

Mkindo Forest Reserve

Forest Disturbance Report

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Tanzania
Forest
Conservation
Group



Participatory Environmental Management
Programme (PEMA)

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Executive Summary

The forest disturbance survey was conducted in Mkindo Forest Reserve, Mvomero District, between 1st May and 19th May 2006. This survey is a part of the Participatory Environmental Management Programme (PEMA), which is implemented by Tanzania Forest Conservation Group (TFCG). The work will contribute to the characterisation of the Nguru South Mountains landscape with the aim of poverty alleviation, natural resource management and biodiversity conservation.

Mkindo Forest Reserve (FR) is located within the Nguru South Mountains, part of the Eastern Arc Mountains, latitude 6° 12' – 6° 16'S and longitude 37° 28' – 37° 34' E. It is situated in Mvomero District, 12 km from Turiani and 10 km from Mvomero, and was established in 1954 for its water catchment value supplying surrounding villages and the larger Wami catchment area. It covers 5244 ha and consists of miombo (*Brachystegia*) woodland and riverine / lowland forest. It has an elevational range of 380 – 800 m above sea level (asl) and an average rainfall of 1200 – 1500 mm per year (Lovett and Pócs 1993).

This study conducted 12 forest disturbance surveys and recorded opportunistic observations of animals and disturbance throughout Mkindo Forest Reserve.

Forest disturbance

A total transect length of 11.0 km was conducted in Mkindo FR (10 transects at 1000m, one transect at 700m and one transect at 300m). A total of 2,125 poles (defined as woody stems 5-15 cm dbh), 2,696 timber trees (defined as woody stems 15-30 cm dbh) and 826 large timber trees (defined as woody stems 30 cm dbh and above) were recorded. An average of 168.9 live, 13.5 dead and 10.7 cut poles were recorded per hectare, with an average of 212.5 live, 23.1 dead and 9.5 cut timbers recorded per hectare and an average of 68.8 live, 5.4 dead and 0.9 cut large timbers recorded per hectare.

Of the total poles and timbers recorded, 5.5% of poles, 3.9% of timbers and 1.2% of large timbers were cut. However, when comparing old (three months and over) and new (less than three months) cutting, 94% and 85% were old cut poles and timbers, respectively, with 80% old cut large timbers. However, overall extraction of pole and timber resources is low in the reserve. Casual observations highlighted the north east of the reserve, an area of riverine and lowland forest as being targeted for current cutting of *Pterocarpus angolensis* and other timber species. This was particularly prevalent along the Kigombezi river. Several old pitsawing sites were also recorded in this area of lowland / riverine forest. Many of the large trees had already been extracted.

Other types of disturbance recorded were grazing, charcoal burning, mining, cultivation and paths. Grazing is of major concern as it was noted along 40.9% of the transects. Cattle are brought into the reserve for dry season grazing. The impact of this should be investigated, as very few signs of medium to large mammals were seen throughout the reserve. The pressure of grazing is also linked to the yearly fires, which although an integral part of the miombo woodland ecosystem, should be monitored as previous fire damage was noted within lowland / riverine forest in the north east of the reserve.

An area of cultivation was seen in the north west of the reserve, where several farmers are planting crops in a valley by the main Mkindo – Mdera path. Apparently the farmers have been granted permission to farm here by Forestry. This should be investigated.

Charcoal burning is occurring within the reserve, two fresh sites were recorded, targeting *Pterocarpus angolensis*. Cutting is also occurring for firewood collection.

There is a lack of clear forest boundaries on the west of the reserve, where there was some confusion as to exactly where the boundary was; no beacons were located. The east is clearly marked by a well established line of teak trees (*Tectona grandis*). Future management plans should try to clearly demarcate these boundaries.

Of particular note, although not directly linked to Mkindo Forest Reserve, was the confiscation of a number of planks in the reserve. There is a lucrative business (which is sadly occurring throughout the South Nguru Mountains) of illegal timber extraction from the montane forests of Nguru South FR. The planks are carried through Mkindo FR to be loaded on to lorries at night at Mkindo village. Despite being common knowledge within Mkindo village, none of the relevant authorities have taken action to stop this activity. This puts into question the complicity of members of the village government and other officials as well as undermining the joint forest management process that has been established for the reserve.

Opportunistic fauna observations

Opportunistic observations were made of all fauna throughout the survey period. In total, 62 observations of fauna were made, 52 within the reserve and 10 observations in the grassland and farmland (shamba) surrounding the reserve. 38 species of bird were recorded with 14 species of mammal, six species of reptile and four species of amphibian. One frog species was found to be an endemic to the Eastern Arc Mountains (*Callulina cf krefftii*) whilst one primate species (*Galagoides zanzibaricus*) is near-endemic to the Eastern Arc Mountains and is also listed as Vulnerable to extinction by IUCN.

Recommendations

The following recommendations are based on the results of the forest use disturbance survey:

Joint Forest Management

- Investigation into the reasons why Joint Forest Management (JFM) is not addressing the illegal activities occurring in Mkindo
- Provide training to the Mkindo forest officer so that he is more aware of his role and responsibilities
- Increase communities' capacity to participate in joint forest management
- Inform the local communities of the results of the survey by summarising and translating into Swahili to assist with management of the reserve

Specific management issues within Mkindo FR

- Investigation of the allocated farmland within the reserve and the appropriate action taken
- Continued monitoring of the timber planks being brought from Nguru South FR to Mkindo village as a JFM activity
- Clear boundary demarcation and maintenance, particularly in the west and south of the reserve
- Fire management within the reserve, including fire breaks between miombo and forest habitats
- Investigation of the impact of grazing, if there is overgrazing, in the reserve and appropriate action taken;
- Active patrols and prosecution of people involved in pitsawing and charcoal burning in the reserve as a part of JFM

Research

- Conduct a zoological survey in the riverine and lowland forest where Eastern Arc species should be present to provide a species inventory and abundance of key species (a floral survey has already been conducted, Malimbwi and Mugasha, 2002)

- Repeat forest use survey in five years to look at management effectiveness and monitoring of human resource use in Mkindo FR

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Acronyms

BREAM	Biodiversity Research and Awareness in the Lesser Known Eastern Arc Mountains
CITES	Convention on the International Trade of Endangered Species
CMEAMF	Conservation and Management of the Eastern Arc Mountain Forests
CP	Centre point
FAO	Food and Agricultural Organisation
FR	Forest Reserve
FT	Frontier-Tanzania
GPS	Global positioning system
IUCN	The World Conservation Union
JFM	Joint Forest Management
SUA	Sokoine University of Agriculture
PEMA	Participatory Environmental Management Programme
TFCG	Tanzania Forest Conservation Group
WS	Worksite

1 Introduction

Background

This report describes the results of a forest disturbance survey conducted on behalf of the Tanzania Forest Conservation Group as part of the PEMA Programme in Mkindo Forest Reserve during May 2006. The report aims to provide an overview of the current human activities occurring within Mkindo Forest Reserve. This report includes a summary of the systematic data collection recorded along 12 transects, opportunistic disturbance observed throughout the reserve and other opportunistic observations of fauna.

The objectives of the work were:

1. To systematically document forest disturbance along 12 one km transects within Mkindo Forest Reserve (5244 ha) with representative coverage of the reserve.
2. To train one member of PEMA staff and one district representative in how to carry out disturbance transects (details provided in *Mkindo Forest Reserve: Training and logistics report*).

About the Tanzania Forest Conservation Group

The Tanzania Forest Conservation Group is a national non-governmental organisation established in 1985. TFCG's mission is 'to conserve and restore the biodiversity of globally important forests in Tanzania for the benefit of the present and future generations. We will achieve this through capacity building, advocacy, research, community development and protected area management, in ways that are sustainable and foster participation, co-operation and partnership.' TFCG has focused its support for forest conservation in the Eastern Arc and Coastal Forests. TFCG has been working in the South Nguru Mountains since 2003.

About PEMA

PEMA is a partnership programme. In Tanzania, the programme involves the Tanzania Forest Conservation Group (TFCG) and CARE-Tanzania. The programme is financed by DANIDA. TFCG is leading the implementation of the PEMA programme in the South Nguru Mountains, Mvomero District, and contracted this consultancy work in Mkindo Forest Reserve.

The PEMA programme works towards achieving integrated rural poverty alleviation, natural resource management and biodiversity conservation. PEMA aims to involve multiple stake holders at local, national and international level in key stages of programme implementation.

As part of a process of characterising the South Nguru landscape, PEMA has been developing a landscape monitoring programme. One of the tools that has been selected for inclusion in this programme is forest disturbance monitoring. This involves systematically recording forest disturbance along transects. The method was developed by Frontier-Tanzania.

Disturbance transects were conducted throughout the Eastern Arc Mountains by Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF) during 2005 using a very low sampling intensity; however members of the project team decided that a more intensive sampling strategy is necessary in order to provide an adequate baseline for the South Nguru landscape. Frontier-Tanzania is in the process of completing disturbance transects at this higher sampling intensity for Kanga and Nguru South Forest Reserves.

About the Nguru South Mountains and Eastern Arc Mountains

The South Nguru Mountains are part of the Eastern Arc Mountains, which range from the Taita Hills in southern Kenya to the Udzungwa Mountains in southern Tanzania. Nationally, these mountains are important water catchment areas supplying water to Dar es Salaam, Morogoro, Iringa, Chalinze, Tanga and many other smaller settlements. Internationally, the area is part of a biodiversity hotspot, particularly known for its high levels of species endemism.

Mkindo Forest Reserve (5244 ha) is one of three large forest reserves within the Nguru South Mountain landscape, the other two are Kanga (6664 ha) and Nguru South (18,792 ha) FRs. Mkindo FR lies in the foothills of Nguru South FR within the Mkindo water catchment.



Figure 1 Map of the Eastern Arc Mountains

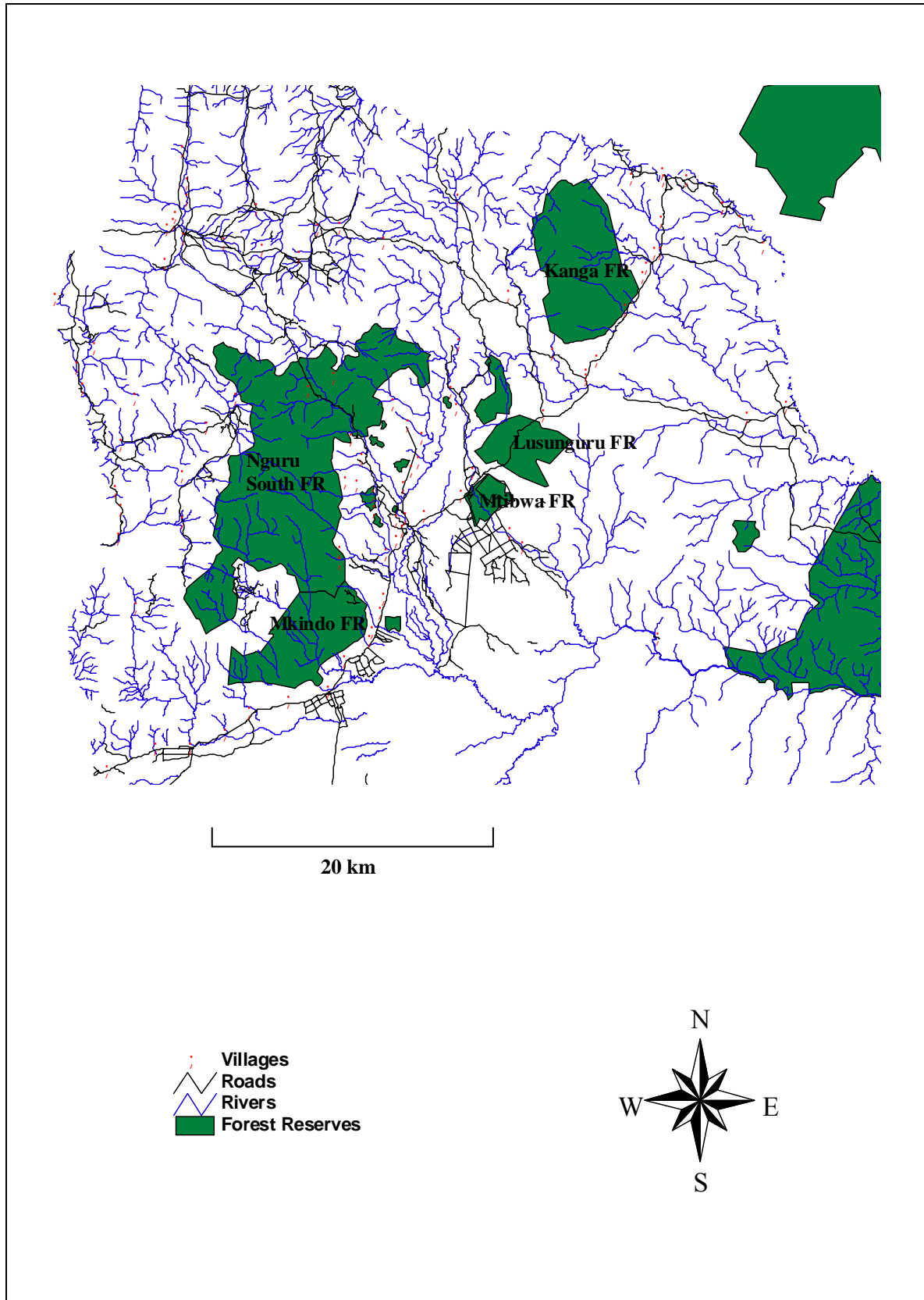


Figure 2 Map of Nguru South Mountains

2 Study Site

Information is taken from Lovett and Pócs (1993).

2.1 Location

Mkindo Forest Reserve (FR) is located on latitude 6° 12' – 6° 16'S and longitude 37° 28' – 37° 34' E in the foothills of the Nguru South Mountains. It covers an area of 52.44 km² (5244 ha) and lies in Mvomero District, Morogoro Region, covering land approximately 12 km from Turiani town and 10 km from Mvomero.

2.2 Site Description

Name: Mkindo Forest Reserve

Area: 5244 ha (from 1980; the 1954 map states 7451 ha {18,635 acres})

Status: Catchment Forest Reserve (protective), established in 1954

Maps: Ordnance Survey topographic maps 1:50,000, Series Y 165/2, 165/4, 166/1, 166/3

Division Map No. Jb. 212 (1954), Jb. 2034 (1980)

Gazette notice: GN 409 of 3/12/1954. There is no variation order.

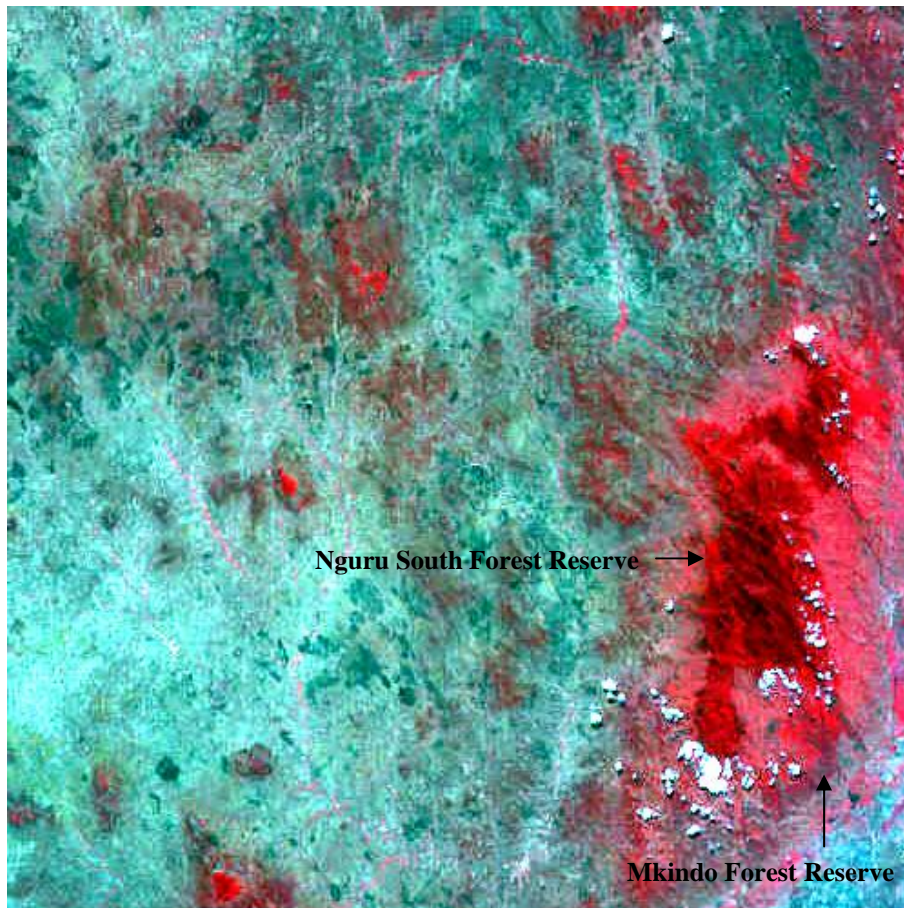


Figure 3 Spot satellite image of Nguru South and Mkindo Forest Reserve (2005) (sourced from Dr. N. Burgess)

Red indicates closed forest graduating to pink indicating woodland, tree-crop agricultural systems, agroforestry and bracken. Green indicates no cover at all, which can represent natural grassland or areas cleared of trees. It can be seen that Mkindo FR is mostly woodland.

2.3 Vegetation

The vegetation is lowland and riverine forest with grassland clearings on level ground and along rivers, with miombo (*Brachystegia*) woodland on the hills in drier areas. Mango trees indicate past cultivation.

Lowland and riverine forest: Broken to intact canopy 20-30 m tall with emergents (*Sterculia appendiculata*) to 40 m. Trees include: *Afrosersalisia cerasifera*, *Albizia* sp., *Antiaris toxicaria*, *Anthocleista grandiflora*, *Breonadia salicina*, *Khaya anthotheca* (formerly *K. nyasica*), *Malacantha alnifolia*, *Milicia excelsa*, *Pachystela brevipes*, *Sterculia appendiculata*, *Trilepisium madagascariensis*.

Woodland: Trees to 10 m, including: *Anonna senegalensis*, *Brachystegia boehmii*, *B. spiciformis*, *Combretum molle*, *Cussonia arborea*, *Pterocarpus angolensis*.

A survey by Malimbwi and Mugasha (2002) of vegetation provides more details on vegetation types and distribution.

2.4 Topography

Mkindo FR covers the southern foothills of the South Nguru Mountains around the Mkindo river from an altitude of 380 – 800 m asl and is characterised by an undulating landscape.

2.5 Geology and soils

The soils under woodland are sandy brown loams over gneissic basement rock with some rocky outcrops on the hills.

2.6 Climate

Mkindo FR is influenced by oceanic rainfall with oceanic temperatures. Rainfall per annum is estimated at 1200 – 1500 mm / year with good ground water recharge capacity. The nearest rainfall station is at Mtibwa Sugar estate. The dry season starts from June to September and temperatures range from a maximum of 26 °C in February to a minimum of 21 °C in July.

2.7 Hydrology

There are some permanent rivers, including Mkindo, Dizingwi and Kigombezi rivers, which are almost impassable in the rainy season. There are also tributaries originating from Mkindo FR and the bordering forest of Nguru South FR. The river supplies water to the bordering villages and the Mkindo rice project sponsored by FAO. There are two water intake pipes at Mkindo and Dizingwi rivers. As well as a local importance, the water sources feed into the Wami river and subsequent Wami catchment area from which people from Chalinze until Tanga depend.

2.8 Land Use

The presence of old Mango trees in the reserve indicates that it was formerly inhabited. Areas of grassland within the forest may be relicts of fields. In the past Mvule and Mkangazi were harvested, and Mvule is still being extracted by pitsawing. There is some collection of firewood and building poles from the woodland, though this is not a great pressure as woodland still exists on public land on the edge of the reserve. Fire occurs every year in the woodlands.

2.9 History and Status

Mkindo FR was gazetted for its important water catchment value in 1954 and to protect these water sources.

2.10 Management plans

Mkindo Forest Reserve is part of a Joint Forest Management pilot project, along with seven other FRs in Morogoro region. Forest operations and various activities have been carried out including the formation of by-laws; formation of Village Natural Resources Committees (four of six surrounding villages); training on nursery techniques; boundary demarcation; normal patrol operations and fire protection activities.

2.11 Forest boundary maps

The sketch map in Figure 4 shows the boundary shape of Mkindo FR as based on the 1954 Jb 212 boundary map. There is also a 1980 Jb 2034 boundary map, which has UTM coordinates and would allow creating a shapefile in GIS for mapping. However the map was unavailable at the Morogoro Catchment offices and at the Mapping department at the Ivory Rooms in Dar es Salaam. The 1980 map has in fact been digitised; however this was also unavailable at the time of writing. It seems that the reserve boundary size changed from 1954 (7451 ha) to 1980 (5244 ha), therefore the sketch map below is not completely accurate and representative of the current boundary. Unfortunately when ground truthing the reserve during the survey work, no beacons were located and the only clear boundary was the line of teak trees on the east and the rivers Kitungwi and Mkindo.

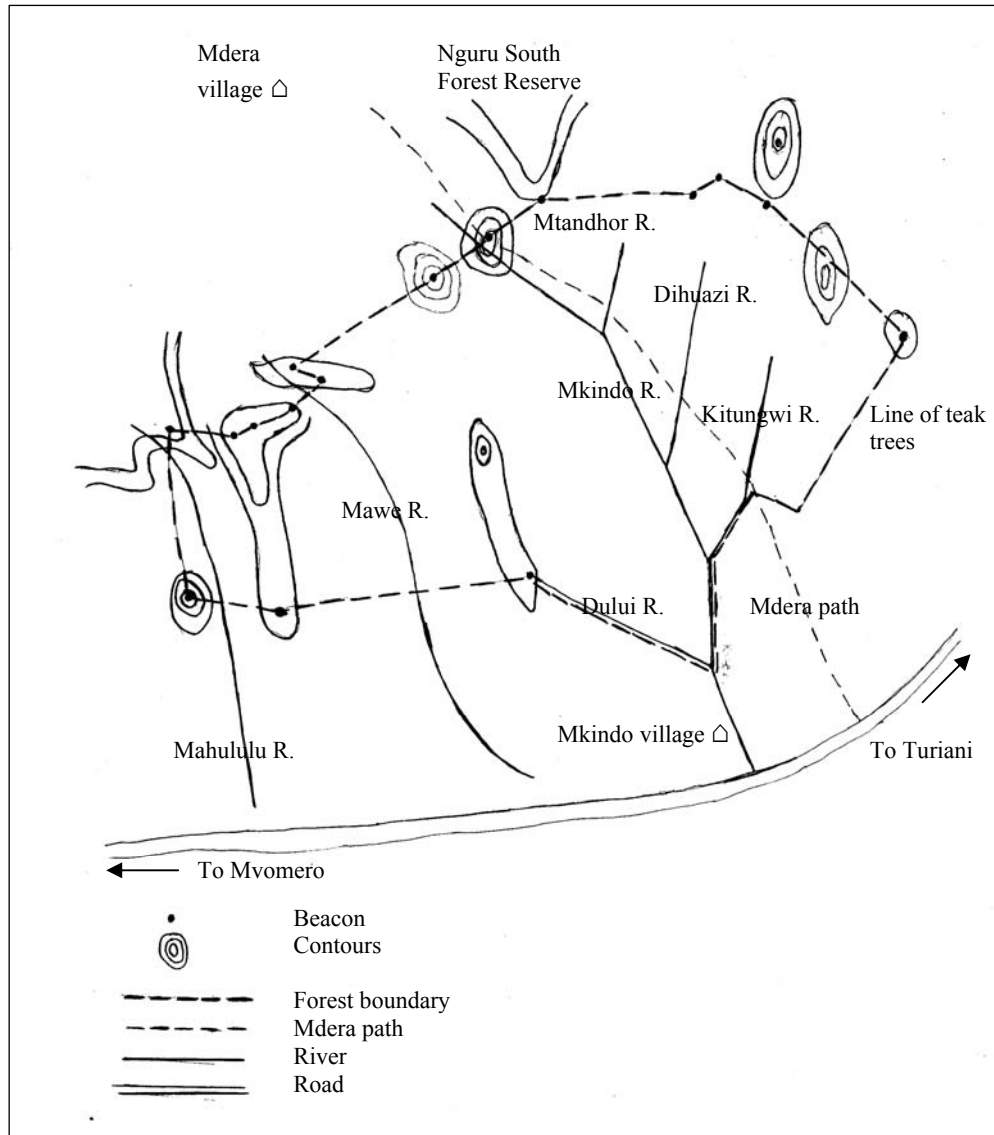


Figure 4 Sketch map of Mkindo FR, based on the 1954 Jb 212 boundary map (not to scale)

Further confusion occurred during the survey, as the topographical map indicates that the reserve is larger than it is with an area to the east of Kitungwi river and the line of teak trees (shown on the map) being part of the reserve. In reality, this area is out of the reserve and is now cultivation. The land has obviously been cleared since the production of the topographical map (1972) approximately 30 years ago. The GIS maps produced by Sokoine University of Agriculture (SUA) show the forest boundary for Mkindo FR based on the topographical map of forest. This GIS boundary map has been used throughout the report to assist orientation of transects, basecamps and centre points within the reserve, despite the inaccuracy of the additional coverage to the east. No other shapefile was available to at least provide representation of Mkindo FR. Presumably this boundary mistake will be rectified in GIS once the digitalised boundary maps have been released. Below are the two boundary maps which can be used to compare the two contrasting boundary outlines. The main Mkindo and Kitungwi rivers can be used to assist in orienting between the two maps as the scales of the maps are not comparable.

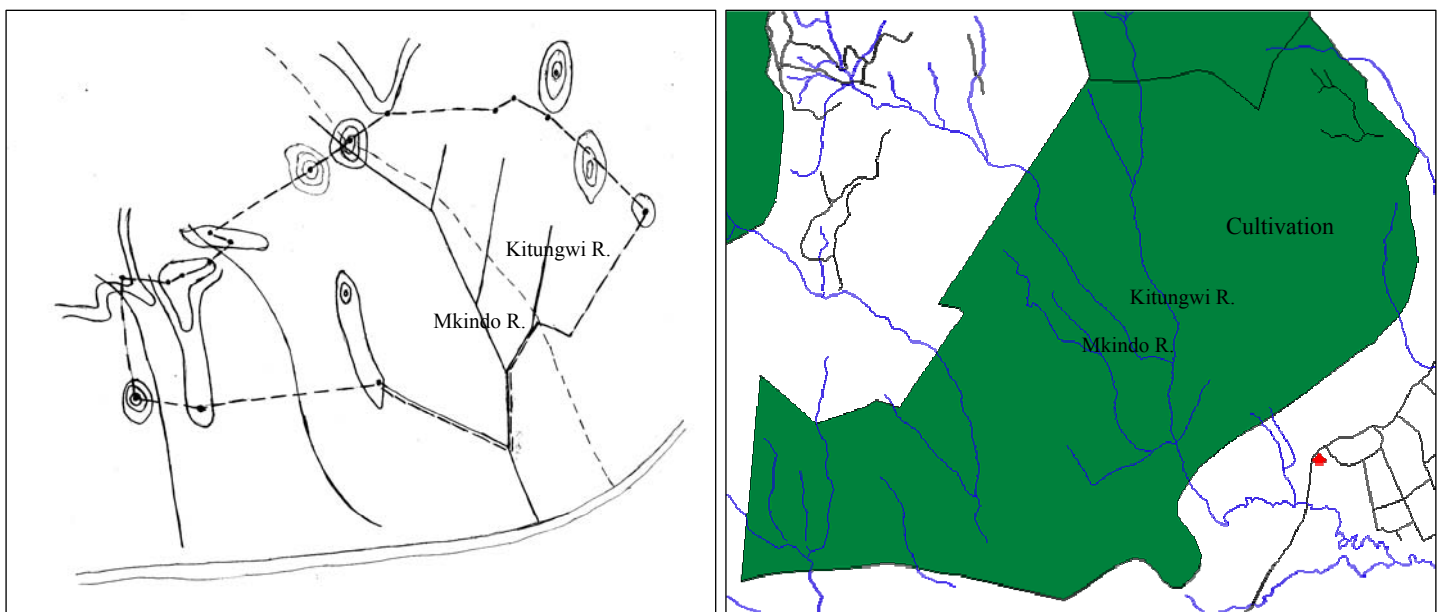


Figure 5 Comparison of the two forest boundary maps (sketch map from 1954 and a GIS map)

3 Methodology

Fieldwork was conducted during the long rains between 1st May and 19th May 2006 for 3 weeks. Survey work concentrated on investigations of the reserve's human disturbance, with methods based on those employed by Frontier-Tanzania in their current Biodiversity Research and Awareness in the Lesser Known Eastern Arc Mountains (BREAM) survey in the Eastern Arc Mountains. Twelve transects were conducted within Mkindo Forest Reserve. Three base camps were established corresponding with the three worksite centre points (Table 2) (**Error! Reference source not found.**). Only three worksites were established, contrary to the planned four, as the size and shape of the reserve limited placement to three worksites. Please see Appendix 1 for GPS co-ordinates of all working locations.

Some problems occurred by using the sampling methodology of Frontier-Tanzania. Four one km transects were placed around a centre point and followed the N, E, S and W directions. However, transect 8 (west) had to be moved approximately 500m south of the centre point as the original transect hit a cliff almost immediately. In addition, some problems were encountered in trying to identify the reserve boundary. This led to one transect being out and repeated (transect 2) (but due to some unforeseen health and safety issues was not completed) and one transect was short (transect one). Transect 11 was completed but had to change direction from south to west as the transect met the border (as indicated by a few discontinuous teak trees). The sampling effort is summarised below in Table 1.

Table 1 Summary of sampling effort in Mkindo Forest Reserve

Survey technique (and sampling unit)	Target taxa	Total sampling effort
Human disturbance		
Transects	Human disturbance	12 transects, 11 km (10 x 1km, 1 x 700m, 1 x 300m)
Opportunistic observation	Human disturbance	19 days
Fauna		
Opportunistic observation/collection	All animal taxa	19 days

Table 2 Summary of work site / centre points in Mkindo Forest Reserve

Work site / Centre point	Waypoint	Description of location	Work conducted	Grid ref (E)	Grid ref (N)	Altitude (m)
				UPS	UTM	
Work site / Centre point 1	MK-CP1	Near basecamp 1 by Mkindo river	4 transects	0337391	9311529	427
Work site / Centre point 2	MK-CP2	On ridgetop in miombo in north of reserve	4 transects, 4 camera traps	0337278	9313851	684
Work site / Centre point 3	MK-CP3	South west of reserve in open miombo	4 transects	0334914	9309452	466

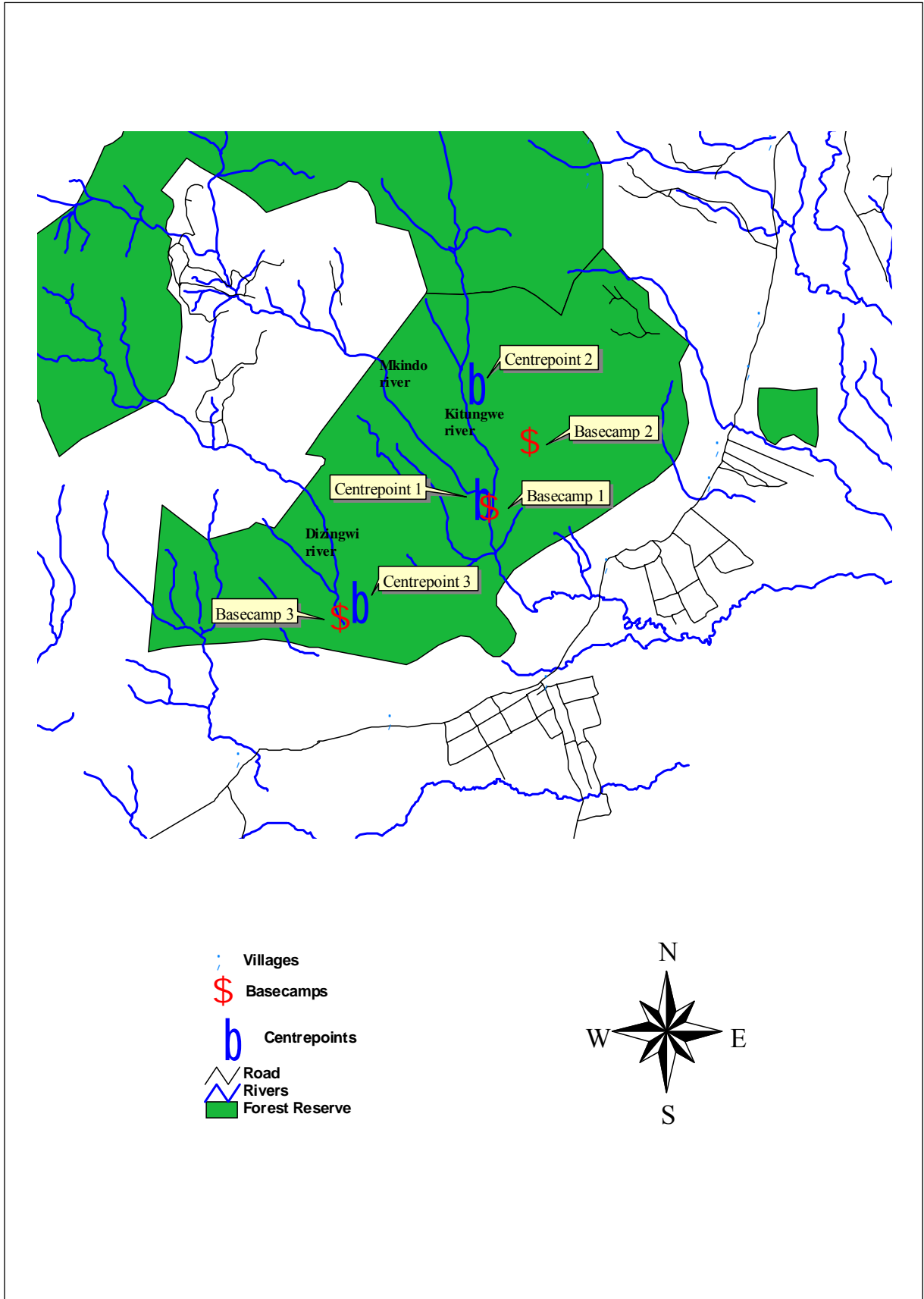


Figure 6 Basecamps and centre points in Mkindo FR

3.1 Disturbance transects

3.1.1 Aim

To determine major types of forest disturbance and proportion of habitat affected by forms of disturbance, through assessing the level of human disturbance with reference to pole cutting and timber extraction.

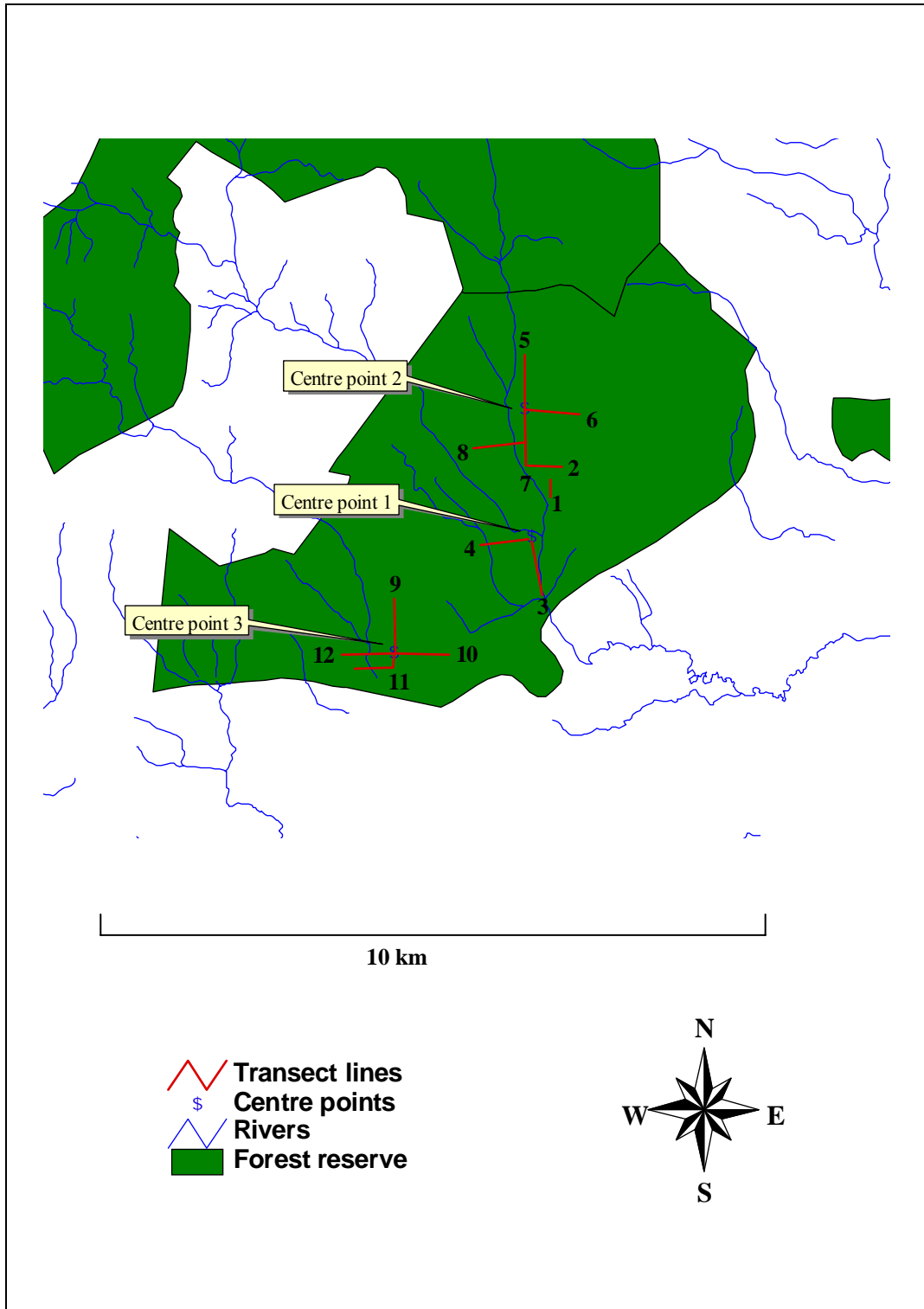


Figure 7 Disturbance transects in Mkindo FR

Table 3 Locations and lengths of disturbance transects in Mkindo FR

Transect numer	Starting point		Altitude (m asl)	Transect length (m)
	E	N		
1	0337735	9312280	451	300
2	0337330	9312849	495	700
3	0337391	9311479	420	1000
4	0337338	9311528	427	1000
5	0337275	9313860	700	1000
6	0337313	9313858	677	1000
7	0337270	9313861	670	1000
8	0337284	9313267	590	1000
9	0334923	9309467	480	1000
10	0334934	9309455	469	1000
11	0334920	9309439	460	1000
12	0334906	9309453	470	1000

3.1.2 Method of sampling

The procedure is systematic. Four transects are placed within a 2 sq. km grid system (a worksite) each starting from a ‘centre point’ in the middle. These transects follow the compass direction of north, east, south and west for one km and a GPS fix is taken at the start and end of the transect. The sampling unit is the disturbance transect.

For the purposes of this survey, the following definitions apply:

- Poles are defined as all trees with straight stems at least 2m in length and with 5-15cm dbh.
- Timber trees are defined as all trees with straight stems at least 3m in length and with 15-30cm dbh.
- Large timber trees are defined as all trees with straight stems at least 3m in length and exceeding 30cm dbh (note that Frontier-Tanzania define large timbers as exceeding 50cm dbh, however as this survey was conducted in miombo woodland a definition of ‘exceeding 30cm dbh’ was deemed appropriate).

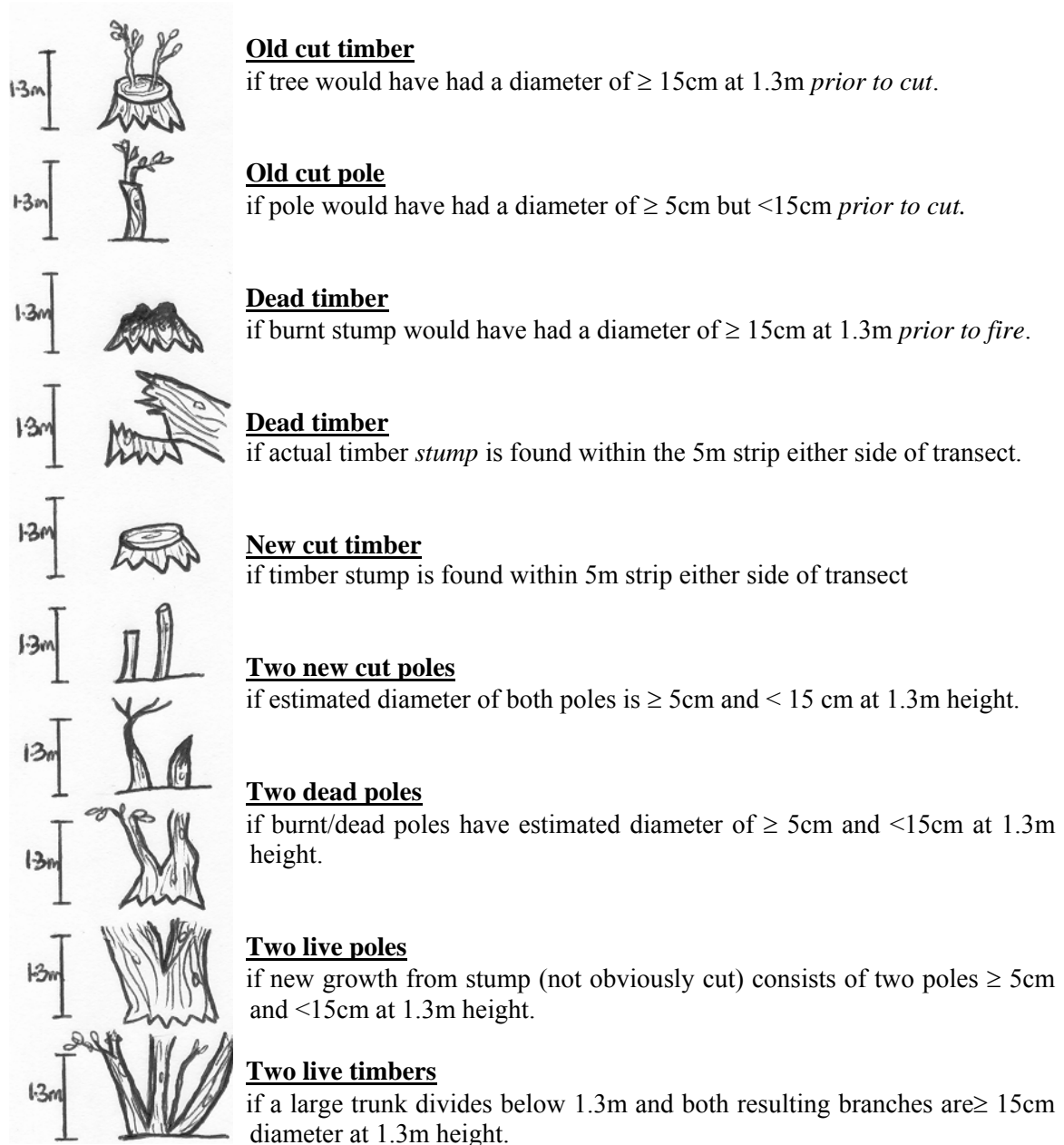
The level of disturbance is assessed in terms of the number of poles and timbers that are cut or left standing in a 10m strip (5m either side of the transect line). The disturbance transect is sub-divided into 50m sections and data is recorded separately for each section within the one km transect. The level of human disturbance can be quantified by comparing the categories of live, naturally dead, new cut and old cut within each 50m section of the transect. Other types of human disturbance are noted within each 50m section, such as the presence of fire damage, pitsawing, charcoal production, animal traps, cultivation, settlement and mining. The presence or absence of these disturbance data per 50m section are used to assess disturbance in the FR by calculating the percentages of total transect 50m sections where disturbance is observed.

3.1.3 Procedure

A team of four people are required; two data recorders, one ‘transecter’ who measures the transect line and one person to hold the end of the rope. The team starts at the beginning of the transect line (i.e. 10-20m from the centre point). Five metres either side of the transect line are investigated for cut, standing and naturally fallen poles and timbers. Cut timbers and poles are described as ‘old cut’ if there is any blackening of the stump, if none is seen it is recorded as ‘fresh cut’. One observer records all the pole and timber data, with help given by

the habitat note recorder if the forest becomes dense. For this survey, most of the transects were in miombo woodland and relatively open. The disturbance transects are sub-divided into 50m sections, and records are taken separately for each section.

Every live tree, live pole, naturally dead tree, naturally dead pole, cut tree stump and cut pole is measured by the observers within the disturbance transect. Dbh is measured at the standard height of 1.3m above the ground using a calibrated dbh tape. The diameter of cut trees and poles is measured at the point of the cut. Fallen tree trunks or branches are not counted. This reduces possible duplicate counts as one does not count a trunk further along the transect but only counts the base from which it came.



Three live poles

if 3 or the 4 multi-trunks are $\geq 5\text{cm}$ and $<15\text{cm}$ at 1.3m height.

Figure 8 Timber and pole recognition

Habitat notes are recorded per 50m section. Topography, canopy cover, shrub layer, ground layer and altitude (m asl) are noted. The cover density estimates for canopy, shrub and ground layers are given in broad percentage categories: <10%, 10-50% and >50%. Additional points of interest are noted.

3.1.4 Data entry

For each transect, the disturbance is recorded on the data sheet titled DISTURBANCE SURVEY SUMMARY (See Appendix 5).

F.R. CODE	Forest reserve code.
TRANSECT NO	Write the transect line number. One transect was recorded on one sheet.
DISTURB. CAT.	Write the disturbance categories in this section
SECTION	Record the disturbance information per section.
NO. OF LIVE POLES	Record the number of standing, live saplings. Saplings were defined as 5 - 15cm dbh and a straight trunk of at least 2m in length.
NO. OF NAT. DEAD POLES	Record the number of dead saplings, either standing or fallen. Saplings were defined as 5 - 15cm and a straight trunk of at least 2m in length.
NO. OF CUT POLES OLD/FRESH	Record the number of cut live saplings. Saplings were defined as 5 - 15cm dbh. To be considered as cut, the panga mark must be visible. Old was defined as anything other than clean, white marks which were classified as fresh.
NO. OF LIVE TIMBERS	Record the number of standing, live timber. Timbers were defined as 15 – 30 dbh and a straight trunk of at least 3m in length.
NO. OF NAT. DEAD TIMBERS	Record the number of standing, live timbers. Timbers were defined as 15 - 30 dbh and a straight trunk of at least 3m in length.
NO. OF CUT TIMBERS OLD/FRESH	Record the number of standing, live timbers. Timbers were defined as 15 - 30 dbh. To be considered as cut, the panga or saw mark must be visible. Old was defined as anything other than clean, white marks which were classified as fresh.
NO. OF LIVE LARGE TIMBERS	Record the number of standing, live large timbers. Large timbers were defined as >30 dbh and a straight trunk of at least 3m in length.
NO. OF NAT. DEAD LARGE TIMBERS	Record the number of standing, live large timbers. Large timbers were defined as >30 dbh and a straight trunk of at least 3m in length.
NO. OF CUT LARGE TIMBERS OLD/FRESH	Record the number of standing, live large timbers. Large timbers were defined as >30 dbh. To be considered as cut, the panga or saw mark must be visible. Old was defined as anything other than clean, white marks which were classified as fresh.

For each transect, the habitat notes are recorded on the data sheet titled DISTURBANCE SURVEY SUMMARY below the pole and timber data.

SECTION	Record the habitat information per section.
TOPOGRAPHY	Record the overall topography of the landscape throughout the transect, such as gentle or steep mid, lower and upper slope; ridge top; plateau; gully; valley floor.
CANOPY COVER	Estimate the extent that the foliage blocks out the sky and record the percentage, defined as <10%, 10-50% and / or >50% cover
SHRUB LAYER	Estimate the extent that the lower canopy blocks out the sky and record the percentage, defined as <10%, 10-50% and / or >50% cover
GROUND LAYER	Estimate the extent that the grass and herb layer covers the ground

	and record the percentage, defined as <10%, 10-50% and / or >50% cover
ALTITUDE	Record altitude in metres above sea level using the Global Positioning System (GPS)
NOTES	Record additional notes about gross habitat type, disturbance seen or any other relevant information

3.2 Opportunistic observations

Observations of human disturbance were made along the transect lines (i.e. those areas outside of the 10m width of the transect) and throughout the reserve. It was hoped that this would complement the standard quantifiable methods employed and give a fuller picture of the state of the reserve with regards to human impact.

Opportunistic observations were also noted of fauna observed within the reserve and are presented as a table in the results section with information on habitat and range of each species.

3.3 Key definitions and information sources for fauna

Within the summary table presented for the opportunistic observations of fauna, the following definitions are used:

Endemic Status:

- E – Endemic: Occurring only in the Nguru South Mountains;
- N – Near endemic: Species with limited ranges in the Eastern Arc mountains and/or the East African lowland forests;
- W - Widespread distribution through Tanzania and Kenya and beyond

The following references were used for identification and information purposes:

Mammals:	Kingdon (1997)
Birds:	Stevenson & Fanshawe (2002)
Reptiles:	Spawls et al (2002)
Amphibians:	Channing and Howell (2006)

4 Results

Survey work aimed at investigating the level of human forest use within the reserve. Results are split into several sections: a summary of the pole and timber counts along the transect; a summary of the habitat notes along the transect; a discussion of other disturbance recorded along the transect, and; opportunistic observations of disturbance and fauna.

4.1 Pole and timber counts

A total of 12 transects were completed throughout the survey period, resulting in a total transect length of 11 km. The transects ranged from an altitude of 390m asl to 790 m asl, thus sampling the full altitudinal range of the reserve. Table 4, Table 5 and Figure 9 provide summaries of the disturbance data. Some problems were encountered in trying to establish the boundary of the reserve, therefore in retrospect transect one was found to be out of the reserve except for the last 300m and the original transect two was entirely out. A replacement transect was conducted, which was aborted at 700m due to two separate incidences of health and safety which prevented two attempts to complete the transect. Transect 11 met the border at 250m and turned west to complete the 1000m. The border was unclearly marked but the team saw a few discontinuous teak trees and made a decision that a change in the transect direction was needed to be sure to collect data in the reserve.

Table 4 Summary of the pole and timber counts along disturbance transects

	Total transect length (m)	Total area of transect (m ²)	Total no. stems sampled	Live (% of total)	Average live per area hectare (ha)	Dead (% of total)	Average dead per area hectare (ha)	Old Cut (% of total)	Average cut per area hectare (ha)	New Cut (% of total)	Average cut per area hectare (ha)
Poles	11,000	110,000	2125	1858 (87.4)	168.9	149 (7.0)	13.5	111 (5.2)	10.1	7 (0.3)	0.6
Timbers	11,000	110,000	2696	2338 (86.7)	212.5	254 (9.4)	23.1	89 (3.3)	8.1	15 (0.6)	1.4
Large Timbers	11,000	110,000	826	757 (91.6)	68.8	59 (7.1)	5.4	8 (1.0)	0.7	2 (0.2)	0.2

11,000m = 10 transects x 1000m, one transect x 300m, one transect x 700m

A total of 2125 poles, 2696 timbers and 826 large timbers were surveyed along the transect lines (Table 4). The majority of these were live poles or timbers (87.4% live poles, 86.7% live timbers and 91.6% live large timbers) with a small percentage of naturally dead trees recorded (7.0% dead poles, 9.4% dead timbers and 7.1% dead large timbers). Most of these dead trees were the result of the fires that are an integral part of the miombo woodland ecosystem, but many are caused by villagers, either spreading from farmland nearby or deliberately set to encourage a new flush of grass for cattle grazing in the dry season within the reserve.

The level of cutting in the FR was relatively low with 5.5% of total poles being cut, 3.9% for timbers and 1.2% for large timbers. When assessing the old and new cut trees separately, it was found that the levels of old cutting (three months and over) is greater than new cutting with 5.2 old and 0.3 new poles cut per hectare. Timber cutting per hectare was 3.3 old cut and 0.6 new cut with large timbers having an average of 1.0 old cut and 0.2 new cut large timbers per hectare. Poles have the highest cutting per hectare, which suggests that villagers utilise the forest more for local building materials (poles) than for commercial building materials (timber and planks).

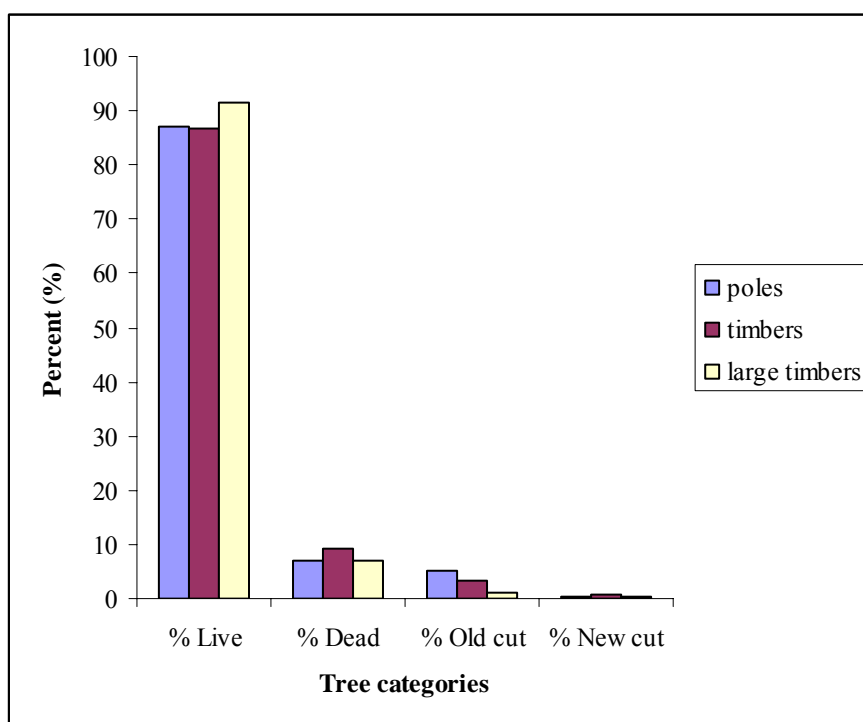


Figure 9 Percentage of poles and timbers within disturbance categories

Table 5 Summary of poles and timbers per transect

Transect Number	Number of poles / saplings per hectare				Number of timbers per hectare				Number of large timbers per hectare			
	Live	Nat. Dead	Old Cut	New Cut	Live	Nat. Dead	Old Cut	New Cut	Live	Nat. Dead	Old Cut	New Cut
1	153	7	10	3	130	63	3	0	87	3	3	0
2	66	3	4	1	56	27	1	0	37	1	1	0
3	116	2	2	1	149	24	14	2	25	0	1	2
4	223	6	7	2	173	7	6	0	84	6	2	0
5	230	36	8	0	256	56	6	0	101	11	1	0
6	158	5	0	0	259	14	10	0	89	6	1	0
7	162	16	12	1	339	26	3	5	81	5	0	0
8	71	12	8	1	181	15	4	5	34	5	0	0
9	240	13	9	0	236	17	3	0	57	8	0	0
10	130	10	20	0	169	23	6	3	67	2	0	0
11	249	20	27	0	238	22	19	0	102	12	0	0
12	133	12	7	1	161	18	9	0	67	1	0	0

Overall, fresh cutting was seen infrequently across all transects with the highest average being five new cut timbers per hectare in transects seven and eight in the north and north west of the reserve. Four transects had no evidence of fresh cutting. Transect 11 had the highest old cutting of poles (27) and timbers (19) per hectare; this corresponds with the charcoal burning seen most frequently in this south west part of the reserve.

4.2 Habitat types

The majority of the forest reserve is miombo woodland with 70.9% of 50m transect sections recorded in miombo. 13.6% of 50m sections were recorded in lowland / riverine forest along transects two, four, five and six. This is the north eastern area of the reserve where there are a series of rivers and streams, some of which flow from Nguru South FR whilst others originate in Mkindo FR itself. Therefore less than 25% of the reserve can be described as Eastern Arc vegetation.



8.2% of these transects were recorded in a grassland habitat of which over half was within transect three in the south central part of the reserve. It is an area heavily grazed and close to Mkindo village. The other grassland patches were small and found within transects six and eight.

1.8% of these transects were farmland, all of which were in the west of the reserve at the end of transect eight. In the south west part of the reserve, some Acacia dominated woodland was recorded along transect nine (4.5% of 50m sections).

Figure 10 Miombo (*brachystegia*) woodland

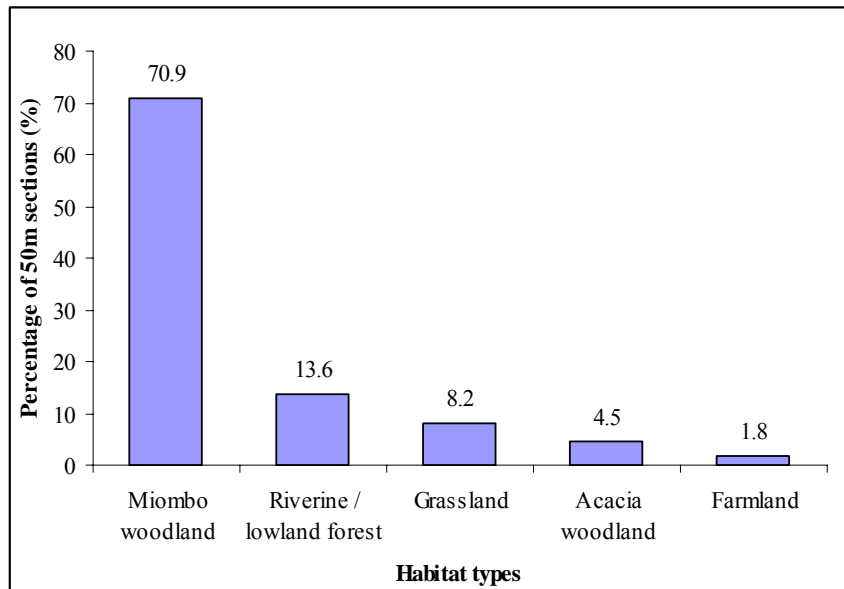


Figure 11 Habitat types recorded within 50m sections along the 12 transect lines

Note that these percentages do not add up to 100% as some 50m sections recorded two habitat types in one section.

For the vegetation layers, the dominant percentage categories of cover (<10%, 10-50% and >50%) were: >50% canopy cover for 46.8% (103 out of 220) of 50m sections, <10% shrub layer cover for 65.9% (145 out of 220) of 50m sections and >50% ground layer cover for 77.7% (141 out of 220) of 50m sections. This is a typical description of woodland with a covered ground layer (in this case tall grasses), a minimal shrub layer and a moderately open canopy (i.e. >50% cover can mean a canopy cover of half to completely closed). These descriptions correspond to the overall designation of miombo woodland which covered 70.9% of the transect lines. The closed canopy will also account for the areas of lowland and riverine forest which consistently had a canopy cover of >50%.

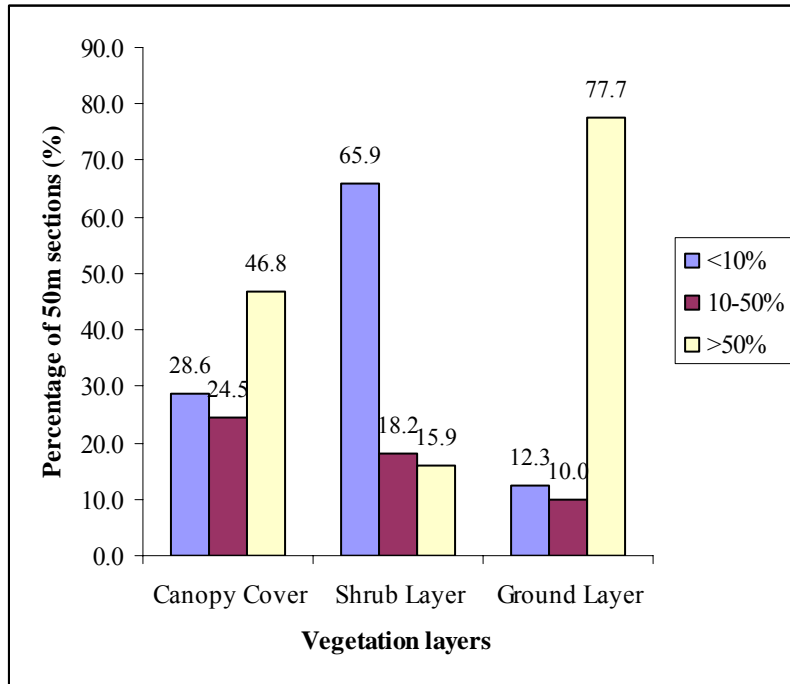


Figure 12 Vegetation layer types and cover recorded within 50m sections along 12 transect lines

4.3 General disturbance

This section covers both systematic disturbance recorded along the transect line and opportunistic observations of disturbance throughout the reserve.

Human forest use recorded in 50m sections along the transect lines reveal several types of human activities occurring within the reserve. Fire, although a necessary and natural part of the miombo woodland ecosystem, is included here as it is still mainly a human caused activity and relates directly to the pressure on the reserve for grazing cattle. 91.4% (201 out of 220 50m sections) of all sections were noted as having previous fires. This does not correspond to the 70.9% miombo habitat recorded along the transects and must also include riverine and lowland forest if looking at the percentages in Figure 9. Transect six, which is 65% riverine / lowland forest, has signs of previous fire along the whole transect.

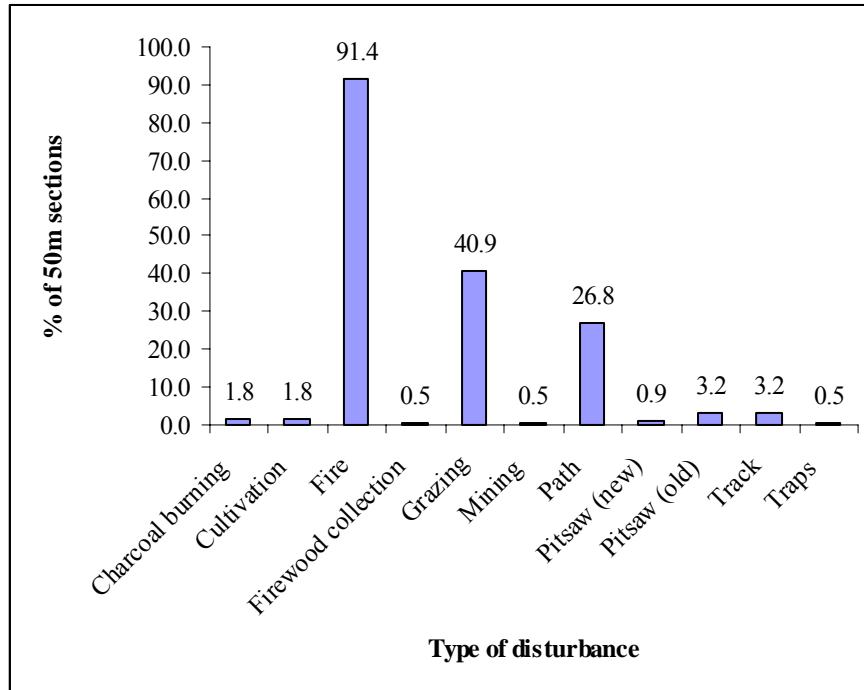


Figure 13 Percentage of 50m sections with various types of human disturbance



Signs of grazing were recorded in 40.9% of all 50m sections (90 out of 220 50m sections). Evidence was a mixture of cattle paths / old dung and was found throughout the central and western parts of the reserve.

26.8% of 50m sections crossed or followed human paths (59 out of 220 50m sections). However 64.4% of these paths (38 out of 59) was actually one path only, which followed a ridge and was recorded along transect five and seven. Most human paths were encountered on ridge tops or by rivers and reflect areas of use rather than access to other villages.

Figure 14 Cutting of Mninga (*Pterocarpus angolensis*)

Only one path runs through the reserve which is used for access to another village – the Mdera path; this is used on a daily basis to travel between Mdera and Mkindo villages, particularly on market day.

3.2% of 50m sections recorded vehicle tracks / roads (7 out of 220 50m sections). Two tracks lead to the intake pipes at Dizingwi river, although one was also a logging track and another was an old logging track by Mkindo river. All tracks were wide enough for tractors.

Old and new pitsawing sites were recorded along the transects. 78% of all pitsaw sites were old (seven out of nine 50m sections), however in total across all the transects only 3.2% and 0.9% of 50m sections recorded old pitsaw and new pitsaw sites (7 out of 220 and 2 out of 220

respectively). Five of the old pitsaw sites were recorded along transect six in riverine and lowland forest. Casual observations along the Kigombezi river also confirmed that people are currently cutting many trees along this river and generally in this forested area. The two new pitsaw sites were located along transect seven and transect four, both in miombo woodland. Three additional fresh pitsaw sites were recorded opportunistically, two on the ridge to centre point two (where the well trodden path is located that accounted for 64.4% of recordings) and one by the Kitungwi river.



Other human disturbance was recorded in low numbers throughout the reserve. Cultivation was recorded in 1.8% of all 50 m sections, as was charcoal burning sites (4 out of 220 50m sections). An area of farmland was recorded at the end of transect eight in the north west of the reserve. The local labourers present (who were not the actual farmers) stated that permission to farm this land (a valley) had been granted by Forestry. It is unknown who authorised the permission and at what level within Forestry (i.e. local or regional). There were over three different farmers farming maize and other crops in the area. The main Mdera village path crossed the edge of this farmland.

Figure 15 Farmland inside the west of the reserve

Fresh charcoal burning sites were seen at the end of transect 10 and transect three. Two old sites were also seen on transect 12 as was a site used for firewood collection. The charcoal mining site by transect 10 was active with two men and three dogs present as the team were transecting. As soon as they saw the team leader, they ran away. However, after inspecting the site, it was clear that most of the charcoal had been taken to the village. A small fire and cooking pots were present at the site.



Figure 16 Fresh charcoal site, transect 3

An old mining site was located along transect three close to where a fresh charcoal site was recorded. It was approximately 10m deep and Kibaba (pers. comm.) stated that the site was approximately three years old and targeted mining of rubies.

Transect three was mostly marshy grassland and there was evidence of clearance for new farmland despite the fact that this was inside the reserve on the west side of the Mkindo river which acts as the FR border at this point.

There is very little hunting within the reserve with only one out of 220 50m sections recording an animal trap for the Giant pouched rat (*Cricetomys gambianus*). This was located in riverine / lowland forest along transect six. Additional opportunistic observations noted the same type of trap at the end of transect one near the Kigombezi river. Another small mammal trap was

noted near the Dizingwi river where a small cave had an old fire, a rag and the small mammal trap outside. It may be possible that medium to large mammals have already been over-hunted, as there were very few signs of animals such as bush pig and small antelope within the reserve. Apparently local people do hunt but only those crop raiding species, such as Yellow baboon (*Papio cynocephalus*), Syke's monkey (*Cercopithecus mitis monoides*) and Bushpig (*Potamochoerus larvatus*). Gunfire was heard from base camp two after alarm calls from baboons (all from the same direction). In a shamba, on the opposite side of the Mkindo river to base camp one (thus out of the reserve), two large steel traps were found. These had been set by the river, where baboons were seen to cross by the survey team. Animals had already been trapped that morning as there was a strong smell of baboon and one trap had hair on it that may have been from the Marsh mongoose (*Atilax paludinosus*) (R. Rajabu, pers. comm.).

The most important and revealing opportunistic observations occurred whilst walking on the Mdera – Mkindo path to centre point two. On 08/05/06, three men were encountered with two planks each of 'Mfimbo' (Kiswahili name). They immediately dropped the planks and ran away; the planks were duly confiscated and taken to the PEMA office at a later date.



Figure 17 Confiscated planks (Mfimbo) on the Mdera path in Mkindo FR

There is a trade of planks from Nguru South FR via Mdera village to Mkindo village, where planks are loaded on to a truck during the night according to various local sources. Reportedly there are over 300 planks stored at Mdera village and this is known amongst Mkindo villagers, such as Kibaba (as Chairman of the Natural Resources committee), the Forest Officer, the Village Chairman and the Village Executive Officer. As a result of this first episode, Benson (TFCG) contacted Ibrahim of the Regional Catchment Morogoro office and requested an investigation into the matter. Benson and Kibaba talked to more villages within their shambas bordering the reserve to gain further information (the consultant did not become involved within this latter activity as it was felt that her presence might be intimidating). On 14/05/06, Ibrahim and two police officers came to Mkindo and caught two people with planks at their houses in the village. The following day they walked to Mdera village and caught two more people with 15 planks. These cases are being taken to court in Morogoro. Further information regarding the outcome of the court cases or follow up action in Mkindo and Nguru South FRs should be sought at the Morogoro Regional Catchment office or PEMA, Turiani.

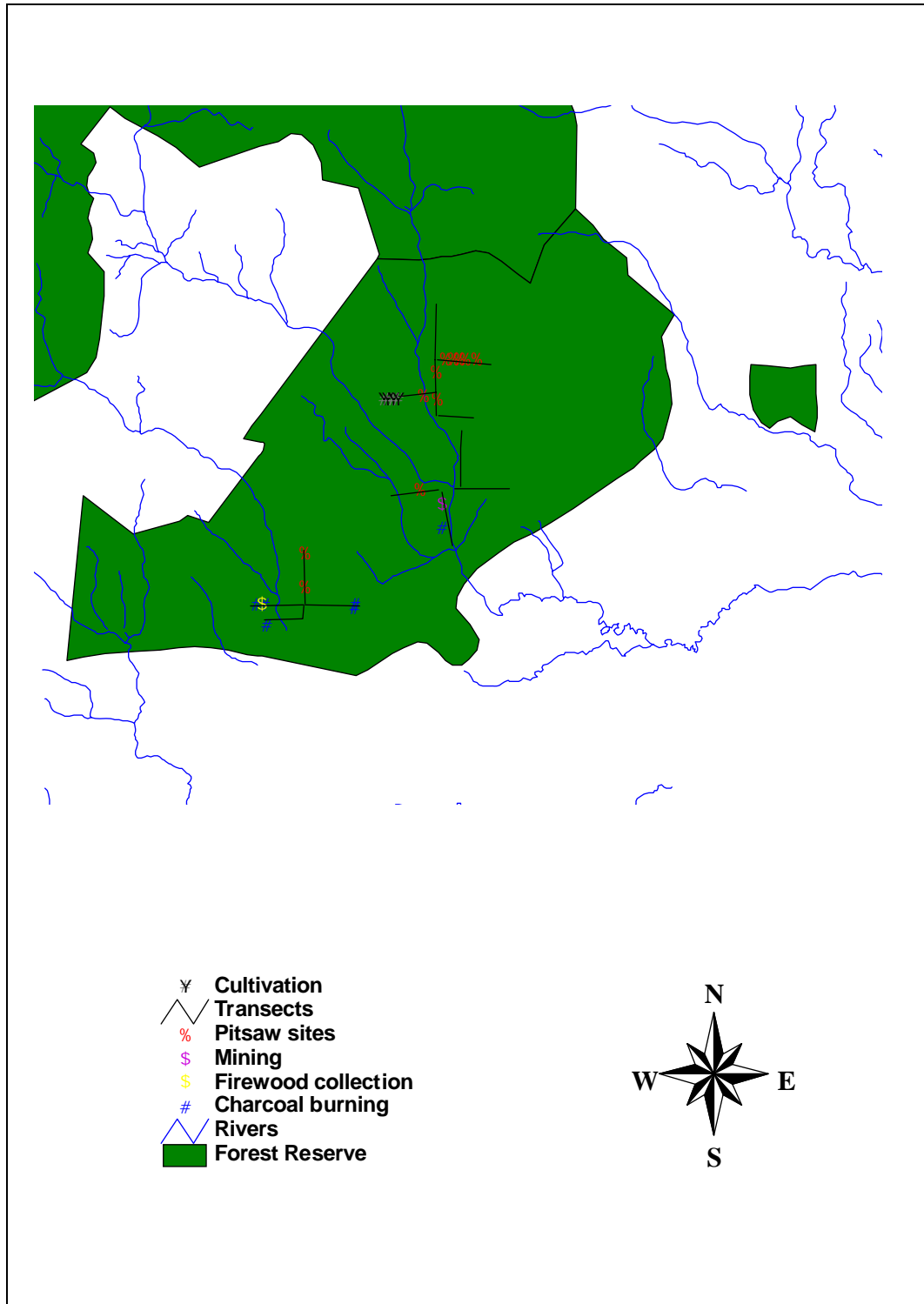


Figure 18 Disturbance recorded within Mkindo FR

4.4 Opportunistic observations of fauna

A summary of the number of species encountered for birds, mammals, amphibians and reptiles is presented in Table 6 below, whilst Tables 7, 8, 9 and 10 present species names recorded within each taxon. In total, 62 observations of fauna were made, 52 within the reserve and 10 observations in the grassland and shamba surrounding the reserve. One frog species was found to be an endemic to the Eastern Arc Mountains (*Callulina cf krefftii*) whilst one primate species (*Galagoides zanzibaricus*) is near-endemic to the Eastern Arc Mountains and is also listed as Vulnerable to extinction by IUCN.

Table 6 Summary of opportunistic fauna observations in and around Mkindo Forest Reserve

Taxon	Total no. species observed	No. species observed in the FR	No. species observed in areas surrounding the FR
Bird	38	29	9
Mammal	14	13	1
Reptile	6	6	0
Amphibian	4	4	0
Total	62	52	10

4.4.1 Bird Observations

All information in Table 7 is compiled from Stevenson and Fanshawe (2002). In total 38 birds were recorded, 29 within the forest reserve, mostly within miombo woodland and 9 in the shamba and grassland surrounding the reserve, especially on the east side. All birds were widespread throughout Tanzania and/or Kenya and Tanzania and common in more open habitat types, such as woodland and grassland. No species were threatened to extinction as listed by IUCN.

Table 7 Bird observations in Mkindo Forest Reserve

Species	Common name	Range	Habitat	Observation type and location	Certainty of identification
SCOPIDAE					
<i>Scopus umbretta</i>	Hammerkop	Widespread	Range of habitats near water source	Seen, heard and nests by Mkindo and Dizingwi rivers	Certain
THESKIORNITHIDAE					
<i>Bostrychia hagedash</i>	Hadada Ibis	Widespread	Grasslands, marshy areas, damp forest edges, gardens and cultivation	Seen and heard flying by to night roost by Mkindo and Dizingwi rivers	Certain
ACCIPITRIDAE					
<i>Gypohierax angolensis</i>	Palm-nut vulture	Resident and locally common from W Uganda and SW Tanzania and in coastal belt	Along coastal and major rivers	Seen at Mkindo river, basecamp 1	Certain

Species	Common name	Range	Habitat	Observation type and location	Certainty of identification
<i>Circaetus fasciolatus</i>	Southern-banded snake eagle	Coastal and inland along major river systems inland	Coastal forest, lowland forest and forest close to the coast	Seen along transect 9	Certain
<i>Stephanoaetus coronatus</i>	African crowned eagle	Widespread	Dense forest and woodland, including riverine and isolated patches	Heard in northern part of reserve	Certain
NUMIDIDAE					
<i>Numida meleagris</i>	Helmeted guineafowl	Widespread	Grassland, bush country, woodland and cultivation	Heard around worksite 3	Certain
PSITTACIDAE					
<i>Poicephalus cryptoxanthus</i>	Brown-headed parrot	Coastal Kenya and E Tanzania	Well-wooded and baobab country	Heard throughout reserve	Certain
STRIGIDAE					
<i>Strix woodfordii</i>	African wood owl	NE Tanzania and Kenya	Forest, forest edge, woodland and mature gardens	Heard at basecamp 2	Certain
CAPRIMULGIDAE					
<i>Caprimulgus sp</i>	Nightjar	?	?	Heard at basecamp 2	Certain
TROGONIDAE					
<i>Apaloderma narina</i>	Narina trogon	Widespread	Forest and richer woodland	Seen along transect 6 near to riverine forest	Certain
ALCEDINIDAE					
<i>Alcedo semitorquata</i>	Half-collared kingfisher	Mainly S Tanzania	Well-wooded streams, rivers and lakes	Heard along Mkindo river	Probable
PHOENICULIDAE					
<i>Phoeniculus purpureus</i>	Green wood-hoopoe	Widespread	Range of wooded and forest habitats	Seen and heard throughout the reserve; often in mixed feeding parties	Certain
BUCEROTIDAE					
<i>Bycanistes bucinator</i>	Trumpeter hornbill	Widespread throughout Tanzania	Forests, woodlands and mature gardens	Seen and heard throughout the reserve	Certain
<i>Tockus alboterminatus</i>	Crowned hornbill	NE and NW Tanzania and S Kenya	Woodland and forest edges	Seen and heard throughout the reserve	Certain
CAPITONIDAE					
<i>Stactolaema olivacea</i>	Green barbet	Coastal Kenya and NE to SW Tanzania	Forest and woodland	Seen along transect 5 in closed miombo	Certain
PICIDAE					

Species	Common name	Range	Habitat	Observation type and location	Certainty of identification
<i>Dendropicos fuscescens</i>	Cardinal woodpecker	Widespread	Forest edge and clearings, open woodland, dry bush and cultivation	Seen and heard throughout the reserve	Certain
HIRUNDINIDAE					
<i>Psalidoprocne holomelas</i>	Blacksaw-wing	NE and W Tanzania, C and W Kenya	Clearings in forest or over riverine woodland	Seen over miombo and shamba on forest edge	Certain
<i>Hirundo abyssinica</i>	Lesser striped swallow	Widespread	Range of habitats except for very arid country	Seen on forest edge in shamba	Certain
MOTACILLIDAE					
<i>Motacilla clara</i>	Mountain wagtail	NE to SW Tz and C Kenya	Residents along fast-flowing rivers, most common in highlands but down to 500m asl	Seen and heard along Mkindo river at 430m asl	Certain
PYCNONOTIDAE					
<i>Pycnonotus barbatus</i>	Common bulbul	Widespread	Virtually all habitats	Seen and heard around basecamp 1	Certain
MUSCICAPIDAE					
<i>Muscicapa caerulescens</i>	Ashy flycatcher	Widespread	Locally common in canopy and middle levels of forest edge, clearings and well-wooded rivers	Seen near basecamp 1 by Mkindo river	Probable
MONARCHIDAE					
<i>Terpsiphone viridis</i>	African paradise flycatcher	Widespread	Forest, open woodland, gardens and bush	Seen throughout the reserve	Certain
MALACONOTIDAE					
<i>Dryoscopus cubla</i>	Black-backed puff back	Widespread	Forest edge, woodland and gardens	Heard in worksite 1 and 2	Certain
<i>Laniarius aethiopicus</i>	Tropical boubou	Widespread	Undergrowth of woodlands, thick bush and gardens	Heard in worksite 1, miombo	Certain
PRIONOPIDAE					
<i>Prionops scopifrons</i>	Chestnut-fronted helmet shrike	NE Tanzania	Woodland and forest canopy	Seen and heard in worksites 1 and 2; mixed feeding parties	Certain
DICRURIDAE					
<i>Dicrurus adsimilis</i>	Fork-tailed drongo	Widespread	Forest edge, open woodland, semi-arid bush and cultivated areas	Seen and heard in worksites 1 and 2	Certain
ORIOOLIDAE					
<i>Oriolus larvatus</i>	Black-headed oriole	Widespread	Woodlands, forest edge, gardens and bush	Seen in worksite 2	Certain

Species	Common name	Range	Habitat	Observation type and location	Certainty of identification
<i>Oriolus chlorocephalus</i>	Green-headed oriole	NE Tanzania	Forest, mature woodland and well-established secondary growth	Seen along transect 5, closed miombo on ridge	Certain
STURNIDAE					
<i>Onychognathus morio</i>	Red-winged starling	Widespread	Near rocky hills and cliffs	Seen flying over basecamp 3	Certain
PLOCEIDAE					
<i>Ploceus bicolor</i>	Dark-backed weaver	Coastal Tanzania and W Tanzania	Variety of forest types	Seen in mixed party along transect 5 in closed miombo near lowland forest	Certain
<i>Euplectes ardens</i>	Red-collared widowbird	Widespread in parts of Tanzania and Kenya	Tall grass, wheat fields, overgrown cultivation and rank herbage	Seen in shamba and grassland surrounding reserve	Certain
<i>Euplectes capensis</i>	Yellow Bishop	E and W Tanzania	Bushed grassland and cultivation	Seen in shamba and grassland surrounding reserve	Certain
<i>Euplectes orix</i>	Southern red bishop	Across Tanzania, except coastal areas	Marshes, high grasses cultivation	Seen in shamba and grassland surrounding reserve	Certain
EMBERIZIDAE					
<i>Uraeginthus sp</i>	Cordon-bleu	Widespread	Variety of habitats except forest interior	Seen in shamba and grassland surrounding reserve	Certain
<i>Lagonosticta rubricata</i>	African firefinch	E and W Tanzania and S Kenya	Woodland, thickets and overgrown cultivation	Seen in shamba and grassland surrounding reserve	Certain
<i>Lonchura cucullata</i>	Bronze mannikin	Widespread	All habitats except desert	Seen at basecamp 3	Certain
<i>Vidua macroura</i>	Pin-tailed whydah	Widespread	Woodland, bush country, cultivation and gardens	Seen in shamba and grassland surrounding reserve; breeding males	Certain
<i>Vidua chalybeata</i>	Village indigobird	Widespread	Variety of habitats	Seen in shamba and grassland surrounding reserve	Certain

4.4.2 Mammal observations

All information in Table 8 is compiled from Kingdon (1997). Fourteen mammal species were recorded, 13 within the reserve and one on the reserve edge within shamba. Five primate species were seen and/or heard, whilst a large antelope's tracks were found leading down a steep slope to the Dizingwi river near basecamp three (Figure 19). The identity is uncertain, but may be waterbuck, sable or kudu. Generally signs of mammals, such as small duikers and bushpig, were uncommon. One resident group of Syke's monkey (*Cercopithecus miti monoides*) was seen within worksite two each day and most commonly encountered were Yellow baboons (*Papio cynocephalus*). The black and white colobus (*Colobus angolensis palliatus*) was heard once, possibly up to one km away, therefore the call may have come from the north of Mkindo FR or from the south of Nguru South FR. One primate species, the Zanzibar galago (*Galagoides zanzibaricus*), is near-endemic to the Eastern Arc Mountains and is Vulnerable to extinction as listed by IUCN.



Figure 19 Large antelope track seen near Dizingwi river

Table 8 Mammals observations in Mkindo Forest Reserve

Species	Common name	Range	Habitat	Observation	Certainty of Identification
COLUBRIDAE					
<i>Colobus angolensis palliatus</i>	Black and White colobus	Widespread	Montane and lowland forests	Heard from transect 6 coming from either the north of the reserve or from Nguru South	Certain
CERCOPITHECIDAE					
<i>Papio cynocephalus</i>	Yellow baboon	Widespread	Miombo woodland, dry bushland, thickets	Seen and heard throughout the reserve	Certain
<i>Cercopithecus mitis monoides</i>	Syke's monkey	Widespread	Evergreen forest and woodland	Seen and heard in worksite 2, miombo	Certain
GALAGONIDAE					
<i>Otolemur crassicaudatus</i>	Greater galago	Widespread	Miombo woodland, coastal and montane areas	Heard at basecamp 1 and 2	Certain
<i>Galagoides zanzibaricus</i>	Zanzibar galago	NE Tanzania and S Kenya, Eastern Arc near-endemic	Coastal lowland rainforest and thickets, riverine forest and secondary growth	Heard at basecamp 2, riverine forest	Probable
THRYONOMYIDAE					
<i>Thryonomys sp</i>	Cane rat	Widespread	Grassland areas	Signs of eating grass seen in shamba on edge of reserve	Certain
CRICETOMYINAE					
<i>Cricetomys gambianus</i>	Giant pouched rat	Widespread	Rainforest	Traps designed to trap in lowland forest along transect 6	Certain
HERPESTIDAE					
<i>Herpestes sanguinea</i>	Slender mongoose	Widespread	Wooded savanna, thicket and forest	Seen by river at transect 1	Certain
<i>Atilax paludinosus</i>	Marsh mongoose	Widespread	River courses and lake-shores areas	Tracks seen by Mkindo river	Certain
PROCAVIDAE					
<i>Heterohyrax brucei</i>	Bush hyrax	Widespread	Wooded localities on riverbanks, escarpments and rocky outcrops	Urine and dung signs along transect 6 in lowland / riverine forest	Probable (Certain it is hyrax)
SUIDAE					
<i>Potamochoerus larvatus</i>	Bushpig	Widespread	Forested and woodland habitats	Dung and tracks through the reserve	Certain
TRAGELAPHINI					
<i>Tragelaphus scriptus</i>	Bushbuck	Widespread	Thick cover in forest and woodland	Grazing signs seen along transect 3	Certain
CEPHALOPHINI					
<i>Cephalophus harveyi</i>	Red duiker	Widespread	Coastal thickets to montane forests	Tracks seen in northern part of reserve	Certain

Species	Common name	Range	Habitat	Observation	Certainty of Identification
	Large antelope, such as Waterbuck, Kudu or Sable	?	?	Tracks of single individual seen descending to the Dizingwi river, miombo. Tracks 12cm long and width 5cm and 11.5cm	Uncertain

4.4.3 Reptile observations

All information in Table 9 is compiled from Spawls et al (2002). Six reptile species were observed in Mkindo FR, none of which are endemic or threatened by extinction, as listed by IUCN or CITES. The sighting of a Gaboon viper (*Bitis gabonica*) was interesting as this species is not commonly seen (Figure 20).

Table 9 Reptile observations in Mkindo Forest Reserve

Species	Common name	Range	Habitat	Observation	Certainty of identification
AGAMIDAE					
<i>Agama agama</i>	Red-headed agama	Widespread	Coastal thicket and woodland, moist and dry savanna	Seen on rocky outcrops throughout the reserve; saw male and females	Certain
BOIDAE					
<i>Python natalensis</i>	Southern african rock python	Widespread	Coastal thicket, grassland, moist savanna and woodland	Seen by RR in grassland on edge of reserve	Certain
COLUBRIDAE					
<i>Philothamnus sp</i>	Green snake	?	?	Seen in worksite in miombo. Large golden eye with bright green body and black along the scales. Blue chin	Certain
SCINCIDAE					
<i>Mabuya cf varia</i>	Variable skink	Widespread	Coastal thicket, woodland, moist and dry savanna and high-altitude grassland	Seen throughout the reserve on rocks	Probable
VARANIDAE					
<i>Varanus niloticus</i>	Nile monitor	Widespread	Near water sources in a variety of habitats	Juvenile seen basking on a rock by the Dizingwi river, basecamp 3	Certain
VIPERIDAE					
<i>Bitis gabonica</i>	Gaboon viper	Widespread but disjunct range. Coastal Tanzania	Coastal forest and thicket, woodland, forest-savanna mosaic, well-wooded savanna and forest	Seen in open grassland area along transect 8. Brown form about 1.5m long	Certain



Figure 20 Gaboon viper seen along transect 8 in a grassy valley, Mkindo FR

4.4.4 Amphibian observations

All information in Table 10 is compiled from Channing and Howell (2006). Four amphibians were observed in Mkindo FR, three of which are common and widespread. One amphibian species, *Callulina cf krefftii*, is of particular interest as it is an Eastern Arc endemic genus and four new species have already been found within the montane forests of the Nguru South Mountains within the last year and a half (Doggart and Loserian, 2006). This individual was heard calling in the north of the reserve in lowland forest (750m asl) after rain at midday; no sightings were made. No species were threatened to extinction as listed by IUCN and CITES, although it is likely with revisions that *Callulina cf krefftii* will have a categorisation of Endangered or Critically Endangered (IUCN).

Table 10 Amphibian observations in Mkindo Forest Reserve

Species	Common name	Range	Habitat	Observation	Certainty of identification
ARTHROLEPTIDAE					
<i>Arthroleptis stenodactylus</i>	Common squeaker	Widespread	Range of woodland and forest	Seen throughout reserve within miombo woodland	Certain
BUFONIDAE					
<i>Bufo cf guttaralis</i>	Toad	Widespread	Range of woodland and forest	Seen at basecamp 1 each evening	Certain
MICROHYLIIDAE					
<i>Callulina cf krefftii</i>	Warty frog	Eastern Arc	Forest, cultivated or wild bananas	Vocalisation heard in lowland forest at end of transect 5 after rain	Certain
RANIDAE					
<i>Phrynobatrachus sp</i>	Puddle frog	Widespread	Range of woodland and forest	Seen along transect 9 on side of wet rock	Certain

5 Discussion

5.1 Forest Disturbance

From both the systematic survey and opportunistic observations in Mkindo FR, it is clear that people are utilising the woodland and forest resources. In general there has been an increase in human populations in the lowlands surrounding the Nguru South Mountains increasing the demand on woodland and forest resources. Loss of forest between the 1970s and 2000 is estimated at 6% (based on analysis of satellite images, Mbilinyi and Kashaigili, in prep.) and most of this is concentrated at lower altitudes. Such trends correspond with the observation that the land surrounding the east side of Mkindo FR, shown as forest on the 1972 topographical map, is now farmland right up until the forest border. Fortunately in the east of the FR the boundary is extremely clear with a line of mature teak trees and there can be no confusion, accidental or wilful, as to where the boundary lies. The situation is less clear in the south west of the reserve and boundary demarcation should be addressed in management plans. An area of cultivation was recorded in the west of the reserve by the main Mdera – Mkindo path. Locals present at the shamba stated that farming in this valley had been permitted by Forestry, although it is unclear by whom, at what level of authority (local or regional), the legality of the permission and in what form it was granted (verbal or written). This matter should be investigated and confirmed with the appropriate action taken by Forestry.

The majority of Mkindo FR is miombo (*Brachystegia*) woodland, so the pressures on the FR are likely to be different to those of Nguru South and Kanga FRs, which are submontane and montane Eastern Arc forests. Grazing of cattle in the dry season occurs throughout the reserve. Open woodland is commonly used to graze cattle due to the density of grasses, especially after the yearly fires, so the concern (apart from the fact that this activity is illegal within a catchment forest reserve) must be whether *over* grazing is occurring and affecting the ecology of miombo. The demand for grazing within the reserve will be directly linked to the setting of yearly fires to encourage the new flush of grasses for cattle. Fire is an inherent part of miombo woodland, such that some seed germination relies on fire and many of the tree species have fire resistant bark. Therefore, fire per se is not necessarily of concern; it is *uncontrolled* fire that must be managed. Old fire damage was seen within the lowland and riverine forest in the north east of the reserve. These forests are not fire-adapted and if yearly fires are consistently spreading to these areas, this must be of great concern not only in terms of the rich Eastern Arc biodiversity expected in these pockets of forest but also in terms of damage to the forest structure and species composition. Fire management is needed and should be coordinated by the Forest Officer and Natural Resources Committee as part of the Joint Forest Management (JFM) initiative. Charcoal burning is occurring in Mkindo FR, mainly *Pterocarpus angolensis* and seems to be located in the west and south of the reserve. This activity should also be stopped by JFM.

Pole cutting and timber extraction were both recorded in Mkindo FR at low levels. Old pitsaw sites were found in the lowland / riverine forests and there was evidence of much cutting along both the Kigombezi and Kitungwi rivers. Most timber extraction is for *Pterocarpus angolensis*, however in the forest other species were targeted but were not identified in this report. Historically timber extraction has been a significant cause of forest loss. Commercial timber operations took place in Nguru South FR until a government ban in catchment forests in 1992. Since then timber extraction has continued illegally and on a smaller scale, particularly from Nguru South FR, although activities are also increasing in Kanga FR (C.Bracebridge, pers.comm.). Evidence of these illegal activities was encountered within Mkindo FR with planks being brought out through Mkindo FR from Nguru South FR. Transportation of the planks (a species called Mfimbo in Kiswahili; the scientific name unknown) is carried out at night from Mkindo village. Given that nothing has been done to

prevent this illegal activity and given that this forest reserve is part of a Joint Forest Management scheme, it suggests complicity of different authorities.

Hunting is occurring at low levels in Mkindo as are actual signs of medium to large mammals. In open woodland, the presence of large grazing antelope would be expected. It is known that elephant and buffalo migrate in to this lowland area at certain times of year with elephant raiding village crops (Felix, pers. comm.). A track was observed of a large antelope, but of one individual only. It is uncertain, without some historical data, exactly which species were / are present in Mkindo, in what densities and if all these species are migratory or resident. There may always have been a low abundance of large mammals in this area or it is possible that hunting has already severely decreased numbers of large mammals. Given that hunting pressure is particularly high in Nguru South FR (in comparison to Kanga FR; Doggart and Loserian, 2006) it seems possible that hunting in the foothills, which are more easily accessible than the mountains, has already taken place. Hunting within the woodland and forest for food is differentiated from killing crop raiding 'pests' within shamba, which is common around Mkindo FR.

5.2 Faunal observations

Opportunistic observations were recorded for fauna. The majority of observations were birds. A low number of mammals were recorded and even fewer reptiles and amphibians. Only two species were not widespread and common in distribution and most species live in a variety of more open habitats. The Zanzibar galago is an Eastern Arc near-endemic species and the *Callulina* frog is an Eastern Arc endemic. Both of these species were recorded in riverine / lowland forest. It would be useful to conduct a zoological survey of the reserve, especially the forest where Eastern Arc species are present, by systematic trapping to sample small fauna (such as pitfalls and Sherman traps) and setting more camera traps for medium to large mammals.

5.3 Maps and forest boundary

As discussed in the section 2, there was some confusion with forest boundaries, both when using the maps and actually during the survey on the ground. The Jb 2034 map was not available for the survey; topographical maps (1972) and the 1954 Jb 212 boundary map were relied on. Unfortunately the topographical map no longer represents the correct vegetation cover as maize, ufuto (a plant grown for oil) and ground nut cultivation have replaced the miombo to the east of the reserve. The 1954 map was hard to translate on to the topographical map to define reserve boundaries as there are no UTM coordinates and the accuracy of the drawing (such as placement of rivers and names of rivers) makes it difficult to compare to the topographical map. The 1980 boundary map has been digitised but is currently unavailable. This should help clarify the reserve border on the topographical map and enable the correction of the GIS reserve shape file created by SUA and used in this report. This reserve shape file was constructed based on the vegetation cover on the 1972 topographical map. As a result of the uncertainty, one transect was partly out of the reserve whilst another was completely out and was repeated in another location inside Mkindo FR.

5.4 Management issues

Mkindo FR is part of a Joint Forest Management pilot in Morogoro Region. By-laws have been passed and Natural Resources Committees set up in four of the six villages surrounding Mkindo FR. Other activities have been conducted to facilitate and encourage JFM in Mkindo FR. This survey did not witness any JFM activities happening during the three weeks in the area. Most salient is the incidence with the storage and transportation of planks from Mkindo village and the common knowledge of the activities with no action taken against those people involved. Firstly this questions the activities and motives of the Mkindo Forest Officer and other responsible members of the village. Secondly, it questions the presence of active JFM in Mkindo FR. Conversations with Kibaba, who joined the survey team and is the chairman of

the Natural Resources Committee for Mkindo, confirmed that the Forest Officer and the villagers are not working together in any JFM activities and that no management of any kind appears to be happening. The Natural Resources Committee understand the principles of JFM, are aware that Mkindo is a FR that should have JFM and that by-laws are in place that allow the villagers to act against illegal activities themselves. Despite this, JFM at this time is not being actively implemented. The Technician Manager of a government water project in the area stated that despite the water project working inside the reserve, having set up water pipes at the Mkindo and Dizingwi rivers, there was no liaison with the local Forest Officer (Salum Ali, pers. comm.). It is hoped that Kibaba's participation in the survey and the success of involving Morogoro Catchment staff in confiscating the planks from Nguru South FR and prosecuting those involved, will motivate and empower him to take some positive action in the future.

6 Conclusions

Mkindo Forest Reserve may not be as biologically rich as the montane areas of the Nguru South landscape, yet it does have one of the few areas of Eastern Arc lowland and riverine forest in the landscape and should be conserved for this biological value. The main importance of Mkindo FR remains its water catchment value with several large rivers feeding into the Wami river, which the surrounding local communities and the people of Chalinze and Tanga depend on. Further forest loss could have a significant negative impact. However it is clear that the local communities depend on Mkindo FR for some natural resources and the sustainability of this use must be investigated and managed.

The Nguru South landscape is in the process of being defined both from a biophysical and a natural resource management and livelihoods perspective. This survey, by quantifying human forest use and identifying current management issues in Mkindo Forest Reserve, will hopefully contribute to the larger participatory environmental management and joint forest management schemes in the landscape and assist in conservation management and poverty alleviation, which to succeed, must continue hand in hand.

7 Recommendations

The following recommendations are suggested for the conservation and management of Mkindo Forest Reserve in the future:

Joint Forest Management

- Investigation into the reasons why there is no Joint Forest Management (JFM) in Mkindo
- Provide training to the Mkindo forest officer so that he is more aware of his role and responsibilities in JFM
- Increase communities' capacity to participate in JFM
- Inform the local communities of the results of the survey by summarising and translating into Kiswahili to assist with management of the reserve

Specific management issues within Mkindo FR

- Investigation of the allocated farmland within the reserve and the appropriate action taken
- Continued monitoring of the timber planks being brought from Nguru South FR to Mkindo village as a JFM activity
- Clear boundary demarcation and maintenance, particularly in the west and south of the reserve
- Fire management within the reserve, including fire breaks between miombo and forest habitats

- Investigation of the impact of grazing, if there is overgrazing, in the reserve and appropriate action taken;
- Active patrols and prosecution of people involved in pitsawing and charcoal burning in the reserve as a part of JFM

Research

- Conduct a zoological survey in the riverine and lowland forest where Eastern Arc species should be present to provide a species inventory and abundance of key species (a floral survey has already been conducted, Malimbwi and Mugasha, 2002)
- Repeat forest use survey in five years to look at management effectiveness and monitoring of human resource use in Mkindo FR

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Appendix 1 GPS Co-ordinates in Mkindo Forest Reserve

Longitude and Latitude in degrees, seconds, minutes and Grid references in UTM/UPS

Summary of basecamps and centre points

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Basecamp 1	MK-BC1	Basecamp 1 by Mkindo river in miombo	06° 13' 45.0"	037° 31' 53.0"	0337526	9311314	400
Basecamp 2	MK-BC2	Basecamp 2 at south east reserve by teak tree line boundary in riverine forest	06° 13' 01.0"	037° 32' 20.0"	0338348	9312654	402
Basecamp 3	MK-BC3	Basecamp 3 in west of reserve by Dizungwi river im miombo	06° 14' 56.0"	037° 30' 15.0"	0334518	9309112	456
Centr point 1	MK-CP1	Near basecamp 1 by Mkindo river	06° 13' 38.0"	037° 31' 49.0"	0337391	9311529	427
Centre point 2	MK-CP2	On ridgetop in miombo in north of reserve	06° 12' 22.0"	037° 31' 45.0"	0337278	9313851	684
Centre point 3	MK-CP3	South west of reserve in open miombo	06° 14' 45.0"	037° 30' 28.0"	0334914	9309452	466

Summary of camera trap sites

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Worksite 2	MK-CT2	Deercam 2 in lowland forest	06° 11' 49.0"	037° 31' 47.0"	337331	9314854	770
Worksite 2	MK-CT3	Deercam 3 in lowland forest	06° 11' 50.0"	037° 31' 47.0"	0337331	9314824	790
Worksite 2	MK-CT4	Deercam 4 in miombo	06° 12' 07.0"	037° 31' 45.0"	0337275	9314307	774
Worksite 2	MK-CT5	Deercam 5 in miombo	06° 12' 09.0"	037° 31' 47.0"	0337313	9314238	765

Summary of transects

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Worksite 1	MK-T1N	Start of transect 1, north; miombo (OUT)	06° 13' 36.0"	037° 32' 00.0"	0337730	9311580	425
Worksite 1	T1N700	700m of transect 1, north. The former part of transect is out. This is the new start point	06° 13' 10.0"	037° 32' 00.0"	0337735	9312280	451

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Worksite 1	T1NEND	End (1000m) of transect 1, north, miombo	06° 13' 03.0"	037° 32' 00.0"	0337740	9312586	459
Worksite 1	MK-T1E	Start of transect 2a, east; river edge, shamba (OUT)	06° 13' 37.0"	037° 31' 56.0"	0337620	9311537	399
Worksite 1	T1EEND	End of transect 2a, east; grassland (OUT)	06° 13' 03.0"	037° 32' 00.0"	0338607	9311540	452
Worksite 1	MK-T1E	Start of transect 2b, east; miombo (replacement transect)	06° 12' 55.0"	037° 31' 47.0"	0337330	9312849	495
Worksite 1	T1E700	End (700m) of transect 2b, east; miombo (replacement transect)	06° 12' 55.0"	037° 32' 07.0"	0337951	9312822	490
Worksite 1	MK-T1S	Start of transect 3, south; miombo	06° 13' 39.0"	037° 31' 49.0"	0337391	9311479	420
Worksite 1	T1SEND	End (1000m) of transect 3, south; grassland	06° 14' 11.0"	037° 31' 55.0"	0337579	9310509	390
Worksite 1	MK-T1W	Start of transect 4, west; miombo	06° 13' 38.0"	037° 31' 47.0"	0337338	9311528	427
Worksite 1	T1WEND	End (1000m) of transect 4, west; miombo	06° 13' 41.0"	037° 31' 19.0"	0336469	9311419	469
Worksite 2	MK-T2N	Start of transect 5, north; miombo	06° 12' 22.0"	037° 31' 45.0"	0337275	9313860	700
Worksite 2	T2NEND	End (1000m) of transect 5, north; lowland forest	06° 11' 49.0"	037° 31' 46.0"	0337281	9314854	771
Worksite 2	MK-T2E	Start of transect 6, east; miombo	06° 12' 22.0"	037° 31' 47.0"	0337313	9313858	677
Worksite 2	T2EEND	End (1000m) of transect 6, east; lowland forest	06° 12' 25.0"	037° 32' 17.0"	0338263	9313764	630
Worksite 2	MK-T2S	Start of transect 7, south; miombo	06° 12' 22.0"	037° 31' 45.0"	0337270	9313861	670
Worksite 2	T2SEND	End (1000m) of transect 7, south; miombo	06° 12' 54.0"	037° 31' 46.0"	0337301	9312853	508
Worksite 2	MK-T2W	Start of transect 8, west; miombo	06° 12' 41.0"	037° 31' 46.0"	0337284	9313267	590
Worksite 2	T2WEND	End (1000m) of transect 8, west; farmland	06° 12' 44.0"	037° 31' 15.0"	0336350	9313159	515
Worksite 3	MK-T3N	Start of transect 9, north; miombo	06° 14' 44.0"	037° 30' 28.0"	0334923	9309467	480
Worksite 3	T3NEND	End (1000m) of transect 9, north; acacia woodland	06° 14' 13.0"	037° 30' 28.0"	0334919	9310435	758
Worksite 3	MK-T3E	Start of transect 10, east; miombo	06° 14' 45.0"	037° 30' 29.0"	0334934	9309455	469
Worksite 3	T3EEND	End (1000m) of transect 10, east; miombo	06° 14' 46.0"	037° 31' 00.0"	0335907	9309435	590
Worksite 3	MK-T3S	Start of transect 11, south; miombo	06° 14' 45.0"	037° 30' 28.0"	0334920	9309439	460
Worksite 3	T3S250	250m of transect 11, turn west as reach border; miombo	06° 14' 53.0"	037° 30' 27.0"	0334887	9309203	450
Worksite 3	T3SEND	End (1000m) of transect 11, south/west; miombo	06° 14' 54.0"	037° 30' 05.0"	0334202	9309178	493
Worksite 3	MK-T3W	Start of transect 12, west; miombo	06° 14' 45.0"	037° 30' 28.0"	0334906	9309453	470
Worksite 3	T3WEND	End (1000m) of transect 12, west; miombo	06° 14' 56.0"	037° 29' 57.0"	0333954	9309423	563

Summary of opportunistic disturbance observations

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Worksite 2	MK-PS1	Fresh pitsaw site on ridge to CP2; Mninga (<i>Pterocarpus angolensis</i>)	06° 12' 45.0"	037° 31' 47.0"	0337319	9313152	585
Worksite 2	MK-PS2	Fresh pitsaw site on ridge to CP2; Mninga (<i>Pterocarpus angolensis</i>)	06° 12' 29.0"	037° 31' 46.0"	0337285	9313620	664
Worksite 2	MK-PS3	Pitsaw site at Kitungwi river	06° 12' 43.0"	037° 31' 38.0"	0337053	9313205	532
Worksite 2	MK-CUT	Fresh cut Mninga on ridge to CP2	06° 12' 41.0"	037° 31' 47.0"	0337319	9313252	590
Worksite 3	MK-CHA	Charcoal burning site near Transect 10	06° 14' 47.0"	037° 30' 58.0"	0335832	9309386	576
Worksite 3	MKCHA2	Old charcoal burning site near BC3	06° 14' 57.0"	037° 30' 06.0"	0334234	9309082	481

Summary of miscellaneous waypoints

Worksite	Waypoint	Description of location	Latitude (S)	Longitude (E)	Grid ref (E)	Grid ref (N)	Altitude (m asl)
Worksite 1	MK-3STR	3 river meeting point in Central Mkindo	06° 14' 15.0"	037° 31' 54.0"	0337558	9310370	385
Casual	VILLAGE	small village/ settlement on east side, out of forest reserve	06° 13' 25.0"	037° 32' 43.0"	0339065	9311907	438
Casual	MKTEAK	Teak tree line border	06° 13' 12.0"	037° 32' 00.0"	0337728	9312325	451

Appendix 2 Summary of transecting data

Transect no.	Total LP	Average LP per 50m	Total DP	Average DP per 50m	Total OC P	Average OC P per 50m	Total NC P	Average NC P per 50m	Total LT	Average LT per 50m	Total DT	Average DT per 50m	Total OCT	Average OCT per 50m	Total NCT	Average NCT per 50m	Total LT*	Average LT* per 50m	Total DT*	Average DT* per 50m	Total OCT*	Average OCT* per 50m	Total NCT*	Average NCT* per 50m
1	46	7.67	2	0.33	3	0.50	1	0.17	39	6.50	19	3.17	1	0.17	0	0.00	26	4.33	1	0.17	1	0.17	0	0.00
2	100	7.14	15	1.07	8	0.57	0	0.00	138	9.86	13	0.93	8	0.57	0	0.00	24	1.71	2	0.14	2	0.14	0	0.00
3	116	5.80	2	0.10	2	0.10	1	0.05	149	7.45	24	1.20	14	0.70	2	0.10	25	1.25	0	0.00	1	0.05	2	0.10
4	223	11.15	6	0.30	7	0.35	2	0.10	173	8.65	7	0.35	6	0.30	0	0.00	84	4.20	6	0.30	2	0.10	0	0.00
5	230	11.50	36	1.80	8	0.40	0	0.00	256	12.80	56	2.80	6	0.30	0	0.00	101	5.05	11	0.55	1	0.05	0	0.00
6	158	7.90	5	0.25	0	0.00	0	0.00	259	12.95	14	0.70	10	0.50	0	0.00	89	4.45	6	0.30	1	0.05	0	0.00
7	162	8.10	16	0.80	12	0.60	1	0.05	339	16.95	26	1.30	3	0.15	5	0.25	81	4.05	5	0.25	0	0.00	0	0.00
8	71	3.55	12	0.60	8	0.40	1	0.05	181	9.05	15	0.75	4	0.20	5	0.25	34	1.70	5	0.25	0	0.00	0	0.00
9	240	12.00	13	0.65	9	0.45	0	0.00	236	11.80	17	0.85	3	0.15	0	0.00	57	2.85	8	0.40	0	0.00	0	0.00
10	130	6.50	10	0.50	20	1.00	0	0.00	169	8.45	23	1.15	6	0.30	3	0.15	67	3.35	2	0.10	0	0.00	0	0.00
11	249	12.45	20	1.00	27	1.35	0	0.00	238	11.90	22	1.10	19	0.95	0	0.00	102	5.10	12	0.60	0	0.00	0	0.00
12	133	6.65	12	0.60	7	0.35	1	0.05	161	8.05	18	0.90	9	0.45	0	0.00	67	3.35	1	0.05	0	0.00	0	0.00
Total	1858	100.41	149	8.00	111	6.07	7	0.47	2338	124.41	254	15.20	89	4.74	15	0.75	757	41.40	59	3.11	8	0.56	2	0.10

P = Pole, T = Timber, T*= Large timber; L = Live, D = Dead, OC = Old cut, NC = New cut

Appendix 3 Pole and timber raw data per transect

Each transect is 1000m length x 10m width = 10 000m², apart from two transects which were shortened in length: transect 1 was 300m and transect 2 was 700m.

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat.dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
03/05/2006	1	1	North	700-750	F, TR	7	0	0	0	10	0	0	0	3	0	0	0
				750-800	F	11	0	0	1	3	0	0	0	9	0	0	0
				800-850	F	6	0	1	0	6	5	0	0	9	0	0	0
				850-900	F	6	0	1	0	6	5	0	0	2	0	0	0
				900-950	F	13	1	1	0	7	9	1	0	3	1	0	0
				950-1000	F	3	1	0	0	7	0	0	0	0	0	1	0
13/05 and 15/05/06	1	2	East	0-50	F	4	0	1	0	14	1	0	0	1	0	0	0
				50-100	F	12	1	0	0	19	1	0	0	2	0	1	0
				100-150	F	9	2	0	0	10	0	0	0	0	0	0	0
				150-200	F	11	0	0	0	21	1	0	0	2	0	0	0
				200-250	F	5	0	1	0	6	0	1	0	1	0	0	0
				250-300	F	12	0	1	0	7	2	0	0	2	0	0	0
				300-350	F	13	1	5	0	20	1	1	0	0	1	0	0
				350-400		5	0	0	0	8	1	3	0	3	0	0	0
				400-450		4	1	0	0	6	1	0	0	7	0	0	0
				450-500		2	0	0	0	7	1	3	0	2	0	1	0
				500-550	F	5	1	0	0	8	4	0	0	1	0	0	0
550-600	F	11	3	0	0	8	0	0	0	0	0	0	0				

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat.dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				600-650	F	7	4	0	0	2	0	0	0	2	0	0	0
				650-700	F	0	2	0	0	2	0	0	0	1	1	0	0
04/05/2006	1	3	South	0-50	F	28	0	1	0	21	3	2	0	3	0	0	0
				50-100	F	18	0	0	0	28	3	1	0	1	0	0	0
				100-150	F	23	0	0	0	14	3	1	0	2	0	0	0
				150-200	F	4	0	0	0	9	1	1	0	0	0	0	0
				200-250	F, Gr, M	14	0	0	0	5	1	1	0	2	0	0	0
				250-300	F, Gr	0	0	0	0	3	6	0	0	2	0	0	0
				300-350	F, Gr, R	7	0	0	0	8	1	0	0	3	0	0	0
				350-400	F, Gr	0	0	0	0	7	2	1	0	0	0	0	0
				400-450	F, Gr, R	0	0	0	0	0	0	3	0	0	0	0	0
				450-500	F, Gr, R	0	0	0	0	0	0	2	0	0	0	0	0
				500-550	F, Gr, R, Tr	0	0	0	0	0	0	0	0	1	0	0	0
				550-600	F, Gr	2	0	0	0	8	0	0	0	4	0	0	0
				600-650	F, Gr, Tr	5	0	0	0	4	0	0	0	0	0	0	0
				650-700	F, Gr, Tr, B	0	0	0	0	2	0	0	0	1	0	1	0
				700-750	F, Gr	2	0	0	0	5	0	2	0	1	0	0	0
				750-800	F, Gr	3	1	0	0	11	1	0	0	1	0	0	0
				800-850	F, Gr	4	0	0	0	21	2	0	0	0	0	0	0
				850-900	F, Gr	0	0	0	0	1	0	0	0	1	0	0	0
				900-950	F, Gr, Tr	0	0	0	0	0	0	0	0	1	0	0	0
				950-1000	F, Gr, R	6	1	1	1	2	1	0	2	2	0	0	2
03/05/2006	1	4	West	0-50	F	13	0	1	0	4	0	0	0	4	0	0	0
				50-100	F, Gr	11	0	0	0	5	0	0	0	0	0	0	0
				100-150	F	12	0	1	0	0	0	0	0	8	1	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat. dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				150-200	F	3	1	0	0	14	0	1	0	5	1	0	0
				200-250	F	0	4	0	0	5	0	0	0	11	0	0	0
				250-300	F	0	0	1	0	1	0	0	0	0	2	0	0
				300-350	F	18	0	0	2	20	0	1	0	4	0	2	0
				350-400		9	0	3	0	10	1	0	0	4	0	0	0
				400-450	F	14	0	0	0	5	0	2	0	8	0	0	0
				450-500	F, Gr	10	0	0	0	8	0	0	0	6	0	0	0
				500-550	F, Gr	9	0	1	0	6	2	0	0	9	0	0	0
				550-600	F, Gr	14	0	0	0	6	0	1	0	6	0	0	0
				600-650	F, Gr	6	0	0	0	3	0	1	0	4	0	0	0
				650-700	F	5	0	0	0	13	2	0	0	2	0	0	0
				700-750	F	15	0	0	0	10	2	0	0	7	0	0	0
				750-800	F, Gr, R	21	0	0	0	3	0	0	0	0	0	0	0
				800-850		24	0	0	0	14	0	0	0	0	0	0	0
				850-900		20	0	0	0	28	0	0	0	2	0	0	0
				900-950		10	0	0	0	15	0	0	0	4	0	0	0
				950-1000	Gr	9	1	0	0	3	0	0	0	0	2	0	0
08/05/2006	2	5	North	0-50	F, R	7	0	0	0	12	0	0	0	7	0	0	0
				50-100	F, R	10	0	1	0	10	0	0	0	7	0	0	0
				100-150	F, R	16	0	0	0	13	1	0	0	5	0	0	0
				150-200	F, R	13	1	0	0	11	0	0	0	3	1	0	0
				200-250	F, R	1	1	1	0	6	3	1	0	1	0	0	0
				250-300	F, R	6	0	0	0	10	0	0	0	4	0	0	0
				300-350	F, R	4	0	0	0	9	3	0	0	8	0	0	0
				350-400	F, R	5	1	0	0	14	1	0	0	6	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat.dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				400-450	F, R	12	0	0	0	16	2	0	0	7	0	0	0
				450-500	F, R	5	4	0	0	13	6	0	0	8	0	0	0
				500-550	F, R	4	3	0	0	15	1	1	0	9	0	0	0
				550-600	F, R	7	4	0	0	11	7	0	0	5	0	0	0
				600-650	F, R	14	3	0	0	23	4	0	0	5	0	0	0
				650-700	F, R	21	3	0	0	10	3	0	0	2	0	0	0
				700-750	F, R	13	1	0	0	12	2	2	0	1	1	0	0
				750-800	F, R	29	0	3	0	20	2	1	0	7	4	0	0
				800-850	F, R	28	10	1	0	12	14	1	0	7	1	1	0
				850-900	R	11	1	1	0	16	1	0	0	2	1	0	0
				900-950		15	4	1	0	5	3	0	0	5	0	0	0
				950-1000		9	0	0	0	18	3	0	0	2	3	0	0
07/05/2006	2	6	East	0-50	F	16	0	0	0	5	0	0	0	2	0	0	0
				50-100	F	10	0	0	0	2	0	0	0	3	1	0	0
				100-150	F	8	0	0	0	6	1	1	0	9	1	0	0
				150-200	F, P (old)	10	0	0	0	11	0	0	0	3	0	0	0
				200-250	F	1	0	0	0	5	3	3	0	0	0	0	0
				250-300	F	2	0	0	0	2	2	2	0	0	0	0	0
				300-350	F, P (old)	0	1	0	0	11	1	1	0	2	0	1	0
				350-400	F	1	0	0	0	11	0	0	0	6	1	0	0
				400-450	F, T, P (old)	6	0	0	0	20	1	1	0	3	0	0	0
				450-500	F, P (old)	22	1	0	0	16	0	0	0	4	1	0	0
				500-550	F	15	0	0	0	18	0	0	0	0	1	0	0
				550-600	F	11	0	0	0	14	1	1	0	7	0	0	0
				600-650	F	8	0	0	0	12	0	1	0	2	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat. dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				650-700	F, P (old)	3	0	0	0	9	1	0	0	3	0	0	0
				700-750	F	15	0	0	0	16	1	0	0	4	0	0	0
				750-800	F	7	0	0	0	20	0	0	0	7	0	0	0
				800-850	F	5	0	0	0	27	0	0	0	5	0	0	0
				850-900	F	8	2	0	0	13	0	0	0	15	0	0	0
				900-950	F	1	0	0	0	20	1	0	0	11	0	0	0
				950-1000	F	9	1	0	0	21	2	0	0	3	1	0	0
11/05/2006	2	7	South	0-50	F, R	9	0	0	0	20	1	0	0	6	0	0	0
				50-100	F, R	7	1	0	0	6	1	0	0	4	0	0	0
				100-150	F, R	12	0	1	0	21	0	0	0	1	1	0	0
				150-200	F, R	14	2	0	0	21	3	0	0	0	1	0	0
				200-250	F, R	22	2	1	0	13	6	0	3	8	2	0	0
				250-300	F, R	19	4	2	1	20	0	0	0	2	0	0	0
				300-350	F, R	2	2	1	0	27	4	0	0	2	1	0	0
				350-400	F, R	7	0	0	0	29	1	0	0	4	0	0	0
				400-450	F, R	9	0	0	0	10	2	0	0	4	0	0	0
				450-500	F, R, Gr	2	1	1	0	14	1	0	1	6	0	0	0
				500-550	F, R	7	1	0	0	11	1	0	0	3	0	0	0
				550-600	F, R	4	0	1	0	18	1	0	1	6	0	0	0
				600-650	F, R	4	0	1	0	18	1	0	0	6	0	0	0
				650-700	F, R, P	5	2	0	0	19	1	1	0	4	0	0	0
				700-750	F, R	3	1	0	0	15	0	0	0	6	0	0	0
				750-800	F, R	10	0	0	0	19	1	0	0	9	0	0	0
				800-850	F, R	16	0	1	0	9	0	0	0	4	0	0	0
				850-900	F, R	2	0	0	0	15	1	0	0	4	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat.dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				900-950	F, R	5	0	1	0	10	1	0	0	0	0	0	0
				950-1000	F, R	3	0	2	0	24	0	2	0	2	0	0	0
12/05/2006	2	8	West	0-50	F	4	0	0	0	12	1	0	0	0	0	0	0
				50-100	F	7	1	0	0	17	0	0	0	4	0	0	0
				100-150	F	12	2	1	0	24	0	1	0	1	0	0	0
				150-200	F	13	2	0	0	22	5	0	0	0	1	0	0
				200-250	F	3	0	0	0	8	1	0	0	6	2	0	0
				250-300	F	0	0	0	0	5	0	0	0	0	0	0	0
				300-350	F	6	0	0	0	12	1	1	1	10	0	0	0
				350-400	F, R	7	1	1	0	15	1	1	0	3	0	0	0
				400-450	F	8	0	2	0	18	0	0	0	0	0	0	0
				450-500	F	7	4	1	0	7	5	0	0	2	0	0	0
				500-550	F	3	2	0	0	14	0	0	0	3	0	0	0
				550-600	F	1	0	0	0	11	0	0	0	1	0	0	0
				600-650	F	0	0	0	0	0	0	0	0	0	0	0	0
				650-700	F	0	0	0	0	0	0	0	0	0	0	0	0
				700-750	F, C	0	0	0	0	1	1	0	0	0	0	0	0
				750-800	F	0	0	0	0	3	0	0	0	0	1	0	0
				800-850	F, C	0	0	0	0	5	0	0	0	0	1	0	0
				850-900	F	0	0	3	1	1	0	0	3	0	0	0	0
				900-950	F, C, R	0	0	0	0	6	0	1	1	4	0	0	0
				950-1000	F, C	0	0	0	0	0	0	0	0	0	0	0	0
17/05/2006	3	9	North	0-50	F, Gr	4	1	2	0	18	0	0	0	3	0	0	0
				50-100	F, Gr	1	0	0	0	10	1	0	0	5	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat. dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				100-150	F, Gr	7	0	1	0	14	0	1	0	0	4	0	0
				150-200	F, Gr	10	0	1	0	5	1	0	0	1	0	0	0
				200-250	F, Gr	3	0	0	0	14	0	0	0	2	1	0	0
				250-300	F, Gr	21	0	0	0	7	2	0	0	5	0	0	0
				300-350	F, Gr, P (old)	17	0	2	0	16	2	0	0	6	0	0	0
				350-400	F, Gr	13	0	2	0	9	0	0	0	4	0	0	0
				400-450	F, Gr	15	5	0	0	8	1	0	0	1	0	0	0
				450-500	F, Gr	12	0	0	0	14	1	0	0	4	1	0	0
				500-550	F, Gr	88	0	0	0	16	0	0	0	4	0	0	0
				550-600	F, Gr	3	0	0	0	10	0	0	0	2	0	0	0
				600-650	F, Gr, R	8	1	1	0	17	4	1	0	2	1	0	0
				650-700	F, Gr	8	1	0	0	17	2	1	0	1	1	0	0
				700-750	F, Gr	2	0	0	0	2	0	0	0	0	0	0	0
				750-800	F, Gr	3	1	0	0	9	2	0	0	4	0	0	0
				800-850	F, Gr	1	0	0	0	11	0	0	0	3	0	0	0
				850-900	F, Gr, P (old)	14	2	0	0	20	1	0	0	5	0	0	0
				900-950	F, Gr	7	1	0	0	14	0	0	0	4	0	0	0
				950-1000	F, Gr	3	1	0	0	5	0	0	0	1	0	0	0
18/05/2006	3	10	East	0-50	F, Gr	12	1	0	0	3	0	0	0	2	0	0	0
				50-100	F, Gr	14	1	3	0	19	2	0	0	2	1	0	0
				100-150	F, Gr	5	1	4	0	4	0	0	0	1	0	0	0
				150-200	F, Gr, R	4	0	0	0	7	5	0	0	2	0	0	0
				200-250	F, Gr	9	0	1	0	9	0	0	0	1	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat.dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				250-300	F, Gr	9	1	2	0	15	1	0	0	1	0	0	0
				300-350	F, Gr, R	11	1	7	0	10	2	3	0	6	0	0	0
				350-400	F, Gr	2	0	0	0	10	0	0	0	0	0	0	0
				400-450	F, Gr	10	1	0	0	7	2	1	0	0	0	0	0
				450-500	F, Gr	5	0	0	0	3	0	0	0	2	0	0	0
				500-550	F, Gr	9	0	0	0	9	2	0	0	4	0	0	0
				550-600	F, Gr	1	0	0	0	2	0	0	0	1	0	0	0
				600-650	F, Gr	8	1	1	0	6	0	0	0	5	0	0	0
				650-700	F, Gr	7	0	1	0	20	1	0	0	6	0	0	0
				700-750	F, Gr	6	0	1	0	10	1	2	0	9	0	0	0
				750-800	F, Gr	3	1	0	0	4	6	0	0	11	0	0	0
				800-850	F, Gr	2	0	0	0	5	0	0	2	4	0	0	0
				850-900	F, Gr, B	5	0	0	0	6	1	0	0	6	1	0	0
				900-950	F, Gr	6	2	0	0	13	0	0	1	2	0	0	0
				950-1000	F, Gr	2	0	0	0	7	0	0	0	2	0	0	0
19/05/2006	3	11	South / west	0-50	F, Gr, R	1	1	1	0	8	1	0	0	6	0	0	0
				50-100	F, Gr	12	0	0	0	9	0	0	0	3	2	0	0
				100-150	F, Gr	11	0	0	0	8	0	1	0	7	2	0	0
				150-200	F, Gr	13	0	0	0	13	1	2	0	6	0	0	0
				200-250	F, Gr	10	1	0	0	9	0	0	0	5	2	0	0
				250-300	F, Gr	10	0	2	0	21	4	2	0	12	0	0	0
				300-350	F, Gr	12	2	3	0	15	1	1	0	6	0	0	0
				350-400	F, Gr	22	1	0	0	19	1	1	0	6	0	0	0
				400-450	F, Gr	21	1	0	0	23	0	1	0	5	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat. dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				450-500	F, Gr, R	28	0	0	0	20	0	0	0	3	0	0	0
				500-550	F, Gr	14	0	2	0	8	0	1	0	2	0	0	0
				550-600	F, Gr	5	1	2	0	12	1	2	0	2	3	0	0
				600-650	F, Gr	11	1	0	0	8	2	0	0	3	0	0	0
				650-700	F, Gr	12	1	3	0	5	6	1	0	4	1	0	0
				700-750	F, Gr, R	13	2	1	0	8	0	1	0	1	0	0	0
				750-800	F, Gr	11	4	4	0	7	0	2	0	5	1	0	0
				800-850	F, Gr	12	2	4	0	15	3	0	0	11	0	0	0
				850-900	F, Gr	11	3	2	0	13	2	1	0	7	1	0	0
				900-950	F, Gr, R	7	0	0	0	8	0	0	0	5	0	0	0
				950-1000	F, Gr, R, Tr	13	0	3	0	9	0	3	0	3	0	0	0
16/05/2006	3	12	West	0-50	F, Gr	18	1	0	0	6	0	0	0	2	0	0	0
				50-100	F, Gr, R x2	8	0	1	1	12	1	2	0	3	1	0	0
				100-150	F, Gr	4	0	0	0	5	2	0	0	2	0	0	0
				150-200	F, Gr	6	0	1	0	7	1	0	0	8	0	0	0
				200-250	F, Gr	13	0	0	0	7	4	1	0	7	0	0	0
				250-300	F, Gr	11	0	0	0	3	1	0	0	1	0	0	0
				300-350	F, Gr	14	0	0	0	11	0	0	0	6	0	0	0
				350-400	F, Gr	4	0	0	0	13	1	0	0	2	0	0	0
				400-450	F, Gr	2	1	0	0	5	1	0	0	1	0	0	0
				450-500	F, Gr	8	0	0	0	6	1	2	0	2	0	0	0
				500-550	F, Gr	6	1	0	0	5	0	0	0	2	0	0	0
				550-600	F, Gr	3	0	1	0	9	1	1	0	3	0	0	0
				600-650	F, Gr, Tr	4	0	0	0	3	0	0	0	3	0	0	0
				650-700	F, Gr	6	0	1	0	6	1	0	0	0	0	0	0

Date	Work-site	Transect no.	Direction	Section	Section disturbance category	No. live poles	No. of nat. dead poles	No. of cut poles		No. of live timbers	No. nat. dead timbers	No. of cut timbers		No. live large timbers	No. nat. dead large timbers	No. cut large timbers	
								old cut	new cut			old cut	new cut			old cut	new cut
				700-750	F, Gr, R, B	1	1	0	0	5	0	0	0	2	0	0	0
				750-800	F, Gr, FC	11	2	1	0	17	0	0	0	5	0	0	0
				800-850	F, Gr, B	5	2	1	0	7	1	1	0	5	0	0	0
				850-900	F, Gr	2	0	0	0	6	0	0	0	7	0	0	0
				900-950	F, Gr	4	2	1	0	11	2	2	0	2	0	0	0
				950-1000	F, Gr	3	2	0	0	17	1	0	0	4	0	0	0

Key: B = Charcoal burning, C = cultivation, F = Fire damage, FC = Firewood collection, Gr = Grazing, M = Mining site, P = Pitsawing, R = path, T = Traps, Tr = track

Appendix 4 Habitat notes per transect

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
03/05/2006	1	1	North	700-750	GMS	<10	<10	>50	451	Grassland	Cross track; cross teakline of FR boundary
				750-800	GMS	10-50	<10	>50	452	Miombo	
				800-850	RT	>50	>50	<10	450	Miombo	Red duiker track
				850-900	RT	>50	>50	<10	470	Miombo	
				900-950	RT	>50	>50	<10	475	Miombo	Hear Sykes monkey north
				950-1000	SMS	10-50	10-50	>50	468	Miombo	Open disturbed woodland
13/05 and 15/05/06	1	2	East	0-50	GMS	<10	<10	>50	495	Miombo	Open, grassy, old fire
				50-100	GMS	10-50	10-50	10-50	480	Miombo	Open, grassy, old fire
				100-150	GMS	<10	10-50	>50	510	Miombo	Open, grassy, old fire
				150-200	GMS	>50	10-50	<10	505	Miombo	Cross stream; dense shrubby; old fire
				200-250	GMS	10-50	>50	>50	495	Miombo	Shrubby; old fire
				250-300	GLS	10-50	>50	<10	490	Miombo	old fire
				300-350	GLS	10-50	<10	>50	490	Riverine / lowland forest	old fire
				350-400	GLS	10-50	<10	>50	490	Riverine / lowland forest	Cross Kigombezi river
				400-450	GLS	>50	<10	>50	490	Riverine / lowland forest	
				450-500	GLS	>50	<10	>50	490	Riverine / lowland forest	Cross river
				500-550	GLS	<10	>50	>50	480	Miombo	Open grassy; old fire
				550-600	GLS	<10	>50	>50	470	Miombo	old fire
				600-650	GMS	<10	>50	>50	480	Miombo	old fire

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				650-700	GMS	<10	>50	>50	495	Miombo	old fire; transect aborted as Kibaba lands on panga and cuts thumb deeply; to hospital
04/05/2006	1	3	South	0-50	SLS	10-50	<10	>50	420	Good Miombo	
				50-100	SLS	10-50	<10	>50	420	Good Miombo	
				100-150	GLS	10-50	<10	>50	420	Good Miombo	
				150-200	GLS	<10	<10	>50	410	Miombo	open in to bowl
				200-250	GLS	<10	<10	>50	405	Miombo	open; 10m deep hole, 3 yrs old mining site for rubies
				250-300	GLS	<10	10-50	>50	400	Miombo	open; charcoal burning ongoing
				300-350	GLS	10-50	>50	10-50	395	Miombo	Shrubby; cross footpath
				350-400	GLS	<10	<10	>50	395	Miombo	Open; marshy
				400-450	VF	<10	<10	>50	395	Marshy grassland	Cross footpath
				450-500	VF	<10	<10	>50	395	Marshy grassland	Cross footpath; charcoal burning as casual obs
				500-550	VF	<10	<10	>50	395	Marshy grassland	Path and old logging track
				550-600	VF	<10	<10	>50	395	Marshy grassland	Mongoose digging
				600-650	VF	<10	<10	>50	395	Marshy grassland	follow old track
				650-700	VF	<10	<10	>50	395	Marshy grassland	Cross track; charcoal burning
				700-750	VF	<10	<10	>50	395	Marshy grassland	
				750-800	GLS	>50	10-50	<10	400	Riverine forest	shrub/tangle
				800-850	GLS	>50	<10	<10	400	Riverine forest	shrub/tangle
				850-900	VF	<10	<10	>50	395	Marshy grassland	
				900-950	VF	<10	<10	>50	390	Marshy grassland	Cross logging road
				950-1000	VF	<10	<10	>50	390	Marshy grassland	follow path
03/05/2006	1	4	West	0-50	SLS	10-50	<10	>50	427	Good miombo	Sign of baboons
				50-100	SMS	10-50	<10	>50	440	Good miombo	Sign of grazing cattle
				100-150	SUS/RT	10-50	<10	>50	470	Good miombo	Cut Mpingo

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				150-200	SUS	<10	<10	>50	470	Good miombo	Rocks; tracks like chui
				200-250	SUS	<10	<10	>50	470	Good miombo	Large cliff; baboon dung
				250-300	SMS	<10	<10	>50	460	Good miombo	Rocky
				300-350	GLS	>50	10-50	<10	450	Riverine forest	Tangled. Old path; pitsaw mninga
				350-400	GLS	10-50	<10	>50	450	Good Miombo	
				400-450	GMS	>50	10-50	>50	470	Good Miombo	
				450-500	GMS	>50	10-50	>50	480	Good Miombo	Grazing signs
				500-550	GMS	>50	<10	>50	497	Good Miombo	Grazing signs
				550-600	SUS	10-50	<10	>50	510	Good Miombo	Grazing signs
				600-650	SUS/RT	<10	<10	>50	530	Open miombo	Grazing signs
				650-700	SUS	10-50	10-50	>50	530	Open miombo	
				700-750	SUS	<10	10-50	>50	510	Open miombo	
				750-800	SMS	<10	>50	>50	490	Open miombo	Grazing signs
				800-850	SLS	>50	>50	<10	480	Riverine forest	
				850-900	VF	>50	>50	<10	475	Riverine forest	Tangled; cross small river
				900-950	VF	>50	>50	<10	475	Riverine forest	Tangled; black headed oriole
				950-1000	VF	<10	<10	>50	475	Grassland	Dry season grazing area
08/05/2006	2	5	North	0-50	RT	>50	>50	10-50	705	Good Miombo	Cross or follow path on ridge
				50-100	RT	>50	>50	10-50	710	Good Miombo	Cross or follow path on ridge
				100-150	RT	>50	>50	<10	715	Good Miombo	Cross or follow path on ridge
				150-200	RT	>50	>50	10-50	725	Good Miombo	Cross or follow path on ridge
				200-250	RT	<10	10-50	>50	735	Good Miombo	Cross or follow path on ridge; tree fall area
				250-300	RT	10-50	<10	>50	745	Good Miombo	Cross or follow path on ridge
				300-350	RT	>50	<10	>50	760770	Good Miombo	Cross or follow path on ridge
				350-400	RT	>50	10-50	10-50	780	Good Miombo	Cross or follow path on ridge
				400-450	RT	10-50	>50	10-50	790	Good Miombo	Cross or follow path on ridge; duiker tracks

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				450-500	RT	>50	<10	>50	790	Good Miombo	Cross or follow path on ridge
				500-550	RT	10-50	10-50	>50	790	Good Miombo	Cross or follow path on ridge; baboon digging
				550-600	RT	>50	10-50	>50	785	Good Miombo	Cross or follow path on ridge
				600-650	RT	>50	10-50	>50	780	Good Miombo	Cross or follow path on ridge
				650-700	RT	>50	>50	10-50	780	Good Miombo	Cross or follow path on ridge
				700-750	RT	>50	10-50	>50	780	Good Miombo	Cross or follow path on ridge
				750-800	RT	>50	>50	<10	780	Good Miombo	Cross or follow path on ridge
				800-850	RT	<10	>50	>50	780	Lowland forest/miombo	Cross or follow path on ridge; bracken; old cutting
				850-900	RT	>50	10-50	>50	775	Lowland forest	Bamboo
				900-950	GUS	>50	>50	<10	770	Lowland forest	Bamboo
				950-1000	SUS	>50	10-50	>50	765	Lowland forest	Bamboo
07/05/2006	2	6	East	0-50	SUS	>50	10-50	<10	675	Good miombo	
				50-100	SMS	>50	10-50	<10	650	Good miombo	
				100-150	SMS	>50	>50	<10	630	Good miombo	Tree fall open area. Bushpig digging. Hyrax urine smell
				150-200	SMS	>50	>50	<10	620	Good miombo	Old Pitsaw site / bench
				200-250	GMS	<10	<10	>50	615	Grassland	forest edge
				250-300	GLS	<10	<10	>50	605	Grassland	with bracken
				300-350	GLS	<10	10-50	>50	602	Grassland into disturbed riverine forest	
				350-400	GLS	>50	10-50	>50	590	Disturbed Riverine forest	Cross Kigombezi river. People fishing
				400-450	GLS	>50	10-50	>50	580	Disturbed Riverine forest	Old pitsaw site. Hyraxurine / dung. Giant Pouched rat squash trap

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				450-500	GLS	<10	>50	>50	580	Disturbed Riverine forest	Tangled. Old Pitsaw site. Hear B & W Colobus from north of transect
				500-550	GLS	>50	<10	10-50	580	Good riverine forest	
				550-600	GLS	>50	10-50	<10	590	Good riverine forest	
				600-650	GLS	>50	10-50	10-50	595	Good riverine forest	Cross stream
				650-700	GLS	>50	10-50	<10	600	Good riverine forest	Old pitsaw site; cross stream
				700-750	GLS	>50	>50	<10	600	Good riverine forest	Cross stream; steep slope, tree fall
				750-800	SMS	10-50	<10	>50	610	Lowland forest	open due to tree fall
				800-850	GUS	>50	<10	>50	620	Good Lowland forest	
				850-900	GUS	>50	<10	>50	625	Good Lowland forest	
				900-950	GUS	>50	10-50	<10	625	Good Lowland forest	
				950-1000	GUS	>50	<10	10-50	630	Good Lowland forest	
11/05/2006	2	7	South	0-50	RT	>50	>50	10-50	670	Good miombo	follow ridge and footpath
				50-100	RT	>50	>50	10-50	660	Good miombo	follow ridge and footpath
				100-150	RT	>50	>50	10-50	645	Good miombo	follow ridge and footpath
				150-200	RT	>50	>50	10-50	635	Good miombo	follow ridge and footpath
				200-250	RT	>50	>50	10-50	635	Good miombo	follow ridge and footpath ; cutting Mninga
				250-300	RT	10-50	10-50	>50	630	Good miombo	follow ridge and footpath
				300-350	RT	10-50	10-50	10-50	630	Good miombo	follow ridge and footpath; Burnt Pterocarpus angolensis
				350-400	RT	10-50	<10	10-50	625	Good miombo	follow ridge and footpath
				400-450	RT	<10	<10	>50	615	Good miombo	follow ridge and footpath
				450-500	RT	<10	<10	>50	610	Good miombo	follow ridge and footpath; old cow dung

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				500-550	RT	<10	<10	>50	603	Good miombo	follow ridge and footpath
				550-600	RT	10-50	<10	10-50	590	Good miombo	follow ridge and footpath
				600-650	RT	>50	<10	>50	586	Good miombo	follow ridge and footpath
				650-700	RT	10-50	<10	>50	586	Good miombo	follow ridge and footpath; pitsaw site Mninga
				700-750	RT	10-50	<10	>50	580	Good miombo	follow ridge and footpath
				750-800	RT	>50	<10	>50	575	Good miombo	follow ridge and footpath
				800-850	RT	10-50	10-50	10-50	570	Good miombo	follow ridge and footpath
				850-900	RT	<10	<10	>50	560	Good miombo	follow ridge and footpath
				900-950	RT	10-50	<10	>50	540	Good miombo	follow ridge and footpath
				950-1000	RT	<10	<10	>50	525	Good miombo	follow ridge and footpath
12/05/2006	2	8	West	0-50	RT	<10	<10	>50	590	Miombo	Old fire
				50-100	SUS	10-50	10-50	>50	570	Miombo	Old fire
				100-150	GMS	10-50	>50	10-50	560	Riverine forest	Old fire
				150-200	GLS	>50	10-50	>50	547	Disturbed Riverine forest	Old fire
				200-250	GLS	<10	>50	>50	540	Disturbed Riverine forest	Old fire; cross Kitungwi river
				250-300	GLS	<10	<10	>50	540	Grassland	Old fire, disturbed, old cutting
				300-350	SLS	10-50	10-50	>50	544	Disturbed miombo	Old fire
				350-400	GUS	10-50	10-50	10-50	558	Disturbed miombo	Old fire; cross human path
				400-450	GUS	<10	<10	>50	550	Open miombo	Old fire; old cutting
				450-500	GUS	10-50	10-50	>50	548	Disturbed miombo	Old fire
				500-550	GMS	10-50	<10	>50	540	Disturbed miombo	Old fire
				550-600	GLS	<10	<10	>50	527	Grassland	Old fire; this area called 'Bonde la Mantori'; see Gaboon Viper
				600-650	VF	<10	<10	>50	503	Grassland	Old fire

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				650-700	VF	<10	<10	>50	503	Grassland	Old fire
				700-750	VF	<10	<10	>50	503	Farmland (shamba)	Old fire
				750-800	GLS	<10	<10	>50	508	Open miombo	Old fire
				800-850	GLS	<10	<10	>50	515	Open miombo, into farmland	Old fire
				850-900	GLS	<10	<10	>50	515	Miombo	Old fire
				900-950	VF	<10	<10	>50	515	Miombo into farmland	Old fire; cross main track to Mdera village
				950-1000	VF	<10	<10	>50	515	Farmland (shamba)	Old fire
17/05/2006	3	9	North	0-50	GLS	<10	<10	>50	465	Open miombo	Old fire and grazing; Cross small stream
				50-100	GLS	10-50	<10	>50	470	Open miombo	Old fire and grazing; baboon digging
				100-150	GLS	10-50	<10	>50	480	Open miombo	Old fire and grazing
				150-200	GLS	<10	10-50	>50	490	Open miombo	Old fire and grazing
				200-250	SLS	<10	<10	>50	495	Open miombo	Old fire and grazing; red duiker track
				250-300	GMS	10-50	<10	>50	515	Open miombo	Old fire and grazing
				300-350	SMS	<10	10-50	>50	530	Open miombo	Old fire; very old pitsaw site
				350-400	SMS	<10	<10	>50	535	Open miombo	Old fire; small closed woodland patch
				400-450	SMS	<10	<10	>50	560	Open miombo	Old fire; cross wooded rocky gully
				450-500	SMS	>50	>50	<10	585	Woodland	Old fire; wooded gully
				500-550	SMS	<10	<10	>50	595	Acacia woodland	Old fire; v. steep climb
				550-600	SMS	<10	<10	>50	615	Acacia woodland	Old fire; v. steep climb; bushpig digging
				600-650	SMS	<10	<10	>50	630	Acacia woodland	Old fire; v. steep climb; red duiker path; human path
				650-700	SUS	<10	<10	>50	655	Acacia woodland	Old fire; v. steep climb
				700-750	SUS	<10	<10	>50	690	Acacia woodland	Old fire; v. steep climb; hit cliff and go around
				750-800	SUS	<10	<10	>50	720	Acacia woodland	Old fire; v. steep climb
				800-850	SUS	<10	<10	>50	730	Acacia woodland	Old fire; v. steep climb; baboon digging

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				850-900	GUS	10-50	<10	>50	740	Acacia woodland	Old fire; v. steep climb; old pit saw site
				900-950	SUS	10-50	<10	>50	735	Acacia woodland	Old fire; v. steep climb; cross smal gully
				950-1000	SUS	<10	<10	>50	750	Acacia woodland	Old fire; v. steep climb; rocky
18/05/2006	3	10	East	0-50	SLS	<10	<10	>50	470	Miombo	Old fire and grazing; rocky
				50-100	GLS	<10	<10	>50	455	Miombo	Old fire and grazing
				100-150	GLS	<10	<10	>50	440	Miombo	Old fire and grazing; cross stream
				150-200	GLS	<10	<10	>50	435	Miombo	Old fire and grazing; old cow dung; human path
				200-250	GLS	<10	<10	>50	440	Miombo	Old fire and grazing
				250-300	GLS	<10	<10	>50	450	Miombo	Old fire and grazing
				300-350	GLS / GULLY	>50	10-50	<10	460	Closed miombo	Old fire and grazing; by stream ; human path
				350-400	GLS	<10	<10	>50	478	Open miombo	Old fire and grazing
				400-450	SLS	<10	<10	>50	493	Open miombo	Old fire and grazing
				450-500	SMS	<10	<10	>50	515	Open miombo	Old fire and grazing; cliff go around; see teak tree to south, border but not clear line
				500-550	SUS	<10	<10	<10	535	Open miombo	Old fire and grazing; very rocky; Euphorbia candelabra
				550-600	RT	<10	<10	<10	550	Open miombo	Old fire and grazing; rocky
				600-650	RT	<10	<10	>50	557	Open miombo	Old fire and grazing
				650-700	RT	<10	<10	>50	564	Open miombo	Old fire and grazing
				700-750	RT	<10	<10	>50	590	Open miombo	Old fire and grazing
				750-800	RT	10-50	<10	>50	600	Open miombo	Old fire and grazing
				800-850	RT	<10	<10	>50	612	Open miombo	Old fire and grazing
				850-900	SUS	10-50	<10	>50	604	Open miombo	Old fire and grazing; charcoal burning
				900-950	SUS	<10	<10	>50	596	Open miombo	Old fire and grazing ; (casual charcoal burning site)

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
				950-1000	SUS	<10	<10	>50	595	Open miombo	Old fire and grazing
19/05/2006	3	11	South / west	0-50	GLS	10-50	<10	>50	460	Miombo	
				50-100	GLS / GULLY	<10	<10	>50	455	Miombo	Old fire and grazing; cross path
				100-150	GLS	<10	<10	>50	445	Miombo	Old fire and grazing; cross stream
				150-200	GLS	10-50	<10	>50	451	Miombo	Old fire and grazing
				200-250	GMS	>50	<10	>50	440	Miombo	Old fire and grazing; rocky; see one teak tree just east, assume border is straight line, so turn transect WEST
				250-300	GMS	>50	<10	>50	450	Miombo	Old fire and grazing
				300-350	GUS	10-50	<10	>50	470	Miombo	Old fire and grazing; big rock
				350-400	GUS	10-50	<10	>50	490	Miombo	Old fire and grazing
				400-450	GUS	<10	<10	>50	510	Miombo	Old fire and grazing
				450-500	RT / SUS	<10	<10	>50	520	Miombo	Old fire and grazing; path
				500-550	SMS	<10	<10	>50	485	Miombo	Old fire and grazing; rocky
				550-600	SLS	<10	<10	>50	460	Miombo	Old fire and grazing
				600-650	GLS	>50	10-50	<10	440	Riverine forest	
				650-700	VF / GLS	<10	<10	>50	440	Miombo	Old fire and grazing; cross Dizingwi river; cross water intake pipe
				700-750	SLS	<10	<10	>50	450	Miombo	Old fire and grazing; cross water intake pipe and path
				750-800	SLS / SMS	<10	<10	>50	470	Miombo	Old fire and grazing
				800-850	SMS	<10	<10	>50	485	Miombo	Old fire and grazing
				850-900	SUS / RT	<10	<10	>50	510	Miombo	Old fire and grazing
				900-950	SMS / SLS	<10	<10	>50	495	Miombo	Old fire and grazing; rocky; cow path
				950-1000	VF / GLS	<10	<10	>50	480	Miombo	Old fire and grazing; path and track

Date	Worksite	Transect no.	Direction	Section	Topography	Canopy Cover (%)	Shrub layer (%)	Ground layer (%)	Altitude (m asl)	Habitat type	Notes
16/05/2006	3	12	West	0-50	GLS	<10	<10	>50	468	Miombo	Old fire and grazing
				50-100	GLS	<10	<10	>50	460	Miombo	Old fire and grazing; human path x 2
				100-150	GLS	10-50	<10	>50	470	Miombo	Old fire and grazing; follow / cross path
				150-200	GLS	>50	<10	>50	470	Miombo	Old fire and grazing; follow / cross path
				200-250	GLS	>50	<10	>50	475	Miombo	Old fire and grazing; follow / cross path
				250-300	GLS	>50	<10	>50	480	Miombo	Old fire and grazing; follow / cross path
				300-350	GLS	10-50	<10	>50	485	Miombo	Old fire and grazing
				350-400	SMS	10-50	<10	>50	495	Miombo	Old fire and grazing
				400-450	GMS	<10	<10	>50	490	Miombo	Old fire and grazing
				450-500	GULLY	<10	<10	>50	485	Miombo	Old fire and grazing; cross Dizingwi river
				500-550	GULLY / GLS	10-50	<10	>50	480	Miombo	Old fire and grazing
				550-600	GMS	10-50	<10	>50	490	Miombo	Old fire and grazing; cross small stream
				600-650	GLS	<10	<10	>50	484	Miombo	Old fire and grazing; cross road to intake
				650-700	GMS	<10	<10	>50	490	Miombo	Old fire and grazing
				700-750	GMS	<10	<10	>50	500	Miombo	Old fire and grazing; charcoal burning; path
				750-800	SMS	10-50	<10	>50	515	Miombo	Old fire and grazing; firewood collection
				800-850	SMS	10-50	<10	>50	525	Miombo	Old fire and grazing; charcoal burning
				850-900	SUS	>50	<10	>50	535	Miombo	Old fire and grazing
				900-950	SUS	>50	<10	>50	550	Miombo	Old fire and grazing
				950-1000	GUS / RT	10-50	<10	>50	570	Miombo	Old fire and grazing

Key: B = Charcoal burning, C = cultivation, F = Fire damage, FC = Firewood collection, Gr = Grazing, M = Mining site, P = Pitsawing, R = path, T = Traps, Tr = track

Appendix 5 Example of data sheets used for the Mkindo FR survey

Disturbance transect and habitat notes data sheet

PETA		DISTURBANCE SURVEY SUMMARY						Mkindo Forest Reserve	
FOREST RESERVE:	<input type="text"/>					DATE:	<input type="text"/>		
TRANSECT NO:	<input type="text"/>		STARTING POINT (LONG / LAT)			<input type="text"/>			
RECORDERS:	<input type="text"/>		END POINT (LONG / LAT)			<input type="text"/>			
DISTURBANCE CATEGORY:			PITSAWING	<input type="checkbox"/>	TIMBER, PLANKS, POLES	<input type="checkbox"/>			
DIRECTION: <input type="text"/>			FIRE DAMAGE	<input type="checkbox"/>	CHARCOAL BURNING	<input type="checkbox"/>			
START TIME:	<input type="text"/>		CULTIVATION	<input type="checkbox"/>	TRAPS, PITFALLS, ETC	<input type="checkbox"/>			
END TIME:	<input type="text"/>		SETTLEMENT	<input type="checkbox"/>	ANIMAL REMAINS	<input type="checkbox"/>			
			CAMP SITE	<input type="checkbox"/>	GUNFIRE	<input type="checkbox"/>			
			MINDING (SITE)	<input type="checkbox"/>	OTHER	<input type="checkbox"/>			
			PATH	<input type="checkbox"/>					

DATE (DD/M/Y)	SECTION (m)	SECTION DIST/CAT.	NO. OF LIVE POLES	NO. OF JAT DEAD POLES	NO. OF CUT POLES		NO. OF LIVE TIMBERS	NO. OF JAT DEAD TIMBERS		NO. OF CUT TIMBERS	
					OLD	FRESH		OLD	FRESH	OLD	FRESH
	0-50										
	50-100										
	100-150										
	150-200										
	200-250										
	250-300										
	300-350										
	350-400										
	400-450										
	450-500										
	500-550										
	550-600										
	600-650										
	650-700										
	700-750										
	750-800										
	800-850										
	850-900										
	900-950										
	950-1000										

SECTION	TOPOGRAPHY	CANOPY COVER	SHRUB LAYER	GROUND LAYER	ALT(m)	NOTES
0-50						
50-100						
100-150						
150-200						
200-250						
250-300						
300-350						
350-400						
400-450						
450-500						
500-550						
550-600						
600-650						
650-700						
700-750						
750-800						
800-850						
850-900						
900-950						
950-1000						

Camera-Trap Form 2: camera station description

Forest site..... Site number.....

Forest study area..... Data collector.....

Camera type..... Camera number..... UTM
coordinates.....

Nearest cameras and approx
distance.....

Altitude (m a.s.l.)..... Slope (deg.).....

Placed (date/time)..... Removed
(date/time).....

Sampling effort (days /hours).....

Placed on: large trail (elephant trail) small trail (duiker trail)
 Other.....

Bait used: Any signs/dungs already in site.....

Gross habitat: lowland forest submontane forest montane forest swamp regenerating
forest riverine plantation woodland bamboo grassland cultivation

Other habitat.....

Canopy cover (for forest habitats): closed canopy regenerating shrubby open

Floor cover: shrub/thickets > 2m height < 2m seedlings grass leaf litter rock

Cover density dense moderately dense open

Dominant tree species.....

Dominant understorey species.....

Any further relevant description (e.g. more details on
microhabitat).....

