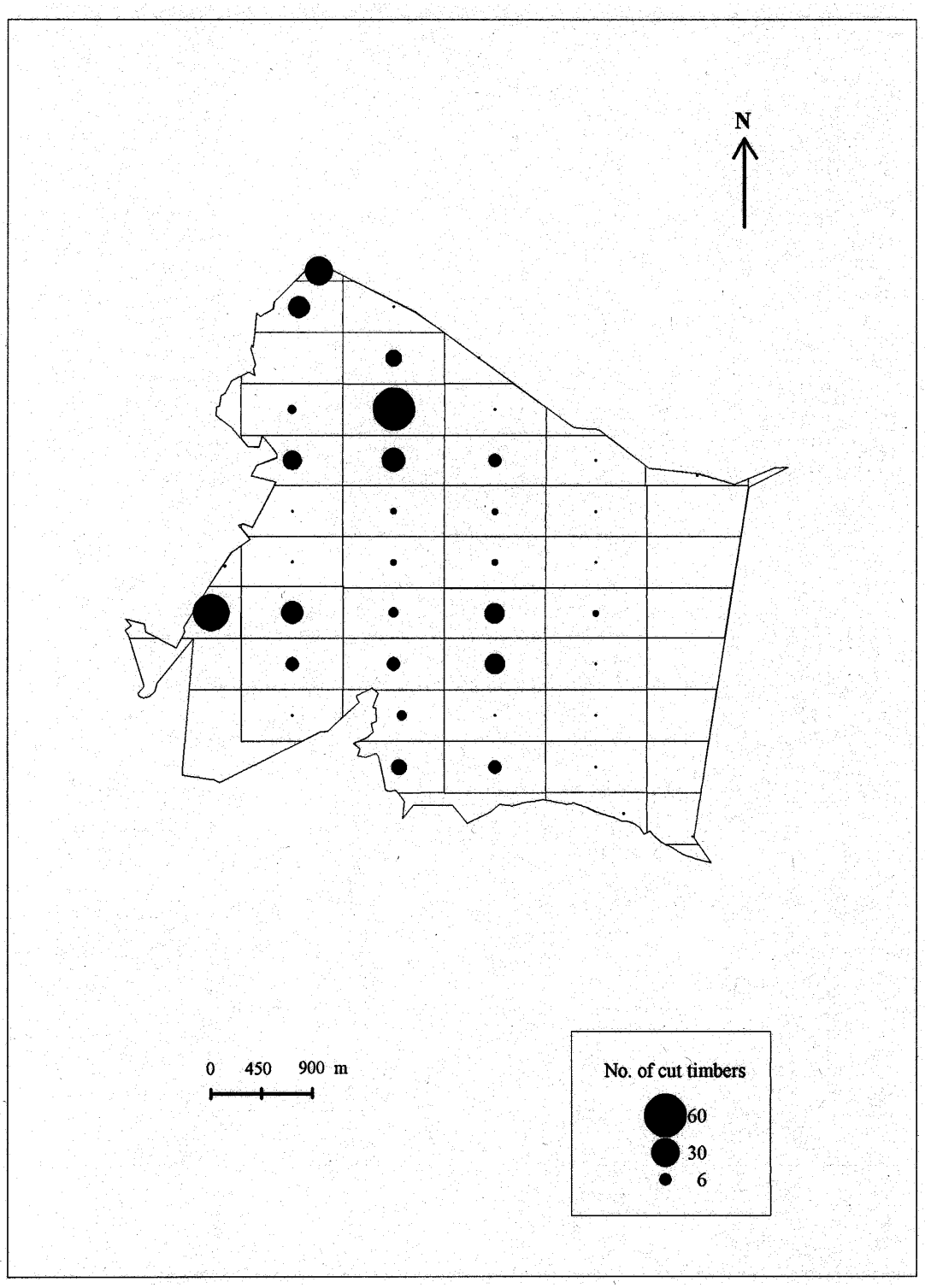
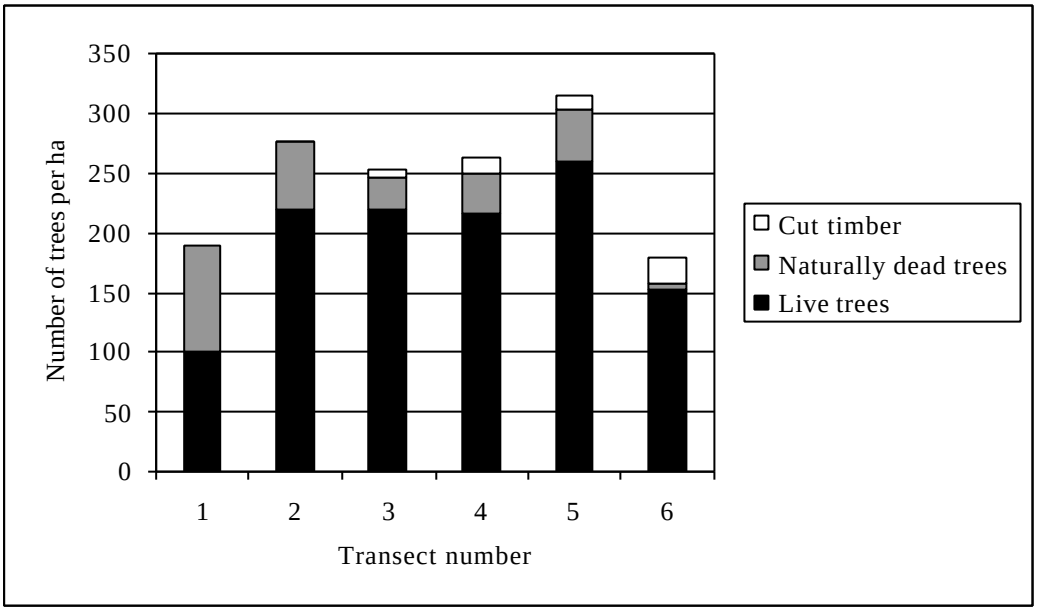


Figure 20. Distribution of timber cutting in the reserve.

Table 14. Disturbance transect results for timber counts.

Transect number	Length of transect (m)	Total trees sampled	Live trees	Naturally fallen timber	Rate per hectare	Cut timber	Rate per hectare	Percentage of trees cut
1	100	19	10	9	**90.0**	0	**0.0**	0.0
2	3128	866	686	179	**57.2**	1	**0.3**	0.1
3	3484	880	766	93	**26.7**	21	**6.0**	2.4
4	4050	1065	879	134	**33.1**	52	**12.8**	4.9
5	3036	956	787	137	**45.1**	32	**10.5**	3.3
6	650	117	99	4	**6.2**	14	**21.5**	12.0



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

Figure 19. The relative abundance of live, naturally dead and cut timber.

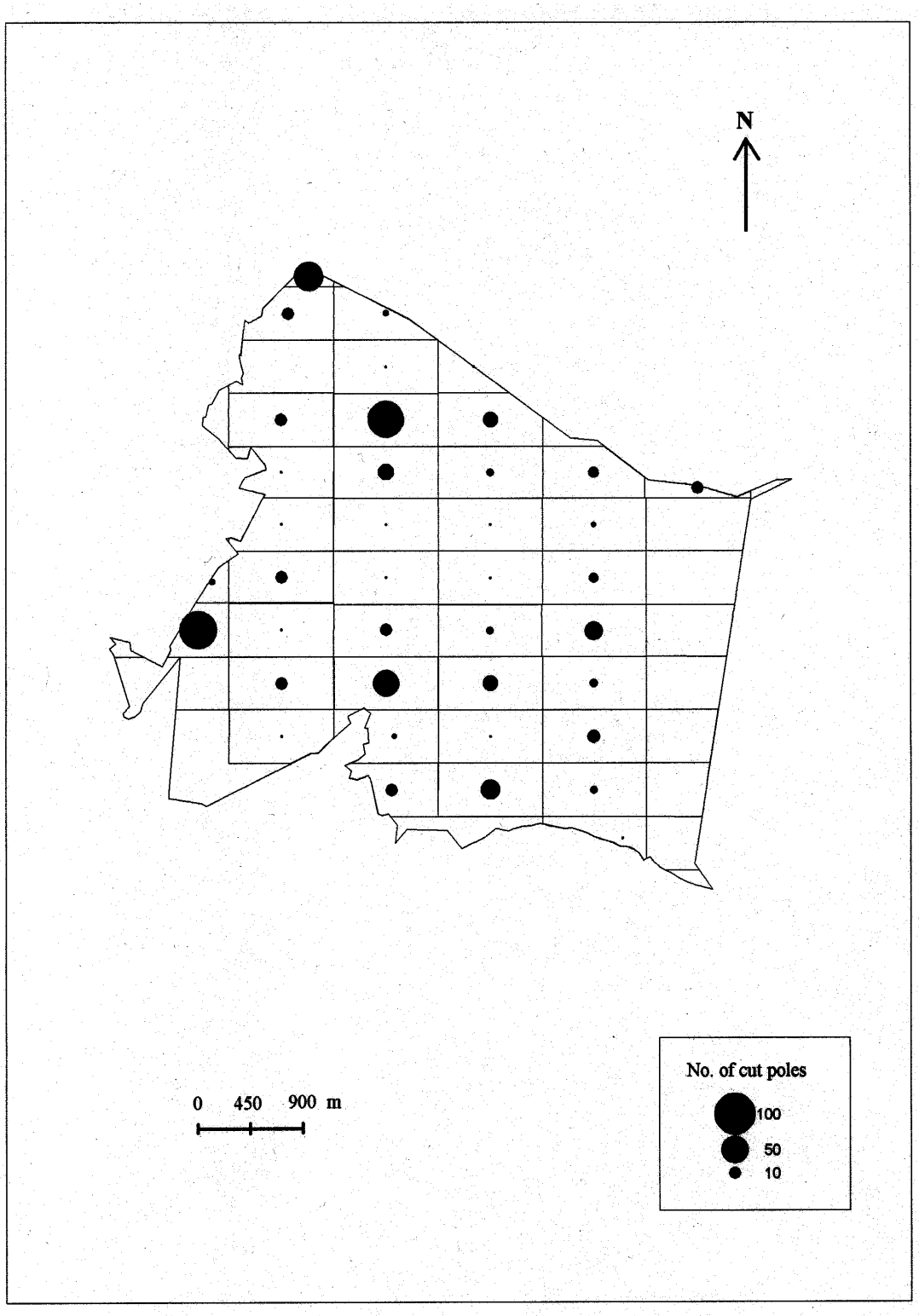


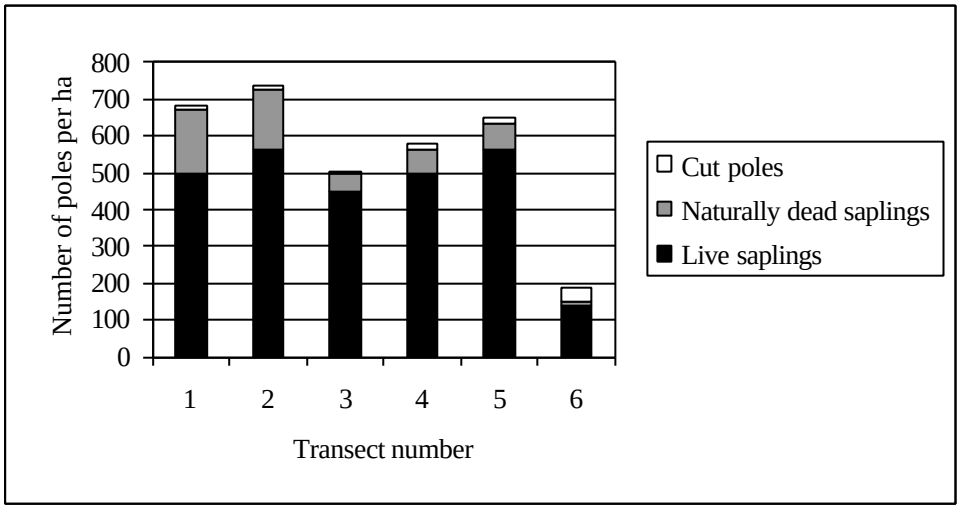
Figure 18. Distribution of pole cutting in the reserve.

4.3.2 Disturbance transects

Six disturbance transects were recorded for pole and timber extraction during the survey. The results of the disturbance transects are summarised in Table 13 for poles and Table 14 for timber. The terms pole and timber are used in this section only as this method examines the forest in terms of its extractive value.

Table 13. Disturbance transect results for pole counts.

Transect number	Length of transect (m)	Total poles sampled	Live saplings	Naturally fallen saplings	Rate per hectare	Cut poles	Rate per hectare	Percentage of saplings cut
1	100	68	50	17	**170.0**	1	**10.0**	1.5
2	3128	2307	1756	522	**166.9**	29	**9.3**	1.3
3	3484	1762	1559	177	**50.8**	26	**7.5**	1.5
4	4050	2352	2024	255	**63.0**	73	**18.0**	3.1
5	3036	1967	1708	216	**71.1**	43	**14.2**	2.2
6	650	123	91	7	**10.8**	25	**38.5**	20.3



Note: Poles are classified as having a dbh between 5 and 15 cm and a minimum of 2 m long relatively straight trunk.

Figure 17. The relative abundance of live, naturally dead and cut poles.

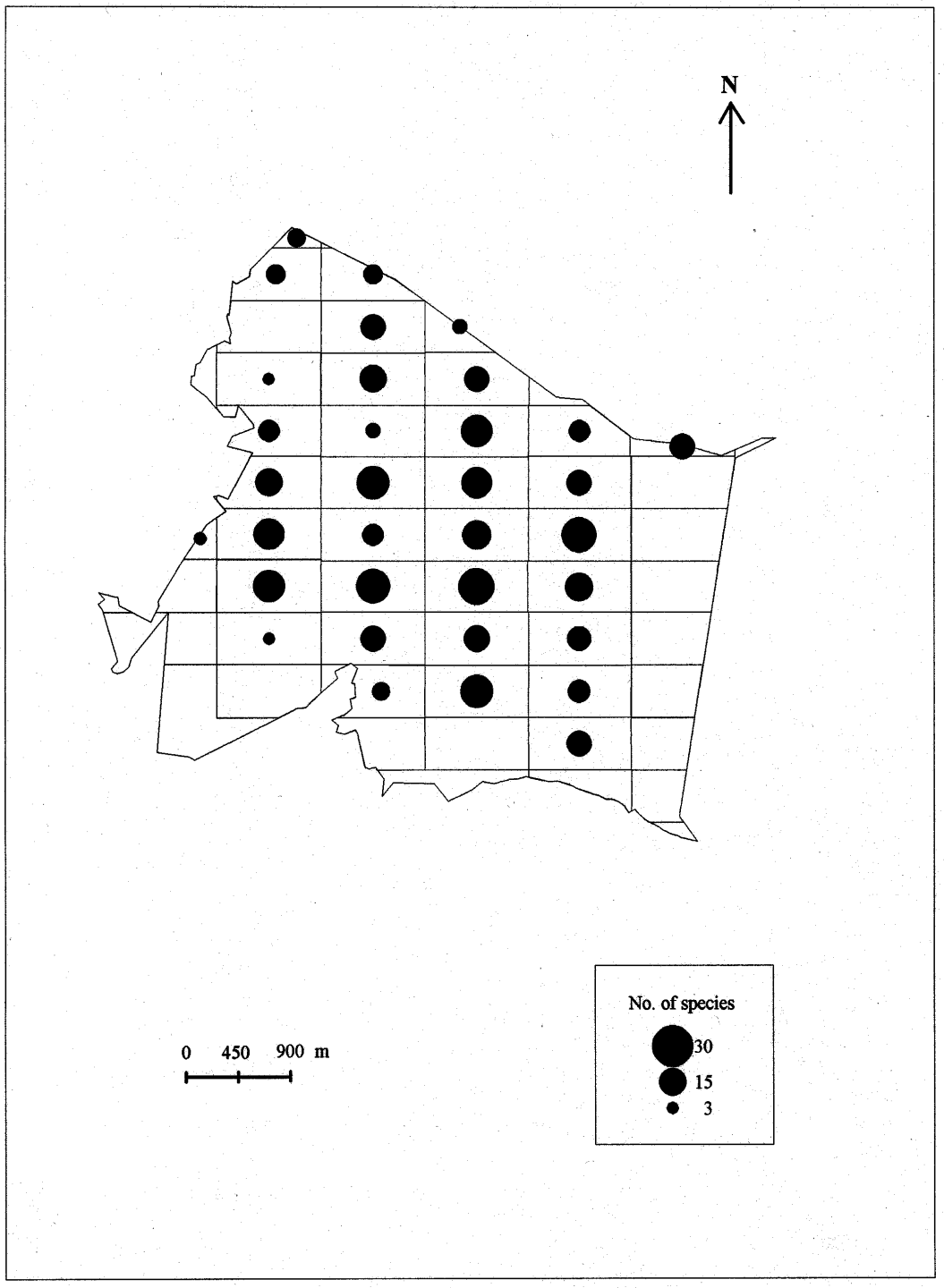


Figure 16. Botanical species richness.

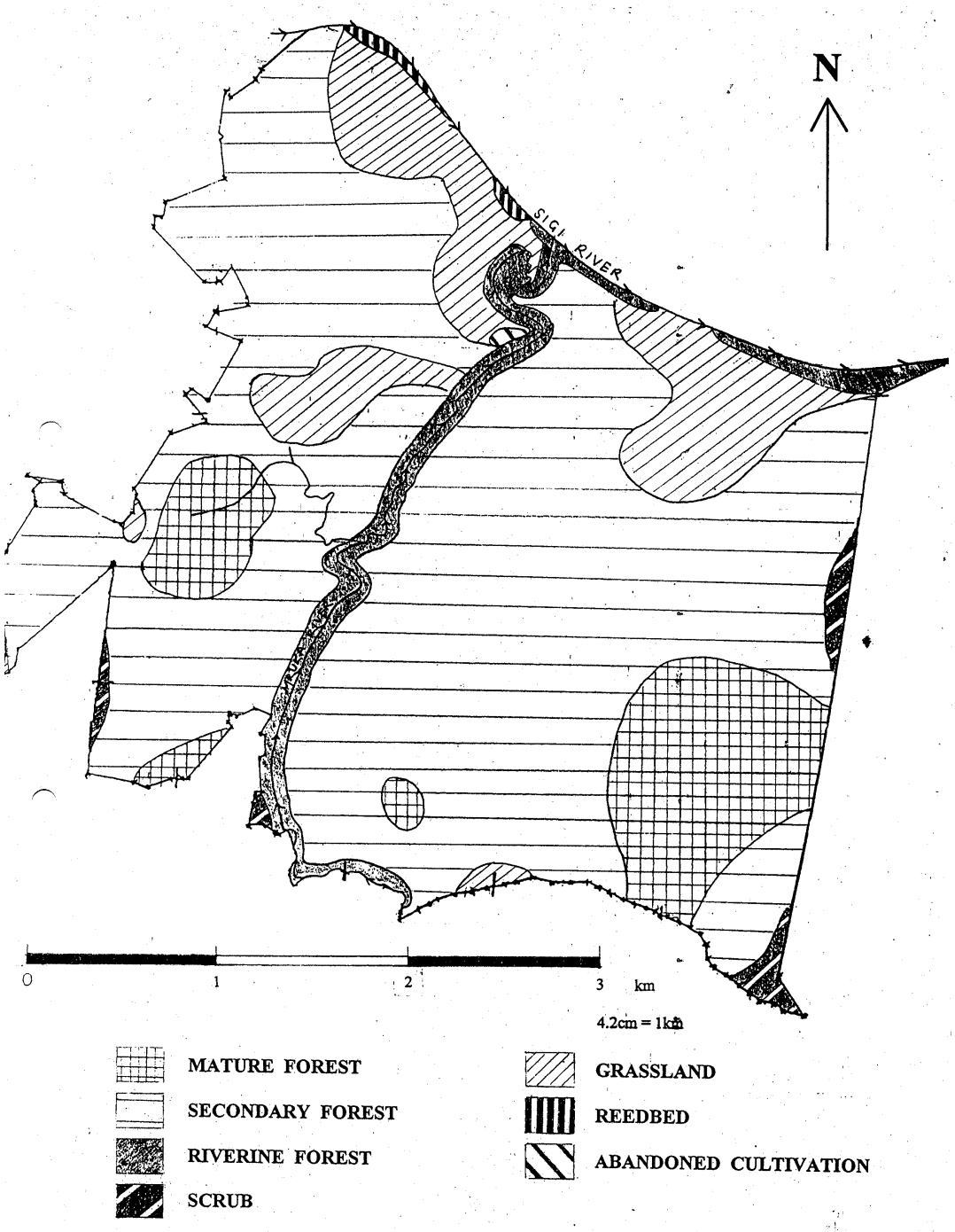


Figure 15. Vegetation of Manga forest reserve.

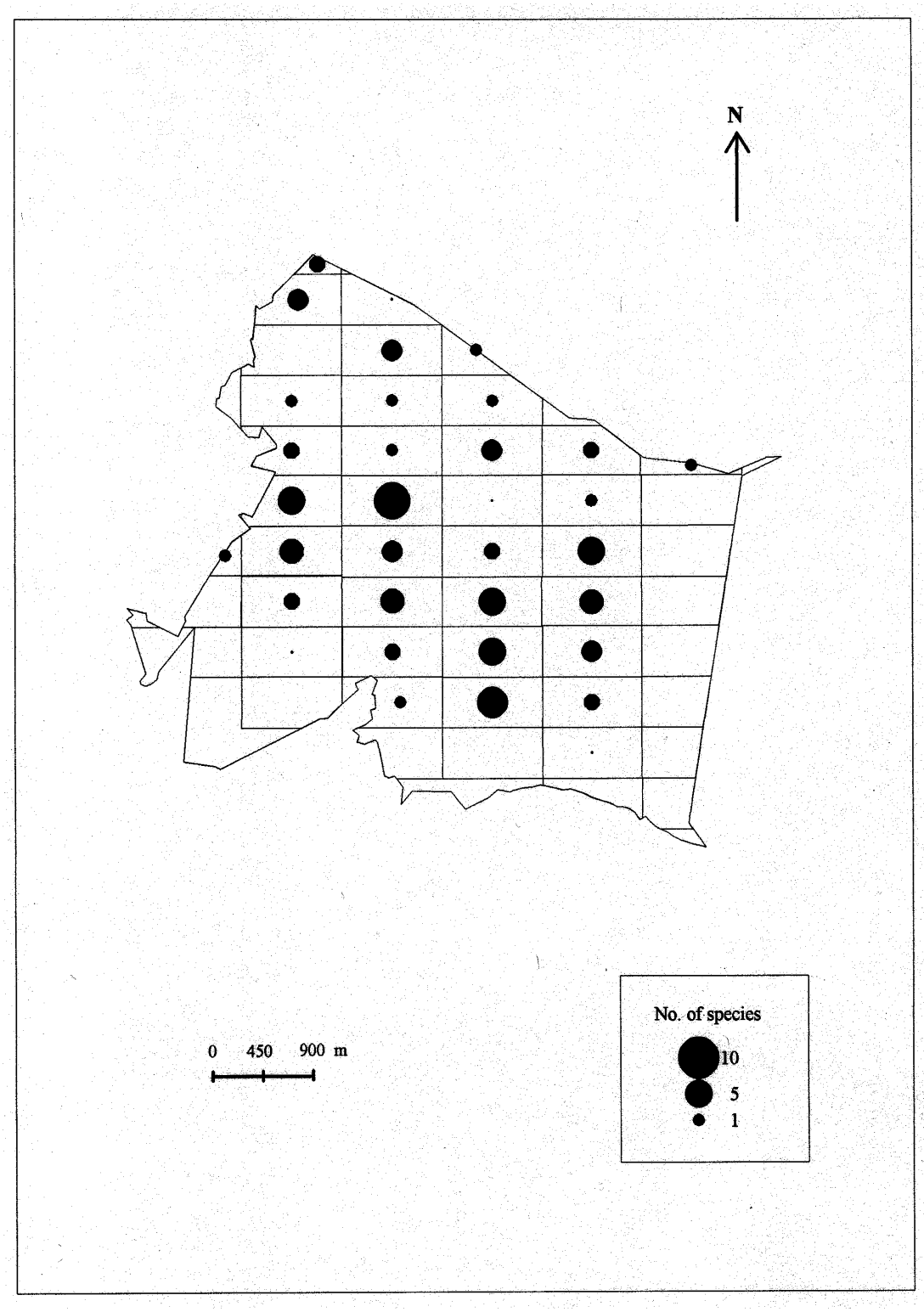


Figure 14. Distribution of near-endemic tree and shrub species.

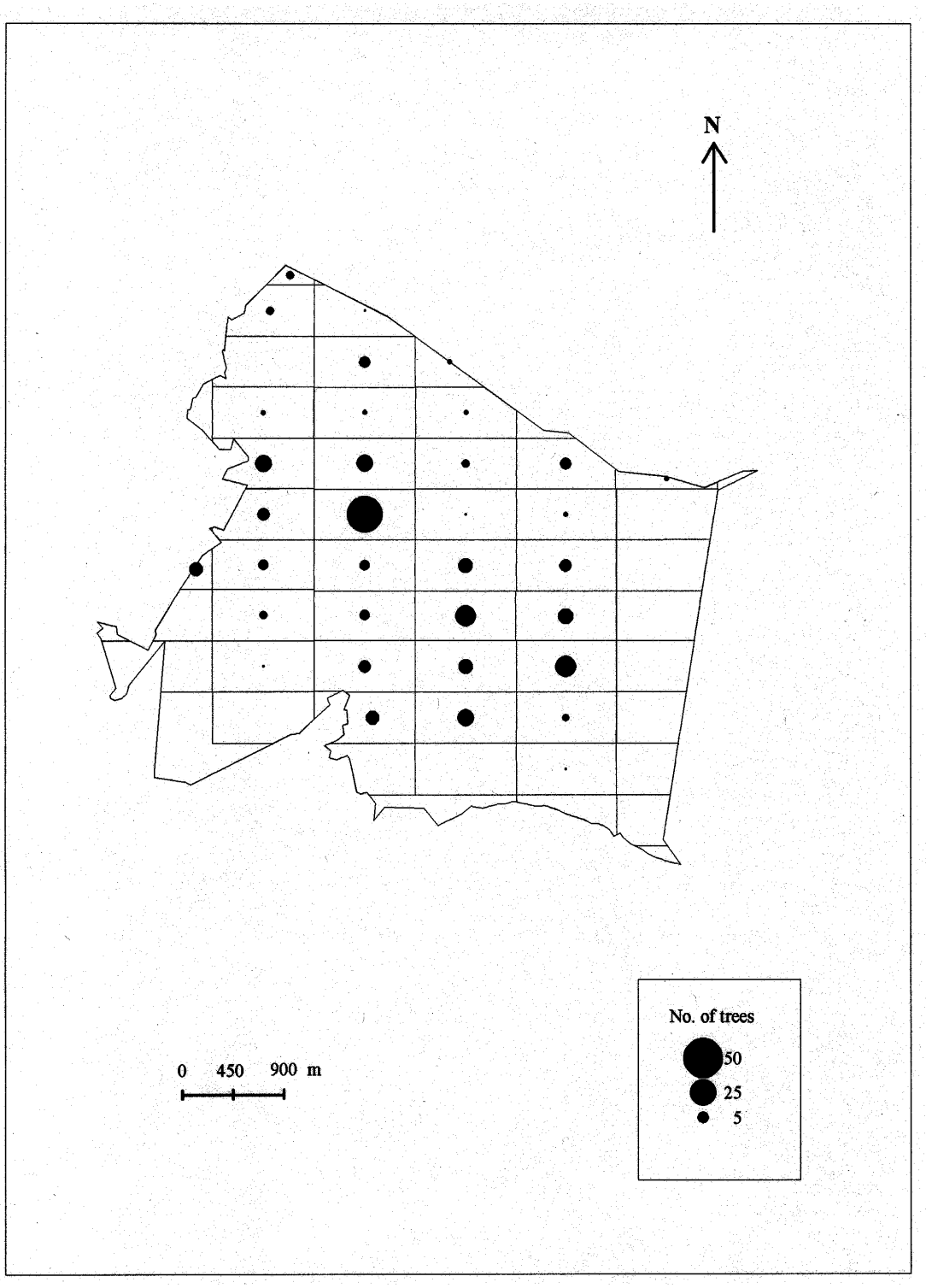


Figure 13. Distribution of near-endemic tree and shrub individuals.

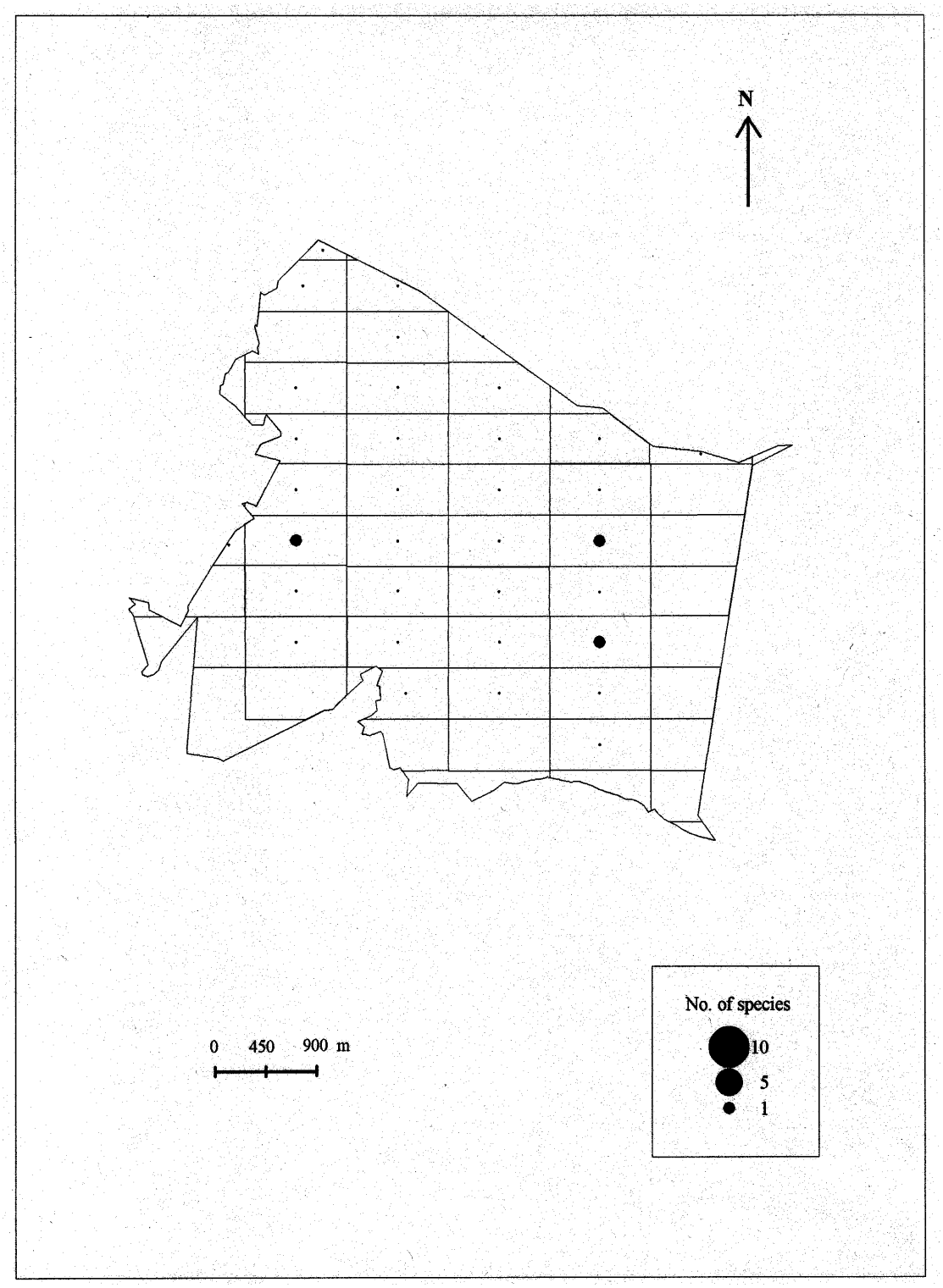


Figure 12. Distribution of endemic tree and shrub species.

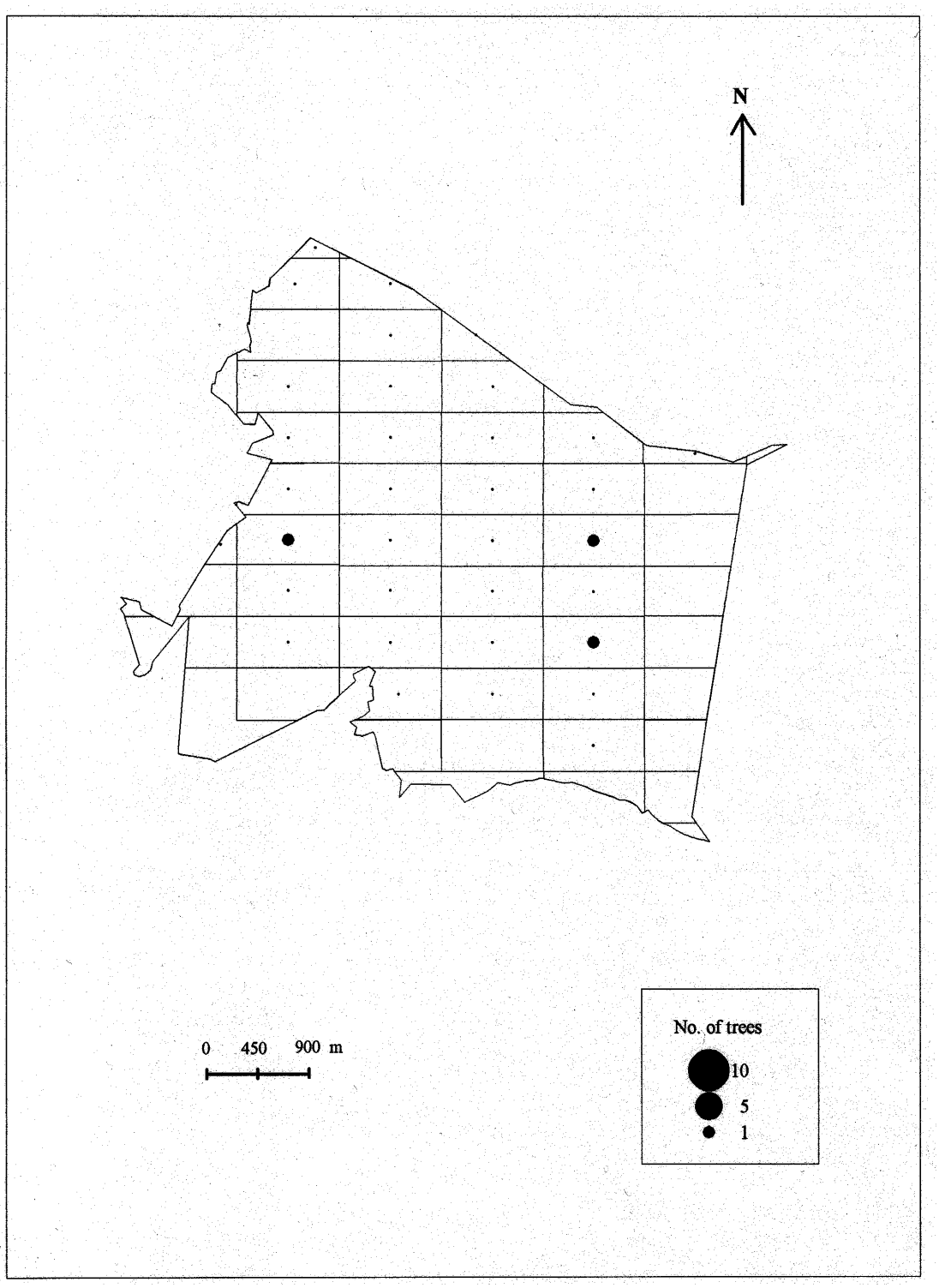


Figure 11. Distribution of endemic tree and shrub individuals.

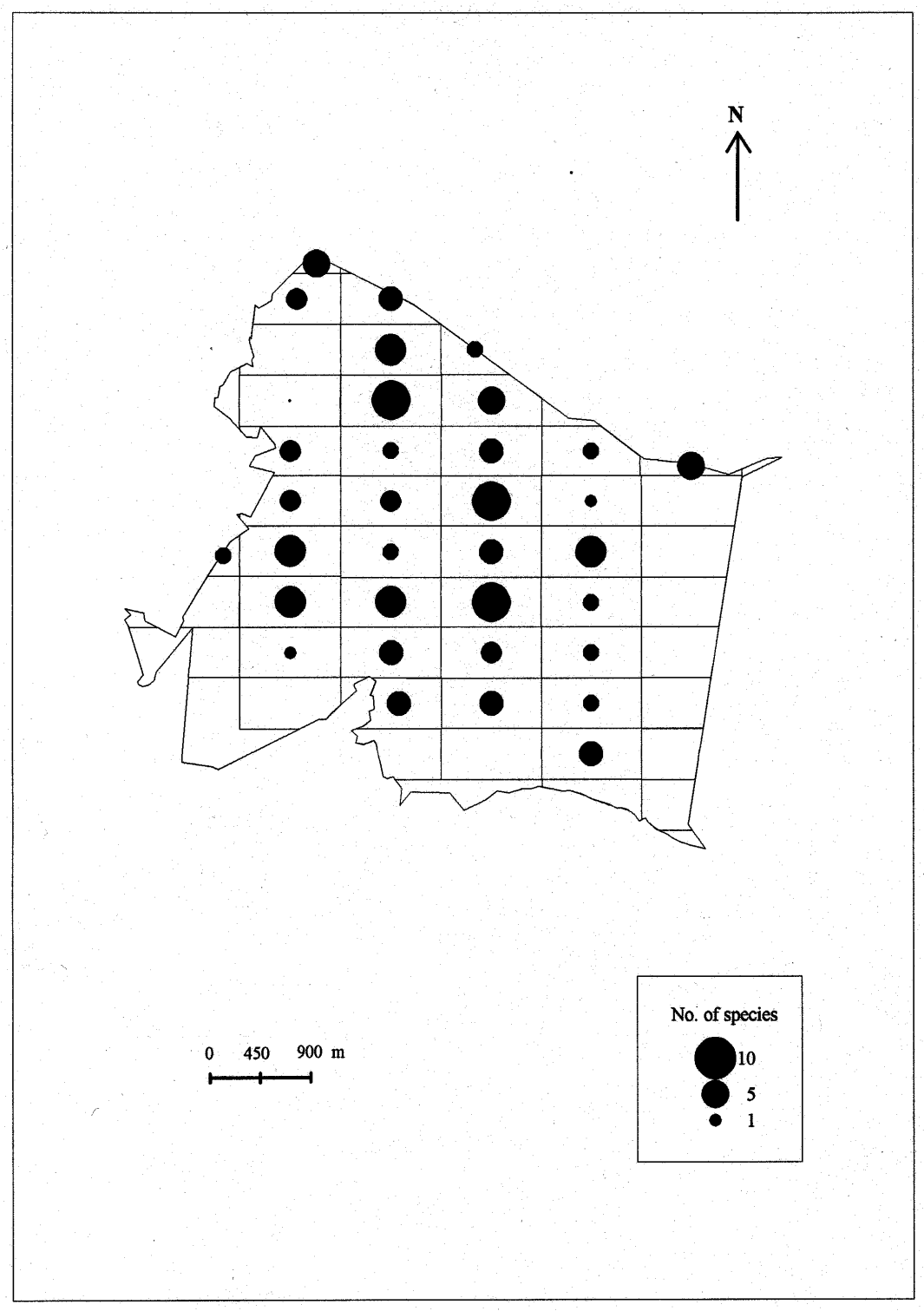


Figure 10. Distribution of submontane tree and shrub species.

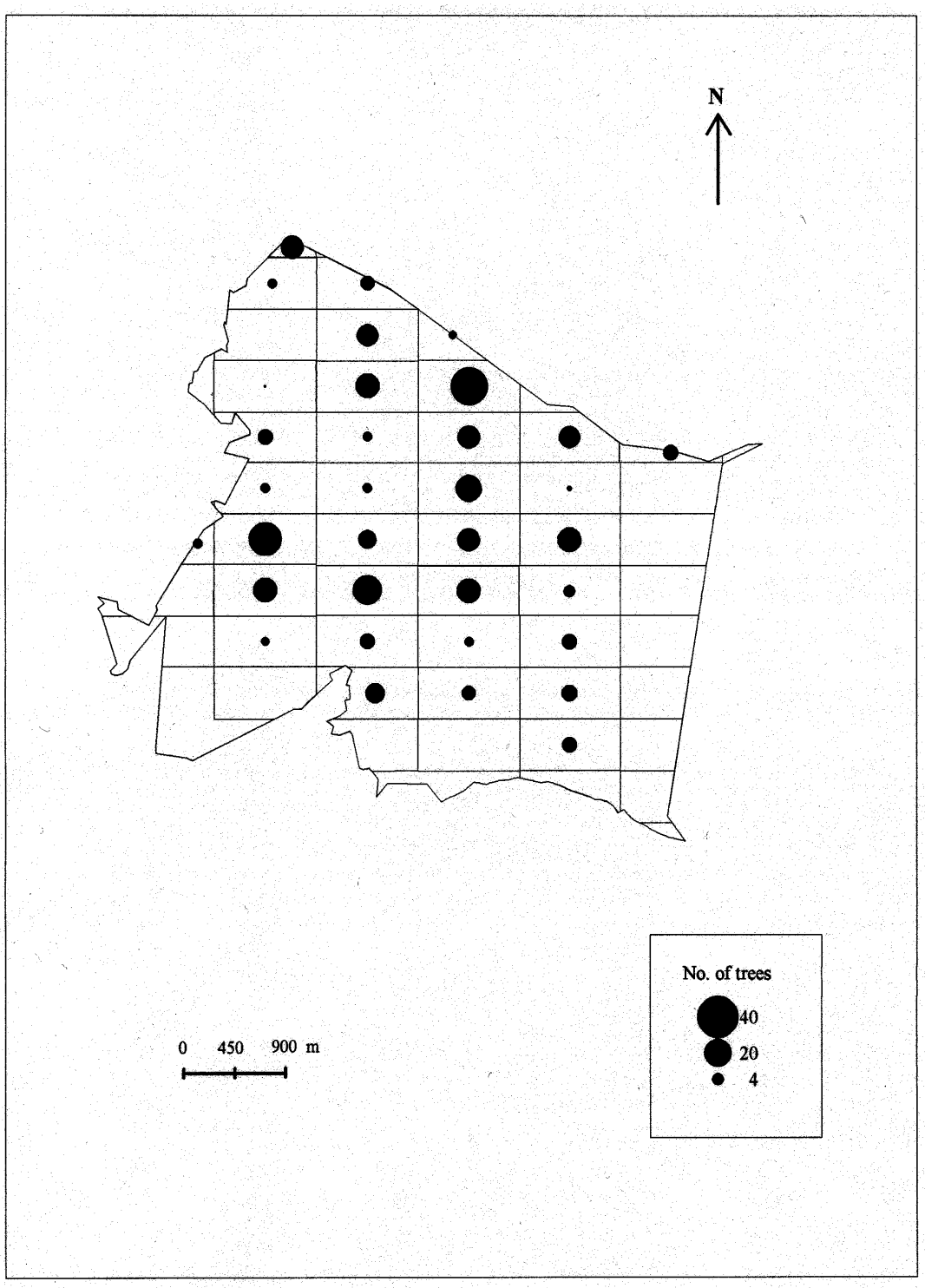


Figure 9. Distribution of submontane tree and shrub individuals.

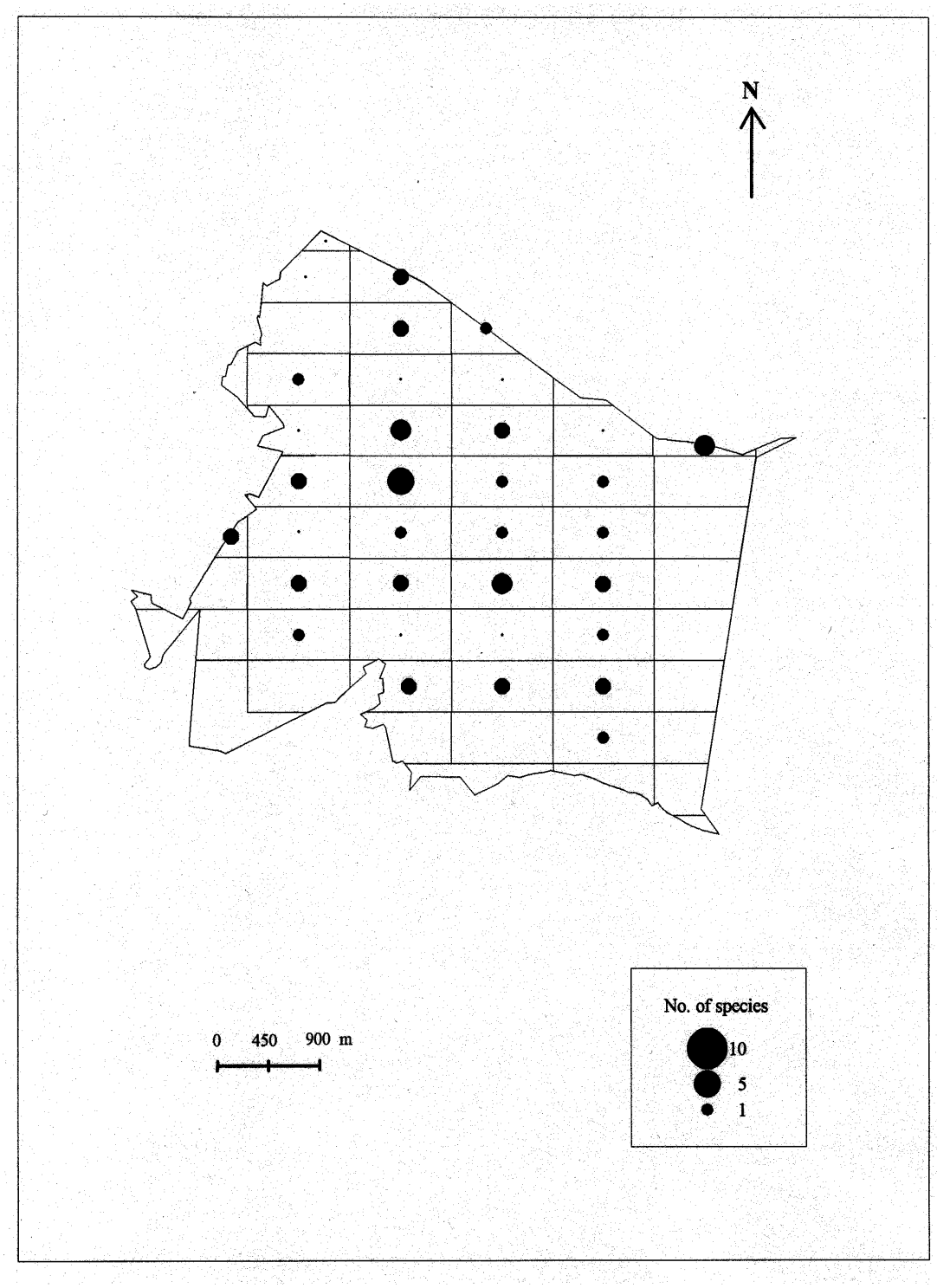


Figure 8. Distribution of non-forest tree and shrub species.

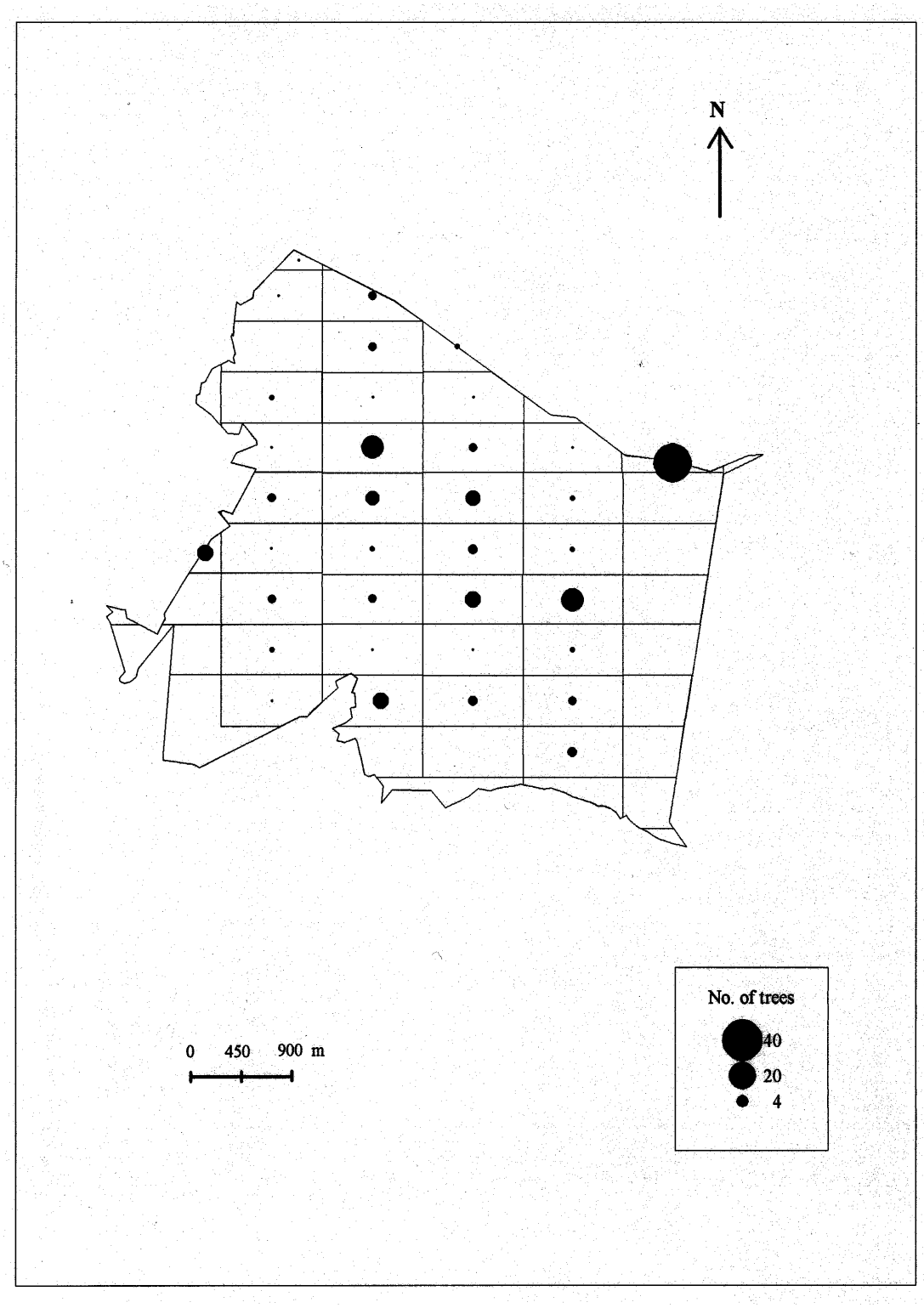


Figure 7. Distribution of non-forest tree and shrub individuals.

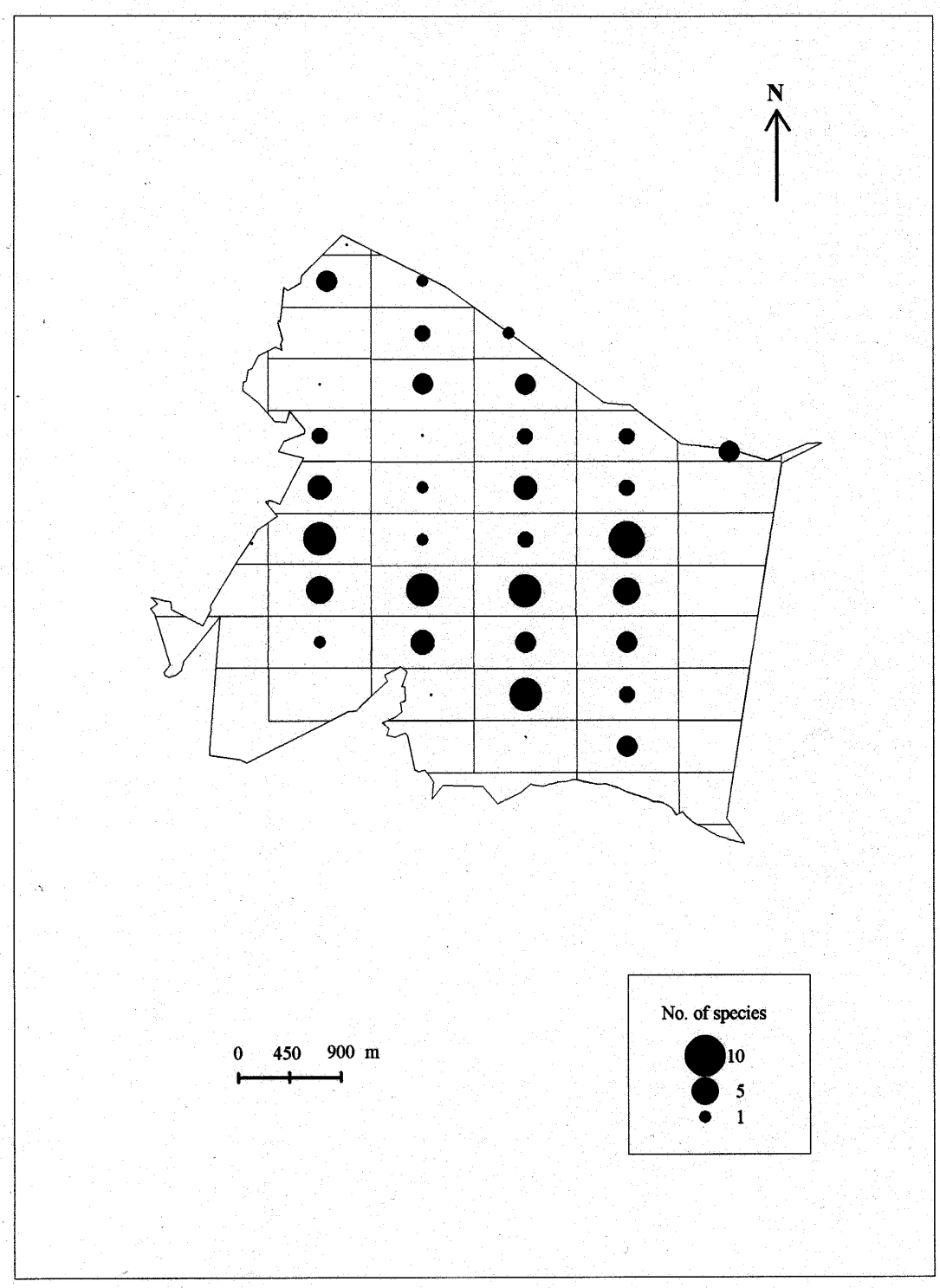


Figure 6. Distribution of forest dependent tree and shrub species.

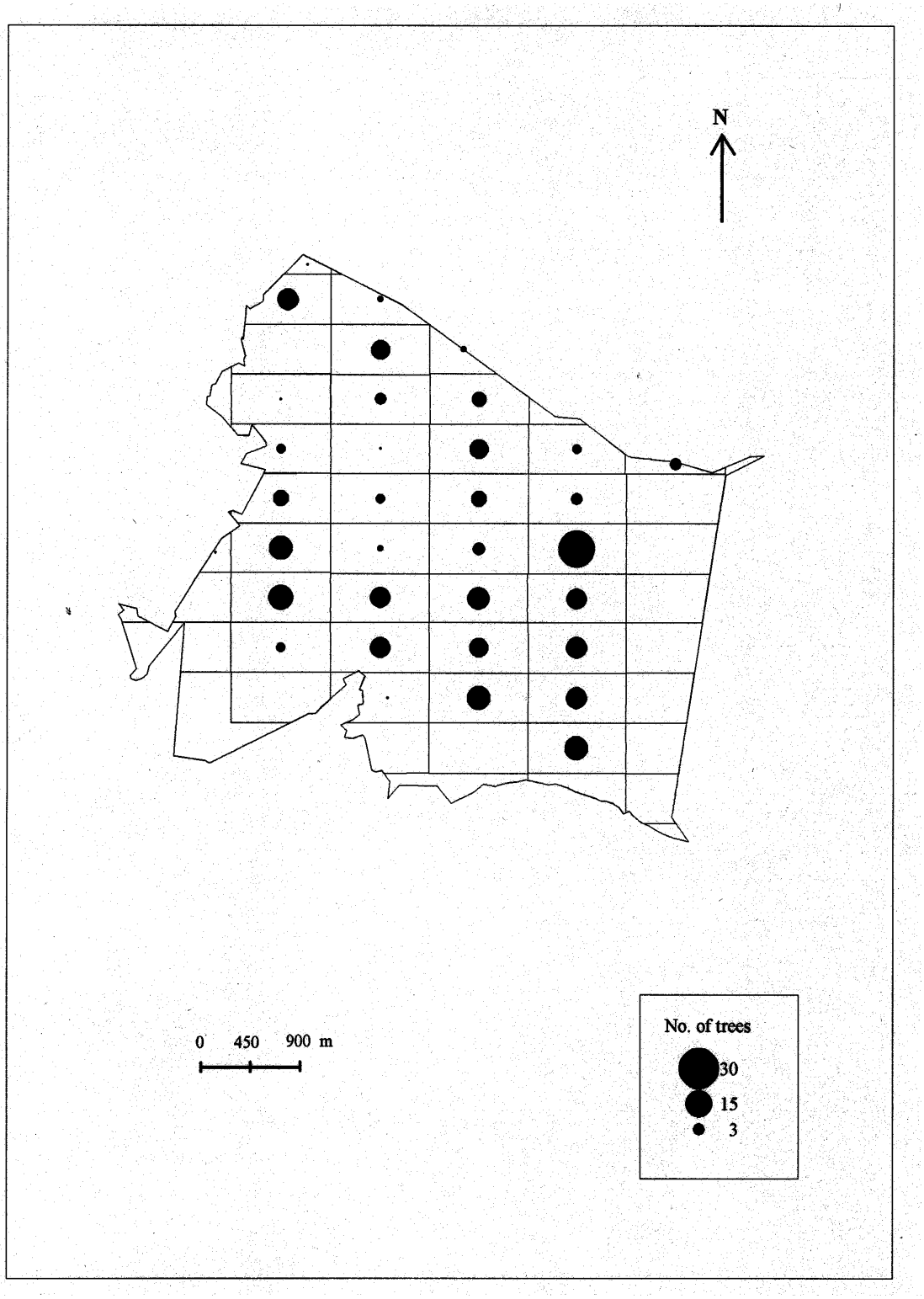


Figure 5. Distribution of forest dependent tree and shrub individuals.

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 individuals
(E) Endemic	3	2.6	3	0.3
(N) Near Endemic	22	19.1	208	19.7
(W) Widespread	80	69.6	808	76.7
Unknown	10	8.7	35	3.3
Total:	**115**	**100**	**1054**	**100**

* EU - East Usambara mountains
WU - West Usambara mountains

Timber Value

Formerly logging was permitted in Manga 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
Cephalosphaera usambarensis	0	0	0	0.0
Khaya anthotheca	1	3	1	0.1
Milicia excelsa	12	33	41	3.9
Newtonia buchananii	0	0	0	0.0
Ocotea usambarensis	0	0	0	0.0

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 of individuals	% of total number of individuals
(F) Forest dependent species	26	22.6	147	14.0
(f) Non-forest dependent Species	59	51.3	734	69.6
(O) Non-forest species	19	16.5	131	12.4
Unknown	11	9.6	42	4
Total:	**115**	**100**	**1054**	**100**

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	61	53.0	521	49.5
(S) Submontane Species	37	32.2	316	29.9
Unknown	19	14.8	217	20.6
Total:	**115**	**100**	**1054**	**100**

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

Species	Lowest altitude at which recorded
Acacia mellifera	120
Albizia schimperiana	110
Ceiba pentandra	130
Cola greenwayi	180
Diospyros kabuyeana	150
Dracaena steudneri	110
Drypetes usambarica	110
Haplocoelum foliolosum	175
Leptactina platyphylla	160
Margaritaria discoidea	210
Maytenus acuminata	140
Maytenus undata	110
Tricalysia anomala	110
Uvariodendron oligocarpum	270

Species accumulation rates:

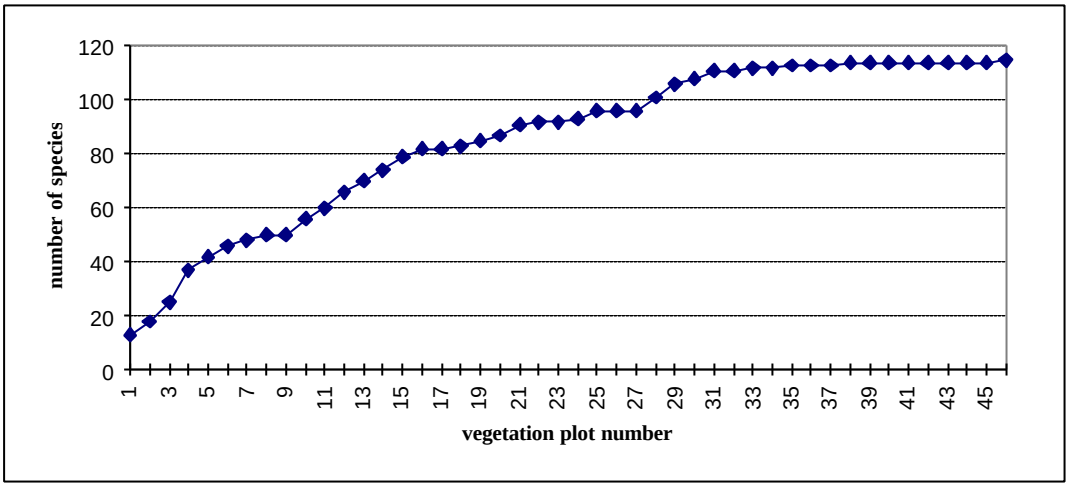


Figure 4. Species accumulation rates of recorded species by vegetation plot.

In 1986 - 1987 a botanical survey was conducted in the East Usambaras (Ruffo et al. 1989). The survey did not include Manga Forest Reserve although neighbouring forests including Marimba and Mlinga were visited. 14 species recorded in Manga by the current survey were not recorded by Ruffo et al. in the Sigi Valley group of forests although they were recorded elsewhere in the Usambaras. These are listed in Table 7. Only those species listed by Ruffo et al. (1989) are included in this comparison.

Table 7. Trees found outside their previously recorded range in the East Usambara Mountains.

Species	**Location as previously recorded**[1]
Albizia zimmermannii	Kwamgumi, Segoma and Mtai FRs
Cola greenwayi	Kwamkoro and Lutindi
Commiphora eminii	Lutindi and Mtai
Cussonia zimmermannii	Kwamgumi, Segoma and Mtai FRs
Diospyros mespiliformis	Amani area and Kwamgumi / Segoma area
Diospyros natalensis	Kwamgumi, Segoma and Mtai FRs
Ficus exasperata	Southern part of main range, Lutindi, Kwamgumi / Segoma, Mlinga and Mtai
Ficus sur	Northern and southern part of main range, Mlinga and Kwamgumi / Segoma area
Ficus sycomorus	Kwamsambia, Kwamgumi / Segoma and Mtai.
Maytenus acuminata	Kwamkoro and Amani area
Maytenus undata	Northern part of main range
Sterculia appendiculata	Kwamsambia, Lutindi, Kizara, Mlinga, Kwamgumi / Segoma and Mtai
Teclea nobilis	Kwamkoro, Kwamsambia and Kwamgumi FRs.
Uvariodendron oligocarpum	Kwamkoro and Kwamsambia / Kihuhwi FRs

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

Species	Ecological status	Habitat	Endemic status
SOLANACEAE			
Solanum goetzei	F		W
STERCULIACEAE			
Cola microcarpa	F	S	N
Cola sp.			
Cola stelacantha			
Dombeya shupangae	O	S	W
THYMELAECEAE			
Synaptolepis kirkii	f	L(&S)	W
TILIACEAE			
Corchorus aestuans			
Grewia sp			
ULMACEAE			
Celtis zenkeri	f	L&S	W
Trema orientalis	f	L&S	W
UMBELLIFERAE			
Steganotaenia araliacea	O	L&S	W
URTICACEAE			
Laportea lanceolata	f	L&S	N
Obetea radula	O	L&S	W
Urera hypselodendron	f	S	W
VERBENACEAE			
Clerodendron capitatum	f	L&S	W
Lantana camara	f	L&S	Introduced
Premna chrysoclada	O	L	N
Vitex strickeri	f	L&S	W
VIOLACEAE			
Rinorea arborea	F	L	W
Rinorea ilicifolia	F	L&S	W
Rinorea squamosa	F	L	N
VITACEAE			
Ampelocissus multistriata	f	L&S	W
Cyphostemma braunii	f	L&S	N
Rhoicissus revoilii	O	L&S	W
ZAMIACEAE			
Encephalartos hildebrandtii	f		W

KEY TO ABBREVIATIONS FOR TABLE 4, 5 and 6

Ecological type: (based on Iversen, 1991b)

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

Habitat: (based on Hamilton, 1989)

- L - Lowland: Species occurring at altitudes of <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, 1991b):

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

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

Species	Ecological status	Habitat	Endemic status
MALVACEAE (cont.)			
Sida acuta	O		W
Wissadula rostrata			
MYRTACEAE			
Psidium guajava			Introduced
OCHNACEAE			
Ochna thomasiana			W
ONAGRACEAE			
Ludwigia erecta			
PALMAE			
Elaeis guineensis	F	L&S	W
PASSIFLORACEAE			
Adenia cissampeloides	f	S	W
Schlecterina mitostemmatoides	F	L	W
PERIPLOCACEAE			
Cryptolepis sp.			
RUBIACEAE			
Breonadia salicina	F	L&S	W
Heinsia crinita	O	L	W
Keetia sp.			
Oxyanthus pyriformis	f	L&S	W
Parvetta sp.			
Pentas micrantha	f	L	W
Psychotria goetzei	F	S	N
Psychotria meridiano-monta	f	S	W
Psychotria triclada	F	S	E
Rytigynia amaniensis	f	L(&S)	W
Tricalysia ovalifolia	f	L&S	W
Tricalysia sp. H	F	L	E
Vangueria infausta	f	L(&S)	W
RUTACEAE			
Citrus limonia			Introduced
Citrus sinensis			Introduced
Clausena anisata	f	L&S	W
Diphasia morogorensis	f	S	
Teclea amaniensis	f	L&S	N
Toddalia asiatica	O	L&S	W
Zanthoxylum chalybeum	O	S	W
Zanthoxylum usambarense	F	S	W
SAPINDACEAE			
Allophylus abyssinicus	F	S	W
Paullinia pinnata	f	L&S	W
SAPOTACEAE			
Bequartiodendron natalense	f	L&S	W
Malacantha alnifolia	f	L&S	W
Pachystela msolo	F	L&S	W
SCROPHULARIACEAE			
Clausena anisata			
SIMAROUBACEAE			
Harrisonia abyssinica	f		W
SMILACACEAE			
Smilax anceps	f	L&S	W

Species	Ecological status	Habitat	Endemic status
FLAGELLARIACEAE			
Flagellaria guineensis	O		W
GRAMINEAE			
Olyra latifolia	f	L	Introduced
Oplismenus hirtellus	F	L&S	W
Panicum brevifolium	F	L(&S)	W
Paspalum conjugatum	O		W
Pennisetum purpureum	f	L&S	W
Rottboellia exaltata			
Sorghum verticilliforum	O	L&S	W
Themeda triandra	f	L&S	W
GUTTIFERAE			
Garcinia volkensii	F	(L&)S	W
Harungana madagascariensis	F	L&S	W
HYPERICACEAE			
Psorospermum sp.			
LABIATAE			
Hoslundia opposita	f		W
Hyptis suaveolens			Introduced
Ocimum usambarensis			
Basilicum polystachyon			
LEGUMINOSAE-CAESALPINIOIDEAE			
Afzelia quanzensis	f	L&S	W
Caesalpinia bonduc	O	L	W
Caesalpinia trothae	F	L&S	W
Caesalpinia volkensii	f	L&S	W
Piliostigma thonningii	O	L&S	W
Tamarindus indica	O	L&S	W
Zenkerella sp.			
LEGUMINOSAE-MIMOSOIDEAE			
Acacia brevispica	O	L&S	W
Acacia robusta	f		W
Acacia schweinfurthii	F	L	W
Albizia versicolor	O	L&S	W
Dichrostachys cinerea	O	L&S	W
Entada pursaetha	f	L	W
LEGUMINOSAE-PAPILIONOIDEAE			
Baphia kirkii	f	L	N
Crotalaria retusa	O	L(&S)	W
Crotalaria zanzibarica	O	L&S	N
Dolichus oliveri	O	S	W
Eriosema psoraleoides	O	L&S	W
Millettia sacleuxii	f	L	N
Millettia usaramensis	O	S	W
Mucuna pruriens	O	L&S	W
Ormocarpum kirkii	O	L&S	W
Vigna sp.			
LOGANIACEAE			
Strychnos panganensis	f	L	W
Strychnos spinosa	f	L	W
Strychnos usambarensis	f	L&S	W
MALVACEAE			
Abutilon sp.			

Species	Ecological status	Habitat	Endemic status
COMBRETACEAE (cont.)			
Combretum paniculatum	f	L&S	W
COMPOSITAE			
Aspilia kotschy			
Aspilia mossambicensis	f		W
Bidens pilosa	O		W
Brachylaena huillensis	O		W
Microglossa parvifolia			W
Vernonia colorata	O		W
Vernonia galamensis	f		N
Vernonia subuligera		S	W
CONNARACEAE			
Agelaea setulosa	f	L	N
CONVULVULACEAE			
Astripomoea hyoscyamoides	O	S	W
Hewittia sublobata	O	L&S	W
Ipomoea mombassana	O	L&S	W
CUCURBITACEAE			
Coccinia grandis	f	L&S	W
Cucumis prophetarum	O	L&S	W
Luffa cylindrica	f	L&S	W
Momordica foetida	f	L&S	W
Momordica glabra	F	L&S	W
CYPERACEAE			
Cyperus latifolius			
DICHAPETALACEAE			
Dichapetalum arenarium	f	L	N
Dichapetalum mossambicense	f	L	W
DIOSCOREACEAE			
Dioscorea asteriscus	f	L&S	W
Dioscorea sansibarensis	f	L&S	W
DRACAENACEAE			
Dracaena aletriformis			
Dracaena usambarensis	f	L	W
Sansevieria kirkii	O		W
EBENACEAE			
Diospyros amaniensis	F	L(&S)	N
EUPHORBIACEAE			
Acalypha psilostachya	f		W
Acalypha sp. A	O	L	W
Antidesma venosum	f	L&S	W
Bridelia melanthesoides	O	L&S	W
Croton sylvaticus	f	L&S	W
Drypetes natalensis	f	L&S	W
Drypetes reticulata	f	L(&S)	W
Erythrococca kirkii	O	L&S	W
Erythrococca usambarica	F	L&S	N
Monadenium capitatum	O	S	W
Synadenium glaucescens	O	L&S	N
Tragia brevipes	f	L&S	W
Tragia furialis	f	L(&S)	W
FLACOURTIACEAE			
Grandidiera boivinii	f	L&S	W

Species	Ecological status	Habitat	Endemic status
APOCYNACEAE (cont.)			
Saba comorensis	f		W
Schizozygia coffaeoides	F		W
Tabernaemontana ventricosa	F	L	W
Voacanga africana	f		W
ARACEAE			
Amorphophallus stuhlmannii	F	L&S	N
Anchomanes abbreviatus	F	L	N
Callopsis volkensii	F	L	?W
Culcasia orientalis	f	L	N
Gonatopus boivinii	f	L(&S)	
Zamioculcas zamiifolia	f	L	W
ASCLEPIADACEAE			
Calotropis procera	O		W
Kanahia laniflora	O		W
Parquetina nigrescens	f		W
Sarcostemma sp.			
ASPARAGACEAE			
Asparagus falcatus	f		W
ASPHODELACEAE			
Chlorophytum filipendulum			
ASPLENIACEAE			
Asplenium buettneri	f		N
ASTERACEAE			
Mikania cordata			
BEGONIACEAE			
Begonia princeae			
BIGNONIACEAE			
Markhamia obtusifolia	O		W
Markhamia zanzibarica	f		W
Stereospermum kunthianum	f	L&S	W
BOMBACACEAE			
Adansonia digitata	O		W
BURSERACEAE			
Commiphora pteleifolia	O	L&S	W
Commiphora zanzibarica	O	S	W
CACTACEAE			
Opuntia cochenillifera	O	L	Introduced
CAPPARACEAE			
Maerua triphylla	O	L&S	W
CAPPARIDACEAE			
Capparis erythrocarpos	O	L&S	W
Capparis tomentosa	f	L&S	W
CECROPIACEAE			
Myrianthus holstii	f	S	W
CELASTRACEAE			
Salacia leptoclada	F	L&S	W
Salacia pyriformis	f	L&S	W
CHRYSOBALANACEAE			
Parinari sp.			
COMBRETACEAE			
Combretum apiculatum	O	L&S	W
Combretum molle	O	L&S	W

Table 5. Species found in the regeneration plots but not in the main vegetation plots.

Species	Ecological Type	Habitat	Endemic Status
ANNONACEAE			
Mkilua fragrans	F	S	N
COMBRETACEAE			
Pteleopsis myritifolia	f		W
EBENACEAE			
Phyllanthus sp.			
EUPHORBIACEAE			
Acalypha ornata	f		W
LAURACEAE			
Parkia filicoidea	F		W
LEGUMINOSAE - CAESALPINIOIDEAE			
Cynometra sp.			
MORACEAE			
Dorstenia kameruniana	f	L&S	W
SAPINDACEAE			
Zanha golungensis	F		W
SAPOTACEAE			
Pouteria alnifolia			
Vincentella passargei	f		W

Table 6. Summary of opportunistic botanical records.

Species	Ecological status	Habitat	Endemic status
ACANTHACEAE			
Adhatoda engleriana			
Asystasia gangetica	O		W
Hypoestes aristata	O		W
Hypoestes hildebrandtii			
Justicia euosmia	f	S	
Justicia pseudorungia	f		W
Pseuderanthemum hildebrandtii	f		W
Thunbergia affinis	O		W
AMARANTHACEAE			
Achyranthes aspera	f	L&S	W
ANACARDIACEAE			
Mangifera indica	f	L&S	Introduced
ANNONACEAE			
Asteranthe asterias	f	L	N
Isolona cauliflora	F	L	N
Lettowianthus stellatus	f	L	N
Monanthotaxis fornicata	f	L	N
Monanthotaxis trichocarpa	F	L(&S)	N
Uvaria acuminata	f	L	W
Uvaria tanzaniae	F		N
APOCYNACEAE			
Adenium obesum	f		W
Ancylobothrys petersiana	O		W
Landolphia kirkii	f		W
Oncinotis tenuiloba	f		W
Rauvolfia mombasiana	f	L	N

Species	Ecological type	Habitat	Endemic status
MORACEAE			
Antiaris toxicaria	f	S&L	W
**Ficus exasperata*	f	S&L	W
Ficus natalensis	f	L	W
Ficus sp.			
Ficus sur	f	S&L	W
Ficus sycomorus[1]	F	L	W
Milicia excelsa	f	S&L	W
**Streblus usambarensis*	f	L	W
Trilepisium madagascariensis	f	S&L	W
OCHNACEAE			
Ochna macrocalyx	O		W
Ochna sp.			
Ouratea scheffleri	f		N
RUBIACEAE			
Chassalia albiflora	F	S&L	E(EU&WU)
Leptactina platyphylla	f	S	W
Polysphaeria multiflora	f	L&S	W
Rothmannia manganjae	F	S&L	W
Rytigynia celastroides	f	L(&S)	W
**Rytigynia sp.*			
Sericanthe odoratissma	F	L&S	E(EU&WU)
Tarrena nigrescens[1]	f	L	W
Tarrena pavettoides	F	L&S	W
Tricalysia anomala	F	S	N
Tricalysia sp.			
RUTACEAE			
**Teclea nobilis*	f		W
SAPINDACEAE			
**Allophylus rubifolius*	f	(L&)S	N
**Blighia unijugata*	f	L&S	W
Deinbollia borbonica	O	L&S	W
Haplocoelum foliolosum	O	S	W
**Lecaniodiscus fraxinifolius*	f	L&S	W
Melanodiscus oblongus[1]	f	L&S	W
SAPOTACEAE			
Manilkara sulcata	f	L	W
Mimusops kummel	f	L	W
STERCULIACEAE			
**Cola clavata*[1]	F	L	W
**Cola greenwayi*	F	S	W
Dombeya shupangae	O		N
**Sterculia appendiculata*	F	L	W
TILIACEAE			
Carpodiptera africana	O		W
Grewia goetzeana	f	L	N
Grewia holstii	f		N
**Nesogordonia holtzii*[1]			
ULMACEAE			
Celtis africana	F	L	W
Celtis mildbraedii	F	S&L	W
Celtis wightii	f	L&S	W

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

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

Species	Ecological type	Habitat	Endemic status
EBENACEAE			
Diospyros kabuyeana	f	S	N
Diospyros mespiliformis	f	L	W
**Diospyros natalensis*	f	L	W
Diospyros squarrosa[1]	F	L	W
EUPHORBIACEAE			
Antidesma membranaceum	f	S&L	W
Bridelia cathartica	f	L&S	W
Bridelia micrantha	f	S&L	W
Drypetes usambarica	f	S	N
Euphorbia nyikae	O	L	N
Flueggea virosa	f	L&S	W
Manihot glaziovii	O		W
Margaritaria discoidea	f	S	W
**Mildbraedia carpinifolia*	f	L&S	N
Ricinodendron heudelotii	f	L	W
**Suregada zanzibarense*	f	L	W
HERNANDIACEAE			
Gyrocarpus americanus	f	L	W
LECYTHIDACEAE			
Barringtonia racemosa	f	L	W
LEGUMINOSAE - CAESALPINIOIDEAE			
Cynometra engleri	F	L	N
**Cynometra webberi*	f	L	N
Dialium holtzii	f	L	N
Julbernardia globiflora	O	S&L	W
Julbernardia magnistipulata	f	L&S	N
**Scorodophloeus fischeri*	f	L	N
Senna singueana	O		W
LEGUMINOSAE - MIMOSOIDEAE			
Acacia mellifera[1]	O	S	W
**Acacia senegalensis*[1]	O	L&S	W
Albizia adianthifolia	f	L&S	W
Albizia anthelmintica	O	S&L	W
Albizia glaberrima	f	L	W
Albizia petersiana	f	S&L	W
Albizia schimperiana	F	S	N
Albizia zimmermannii	f	L	W
**Leucaena leucocephala*	O		W
Newtonia paucijuga	F	L	N
LEGUMINOSAE - PAPILIONOIDEAE			
**Craibia brevicaudata*	f	L	W
Erythrina caffra[1]	F		W
Lonchocarpus bussei	O	L&S	W
Millettia stuhlmannii[1]	O	L&S	
Pterocarpus mildbraedii	F	L	N
Pterocarpus tinctorius	F	S&L	W
MALVACEAE			
Thespesia danis	O	L	W
MELIACEAE			
Khaya anthotheica[1]	F	L&S	W
Trichilia emetica	f	L&S	W

4.3 Results

4.3.1 Quantitative vegetation analysis

Table 4 presents a checklist of the tree and shrub species recorded in the 20 m x 50 m vegetation plots. Species are described, using the FTEA where possible, 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	Endemic status
ANACARDIACEAE			
Lannea schweinfurthii	f	S&L	W
Lannea welwitschii	F	L	N
Rhus natalensis	f	S&L	W
**Sorindeia madagascariensis*	f	S&L	W
ANNONACEAE			
Annona senegalensis	f	S&L	W
Monodora grandidieri	f	L&S	N
Polyalthia stuhlmannii	F	L	N
Uvariodendron oligocarpum	F	S	E(EU&WU)
**Xylopia parviflora*	f	L	W
APOCYNACEAE			
Holarrhena pubescens	O	L	W
ARALIACEAE			
Cussonia arborea	O	L&S	W
Cussonia zimmermannii	f	L	N
BIGNONIACEAE			
Fernandoa magnifica	f	L	W
Kigelia africana	f	L	W
**Markhamia lutea*	f	S&L(forest gaps)	W
BOMBACACEAE			
Bombax rhodognaphalon	f	L	N
Ceiba pentandra	f		W
BORAGINACEAE			
Ehretia cymosa	F	(L)&S	W
BURSERACEAE			
Commiphora eminii	f	L	W
CELASTRACEAE			
Maytenus acuminata	F	S	W
Maytenus mossambicanis	f	L&S	W
Maytenus senegalensis	O	L&S	W
Maytenus sp.			
Maytenus undata	f	S	W
COMBRETACEAE			
Combretum illairii	f	L	W
Combretum padoides	f	L&S	W
Combretum schumannii	F	L	W
Terminalia sambesiaca	f	L	W
DRACAENACEAE			
Dracaena steudneri	f	S	W

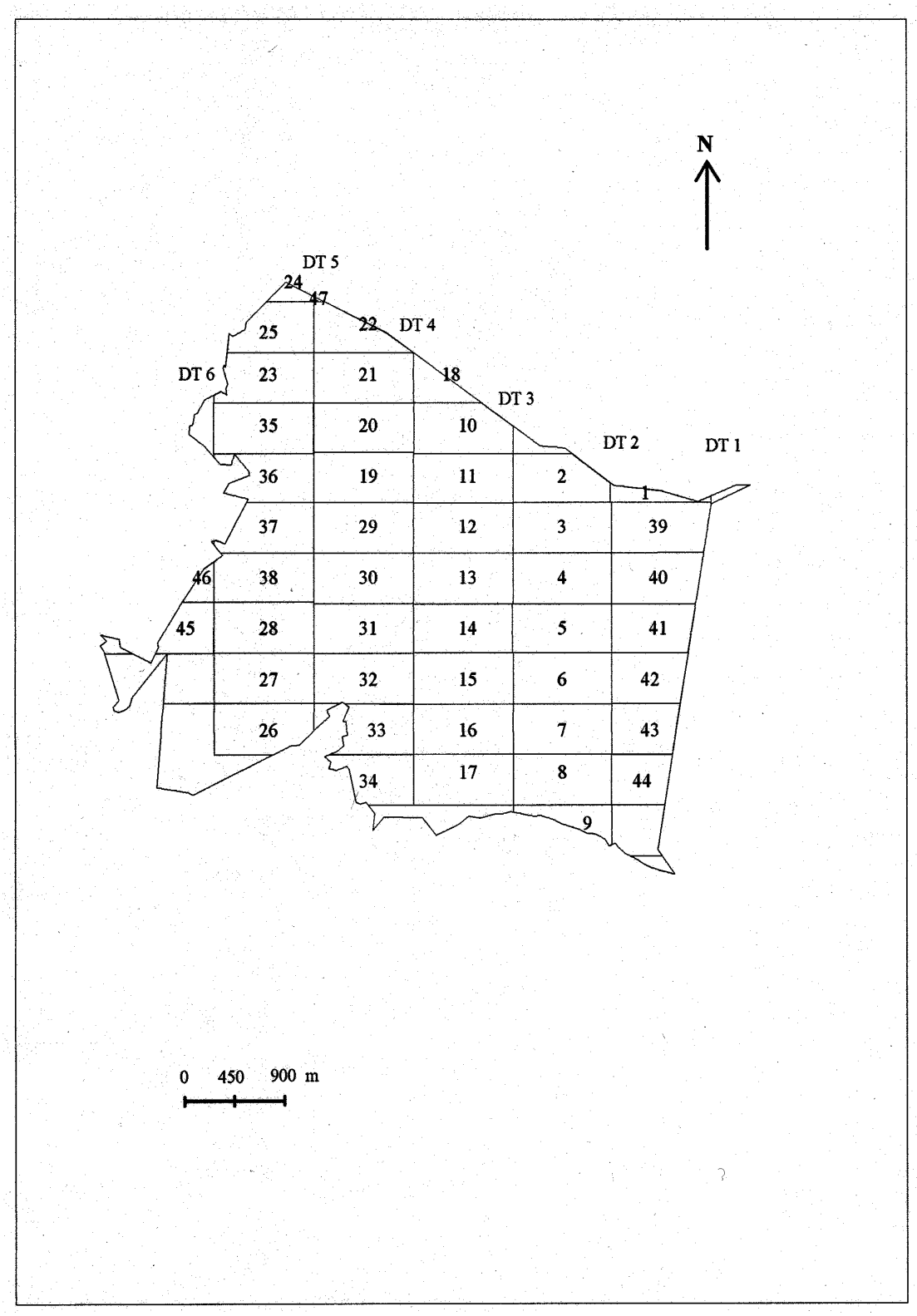


Figure 3. Location of vegetation plots and disturbance transects.

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.

4.0 VEGETATION

4.1 Introduction

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

4.2 Methods

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

4.2.1 Forest composition

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

4.2.1.1 Quantitative vegetation analysis

A standardised method of vegetation plot sampling was used, based on a 450 m x 900 m grid system. The grid system is identified using transects marked with boundary tape. One 50 m x 20 m sample plot was recorded in each grid rectangle, giving an approximate sampling intensity of 0.25%. Within the sample plot, every tree with a dbh (diameter at breast height) of 10 cm or greater 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. A botanist from the Tanzanian Forestry Research Institute (TAFORI) provided the field identification of plant species.

4.2.1.2 Casual botanical collections

Throughout the survey period casual botanical collections were made by the Botanist, Ahmed Mndolwa, in order to make the inventory as comprehensive as possible. In addition the survey was joined by collectors from the Missouri Botanical Gardens Local Collectors Training Programme. The results of their collections have been included.

4.2.1.3 Disturbance transects

Disturbance transects were used to record the intensity of pole and timber cutting. 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

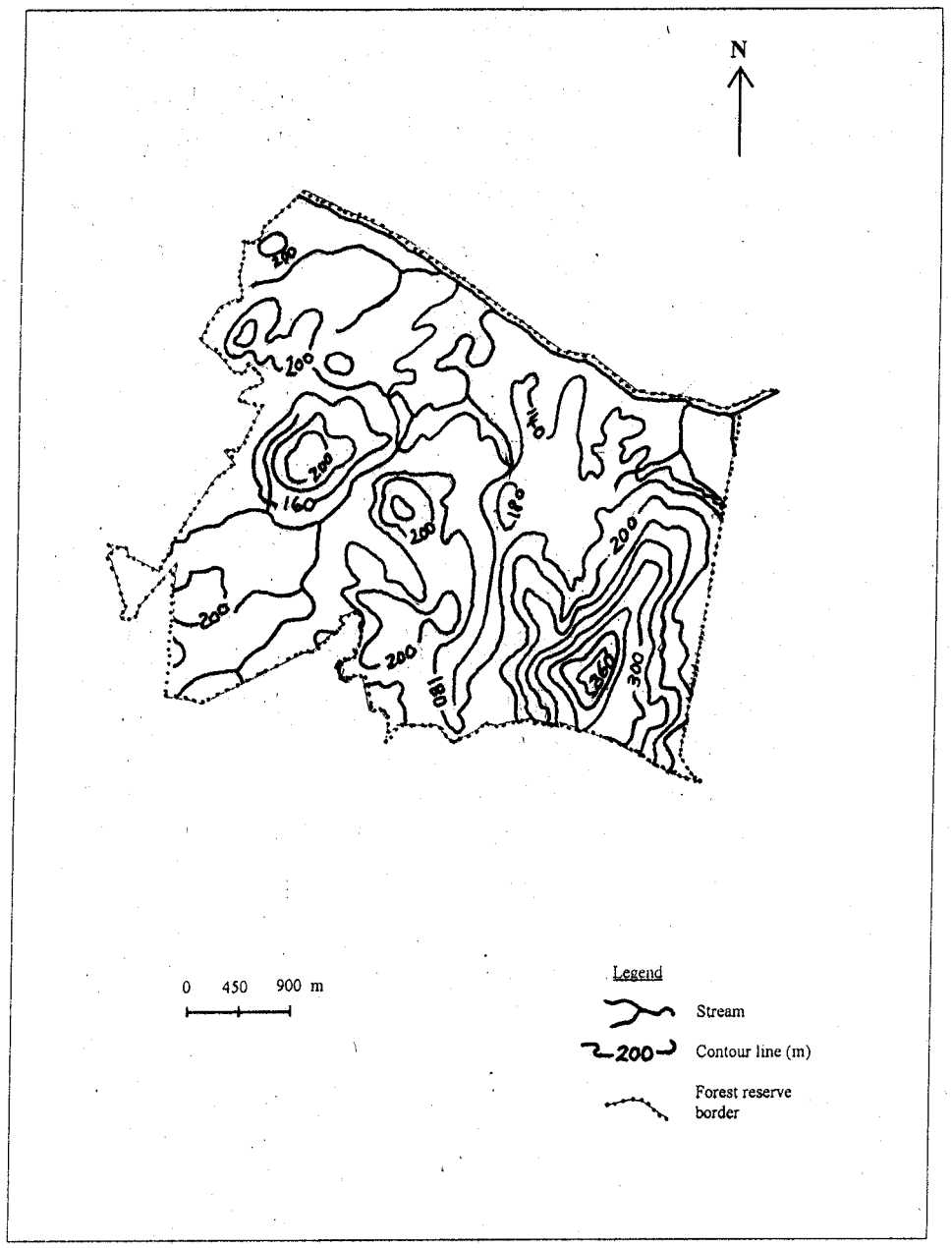


Figure 2. Topographical map.

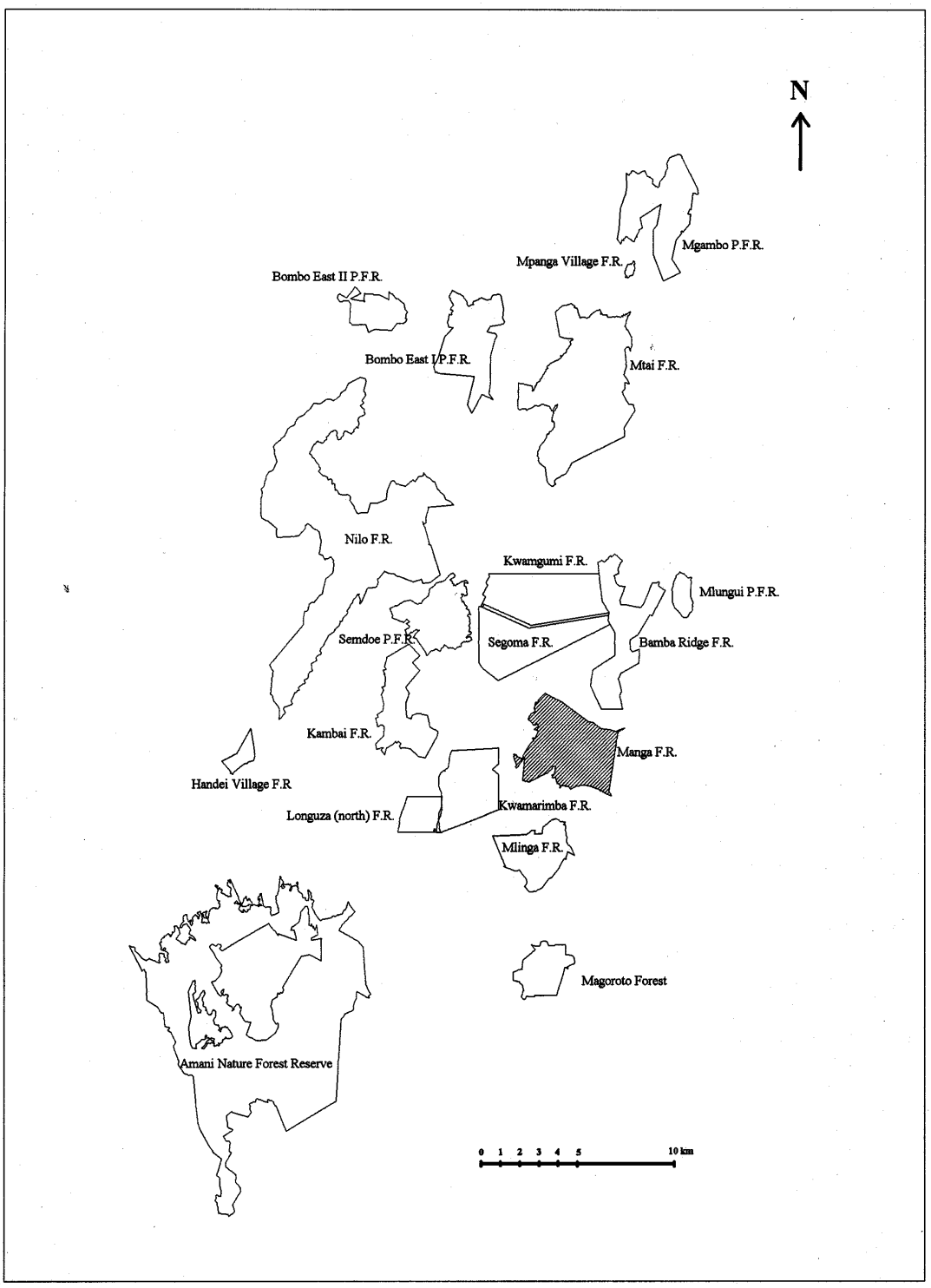


Figure 1. The location of Manga Forest Reserve in relation to other East Usambara forests.

3.1.3 History and Status

Manga Forest Reserve was one of six forest reserves, in the Usambaras, gazetted by the government after the Second World War. In 1962 there was pressure to degazette the forest or to turn it into a teak plantation. These plans were resisted although the eastern boundary of the reserve was moved back in order to give the villagers of Mkwajuni 60 acres for settlement purposes. The forest was logged in the 1980s and a number of logging roads formerly ran through the reserve. These are now overgrown and impassable by vehicle.

In 1999 an additional 855 ha to the west of the River Mazingira were gazetted bringing the total area of the reserve up to 1635 ha.

3.0 DESCRIPTION OF THE FOREST

3.1 General description

3.1.1 Description

Name: Manga Forest Reserve
Muheza District, Tanga Region, Tanzania.

Area: 1616 ha; 16.2 km^2, 5.8 sq. miles

Status: Central Area Forest Reserve
Gazettement Notice 112 (1955); Gazettement Notice 146, 204 (1961)

Maps: Ordnance Survey topographic maps 1: 50 000 Series Y742
Sheet 130/2 'Muheza' of 1990

Forest Division map: JB 2282

3.1.2 Location

Grid reference: $38^o45'E$ - $38^o47'E$; $5^o00'S$ – $5^o02'S$

Elevation 120 - 360 m above sea level

Manga Forest Reserve is located to the east of the main East Usambara Range. The northern border is the Sigi River. Running north-south through the centre of the reserve is the Mruka River, a tributary of the Sigi River. To the east of the reserve the land rises to 360m around Manga peak. There are a number of other smaller hills in the west of the reserve.

Agricultural land adjoins the reserve on all sides. To the north-east of the reserve lies the village of Mkwajuni, to the south lies Misozwe and in the north-west lies Kwatango. On the opposite bank of the Sigi lies the village of Segoma.

The latest survey of the area was carried out by Hyytiäinen (1995), and updated by Johansson & Sandy (1996). The results for Manga forest reserve are summarised in Table 3 below. The majority of Manga forest reserve can be classified as dense lowland forest. In addition to forest there are expanses of grassland in the north of the reserve which were not described by Johansson & Sandy (1996).

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

Manga Forest Reserve	**Area (ha)**	**Percent (%)**
Dense lowland forest	1348.8	83.5
Poorly stocked forest	258.3	16.0
Cultivation under forest	8.9	0.5
Total for the reserve:	**1616**	**100**

2.0 AIMS OF THE SURVEY

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

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

Furthermore, the aims of the survey methods applied are:

- to sample the vegetation and tree species composition of selected forests of the East Usambaras using systematic sampling techniques along systematically located vegetation transects, which sample approximately 0.25% in 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 standard and repeatable methods to record biodiversity values of the forest in terms of small mammal species, reptiles, amphibians, and invertebrate species;
- to collect opportunistic data on all other groups of vertebrate and invertebrates. Species lists resulting from this will be compared against standard appraisals of species rarity and other values in order to assess the overall biodiversity values of each forest.
- 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.

which they represent. In those plots where no spot is shown, the relevant taxa was not surveyed.

1.4 Data and monitoring

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

1.5 Survey period and personnel

The survey of Manga Forest Reserve was conducted between March and May 1994 and between July and September 1997 for a total of 126 research-days. The survey was conducted by Frontier-Tanzania staff, Catchment Forest Officers, volunteers and field assistants from Maramba and Semdoe.

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

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, 1991).

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

1.2 Report structure

This report provides a floral and faunal inventory of Manga 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

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 shows 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.

The results of a botanical collection made by the Missouri Botanical Gardens Local Collectors training programme at the time of the survey have been incorporated and we are greatful to Peter Philippson from Missouri Botanical Gardens, Mr Sitoni from the National Herbarium and all the trainees for providing us with this data.

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

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

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

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

EXECUTIVE SUMMARY

Manga Forest Reserve, in the East Usambara Mountains in north-east Tanzania was gazetted in 1955. It is situated in Muheza District, Tanga Region and covers 1616 ha between 120 – 360 m asl, encompassing lowland forest and grassland.

As part of the East Usambara Catchment Forest Project (from 1999 East Usambara Conservation Area Management Programme, EUCAMP), Frontier-Tanzania conducted a biological survey of Manga Forest Reserve between March - May 1994 and between July - September 1997 for a total of 126 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 patterns of human disturbance within the reserve and presents the results of a socio-economic study in neighbouring villages. 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, shrubs and herbs	329	19	73	5	51	**23**
mammals	30	2	0	0	2	**1**
birds*	82	7	6	0	2	**2**
reptiles	26	2	3	0	5	**4**
amphibians	22	2	3	0	5	**3**
butterflies	102	22	12	2	7	**6**
Total	**591**		**97**	**7**	**72**	**39**

*This does not represent an inventory as burds were not surveyed systematically.

Manga Forest Reserve is significant, in terms of conservation as a good example of mature lowland forest with a high species diversity. The reserve provides habitat to a number of endemic and threatened species including three trees endemic to the Usambaras.

In terms of fauna, the reserve is home to three endangered species and four vulnerable species according to IUCN categories. Relative to other forests surveyed in the East Usambaras, Manga has the highest diversity of butterfly species including *Euthecta* sp. nov. which was discovered during the survey. The reserve also has a diverse bird fauna including the near endemic East Coast akalat and the Amani sunbird.

Commercial timber extraction has now largely stopped however poles and timber are still cut throughout the reserve. Fire had affected 37% of the plots leaving some areas as woodland and grassland. There is some resentment from the villagers that they have been denied access to resources following the gazettement of the Forest Reserve.

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

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East Usambara Conservation Area Management Programme (EUCAMP)
The East Usambara rain forests are one of the most valuable conservation areas in Africa. Several plant and 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 Catchment Forest Project (EUCFP). This survey of selected forests collects baseline biodiversity data and assists the EUCFP in the management of the East Usambara forests.

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Manga Forest Reserve

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