The United Republic of Tanzania

MINISTRY OF NATURAL RESOURCES AND TOURISM

Conservation and Management of the Eastern Arc Mountain Forests, Tanzania

GEF-UNDP: URT/01/G32

Uluguru Component Biodiversity Survey 2005 (Volume I)

Methods Manual

Frontier-Tanzania

Frontier-Tanzania Environmental Research

CMEAMF: Uluguru Component
Biodiversity Survey 2005
(Volume I)

Methods Manual

Bracebridge, C., N., Fanning, E., Howell, K. M. & St. John, F. A. V. (eds)

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Uluguru Mountains Environmental Management and Conservation Project (UMEMCP)

This project is a component of the Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF), a project of the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism - funded by the Global Environment Facility through the United Nations Development Programme. UMEMCP is managed by CARE International in Tanzania under a Memorandum of Understanding with the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism. It aims to improve forest management and conservation of catchment forests in the Uluguru Mountains, as well as improve land husbandry practices in adjacent villages with local communities, government authorities and other stakeholders. Implementation of UMEMCP is over a six-year period from 2003-2008.

The University of Dar es Salaam (UDSM)

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

The Society for Environmental Exploration (SEE)

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

Frontier Tanzania Forest Research Programme (FT FRP)

The Society for Environmental Exploration and the University of Dar es Salaam have been conducting collaborative research into environmental issues since July 1989 under the title of Frontier Tanzania, of which one component is the Frontier-Tanzania Forest Research Programme (FT FRP). Biological field surveys were conducted in the coastal forests from 1989 to 1994, in the East Usambara mountains in collaboration with EUCAMP, Tanga from 1995 to 2002, the Udzungwa mountains in collaboration with MEMA, Iringa 1999 to 2001, in the Mahenge Mountains in 2003 and in Mpanga / Kipengere Game Reserve, in collaboration with WWF-TPO, Dar es Salaam, in 2003.

FOR MORE INFORMATION:

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

Frontier Tanzania
P.O. Box 9473, Dar es Salaam, Tanzania
Tel: 255-22-2780063
E-mail: frontier@africaonline.co.tz

Society for Environmental Exploration
50-52 Rivington Street, London, U.K.
Tel: +44 20 76 13 24 22
Fax: +44 20 76 13 29 92
E-mail: research@frontier.ac.uk

Conservation and Management of the Eastern Arc Mountain Forests, CMEAMF): Uluguru Component
P. O. Box 289, Morogoro, Tanzania
Tel: 255-23-2601735
E-mail: easternarc@easternarc.or.tz, care-tzhq@care.org

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Managing Director:	Ms. Eibleis Fanning
Project Manager:	Mr. Paul Rubio

UNIVERSITY OF DAR ES SALAAM

Frontier- Tanzania Co-ordinators	Dr. M.Muruke & Prof. K.M. Howell

FRONTIER-TANZANIA

Dar es Salaam Country Co-ordinator:	Ms. Freya St John
Principal Investigator:	Ms. Claire Bracebridge
Primary Research Officer:	Ms. Rosalind Salter
Research Officers:	Mr. Daniel Cox, Mr. James Nicodem
Botanist:	Mr. George Sangu
Ornithologist (independent)	Mr. Jacob Kiure
Field Assistants:	Mr. Ramathan Rajabu, Mr. Hassani Abedi, Mr. Mohammed Ali
Camp Assistant:	Mr. Isaya Pascal

CONSERVATION AND MANAGEMENT OF THE EASTERN ARC MOUNTAIN FORESTS

National Project Co-ordinator:	Dr. Felician Kilahama
Technical Advisor, Strategy:	Dr. Neil Burgess
Technical Advisor, Uluguru SEM:	Dr. Dawn Hartley
Technical Advisor, Strategy:	Dr. Neil Burgess
Project Manager Uluguru:	Mr. Gabriel Batulaine, Mr. Babu Matunda
Project Officer PA/PFM, Uluguru:	Mr. Anthony Sangeda
Office Administor:	Mr. Vincent Benjamin
Office Assistant:	Ms. Rose William Massoi
Drivers:	Mr. George Bashange, Mr. Elimringi Minde, Mr. Ezekiel Mwinuka, Mr. Rashid Saidi

CATCHMENT FORESTRY, FORESTRY AND BEEKEEPING DIVISION, MINISTRY OF NATURAL RESOURCES AND TOURISM

Regional Catchment Forest Officer:	Mr. Venance Mialla
District Catchment Forest Officer:	Ms. Lilian Masaki, Mr. Togolai Tindikali
Assistant Forest Officers:	Mr. Jonathan Mpangala (Bunduki), Mr. Servinus Shirima (Kimboza), Mr. Juma Buruhani (Mvuha)

DISTRICT NATURAL RESOURCES OFFICE, DISTRICT COUNCIL

Acting Regional Natural Resources / District Forest Officer:	Mr Joseph Mchau
Assistant Forest Officer:	Mr Beda Karani

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LIST OF ABBREVIATIONS / ACRONYMS

CITES	Convention on the International Trade of Endangered Species
CMEAMF	Conservation and Management of the Eastern Arc Mountain Forests
FBD	Forest and Beekeeping Division of the Ministry of Natural Resources and Tourism
FR	Forest Reserve
FT FRP	Frontier-Tanzania Forest Research Programme
FTEA	Flora of Tropical East Africa
ICBP	International Council for Bird Preservation (now called BirdLife International)
IUCN	The World Conservation Union
LEAP	List of East African Plants
S & H	Svendsen & Hansen
SEE	Society for Environmental Exploration
SUA	Sokoine University of Agriculture
UCBS	Uluguru Component Biodiversity Survey
UDSM	University of Dar es Salaam
UMADEP	Uluguru Mountains Agricultural Development Project
UMBCP	Uluguru Mountains Biodiversity Conservation Project
UMEMCP	Uluguru Mountains Environmental Management and Conservation Project
UMEMCP	Uluguru Mountains Environmental Management and Conservation Project
WCST	Wildlife Conservation Society of Tanzania

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1.0 INTRODUCTION

1.1 Background to the Biodiversity Survey

The Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Component (GEF/UNDP:URT/01/G32) is a project of the Forest and Beekeeping Division of the Ministry of Natural Resources and Tourism and it is funded by the Global Environment Facility through the United Nations Development Programme. CARE International in Tanzania implements the Uluguru Component under terms of an agreed Memorandum of Understanding with the Forest and Beekeeping Division that was signed on the 12th August 2003.

The purpose of the Uluguru Component is:

Improved forest management and conservation and improved land husbandry practices in the Uluguru Mountain forests and adjacent villages implemented by local communities, government authorities and other stakeholders.

Frontier-Tanzania* was contracted by CARE International in Tanzania to undertake a biodiversity survey to provide a baseline to assess the impact of the project on the flora and fauna of the Uluguru Mountains and generate information relevant to the development of management plans for the Uluguru Mountain forests. This report serves to detail the methodologies employed by Frontier-Tanzania to conduct biodiversity and human disturbance surveys of the Uluguru North and Uluguru South Forest Reserves.

Specific aims and objectives of the survey were defined in the ToRs as:

Aim: To undertake systematic biodiversity and forest resource-use assessment of the Uluguru North and Uluguru South Catchment Forest Reserves to establish a baseline for measuring the Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Component's impact on maintaining biodiversity values and reducing threats in the longer term.

Objectives of the biodiversity assessment:

1. Major types of forest disturbance and proportion of habitat affected by forms of disturbance;

2. Population density of key floral indicator species e.g. *Allanblackia uluguruensis; Ocotea usambarensis;*

3. Species richness of flora and vertebrates; and

4. Crude abundance of endemic; globally threatened and Eastern Arc characteristic species.

1.2 Linkages to Frontier-Tanzania Forest Research Programme

Frontier-Tanzania has been conducting baseline biodiversity surveys within biologically the rich Eastern Arc and Coastal forests since 1989. Technical reports have been published from

* Frontier-Tanzania a collaboration between the University of Dar es Salaam and the Society for Environmental Exploration

work in the Coastal forests and the following Eastern Arc Mountains: East Usambaras, Udzungwa, Mahenge; and Mpanga / Kipengere Game Reserve. [*]

During the East Usambara forest biodiversity surveys, Frontier-Tanzania Forest Research Programme (FT FRP) developed an effective methodology that allowed systematic baseline biodiversity surveys to be conducted in a cost-effective way. This methodology has been applied to the present study and is comprehensively documented in this volume (Volume I) of this series of project reports. Frontier-Tanzania provides feedback to the Catchment Forest Project of the Forestry and Beekeeping Division of the Ministry of Natural Resource and Tourism (FBD) on the strength of their research findings, as well as training in survey techniques used to facilitate future monitoring initiatives. The long-term aim of FT FRP is to provide baseline information about targeted areas, those understudied and unknown, within the Eastern Arc Mountains, thus helping to further scientific knowledge, identify conservation values and allow effective development of forest management plans.

1.3 Uluguru Component Biodiversity Survey Reports

Three reports (Volumes I to III) exist in the Uluguru Component Biodiversity Survey 2005 series. The reports are the culmination of five months of field working within the Uluguru North and South Forest Reserves.

Uluguru reports in the series

Frontier-Tanzania (2005) Uluguru Component Biodiversity Survey 2005 (Volume I): Methods Manual. Bracebridge, Fanning, Howell, Rubio & St. John (eds). Society for Environmental Exploration and the University of Dar es Salaam; CARE-Tanzania, Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Component, Forestry and Beekeeping Divison of the Ministry of Natural Resources and Toursim, GEF/ UNDP:URT/01/G32.

Frontier-Tanzania (2005) Uluguru Component Biodiversity Survey 2005 (Volume II): Uluguru South Forest Reserve. Bracebridge, Fanning, Howell, Rubio & St. John (eds). Society for Environmental Exploration and the University of Dar es Salaam; CARE-Tanzania, Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Component, Forestry and Beekeeping Divison of the Ministry of Natural Resources and Toursim, GEF/ UNDP:URT/01/G32.

Frontier-Tanzania (2005) Uluguru Component Biodiversity Survey 2005 (Volume III): Uluguru North Forest Reserve. Bracebridge, Fanning, Howell, Rubio & St. John (eds). Society for Environmental Exploration and the University of Dar es Salaam; CARE-Tanzania, Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Component, Forestry and Beekeeping Divison of the Ministry of Natural Resources and Toursim, GEF/ UNDP:URT/01/G32.

[*] refer to Frontier Publications List www.frontier.ac.uk. Selected reports will be available for download on the website shortly

1.4 The Eastern Arc and Uluguru Mountains

The Eastern Arc Mountains are defined as the broken mountain chain stretching from Taita Hills in south-eastern Kenya and extending down to the south-western part of Tanzania. Each mountain range is separated from the next by drier woodland and savannah vegetation, although they all share a common geological history that dates back to at least the Miocene (Griffiths, 1993). Evidence shows that each mountain range is a block-fault mountain, shaped by periods of repeated uplift and vertical movements followed by longer periods of stability and erosion (Griffiths, 1993). The high proportion of endemic forest-dwelling organisms in the Eastern Arc is ascribed to the long presence of a humid forest cover fostered by a seasonal, but highly predictable rainfall pattern (Lovett 1993). This precipitation arises from moisture evaporating from the Indian Ocean, being subsequently carried towards the East African coast and discharged (Lovett, 1990 & 1993).

The Uluguru Mountain range is part of the Eastern Arc Mountains. The range is host to isolated patches of ancient crystalline forest, located 180km west of the Indian Ocean. It is under the direct climatic influence from the Indian Ocean, with the eastern slopes consequently having a much higher rainfall per annum than the western slopes. The main Uluguru range stretches 45 km along a north-south axis. Uluguru North rises to 2340m and is divided from Uluguru South (up to 2638m) by the Bunduki gap, a deforested saddle between the two ridges. The FRs encompasses the montane forest and grassland, with steep slopes on either side. There are many summits in each reserve: North – Lupanga (2138m), Kinazi (2150m), Bondwa (2120m), Nziwane (2270m), Magari (2340m), Miwa (1900m), Mnyanza (2140m) and Kifuru (2010m); South – Makumbaku (2420m), Kimhandu (2638m) and Lukwangule (2634m). The 20km^2 Lukwangule plateau is between two parallel north-south ridges at an altitude of over 2300m. The mountain range is divided from the lowland plains (which stretch to the coast, Selous, Mikumi) by foothills.

Soil types are acidic lithosols and ferralitic red, yellow and brown latosols, which have developed on Precambian granulite, gneiss and migmatite rocks. Some of the upper areas, such as Lukwangule Plateau are covered by peat deposits. The Ngerengere and Morogoro rivers, originating in the North FR, provide water for Morogoro before flowing into the Ruvu river (which also drains Uluguru south) to supply Dar es Salaam.

The Uluguru North and South Reserves cover 8,356.7 ha and 17, 292.7 ha respectively. They lie in the Districts of Morogoro and Mvomero in Morogoro Region. The altitude varies between 1000m and 2638m a.s.l., Latitude between 37^{0}36’ and 37^{0}45’E and Longitude between 6^{0}51’ and 7^{0}12’S. The nearest town large town is Morogoro 5km and 10km to the north-west, respectively from the North and South FRs.

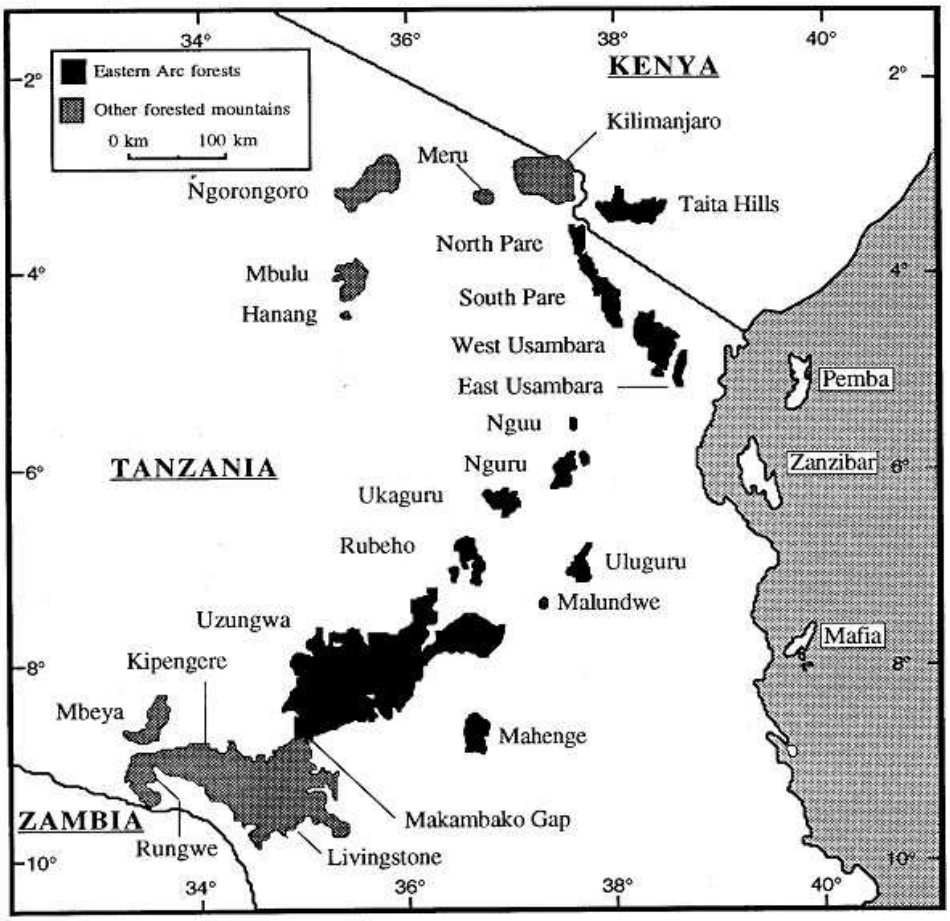

Figure 1 Mountains of eastern Tanzania and southern Kenya that support moist forest. Eastern Arc Forests shown in black. From Lovett (1993).

2.0 AIMS AND OBJECTIVES AND OVERVIEW OF METHODS

Aim:
To undertake systematic biodiversity and forest resource-use assessment of the Uluguru North and Uluguru South Catchment Forest Reserves to establish a baseline for measuring the Conservation and Management of the Eastern Arc Mountain Forests (CMEAMF): Uluguru Components' impact on maintaining biodiversity values and reducing threats in the longer term.

Objectives:[*]

1. To conduct baseline biodiversity surveys (flora and fauna), assessing both species richness and diversity, using systematic surveys methodologies, field observations, and opportunistic collections.

2. To conduct baseline forest disturbance surveys, using systematic survey methodologies, field observations, and casual collections to quantify anthropogenic threats.

3. To collate and disseminate baseline biodiversity and forest resource-use information through the production of reports.

4. To provide information on the biological value and use of the forests based on systematic surveys.

The methods in this manual have been devised and compiled in order to collect data to facilitate and describe the following:

i). Major types of forest disturbance and proportion of habitat affected by forms of disturbance:

This is achieved through conducting forest disturbance surveys. Disturbance is categorised via quantitative assessment of pole (5>15cm dbh) and timber (≤15cm dbh) cutting along stratified semi-randomly placed transect lines. Vegetation plots are placed along transect lines, allowing quantitative vegetation analysis. Each transect is stratified into two categories: 'edge' classified as starting from the forest edge to 500m inside of the reserve or 'interior' starting from 500m or more inside the reserve, with 900m transects placed semi-randomly within the two conditions. Evidence of grazing, burning, charcoal production, settlement, hunting/trapping, pit-sawing, honey-collection is recorded per 50m. For field purposes, habitat is initially categorised as either lowland (X<800m a.s.l), sub-montane (1500m>X>800m) or montane (X>1500m), and then further categorised during report production.

ii). Population density of key floral indicator species e.g. Allanblackia uluguruensis; Ocotea usambarensis.

Quantitative vegetation analysis is achieved through the demarcation of 0.1 ha (50 x 20m) vegetation plots at a sampling intensity of approximately 0.03%, where vegetation plots are sited approximately every 400m along transect lines, allowing two or three vegetation plots to be demarcated per transect. Tree species composition is evaluated using the vegetation plot data. Each tree ≤ 10cm diameter at breast height (dbh) is identified, marked and measured. Regeneration subplots (3x3m) are established to identify those genera/species regenerating

[*] As per the CARE-Tanzania Consultant Agreement with the Society for Environmental Exploration/Frontier-Tanzania

through ground and shrub layers (0.5cm ≤10cm dbh). There is huge potential for utilising multivariate analyses (such as DECORANA) with these data from the Ulugurus, East Usambaras, Udzungwas and Mahenge mountains, where systematic data exists for comparative analysis within the hotspot. Specific indicator species data can be extracted from the major project data-set.

Opportunistic botanical sampling is conducted to supplement systematic data collection, to compile a more comprehensive botanical inventory. This will include herbaceous and woody plants.

Plant species are identified in the field by botanists. Botanical samples are collected where field identification is not possible, with duplicate specimens deposited for identification and curation at the University of Dar es Salaam Herbarium, Arusha Herbarium. Selected specimens are sent to Missouri and Kew botanical gardens for future verification description of potential new species.

iii) Species richness of flora and vertebrates.

Floral species richness is determined from the vegetation plot and opportunistic botanical recording and collection. This can be presented as a species inventory checklist.

Vertebrate species richness are determined using a variety of methods and survey techniques. Zoological traps sites are conducted within representative forest habitats. Trap sites are sampled for an eight trap night duration, to record mammal, bird, amphibian and reptile species utilising: 100 Sherman traps [small mammals]; 33 bucket pitfall traps within 3 trap lines (11 buckets/line) [small mammals, reptiles and amphibians]; standardised timed searches (approximately 15 man hours per trap site) for amphibians and reptiles; mist nets and potential use of harp traps to sample bats (mega and micro-chiroptera) within a standardised effort calculated by net metre hours; mist nets to sample birds within a standardised effort calculated by net metre hours; dung and track survey along transect lines. Opportunistic species records and specimen collection occurs throughout the field-work.

Each animal is identified with appropriate data recorded (i.e. sex, weight, and location of capture), entered onto data sheets titled MAMMAL, BATS, REPTILE and AMPHIBIAN. Bird and bat data books will store effort, location and species data from each location (trap site, transect, opportunistic).

In total, at least six systematic trap sites are studied during the project period, spending 8 nights at each trap site. If time permits, an extra trap site is studied.

iv) Crude abundance of endemic; globally threatened and Eastern Arc characteristic species.

Analysis of the project raw data includes species categorisation, using for example: IUCN Red List, CITES, National Biodiversity Database, LEAP database (Knox 2000), Iversen (1991). Species can be categorised, for example, by: ecological requirements (forest dependent, forest non-dependent, non-forest species), endemism (endemic, near-endemic, wide-spread), habitat (lowland, sub montane, montane), using a variety of references readily available to Frontier-Tanzania (2001). Crude abundance can be illustrated by using GIS applications. Categories will be defined during the preparation and report production period of the project.

Taxonomic verification: Selected specimens are sent to a number of taxonomic authorities at established institutions via UDSM's collaborative links. Frontier-Tanzania has been successfully collecting, storing and exporting specimens for 15 years. Voucher specimens are sorted and deposited at UDSM for reference and teaching purposes. Professor Kim Howell

(Zoology Dept. UDSM) is able to facilitate export permits and obtain CITES clearance from the Wildlife Division, Ministry of Natural Resources and Tourism. All specimens are the property of UDSM. Species lists will be sent back to the UDSM and Frontier-Tanzania when specimens have been identified in order to verify and update field identifications.

3.0 FOREST DISTURBANCE ASSESSMENT

In line with the aims of the Uluguru Component Biodiversity Survey (UCBS), an integrated survey of the vegetation types within each forest reserve are undertaken. This enables both floristic diversity and composition to be assessed. Furthermore, disturbance within each forest reserve is surveyed to determine the level and pattern of human pressure facing each forest under investigation. Simple, quantitative methods are employed. These methods are outlined in the following section of this report.

3.1 Disturbance transects

3.1.1 Aims

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:

3.1.2 Method of sampling

The procedure is systematic. The sampling unit is the disturbance transect. The disturbance transects are carried out where the forest is accessible, therefore the sampling method is stratified and semi-random. The level of both pole cutting and timber extraction are assessed.

For the purposes of this survey, 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 exceeding 15cm dbh.

The level of disturbance is assessed in terms of the number of poles and timber 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. Disturbance is recorded along all 900m sections of the transect lines.

3.1.3 Procedure

A team of three people are required; two observers and one recorder. The team starts at the beginning of the transect line (i.e. at the forest boundary). Five metres either side of the transect line are investigated for cut, standing and naturally fallen poles and timber. Cut timbers and poles are described as ‘old cut’ if there was any blackening of the stump, if none is seen it was recorded as ‘fresh cut’. One observer describes one side of the transect the second observer describes the other side, and the recorder notes down all observations made. 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 then further along the transect count the base from which it came. Opportunistic notes on other human disturbance seen along the transect are made, such as animal traps, pitsaw sites, cleared areas, evidence of fire, charcoal production or grazing.

3.1.4 Data entry

For each transect, the disturbance is recorded on the data sheet titled DISTURBANCE SURVEY SUMMARY.

F.R. CODE	Forest reserve code.
TRANSECT NO	Write the transect line number. One transect was recorded on one sheet.
DISTURBANCE CATEGORY	Fill in the codes beside the plot number.
PLOT ID	Write in the plot number once.
DISTURB. CAT.	Write the disturbance categories in this section. **This section was for all disturbance observed in the plot not just during the disturbance survey. Note how many times each was observed.
SECTION	Record the disturbance information per section.
NO. OF LIVE SAPLINGS	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 SAPLINGS	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 SAPLINGS 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 TREES	Record the number of standing, live saplings. Saplings were defined as >15 dbh and a straight trunk of at least 3m in length.
NO. OF NAT. DEAD TREES	Record the number of standing, live saplings. Saplings were defined as >15 dbh and a straight trunk of at least 3m in length.
NO. OF CUT TREES OLD/FRESH	Record the number of standing, live saplings. Saplings were defined as >15 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.

4.0 VEGETATION/BOTANY

4.1 Quantitative vegetation analysis

This method is modified from the East Usambara Biodiversity Survey (EUBS) 900m x 450m grid. In order to cover the large reserve area the sampling intensity has been decreased.

4.1.1 Aims

- To determine species richness of flora through sampling trees equal to or greater than 10cm dbh within systematically located vegetation plots in the survey area;

- To determine the floristic composition of the forest under investigation and the population density of key floral indicator species e.g. *Allanblackia uluguruensis; Ocotea usambarensis;*

- To determine a crude abundance of endemic; globally threatened and Eastern Arc characteristic plant species

4.1.2 Method of sampling

The method of sampling is semi-random stratification. The sampling unit is a vegetation plot, a 50m x 20m (0.1 ha) rectangle located along each transect.

The sampling intensity will vary depending on forest size and length of time spent in the forest reserve.

4.1.3 Procedure

4.1.3.1 Transects

Transects are established throughout the forest reserve. Transects are most often orientated from west – east to facilitate maximum sampling of the altitudinal variation.

Transects are established using a pre-measured 50m rope, a clinometer, a compass and coloured plastic tags. Each 50m section of transect is cut through the forest on a 90 or 180 degree bearing. Regardless of the vegetation type, two plastic tags are placed at each 50m interval along the transect and the distance along that transect section was written; for example, at 50m along the transect, the tags were marked “50m”. After another 50m, the two tags were marked “100m” etc.

Vegetation plots are established at one of the 50m tags. They are orientated 50m along the transect line (usually east) and 20m north from this tag.

Transects are numbered sequentially. Each section along the transect is also given an identification number. This identification number is the same given to the 50m x 20m vegetation plot.

4.1.3.2 Vegetation plots

The 50m x 20m vegetation plot is established using a compass and pre measured ropes (2 x 20m ropes and 2 x 50m ropes). The 50m ropes are laid on a 180 or 90 degree (east – west) bearing and the 20m ropes are laid using 0 or 270 degree (north – south) bearing, the ropes remain laid out while the trees are being measured and marked.

Once the ropes are laid out, all trees with 10cm dbh and over are marked and recorded. Diameter is measured at a standard height of 1.3m above ground level, on the uphill side of the stem. These measurements are made using a tape calibrated (dbh tape) to give a diameter reading from the circumference measured. All trees in the 50m x 20m plot are marked using red gloss paint. A line is painted where the dbh measurement is made. Then, all trees and shrubs of 10cm dbh and above within the 50m x 20m plot, are numbered sequentially

beginning at "1". This individual tree identification number is painted directly below the dbh line. Above the dbh line, the number of the vegetation plot is painted; refer to Figure 2 for an illustrative example.

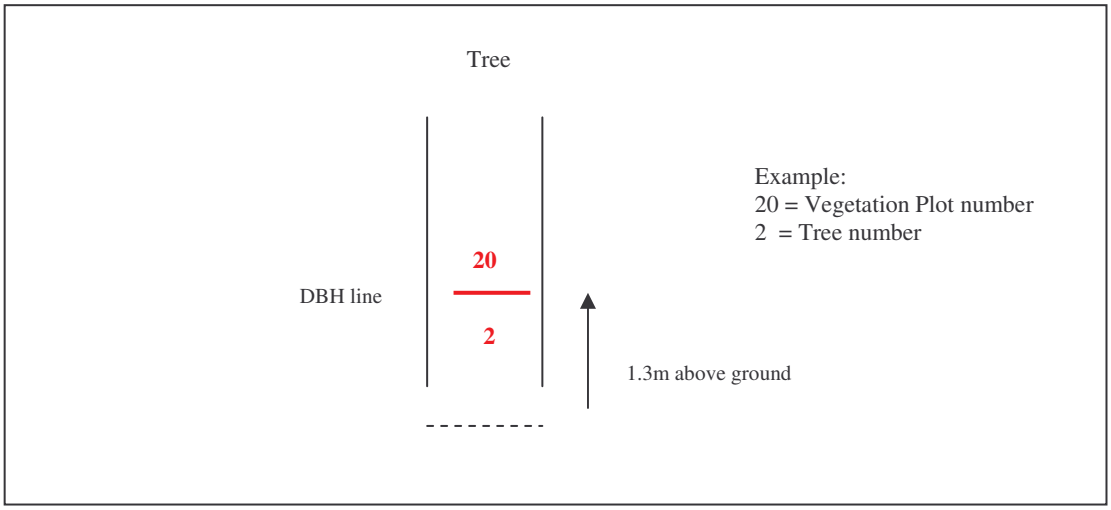

Figure 2 A diagram of diameter at breast height (DBH) measurement of trees (>10cm DBH) and the painting protocol.

Plot number (e.g. 20) is painted above tree number (e.g. 2), with a line between the two showing where the DBH was measured

Multi-stem trees with individual stems of less than 10cm dbh, are recorded if the cumulative dbh was 10cm or over. All stems arising from the central stem at 1.3m and below are added. The stems are marked with paint at the dbh measurement point. If the tree has a buttress, the dbh is measured 1.3m above the top of the buttress (where possible). For some specimens this has to be estimated as this height is not within reach. Fallen trees that are still alive are processed as above. Dead trees are not counted. Where the tree is growing on a slope the 1.3m is measured from the uphill side of the tree (Figure 3).

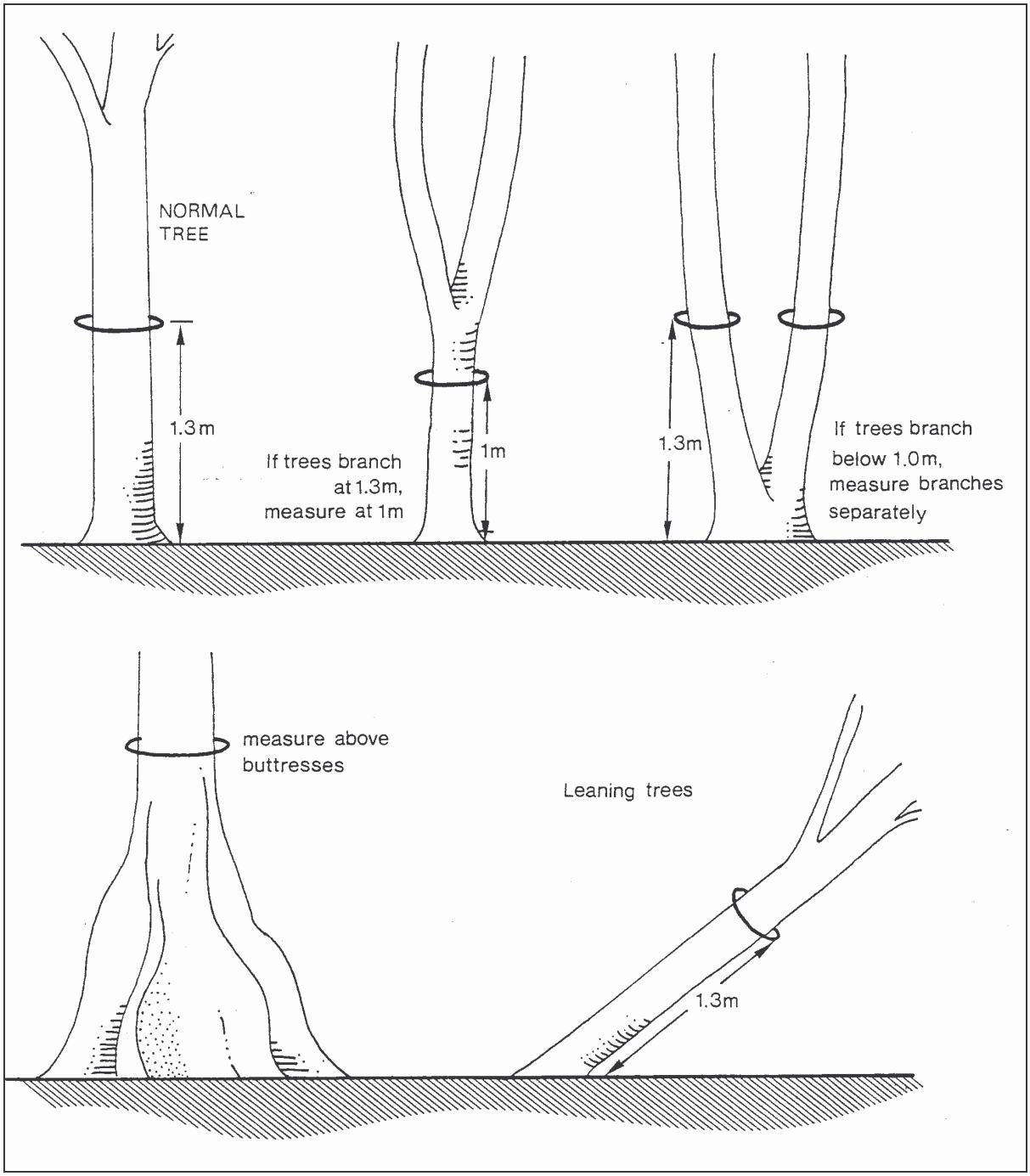

Figure 3 Diagram of how to measure dbh within vegetation plots

4.1.4 Data entry

Summary sheets, titled VEGETATION PLOT (50m x 20m), are filled in for each 50m x 20m plot.

F.R. CODE	Forest reserve code.
TRANSECT NO	Number of line on which the 50m x 20m plot lies.
PLOT ID	Each plot was given a unique number.
TEAM	Initials or name of people doing the vegetation plot.
DAY	Write in numbers.
MONTH	Write in numbers.
YEAR	Write in numbers.
ALTITUDE (m)	Altitude in metres at the 0 mark of the plot.
SLOPE (deg)	Slope in degrees at the 0 mark of the plot.
ASPECT	General aspect of the plot. Aspect measures direction down the slope.
TOPOGRAPHY	Check only one which describes the position of the 50m x 20m plot.
GENTLE LOWER SLOPE	Slope of $<30^{o}$ at the lower third of a hill. This was a macro-habitat note.
STEEP LOWER SLOPE	Slope of $>30^{0}$ at the lower third of a hill. This was a macro-habitat note.
GENTLE MID-SLOPE	Slope of $<30^{o}$ at the middle third of a hill. This was a macro-habitat note.
STEEP MID-SLOPE	Slope of $>30^{o}$ at the middle third of a hill. This was a macro-habitat note.
GENTLE UPPER SLOPE	Slope of $<30^{o}$ at the upper third of a hill. This was a macro-habitat note.
STEEP UPPER SLOPE	Slope of $>30^{o}$ at the upper third of a hill. This was a macro-habitat note.
RIDGE/HILL TOP/PEAK	Narrow area at the top of a mountain. This was a macro-habitat note.
UPLAND PLATEAU	Level area at altitude away from valley floor. This was a macro-habitat note.
VALLEY FLOOR	Low-lying area between two ridges. This was a macro-habitat note.
LOWLAND PLAIN	This was a macro-habitat note.
GULLY	Channel cut by water. This was a macro-habitat note.
OTHER	Use sparingly.
SIGNS OF PAST USE	Check as many as required. These relate only to the 50m x 20m plot.
FEATURES OF INTEREST	Check as many as required. These relate only to the 50m x 20m plot.
VEGETATION TYPE	Check only one in the following section.
LOWLAND FOREST	Relatively continuous stand of trees at least 10m tall, with interlocking canopy, less than 850m a.s.l..
SUBMONTANE FOREST	Relatively continuous stand of trees at least 10m tall, with interlocking canopy, 850m or higher a.s.l..
MONTANE FOREST	Relatively continuous stand of trees at least 10m tall with interlocking canopy, above 1200m a.s.l..
SWAMP FOREST	Relatively continuous stand of trees at least 10m tall, with interlocking canopy in an area that has a high water table or on land permanently water-logged.
COLONIZING FOREST	Broken canopy cover with many young trees. This was usually a previously disturbed area.
RIVERINE FOREST	Relatively continuous stand of trees at least 10m tall with interlocking canopy found in patches along banks of rivers, streams or lakes.
PLANTATION FOREST	Planted tree species.
(OPEN) WOODLAND	An open stand of trees at least 8m tall with a canopy cover of 40% or more. Usually grassy understory.
SCRUB/THICKET/BUSH	An open or closed stand of shrubs or bushes up to 7m in height with a canopy cover of 40% or more.
BAMBOO	Dominated by bamboo grasses.
GRASSLAND	Land covered with grasses and other herbs with or without woody plants not covering more than 10% of the ground cover.
HERB. MARSH/SWAMP	Areas permanently waterlogged with lower canopy cover.
FERNS DOMINATED	Areas where ferns were the most common plant. Usually this vegetation type occurs at higher altitudes.
FALLOW/PREV. DISTURBED	Areas formerly cultivated but now regenerating.
CULTIVATION	Areas where the dominant plant species were domesticated.
ROCK/BARREN	Areas with little or no vegetative cover.
OTHER	Specify vegetation type. Use sparingly.
TREE CANOPY	Estimate the extent that the foliage blocks out the sky. This was general for the 50m x 20m plot.
GROUND LAYER	Estimate the extent that the grass and herb layer covers the ground. This was general for the 50m x 20m plot.
SHRUB LAYER	Estimate the extent that the lower canopy blocks out the sky. This was general for the 50m x 20m plot.
CANOPY HEIGHT	Estimate the average height of the upper canopy excluding emergents.

WATER ASSOCIATION	Check only one of the following.
RIVER	Generally taken as a watercourse with a name regardless of size.
STREAM	Usually an unnamed watercourse.
POND/LAKE	A non-stagnant pool of water
MARSH/SWAMP	A relatively stagnant pool of water.
DRY RIVER BED	A seasonal water course.
OTHER	Use sparingly.
SPECIMEN NO	A unique number was given for each tree or shrub. This number was painted on each specimen with the plot number printed above it. A line was drawn between the two numbers at the point were the dbh was measured.
DBH (cm)	Diameter at breast height measurement of tree or shrub.
GENUS	This was left blank, to be filled in by the botanist.
SPECIES	This was left blank, to be filled in by the botanist.
SUBSPECIES	This was left blank to be filled in by the botanist.

4.1.5 Identification

Tree species are identified in the field. If field identification is not possible, duplicate botanical specimens are collected for identification. Specimen duplicates are sent to national and international herbaria, University of Dar es Salaam; and Missouri Botanical Gardens, USA.

4.2 Regeneration

4.2.1 Aims

- To sample trees and shrubs less than 10cm diameter at breast height (dbh) within the survey area.

- To determine whether or not the species regenerating were typical forest species or invasive.

- To assess the diversity and endemism of regenerating tree and shrub species.

4.2.2 Method of sampling

The method of sampling is systematic. The sampling unit is a 3m x 3m (6 x 6) subplot at the centre of the 50m x 20m vegetation plot. The sampling intensity is 0.9 % (3.6%) of the sampled vegetation plot.

4.2.3 Procedure

The regeneration plot is laid out using a tape measure in the centre of the 20 x 50m vegetation plot. All woody growth less than 10cm dbh is counted and identified. If the plant is less than 1cm dbh, the height measurement is recorded. One regeneration subplot was made in each of the 50m x 20m plots.

4.2.4 Data entry

The form titled REGENERATION SUBPLOT (3 X 3m) was filled in for each subplot.

F.R. CODE	Forest reserve code
TRANSECT NO	Record the transect number.
PLOT NO	Record the number of the 50m x 20m plot.
TEAM	Name or initials of people present.
COVER (%)	Total to 100%.
DOMINANCE (%)	Total to 100%.
SOIL TEXTURE	Choose only one.
SOIL COLOR	Choose only one.
SPECIMEN NO	These were number consecutively from 1 up.
DBH (cm)	Only count those between 1 and 9cm dbh and record here.
HEIGHT (cm)	Only mark if the specimen was 1cm dbh and below.
GENUS	Identify if possible.
SPECIES	Identify if possible.
SUBSPECIES	Identify if possible.

The following was used as a guide for soil texture.

1. Does the soil form a coherent ball? Easily = (2)
   No = Sand
   With great care = Loamy Sand (check using 1 and 2)
2. What happens when the ball was pressed between thumb and fore finger?
   Flattens coherently = (3)
   Tends to break up = Sandy Loam (check using 3 & 4)
3. On slightly further moistening, can the ball be rolled into a thick cylinder (5mm thick)?
   Yes = (4)
   No, ball collapses = Sandy loam
4. On slightly further moistening ,can the cylinder be rolled into a cylinder 2mm thick?
   Yes = (5)
   No = Sandy loam
5. Can the thread be bent into a horseshoe without cracking?
   No = (6) Yes = (7)
6. On remoulding with further moisture, what was the general 'feel' of the soil?
   Smooth and pasty = Silty Loam
   Rough and abrasive = Sandy Silt Loam
7. Can a ring of 25mm diameter be formed by joining the two ends of the thread without cracking?
   No = (8) Yes = (9)
8. On remoulding with further moisture, what was the general 'feel' of the soil?
   Very gritty = Sandy Clay Loam
   Moderately tough = Clay Loam
   Doughy = Silty Clay Loam
9. On remoulding without rewetting, can a surface be polished with the thumb?
   No = (8) Yes, a high polish = (10)
   Yes but gritty particles were very noticeable = Sandy Clay.
10. On wetting thoroughly, how does the soil stick ones fingers together?
   Very strongly = Clay
   Moderately strongly = Silty Clay

4.2.5 Identification

Tree species are identified in the field. Specimen duplicates are sent to national and international herbaria, University of Dar es Salaam; National Herbarium of Tanzania, Arusha; East Africa Herbarium, Nairobi; and Missouri Botanical Gardens, USA. If field identification is not possible duplicate botanical specimens are collected and mounted for identification by Frank Mbago of the University of Dar es Salaam.

4.3 Plant collection and opportunistic botanical sampling

4.3.1 Aims

- To collect plant specimens in order to facilitate formal taxonomic verification of species.
- To supplement the data collected during the systematic vegetation survey.
- To compile a more comprehensive botanical checklist.
- To determine the floristic composition of the forest under investigation.

4.3.2 Method of sampling

The method of sampling is opportunistic. Specific focus is given to the location of endemic trees and shrubs and fruiting and flowering material. During the field work project staff conducted opportunistic botanical sampling. The amount of time for such sampling is related to the size of the forest, its vegetation diversity, and other field activities.

4.3.3 Procedure

Casual surveys are carried out by walking through the forest under investigation. During this time the research staff make a particular effort to visit any habitats that do not fall into the systematic vegetation plots. During this type of survey, herbarium specimens are collected, and detailed notes on each sampled plant are taken including its macro and micro habitat. Preliminary field identifications are also made where possible. Particular emphasis is on the location and identification of endemic and near-endemic trees and shrubs.

Specimen collection procedures follow those of the Missouri field techniques.

4.3.4 Identification

Specimens are identified in the field where possible and specimen duplicate sent to national and international herbaria, University of Dar es Salaam; National Herbarium of Tanzania, Arusha; East Africa Herbarium, Nairobi; and Missouri Botanical Gardens, USA.

5.0 FAUNA ASSESSMENT

This section details the procedure for each trapping and observation method used by the UCBS to assess faunal diversity within each study site. Studies are undertaken for a number of "core" taxonomic groups: small mammals; bats; reptiles; and amphibians. In line with the specific aims of the CMEAMF: Uluguru Component, an inventory of these core faunal groups was undertaken at each study site.

All specimens retained for taxonomic purposes are assigned a unique field identification number. Each number is preceded by the code KMH. These are the initials of Professor K. M. Howell at the Zoology Department, UDSM, a Co-ordinator of Frontier-Tanzania. Additional identifications are carried out by various institutions where specimens are held on loan (section 6.0).

All specimen details are entered into the Biodiversity Database held by the Department of Zoology and Marine Biology of UDSM, administered by Prof. K. M. Howell. All future taxonomic determinations will be recorded on this database.

5.1 Capture method

5.1.1 Sherman trapping

5.1.1.1 Aims

- To collect and study a representative sample of the forest small mammal community with reference to associated vegetation types

5.1.1.2 Method of sampling

Sherman traps sample diurnal, crepuscular, and nocturnal mammals whose habitat is the forest floor. Scansorial mammals (those adapted to climbing) are also sampled as traps are placed in lower tree branches. Sampling of small mammals is carried out using lines of Sherman traps. An attempt is made to sample the range of vegetation types within the study site. The sampling unit is the trap night.

The sampling intensity is calculated as follows:
100 traps x number of trap nights (8) per site = number of trapping nights

trapping nights x number of trap sites = total trapping nights per forest reserve

5.1.1.3 Procedure

Traps are set around the bucket pitfall lines (33 or 34 Sherman trap per line), each placed at approximately 2-5m intervals. Traps are placed in likely mammal habitats, including: the base of large trees; on/under/near rotting logs; on branches; along vegetation boundaries; in dense under storey; and around rocks. At each trap site several of the traps are also placed in the lower branches of trees, up to 1.3m above ground, in order to catch scansorial species. Large open spaces with no ground cover are avoided as these were unlikely habitats. A tag is tied at eye level as directly above the trap as possible. Tags are positioned so that they are visible from one trap to another in order to facilitate relocation. This prevents traps being lost and makes the trap line easy to follow and re-bait. Each trap and tag is numbered to facilitate checking and re-baiting.

Traps are baited with fried coconut mixed with peanut butter. Trap lines are left for 8 nights at each sampling plot (trap site). Traps are baited every evening and checked as early as possible the following morning. Traps are set as sensitively as possible.

Most trapped specimens are still alive. Animals to be collected as specimens are placed into an airtight plastic bag containing a small amount of cotton wool soaked in chloroform. Once

dead, the specimen is removed carefully so as not to damage it. Duplicate animals that are released are identified, measured, described and given a unique coding (by cutting small sections of fur from the back), before being released. At the end of the survey, traps are cleaned thoroughly, sun-dried and the spring mechanism checked before storage.

5.1.2 Bucket pitfall trapping

5.1.2.1 Aim

- To collect and study a representative sample of the shrew, reptile and amphibian communities of the forest with reference to associated vegetation types

5.1.2.2 Method of sampling

Bucket pitfall trapping samples diurnal, crepuscular and nocturnal vertebrates whose habitat is the forest floor. Trap sites are selected in a stratified manner dependent upon habitat type and are then sampled systematically. The sampling unit is the pitfall array. An attempt is made to sample the range of vegetation types within the trap site.

Sampling intensity is calculated as follows:
33 buckets x number of trapping nights (8) = number of trapping nights
Trapping nights x number of trap sites = total trapping nights per forest reserve

5.1.2.3 Procedure

A single bucket pitfall array comprises a line of 11 x 20 litre plastic buckets, each of which is sunk into the ground until the rim is level with the ground or slightly below. Each bucket is placed at 5m intervals from the next in a more or less straight line. A single sheet of transparent plastic 55m in length is erected as a "drift fence" such that it runs continuously down the centre of the line of buckets. The plastic drift fencing is perpendicular to the ground and crosses the centre of each bucket. Support stakes are positioned at least at every metre in order to keep the fencing erect. A stake is also positioned on either side of every bucket in order to keep the drift fencing stretched to the maximum. It is important to clear away vegetation from under the drift fence and that the overlap (lip) is flush to the ground with soil and leaf litter piled on top. Two slits are made in the lip above the bucket to prevent animals using the lip as a bridge over the bucket. Any animals encountering the plastic fence are channelled into a bucket. Three lines of 11 buckets are located within each trap site. Buckets are checked twice a day: early in the morning and in the afternoon when Sherman traps are baited.

Figure 4 Photo of zoological site in Uluguru South FR

5.1.3 Bat netting

5.1.3.1 Aim

- To collect and study a representative sample of the forest bat community with reference to associated vegetation types

5.1.3.2 Method of Sampling

Sampling of bats is carried out by mist netting. Netting sites are located close to likely bat roost sites and flyways within the forest. Sampling intensity varies between forest reserves and is calculated as follows: number hours x metres of net erected. The time of sampling encompasses both nocturnal and crepuscular bat species.

5.1.3.3 Procedure

Typical bat "flyways" or roost sites are selected for netting. Potential flyways are across streams and pools of still water, across paths or passes (between two valleys). Where possible, the nets are set so that a funnel effect can be obtained using the vegetation. Over water, the bottom of the net is positioned about 10cm above the water surface (to catch drinking bats without drowning them). The net is erected at dusk and constantly attended or checked every 15 minutes. Those attending the nets are as quiet as possible.

To erect the mist nets, any obstructing vegetation is first cleared from the net site. The nets are erected using two poles of approximately three metres in height. The first pole is placed into the ground and secured with the guy ropes tied at a 120^{o} angle to the direction of the net. There are five loops on each side of the bat net, each is attached to a horizontal string which divides the net into four panels. The loops are placed over the pole to hang the net upright. The first loop on each side of the net is coded blue, and the others are all black. This blue coded loop is placed uppermost on the pole. The net is unwound, keeping it taut and clear of the ground or water surface, and looped over the second pole using the same procedure with the blue coded loop uppermost. A check is made for twists in the net and then the guy ropes are tied loosely. The net is opened so that the horizontal strings were as taut as possible. Vertically, however, the panels are attached more loosely so that a bat flying into the net falls into the "bag" of the panels and doesn't "bounce off".

To remove a bat from the net, the collector stands on the side of the net that the bat flew into. The bat is held gently in the left hand (gloved) and disentangled with the right hand (this process is reversed if you are left-handed). The bat is held gently but firmly without squeezing, and untangled beginning with the feet. As each foot is loosened, they are placed gently on the gloved left hand so they have something to grip and don't immediately grasp for the net again (as a bat grips with its feet by natural instinct). The lower half of the body is then freed and then the wings. Special care is taken with the wings, as these are very delicate.

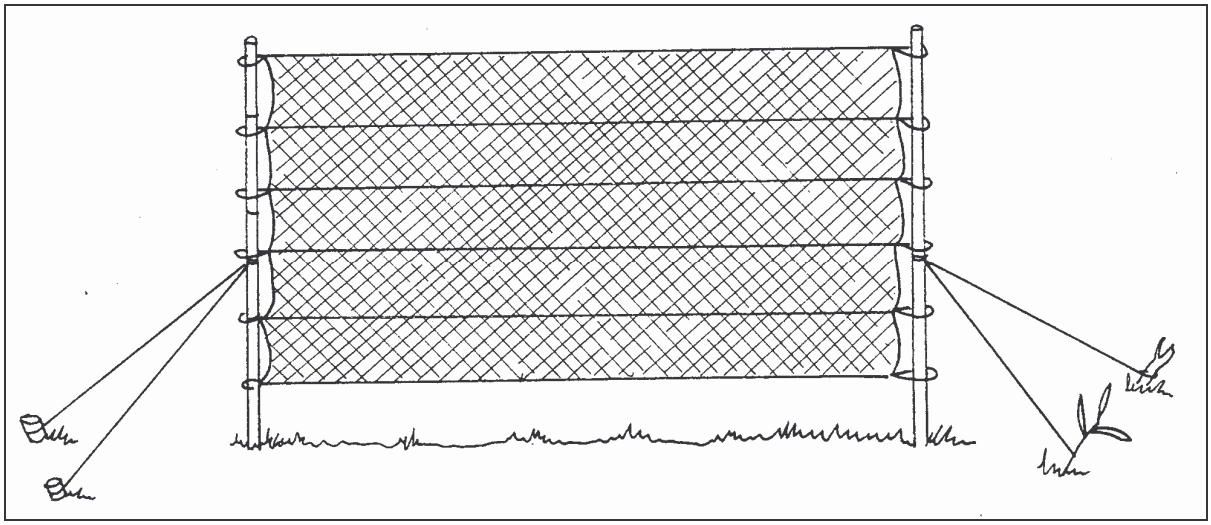

Figure 5 Detail of bat (and bird) netting arrangement

Once the bat is removed from the net it is measured and placed into a labelled cotton bag, tied securely and hung. The inside seams of all bat bags are checked to ensure there are no loose strands of cotton in which the bats may get tangled. Insectivorous bats can be put into two bat bags, one inside of the other. This can prevent them from chewing through the bag to free themselves. Once inside the bag the bat can be weighed. Time of capture, biometrics and bag number are recorded for each specimen in the bat book.

After the netting session, the nets are closed or taken down. To close the net the loops of the net are brought together on each pole, and the net loosely wrapped around itself. To take the net down the loops of the net are brought together on each pole. The loops of the first pole are taken off and the blue coded loop is tied through the others so that all loops on each side of the net are secured. The net is folded up towards the second pole. The loops are taken off the second pole and secured in the same way with the blue coded loop, and the net put away in its bag. Damp nets are dried before they are put away.

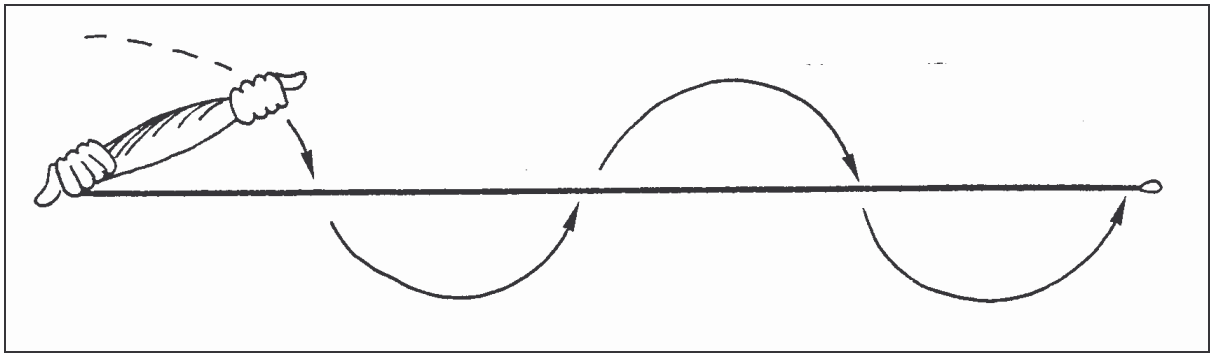

Figure 6 How to close and roll up a bat (and bird) net

All holes in the nets or bat bags are regularly repaired with fine black nylon thread. In situations where it is clear that duplicate specimens have been captured the duplicate is released, releasing females preferentially.

5.1.4 Birds

5.1.4.1 Aim

- To collate an extensive as possible inventory list of birds for the forest reserves under investigation

5.1.4.2 Method of sampling

Sampling of birds is carried out by mist netting, which targets under storey and lower canopy bird species. Sampling intensity varies between forest reserves and work sites and was calculated as follows: number hours x metres of net erected. Casual observations of both vocalisations and visual sightings are also recorded, which can supplement the species list of those higher canopy and/or shy birds.

5.1.3.3 Procedure

Netting sites are located where least visible to sample a variety of microhabitats such as shrubs, clearings and areas with mainly open forest floor. They are usually located within 150m of the camp site as this is where they are processed. Nets are erected at each site for two full days and are opened just before the onset of bird activity (05.30 hours) until half an hour before darkness (18.15 hours). The nets are closed at night to avoid entangling bats and destruction by nocturnal ground dwelling mammals. Mist netting can be carried out if night if certain nocturnal or crepuscular bird species are being targeted e.g. the Nightjar. Nets are checked every hour but more frequently in the early morning or when the weather conditions are not optimal.

To erect the mist nets, any obstructing vegetation is first cleared from the net site. The nets are erected using two poles of approximately three metres in height. The first pole is placed into the ground and secured with the guy ropes tied at a 120^{o} angle to the direction of the net. There are five loops on each side of the bat net, each is attached to a horizontal string which divides the net into four panels. The loops are placed over the pole to hang the net upright. The first loop on each side of the net is coded blue, and the others are all black. This blue coded loop is placed uppermost on the pole. The net is unwound keeping it taut and clear of the ground or water surface, and looped over the second pole using the same procedure with the blue coded loop uppermost. A check is made for twists in the net and then the guy ropes are tied loosely. The net is opened so that the horizontal strings were as taut as possible. Vertically, however, the panels are attached more loosely so that a bird flying into the net falls into the "bag" of the panels and doesn't "bounce off" (Figure 5).

To remove a bird from the net, the collector stands on the side of the net that the bird flew into. The bird is held gently in the left hand and disentangled with the right hand (this process was reversed if you were left-handed). The bird is held gently but firmly without squeezing, and untangled, beginning with the feet. As each foot is loosened, they are placed gently on the left hand so they have something to grip and don't immediately grasp for the net again. The lower half of the body is then freed and then the wings.

Once the bird is removed from the net it is placed into a cotton bag, tied securely and hung. It is sexed, scored for brood patch and moult status and measured. Time of capture is also noted. DNA specimens are taken from every bird by extracting blood from a vein in the wing. Skin specimens were taken as necessary; this a skilled job normally undertaken by an ornithologist. Birds which were wet or caught late in the evening were released immediately.

After the netting session, the nets are closed or taken down. To close the net the loops of the net are brought together on each pole, and the net loosely wrapped around itself. To take the net down the loops of the net are brought together on each pole. The loops of the first pole are taken off and the blue coded loop is tied through the others so that all loops on each side of the net are secured. The net is folded up towards the second pole. The loops are taken off the second pole and secured in the same way with the blue coded loop, and the net put away

in its bag. Damp nets are dried before they are put away (Figure 6). All holes in the nets or bat bags are regularly repaired with fine black nylon thread.

Hides can be placed at points with a good view of the forest canopy; however, new species are as likely to be observed in the vegetation close to the hide itself, provided that the observers remain quiet within the hide. Observation is best carried out in the early morning (0600-0900hr), and towards dusk (after around 1600hr), although many species are active throughout the day. Binoculars are used to aid identification, and a telescope is also useful when viewing from a hide. A portable tape recorder or notepad should be used to make notes and observations as soon after a sighting as possible.

5.1.5 Opportunistic sampling
5.1.5.1 Aims

- To supplement the systematic capture methods for the core vertebrate groups under investigation within each forest and, thereby, conduct a more comprehensive inventory

- To assess the diversity and endemism of the core vertebrate groups sampled with reference to associated vegetation types

5.1.5.2 Method of Sampling
Sampling intensity is variable between taxonomic groups, and the capture methods are generally by hand. Sampling is conducted throughout the work phase. Specimens were processed according to taxonomic group (see relevant specimen processing sections)

5.2 Specimen Processing

Specimens are processed according to taxonomic group: non-bat mammals; bats, birds, reptiles; and amphibians. Where possible, three specimens of each species captured are retained for taxonomic purposes (at least one female and one male). Other duplicates are released.

5.2.1 Mammals

5.2.1.1 Mammals (non-bats): data entry

For non-bat mammals, fill in the form titled MAMMAL (Not bat) data sheet. The information and definitions for this sheet is the same as the VEGETATION PLOT sheet except for the following:

PLOT ID ("O" If outside F.R.)	Record the plot in which the specimen was found. If the specimen was found outside the reserve, mark an "0" and write details on the back of the sheet.
KMH NO ("O" If not collected)	Record the field number that was tied to the specimen. If the specimen was observed only fill in the section below ID, IF NOT COLLECTED.
COLLECTOR	Name or initials of people involve. This aids in future verification of details.
DAY MONTH YEAR	Date that the specimen was collected.
ID, IF NOT COLLECTED	Check the box most likely to reflect the accuracy of the observation.
TAXON ID	Common name for specimen, i.e. bat, frog, rat.
GENUS	Tentative field identification to be verified by taxonomist.
SPECIES	Tentative field identification to be verified by taxonomist.
SUBSPECIES	Tentative field identification to be verified by taxonomist.
CAPTURE METHOD	For example, by hand. If captured by snap trap or bucket pitfall, record the specific trap number and bucket line number.
BAIT USED	Record the bait used or leave blank if none was used.
DETERMINER	Leave blank in the field. The taxonomist's name be entered here.
DET. DATE	Date in dd/mm/yy format for taxonomists identification of specimen.
MICROHABITAT	Check one only.
METERS ABOVE GROUND	If the specimen was found off the ground, note at what height.
ASSOCIATED PLANT SP.	Note the plant the specimen was found on.
FOREST EDGE	Check if the specimen was captured / observed near the edge of the forest proper.
FOREST GAP	Check if the specimen was captured or observed in an area where a large break in the canopy exists. This may be a natural gap such as a tree fall or human-made as a vehicle track.
WATER ASSOCIATION DISTANCE (m)	Distance to water in metres.
SEX	One of the boxes must be ticked.
AGE	One of the boxes must be ticked.
BIOMETRICS	Measured in millimetres and grams.
HEAD + BODY (mm)	With body and head extended, tip of nose to anus.
TAIL (mm)	From anus to tip of tail.
EAR (mm)	Base of ear notch to ear tip. Measured from inside the ear.
HIND FOOT (mm)	Back of heel to longest toe tip. Not including claw.
WEIGHT (g)	Measure in grams before any processing has begun.
OTHER	Use if required.
FEMALE PREGNANT	Note if possible on back of sheet number of foetuses and their size.
FEMALE LACTATING	Note if nipples were large.
COLOUR NOTES	Note all colours when still alive. Use simple basic colours including spots and stripes.
NOTES ON REVERSE:	Record any other relevant notes on the reverse side of the sheet including but not limited to descriptive or capture location.

5.2.1.2 Bats: data entry

For bats, the form titled BATS is filled in for each specimen collected. The information and definitions are the same as the MAMMAL data sheet except for the biometrics. The measurements are made according to the following illustration.

NOTE: If a bat is captured after midnight, the date recorded is the previous day so that all bats captured in the one netting session have the same date of capture. A note is made as to time of capture on the back on the data sheet.

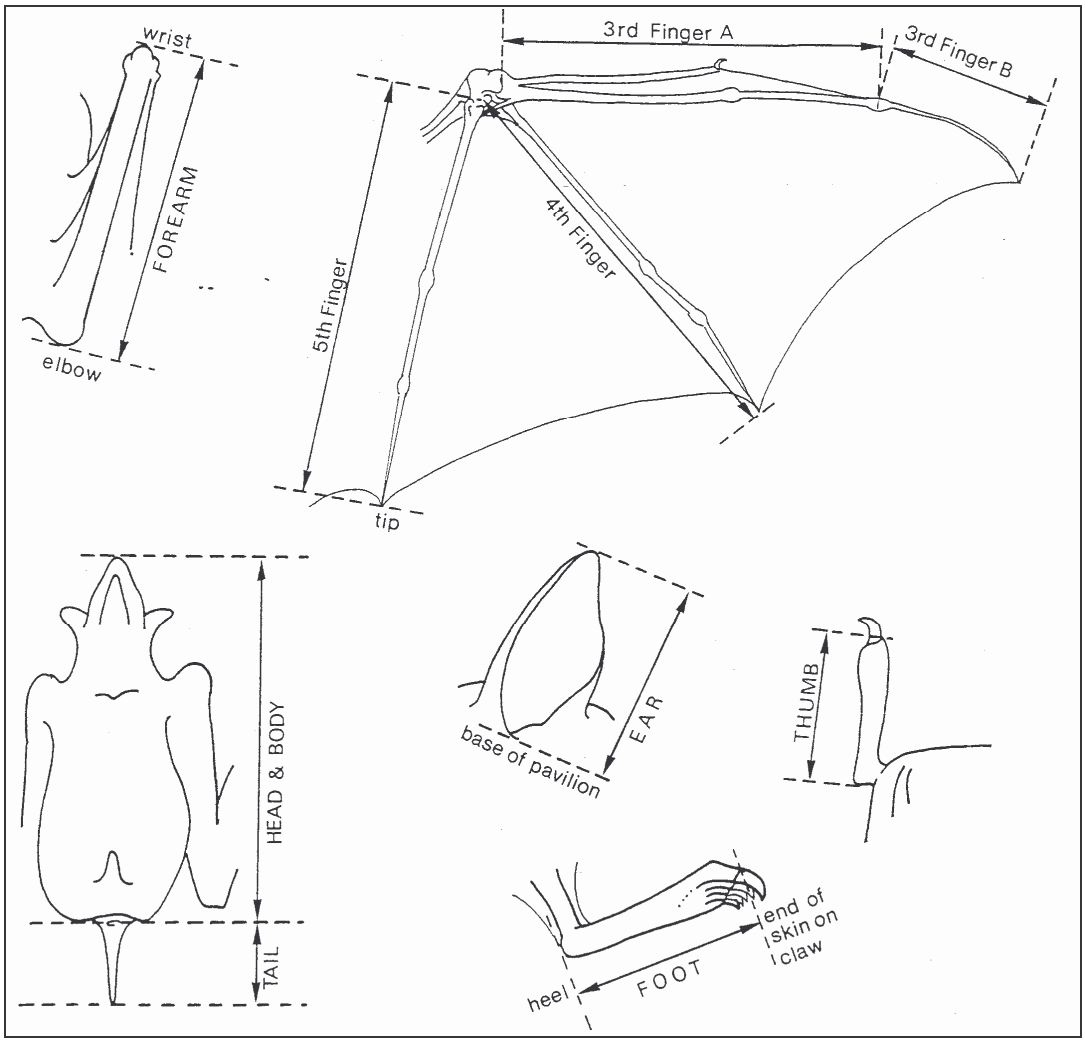

Figure 7 Diagram of what to measure with captured bats

5.2.1.3 Preservation of mammal specimens

Mammal specimens retained for taxonomic purposes are killed using chloroform. The specimen is placed inside an airtight plastic bag with a cotton wool ball soaked in chloroform. Excess air is squeezed out of the bag, and the specimens' snout is placed as close to the cotton wool ball as possible. Specimens are processed and preserved using the following procedure:

1. Specimen weighed;
2. Data sheet completed in entirety;
3. Mouth propped open with a ball of cotton wool;
4. Stomach carefully slit open and muscle blocks injected with 10% formalin. A KMH tag is secured to the right hind foot with surgical thread. It is important that the tag is tied on with as short a piece of thread as possible;
5. Specimen placed in 10% formalin, with 10g of borax or calcium carbonate.
6. Care must be taken that specimens are not crowded in the preserving container. Not more than half of the container is filled with specimens; the rest contained preservative.

5.2.2 Reptile specimens

For safety purposes, on any survey expedition, all snakes are considered as venomous and handled accordingly. Almost all snakes are naturally timid and if encountered would most likely retreat quietly if the observers remain still. When a snake is captured in a bucket pitfall, it is immobilised with a stick pressed firmly behind the head. The snake is then struck firmly with another stick one-third of the way down its body to kill it. Effort is made to avoid damaging the head which is important for identification. Snake specimens are then placed in a plastic bag with a cotton wool ball soaked in ether until the specimen was dead.

5.2.2.1 Data entry for reptile specimens

The data sheets are the same as the MAMMAL data sheet except for the following:

SNOUT-VENT (mm)	Body extended and measured from tip of nose to cloaca.
TAIL (mm)	From cloaca to tip of tail.
EYES, PUPIL SHAPE	Note before killing.
FEMALE, EGGS NUMBER	Note and count if relevant.

5.2.2.2 Preservation of reptile specimens

Specimens are processed and preserved using the following procedure:

1. Specimen weighed;
2. Data sheet completed in its entirety;
3. Mouth propped open the mouth with a ball of cotton wool;
4. Thumb rubbed along the base of the belly towards the vent to determine whether the specimen is male or female. If male, the hemipenes emerge. The area is injected with formalin or ethanol depending on the size of the snake;
5. Five fine, 1cm slits spread along the entire length of the snake cut into the belly of snakes; for other reptiles the belly is carefully slit open;
6. Muscle blocks are injected with 10% ethanol or formalin. Holes are made down the tail of small specimens using a fine needle to aid preservation and prevent rotting. For larger reptiles, such as snakes over 50mm diameter, fine slits were cut into the tail and the mid-body;
7. Any eggs present were counted and measured;
8. A KMH tag is secured with surgical thread to the right hind leg if the specimen is a lizard or a chameleon and round the mid-body if the specimen is a snake. It is important that the tag is tied on with a short of piece of thread as possible in order to avoid specimens becoming tangled inside the storage container. If the tail had been shed, it is placed with the specimen in a plastic bag with holes in it to allow the passage of preservative into the bag;
9. The specimen is placed in 10% formalin or 70% ethanol, care taken to ensure that any shed tails were not lost;
10. Care is taken that specimens are not crowded in the preserving container. Not more than half of the container is filled with specimens; the rest contains preservative.

5.2.3 Amphibian specimens

5.2.3.1 Data entry for amphibian specimens

The data sheets are the same as the REPTILE data sheet except for the following:

EYES: PUPIL SHAPE	Check one only before killing the specimen.
IRIS COLOR	Check one only before killing the specimen.

5.2.3.2 Preservation of amphibian specimens

Amphibian specimens retained for taxonomic purposes are killed by immersion in MS222 solution (1 level teaspoon MS222 to 1/3 litre water). MS222 degrades in UV light. It is, therefore, kept out of direct sunlight. Furthermore, the solution is made up fresh each week to ensure its effectiveness. The amphibian is immersed in MS222 for at least 30 minutes. Specimens are processed and preserved using the following procedure.

1. Colour notes taken before death as these can change rapidly after death;
2. Specimen weighed;
3. Data sheet completed in entirety;
4. KMH tag secured to right hind leg with white silk thread. It is important that the tag is tied on with a short of piece of thread as possible in order to avoid specimens becoming tangled inside the storage container;
5. If any eggs are present these are counted, measured and noted in the relevant section of the data sheets;
6. The specimen is set in a petri dish in a natural resting position with digits splayed to ensure that webbing between each toe was visible;
7. The belly carefully split open, belly and muscle blocks injected with 70 % ethanol.
8. Specimen placed in 70% ethanol for storage;
9. Care taken that specimens are not crowded in the preserving container. Not more than half of the container is filled with specimens; the rest contains preservative.

5.3 Vertebrate observation

5.3.1 Aim

- To note the presence of forest vertebrate species beyond capture

5.3.2 Method of sampling

The method of sampling is conducted on an opportunistic basis. Most of the survey work in the forest is, however, done along transect lines. Sampling intensity is variable and non-definable due to the nature of the observation method. Observations occur during both day and night, and include both visual observations and identified calls.

5.3.3 Observation method

Observations are made on a casual basis throughout the survey period. In addition, local knowledge is utilised during discussion with local communities using books to identify animals living in the area. Tracks and scats are also used to identify species.

5.3.4 Data entry

Data sheets for observations are filled out as follows. Relevant sheets are: MAMMAL (NOT BATS), BATS, REPTILE OR AMPHIBIAN. "0" for observation was noted in the KMH No. section and the level of accuracy of the species recorded: certain, probable or uncertain were filled in for all observations.

5.4 Specimen identification

5.4.1 Mammal identification

Field identification of terrestrial mammals is carried out using:
Kingdon, J. 1974b. East African mammals. An atlas of evolution in Africa-Vol. 2B: Hares and Rodents. Chicago University Press.
E.A.N.H.S. 1994. Checklist of the mammals of East Africa. East Africa Natural History Society. Nairobi.
Taxonomic identifications were confirmed by Prof. K. Howell at UDSM, Tanzania and Dr. W. Stanley at The Field Museum of Natural History, Chicago, U.S.A

Field identification of bats was carried out using:
Kingdon, J. 1974a. East African Mammals. An Atlas of Evolution in Africa Vol 2A: Insectivores and Bats. University of Chicago Press.
Meester, J. & Setzer, H.W. (eds.) 1971. The mammals of Africa: an identification manual. Smithsonian Institution Press, Washington
Cockle, A. 1992. Notes to follow for bat identification. Unpublished. S.E.E. & U.D.S.M., London.
Specimens are sent for confirmation of identification to Prof. K. Howell at the Zoology Department, UDSM, Tanzania and Dr. W. Stanley at The Field Museum of Natural History, Chicago, U.S.A

5.4.2 Reptile identification

Field identification of reptiles is carried out using:
Broadley, D.G.; Howell, K.M. 1991. SYNTARSUS: A check list of the reptiles of Tanzania with synoptic keys. The National Museums and Monuments of Zimbabwe.
Branch, B. 1988. Field guide to the snakes and reptiles of Southern Africa. Struik Publishers, Cape Town.
Specimens are sent for confirmation of identification by Prof. K. Howell at UDSM, Tanzania; Michele Menegon, Museo Trindentino Di Scienze Naturali, Italty (but who works in country and can identify specimens immediately) or Dr R.C. Drewes, Department of Herpetology, California.

5.4.3 Amphibian identification

Field identification of amphibia is carried out using :
Schiøtz, A. 1975. The Treefrogs of East Africa. Steenstrupia Copenhagen.
Schiøtz, A. 1999. Treefrogs of Africa. Frankfurt am Main, Chimaira Edition.
Vestergaard, M. 1994. An annotated and illustrated checklist of the amphibians of the Usambara Mountains with a tentative key and the description of two new taxa. Zool. Museum, University of Copenhagen.

Specimens were sent for confirmation of identification by Prof. K. Howell at UDSM, Tanzania; Michele Menegon, Museo Trindentino Di Scienze Naturali, Italty (but who works in country and can identify specimens immediately) or Prof. J. Poynton, British Natural History Museum, London.

5.5 Mammal transect walks

5.5.1 Aim

- To monitor the number of forest mammals as an indicator of hunting pressure and the success of forest conservation management

- To add to the inventory of animals of each forest reserve species not likely to be captured or observed

5.5.2 Method of sampling

The sampling method is systematic, the sampling unit is the mammal transect. All dung, nests, footprints, burrows and scratchings along the human disturbance transects.

5.5.3 Procedure

A team of three people is required. All dung within 2m either side of the transect is recorded; thus the dung transect constitutes a 4m wide strip. All other signs footpaths, scratchings, burrows and ground resting sites are recorded within a 10m strip (i.e. 5m either side of the transect). Where an animal path crossed the transect up to 3 minutes is spent assigning it to a species on the basis of footprints and dung. If no clear footprints or dung piles are found the path is discarded as being old. The team starts at the beginning of each disturbance transect. One observer searches one side of the transect and the second observer searches the other side. The third person records the observations of the other two. Dung samples are collected and compared with a collection of known samples. The transect is subdivided into 50m sections and records were taken separately for each section.

5.5.4 Data entry

The sheet titled MAMMAL DUNG SURVEY is completed. The categories of topography, vegetation type, vegetation cover and microhabitat is the same as on the MAMMAL collection data sheet (Section 1.8.1). (The only addition is 'animal latrine,' which is an area used regularly for depositing dung). The definitions of each are provided in that section of this report. On the MAMMAL DUNG SURVEY data sheet, codes are completed under the appropriate column. The date of the observation, the plot and which of the 50m sections within the plot the observation was made is noted. Where possible the species or family is noted under the SPECIES ID column. Any samples not already present in the collection of voucher specimens are numbered and added to the collection for later identification. Any observations of paths or burrows are recorded on the same forms. Notes are made detailing whether the burrows were in use or not, and distance to the nearest hole where it was < 50m.

5.5.5 Identification

Field identifications are made by Tanzanian assistants and using the following texts:

Stuart, C. & Stuart, T., 1994. A field guide to the tracks and signs of south and east African wildlife. Southern Book Publishers:Cape Town.

Walker, C., 1988. Signs of the wild. Struik Publishers. Cape Town.

6.0 TAXONOMIC VERIFICATION

6.1 Botany

Vascular plants

Dr. R. E Gereau	Missouri Botanical Gardens	P.O. Box 299, St. Louis, Missouri 63166-0299, USA
Mr. F. Mbago	Department of Botany,	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Mr. George Sangu	Independent botanist	

6.2 Fauna

Bats and small mammals

Prof. K. Howell	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Mr. W. Stanley	Field Museum Natural History	60605-24996 Roosevelt Road, Chicago, Illinois, USA

Rodents and Shrews

Prof. K. Howell Dr. C. Msuya	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Mr. W. Stanley	Field Museum Natural History	60605-24996 Roosevelt Road, Chicago, Illinois, USA

Amphibians

Prof. K. Howell Mr. C. Msuya	Department of Zoology	University of Dar es Salaam, P.O. Box 35060, Dar es Salaam, Tanzania
Prof. J. Poynton Dr. B. Clarke Dr M. Wilkinson	Natural History Museum	Department of Herpetology and Fishes Cromwell Road, London, SW3, UK.
Mr. M Menegon	Museo Tridentino Di Scienze Naturali	Trento, Italy

Reptiles

Prof. K. Howell	Department of Zoology	University of Dar es Salaam , P.O. Box 35060, Dar es Salaam, Tanzania
Dr. D Broadley	The Natural History Museum of Zimbabwe	P.O. Box 240, Bulawayo, Zimbabwe
Dr. R Drewes	Department of Herpetology	California Academy of Sciences, Golden Gate Park, San Francisco, California 94118, USA
Mr. M Menegon	Museo Tridentino Di Scienze Naturali	Trento, Italy

7.0 BIBLIOGRAPHY

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Appendix 1 Field techniques for plant collection

Field Techniques Used by Missouri Botanical Garden

Compiled by R. Liesner with suggestions from MO staff and others.

These notes have been compiled to aid people in collecting and preparing high quality botanical specimens more effectively. In some cases, such as field book size, rather than make a recommendation, the advantages and disadvantages of different options are discussed.

FIELD BOOK

Warning

First and foremost, be legible! We do make MO collectors rewrite their field book if necessary. Since numerous people work from or need to consult field books, the more legible and precise the data, the easier it is to transcribe or extract.

Size of Field Book

The advantage of a smaller field book lies in the fact that one does not carry as much information into the field, so that if it is lost, the total data lost would not be as great. Experience has shown that it is easier to write into and type labels from a larger field book. Better quality paper is more readily available in larger field books. It is important to have a size that can be photocopied easily.

Paper

The quality of paper in field books is highly variable, and may be dependent on what is available locally. Ideally, they should contain pages of acid-free, long-lasting paper written in permanent ink. Field books should be prepared with permanent, archival storage in mind, since they may contain notes and marginalia which do not appear on labels.

Pencils, Pens, and Inks

Pencil lead is permanent and can be erased and changed. It is, however, more difficult to read and at times impossible to photocopy. Fountain pens and rapidographs have better ink but they tend to leak when one changes altitude rapidly. Ball points with black or dark ink can be photocopied and do not leak, but they are not permanent. Over time some ball point inks will fade or etch into the paper (especially in poor quality field books), while some inks run if the field book becomes wet.

Care of Field Books

During field work, carrying field books in clear plastic bags will provide extra protection in case of sudden showers or immersions. Remove field books from luggage when in cars or hotels in case the luggage might be stolen. Most thieves would not bother with a loose book. Care must be taken, however, to remember where you put the field books for safekeeping, and not forget them when traveling.

Arrangement of Information in Field Books

Field books should be arranged for optimal scanning by label typists. They should be legibly written, and without abbreviations (except metric) and compass directions, e.g. N, S, NW, etc. Be especially careful to correctly spell all proper names. All localities should have latitude, longitude, and elevation. If exact figures are unknown, use the best approximation.

Field data should contain the following information at a minimum:

Locality Data:

Locality data should be as specific as possible and applies to a range of collection numbers made sequentially. Someone reading the locality data should ideally be able to find their way to that general site using your description alone.

- Country: State, province or county.
- Distance and direction (km or mi, N-S-E-W not "from", or "near") from nearest city or major landmark that would appear on a map (smaller geographical localities are not on most maps).
- Habitat or vegetation type. Dominant, typical, or associated species if possible.

- Note if plants were preserved in alcohol, or received any other chemical treatment before drying.
- Latitude/Longitude and/or Township/Range; altitude (m or ft); GPS reading if available.
- Date.
- Collector(s).

For Each Collection:
- FAMILY (capitalized).
- Genus species Author (Leave space if unidentified, and for future changes); det. by:
- Tree, shrub, liana, vine, etc. Flower and/or fruit color, scent, height, and unusual features, such as
shaggy bark, buttressed trunk, colored sap, any attribute which cannot be obtained from the prepared specimen.
- More specific notes on locality and habitat (near stream, on rock, in water, etc. [information that is specific to this number]).

Marginal Notes for Each Collection: (noted when describing and pressing plants).
- Coll. No. (periodically check to make sure these remain sequential)
- Number of sets and sheets contained in each set. For example: (1 set of 3, 1 set of 2, 2 sets of 3)**
- L-3: This indicates the number of live specimens made.
- C-2: This indicates the number of color pictures made.
- P-3: This indicates the number of black and white pictures taken.
- A : Indicates if material was preserved in alcohol [pickled].
- Chem: Indicates if the material is a voucher for chemical analysis.

* This is the total number of labels needed for each collection number, including all labels needed for multiple sheets; separate large parts, pickled material, or wood samples, etc. Determine the number of labels that are needed and place the number in the margin under the collection number. If it is entered as you are writing the field notes, then the labels can be produced without a re-examination of the collections. The label count should reflect the actual number of mounted specimens (large collections requiring two or more sheets should be labeled "l of 2," and "2 of 2," etc.). If you dry parts separately to insure better drying but they will be mounted with the leaves, don't include them in the label count. In other words, imagine the end result, not just the number of newspapers you are drying.

** For multiple sheet specimens also indicate in the margin the number of sheets for each set.

In locality descriptions, do not use "above town" to tell direction unless you also give a compass direction. "Above town" only indicates direction to people who know the locality.

Always write out the complete locality each time it is used. It is not correct to write "Same data as No. _____" or "as above". When collecting over extended distances along trails or when making transects, the general area should be stated in the locality data with more precise locations for individual collections given under their respective collection numbers, e.g., Locality: 13.7 km NW of
San Pedro on the road to Incahuara, trail to 12 de Octubre. Specific Information: Ca. 2 km N of trail head. Clarity is very important because of the number of people, not necessarily trained as botanists, who will handle the field book and collections (i.e., typists, plant processor, volunteers, etc.)
Abbreviations should not be encouraged. Typists should be typing, not looking up abbreviations and spellings. Specimens are sent on exchange to many parts of the world and your standard abbreviations e.g.: BCI (Barro Colorado Island) may not be readily understood.

Always leave one or two blank lines between collection numbers in the field book so that the original identification, and later name changes and notes can be added. It is useful to include information about live specimens, color or black and white photographs, pickled parts, seeds,

phytochemical material, or any special collections in the specific information so that it is included in label. The collecting institutions and their acronym(s) should be on the label. That will make it easier to return determinations later.

Begin numbering your collections with 1 and continue sequentially throughout your botanically active life. Do not start over when collecting with other people or in another country or when beginning a new year. Especially, do not use a complicated formula or letters (except for A. B. C. suffixes for divided collections). See Gentry, 1984 (Taxon 33: 355-358). When mass collecting, write the field book clearly and without delay. Do not depend on "remembering" field data hours or days later. It is always inefficient to rewrite field notes.

FINDING SPECIMENS

Localities

Try to cover as many different habitats as possible: in forest, stream edge, ridge top, slope, stone outcrops, cultivated areas, roadside, edge of forest, etc. Even though there are often fewer things to be found easily inside the best primary forest, the rarest plants often turn up there. The roadsides and edges of cultivated areas usually have the most common plants, but may turn up occasional waifs that represent significant distributional records. Frequently the primary forest trees, lianas, and shrubs have their lowest branches at the margin of the forest, so do not neglect this area. It is important to check tree falls; they often bring down branches or twigs of canopy species, as well as epiphytes and lianas. In open areas with more light, plants sometimes flower and fruit which
wouldn't otherwise.

Teams

If two or more collectors are working together, it is more efficient if they go to different habitats or agree ahead of time to concentrate on different life forms, i.e., trees, lianas, epiphytes, ferns, etc. Avoid two collectors collecting the same plants in the same area, on the same day.

Hints

Areas that are being logged or where new roads are under construction, are generally good places to collect, always watching out for falling trees, of course! Trees, lianas, and epiphytes that are ordinarily confined to the canopy are often readily accessible. In areas where the natural vegetation is likely to be destroyed, one should not be too concerned about depleting populations of species. On the other hand, collecting in any conservation unit (park, reserve, etc.) should be made with care and conscious consideration of population sizes. Be open and friendly with local people. Always be ready to explain what you are doing in terms that they will be most likely to understand. If you stop collecting or look furtive, it may be interpreted that you are doing something wrong. They will also feel less threatened if you acknowledge their presence and are friendly.

Common vs. Rare

It is better to make more duplicate specimens of rare species and fewer of common ones. ("Rare species" means those that are rare in the herbarium, they may actually be abundant locally.) This is especially true for perennial plants or abundant herbs, in which collecting will not significantly affect the population. For example, it is better to prepare only three sheets of a very common plant and 11
sheets of something rare; not seven of each. Both ways require the same effort and occupy the same space in the press. Collect a minimum of three sheets whenever possible (one to remain in the country of origin, one for your home institution, and one for a specialist). It is more important to get collections of species that are poorly represented in the herbarium, than those that are well represented. But geography also must be taken into consideration, a species may
be well collected in one area and be of relatively low interest there, but it may be poorly collected in another area and be of very high interest there. More specimens are needed to document the

range of variation in variable species than uniform ones. Also more specimens are needed to understand the differences between very similar species than more distinct ones.

Rare and New Species
Rare or little known plants and new species tend to occur together. If species are found that are rare or new, it is usually worthwhile collecting longer in that area. More often than not, other interesting species will be found. If you have seen most species at least two or three times in an area, it means you have a rather
high percentage of those species. If you have seen a significant percentage only once, it means there are probably numerous other species that haven't been collected yet.

Developmental Stages
Always recollect the same species if you find it in a different developmental stage or in better condition. Also, it is generally worthwhile recollecting species to show extremes in the size of parts, coloration, or other characters. Collect both sexes of dioecious species. One might even tag a plant or population to be certain of getting the same species at different stages. Collect the two or three (depending on group) stylar forms of heterostylous species, when this is known, e.g. *Erythroxylu*m, *Oxali*s, *Eichhorni*a, Rubiaceae, etc. Each should be collected under a different number.

Unicates and Duplicates
If the collection is a unicate, look around a few minutes for more specimens. Frequently after a careful search, you will find the plant isn't as rare as it first appeared. Specimens are needed for the country of origin, specialists, and exchange. Sets of 5 to 10 or more are most desirable. It is very useful to mark labels "unicate." But if one specimen has been left in the country of origin,
and/or one has been sent to the specialist, the single sheet at your institution should not be marked "unicate." Unicate means there are no duplicates anywhere else.

When there is only a unicate, one can often make a second fragmentary specimen. For example, one might take one or two flowers from a multiflowered inflorescence of an orchid and combine it with a leaf or two and a pseudobulb. If you add a photocopy of the good specimen it is even better. If it should be the only representative of the species in the herbarium it would be a valuable addition even though fragmentary. Often a fruit or inflorescence can be cut in half to make an adequate representation for two specimens, e.g., Cyclanthaceae. Combined with a piece of stem and leaves it is a useful specimen, but it is important to indicate on the label it has been divided if that is not obvious.
Some plants are found only as unicates, and are found at another locality also as a unicate. If unicates are not all kept in the country of origin, recollect it even if it is not needed at your institution. Mark the newspaper and the corresponding specific information as to where it is to be deposited, for example, "Unicate for CR."

COLLECTING
Tools
It is recommended that you have a sheath for your clippers and machete, making both hands available, for safer and more efficient collecting. Some botanists attach hand tools to a belt with pull chains to prevent losing or forgetting them in the field. There is risk of getting the chain caught in vegetation or hung up on a limb when climbing with this latter approach and is not recommended.
Additionally, the use of lanyards or wrist ties will allow a tool to swing back into the body and should not be used.
Well maintained tools make your work much easier. Equipment should always be inspected before use. Defective or damaged equipment, especially ropes, harnesses, and securing straps, should be repaired or replaced immediately. Always use proper safety equipment. Whenever purchasing equipment, ergonomical hand grips should be acquired as they provide greater grip strength and reduce fatigue and possible injury.

Improving Collections
It is acceptable to make a skimpy specimen if that is all the material there is. But if sufficient material is available, it requires little more effort to make ample sheets. If only skimpy fertile material is available, the sheet can often be improved by adding extra sterile material. Since the objective of a good specimen is to provide in a convenient form an adequate representation of a plant, one should always include the full range of characters exhibited by the plant, including such things as the largest and smallest leaves, young leaves to show pubescence, stipules, etc.
Specimens should always be improved by adding extra flowers or fruits and inflorescences. There is no reason to include only one inflorescence or one flower per specimen when there is an abundance of material at hand.

Fertile and Sterile Vouchers
It is very important to collect fertile material if at all possible. Collect flowers and if possible fruits for each specimen. If you have sterile vouchers for ecological or anthropological studies, make another collection of fertile material of the same species. Thus the voucher can be matched and verified with the fertile collection because the fertile specimen can be determined much more easily. Do not ignore vegetative characters. If there are different types of leaves, show that. Get mature and immature twigs, especially in vines, etc. Sap shoots or stump sprouts and saplings often have very different characters from mature material, and can be very useful.

Pre-Pressing
Strict field pressing is usually less efficient than collecting in plastic bags. Fragile material can be placed in a field press and sturdy things held in a plastic bag for later pressing. Always carry small plastic bags or newspaper for wrapping smaller or more fragile plants. These can then be put into a larger bag. As an alternative to using small bags, small samples can be wrapped in any large leaf, such as *Heliconi*a.

Bags
When collecting in plastic bags, fold the specimens to the correct length for a herbarium sheet and place them firmly, but carefully, into the bag. Don't just drop them in. This way separate collections will not become tangled and there will be less damage. Later when emptying the bag, turn it upside down and carefully dump it all out if they are tangled. Don't try to pull material out of the bag. This
usually breaks up the specimens. It is preferable to use large bags rather than small ones, as there will be less damage to the plants. If you have large, heavy plants, it is best to put them into a separate bag as they may damage other more delicate plants in the bag. This is especially true for palms and large aroids.

To prevent significant wilting, plants may be wrapped in moist newspaper and placed in a plastic bag, which should be kept shaded. When mass collecting in tropical areas, this is not always feasible.

Special Cases
Mosses, cones, fruits, *Cuscuta* flowers, cacti, and some other succulents, can be put in small paper bags, each numbered on the front, and dried unpressed. If stored in plastic bags, they rapidly mold, even after drying.

Shrinkage During Drying
Plants shrink on drying, which is especially true of more succulent plants. Keep this in mind when collecting and pressing. What may appear to be ample material when fresh may be skimpy once it is dried.

Habit Information and Tags

When collecting actually look at the plant to estimate height or note other characters. Many who have trouble remembering this information never closely examined the plant in the first place. If you have trouble remembering details, carry a small notebook or a marking pen to write directly on the leaves. For example, E could stand for epiphyte, t for terrestrial, s-2 for shrub 2 meters, t-4 for tree 4 meters, etc. Alternatively, write on the edge of the newspaper as you are pressing the plants.
Many collectors tag their collections to prevent later mix-ups. Small white tags should be securely tied to stems or fruits, with the collector's name, collection number, and a field determination written in permanent ink or pencil. Other collectors have used stick-on type tags. These techniques become difficult to use if field conditions are rugged, or if it rains.

Clipper Poles
Clipper (pruning) poles are very useful, if not essential when working in forested areas. The standard MO pole set consist of two nested poles whose combined length, when locked, is about 3.6 m. By adding extra poles one can work relatively easily with up to six poles for a total of about 10.5 m. After locking together several pole segments, the pole must be kept vertical and new pole units added from the bottom. Because of the flexibility of the poles and joints, the clipper head will sway unless the pole is vertical or well supported. The pole can be made more stable by leaning it against a branch while other poles are added or to guide the clipper head to the desired limb. A few people have successfully added a seventh or eighth pole, but this requires a fair amount of strength and
skill and is not recommended.

Field Poles
Poles and other extendable collecting equipment are difficult to carry. As an alternative, one can cut a long, slender, sturdy sapling with a fork on the end. By inserting it among smaller branches and twisting, one can frequently get samples from up to 6 m above the ground. If you cut one of the forks half way and bend it against the other one and tie it, you can form a hook that is useful for pulling down epiphytes. In most areas this will have little significant ecological impact, but do not use it in an area where there will be many botanists working in a relatively small area, or where long-term ecological studies are underway.

Saws
Shooting a lead weight attached to fishing line over a branch using a hunting-type sling shot is another method. One then uses the fishing line to pull back over the branch a strong, slender rope with a piece of chain saw blade in the middle of it. Two people standing a little apart can then pullback and forth and saw through the branch. It is more difficult for one person alone. A modification is to cut a 4 to 6 foot length of chain saw blade in half. By riveting these two pieces together with one-half up and one-half down, one is assured of having a cutting edge facing the correct direction when it is used. Caution is needed to insure you are not positioning yourself in the path of any debri or large specimens as they may fall. A bit of pink or bright colored flagging at each end of the blade helps in positioning the blade.

Tree Climbing Techniques
A sling shot or arrow may also be used to shoot a slender line across a large branch. Then twine is attached and pulled over the branch, and finally the twine is attached to a mountaineer's rope. With the rope one is able to climb using mountaineering techniques and to descend the same way. It is very important to always use a safety belt or harness when moving around in the canopy. Lanyards
or vertical lifelines should not be of natural fiber rope, and should be rated at sustaining 5,000 pounds. D rings and snap hooks should be steel or equivalent and protected from corrosion.

Climbing Irons
Regular tree climbing irons (linemen's spikes) and belt are better for large trees, and French climbing irons are better for smaller trees. One can combine the use of irons for ascending the

tree with mountaineering ropes for descending the tree, which is the most difficult and dangerous part with climbing irons.

Tree Climbing Bicycles
The tree climbing bicycle is another method. These are climbing irons with adjustable bands going around the tree. The only way that it is similar to a bicycle is that it requires a pumping action to ascend and descend. This equipment is easier and probably safer to use than climbing irons but it is
heavier and much bulkier to transport.

Climbing and Clipper Poles
Combining climbing together with clipper poles has been very successful. Once one is positioned near the canopy, one can pull up the clipper pole and can usually reach branches of a number of different trees accessible from the same point. Always remember to tie the clipper pole rope to your belt before ascending.

Guns
A few people have used quality target guns to shoot branches down. This requires great skill and special permits are needed in most places to carry guns. Also, local people are much more concerned about strangers when they are carrying guns. Except in very special circumstances, firearms are not recommended.

Hints
It is necessary to balance the equipment carried (which helps you collect plants) and the distance you are able to cover, because you are less encumbered, thus being able to collect more species and possibly able to get into more places. Also, one has to find a balance between struggling for one particular plant and traveling a greater distance, with the possibility of finding the same plant in a
more accessible place. Rarely collected species are certainly worth more effort than commonly collected ones. Species that are often found near the ground are worth less effort than ones never found near the ground. During the first days in a new area it is better to not expend too much effort on any particular species, because with familiarity you will improve chance of finding the same plant
in a more convenient place.

PRESSING PLANTS

Use of the End Piece of Press
While pressing use the plywood press end to hold down the pile and keep it orderly. Move the board up as needed. This leaves both hands free. It is also a good cutting surface in fancy hotels when you need to section fruits or thick stems.

Order of Sheets While Pressing
If you do not write the field notes as you are pressing plants, reverse every other collection (consisting of one or more duplicates). Then it will not be necessary to open every sheet when you are counting them, writing up the field notes, and writing the numbers on the sheets. Always keep the upper surface of the specimen up.

Numbering
It is very helpful if the collector's initials are placed by the number, i.e., A.G. 45038. If labels are lost, or collections mixed up, it is much easier to recapture the missing data or return the specimen to its proper place. This saves time if you are collecting or processing your plants together with someone else using the same number range, aids in replacing lost labels, and saves confusion if several collections are shipped together. Put the number in the same place on the newspaper each time, preferably along one edge. It is much easier to sort them.

After the sheets are numbered, put all or half of the bundle with the folds in the same direction. Do not flip half of the bundle upside down to balance the packet--this just makes it more complicated to process the plants later.

Complete Collections
Make each specimen for any given number as complete as possible. If both flowers and fruits (or different leaf shapes, etc.) are available, each sheet or set should be representative. After drying, combine parts that were dried separately to form complete specimens before packaging and shipping.

Size Constraints on Specimens
Make the specimens shorter than the mounting paper! More damage is done if they must be refolded later and any parts which extend beyond the newspaper will break off and be lost. Always keep in mind what the material will look like once it is a mounted specimen, not merely getting the plant into the newspaper any which way. Mounting paper at MO is 29 cm (11 1/2 inches) wide by 42 cm
(16 1/2 inches) long.

Wilting
When wilting is a problem, collect for awhile, then press in a convenient spot, then collect again, etc. Wilting can be reduced by sprinkling the bags with water and keeping them in the shade, or placing wet newspaper or towels inside the bags; but remember the sun shifts. If available, white opaque plastic bags do not produce as great a green-house effect. Back at the base camp, wilting can be
reduced by putting the bags in an air-conditioned room or in a refrigerator if available, but seal them because the chilled air is often dryer.
Except for vines, slightly break stems and fold them into a "V" or "N" rather than curve them. If plants are small, put several on the sheet to fill it up: Balance the quality of individual plants on each sheet, some nice, some poor (if not all in prime shape). Otherwise you may end up with the poorest sheet for your own institution. It simplifies later processing if the collector designates the chosen home institution sheet. Grasses and other herbs should not be "top-snatched." Always collect the full specimen, roots and all; dig deep enough to find rhizomes or other underground parts if they are present. Be certain to remove the soil from the roots by shaking or washing. It is best to arrange plants for pressing with the same surface facing upwards as will be seen once the specimen is mounted. Always keep that side up during pressing, numbering, drying, and sorting.

Arrange plants before drying to clearly show both surfaces of leaves and reproductive structures, paying particular attention to ferns. Press some flowers open, and some closed, and others split to show the internal structures (especially in Polemoniaceae and monocots). Phyllaries (bracts) in the capitula of Asteraceae are very important, and should be pressed so some can be clearly seen.
Pubescence, stomata, and other characters are frequently more important on lower leaf surfaces than upper. If only one large leaf or fern frond sample is available, it should be folded so part of both surfaces can be seen.
Do not cover flowers, fruits, or stems with leaves; either spread the leaves away from the other plant parts, or fold the leaf underneath them. When folding leaves, keep the larger part underneath so that you can still measure length, width, etc.:
Cut or break off excess leaves, but always keep part of the petiole to show the position:

Never cut off the petiole base and the stem attachment of a compound leaf. If possible, keep some of the petiole bases of the other leaves and the apex of the stem. Do not mistake a large compound leaf for a branch with simple leaves. Do not split the twig, because the opposite or alternate arrangement of the leaf will no longer be evident. A specimen of two sheets or more may be necessary with very large leaves.

HOW TO RECOGNIZE COMPOUND LEAVES VS A BRANCH WITH SIMPLE LEAVES

1. Petiolules of leaflets are usually not round in cross-section, while true petioles tend to be round.
2. If the "leaves" appear opposite, but the branches are alternate, then the leaf is probably compound.
3. Leaflets in a compound leaf are spread in a single plane while leaves on a branch tend to be in different planes.
4. The terminal leaflet of a compound leaf is truly terminal, while a terminal leaf on a branch will tend to be offset from the apex to a greater or lesser degree..
5. Leaflets do not have buds in their axils while simple leaves on a branch tend to have them.
6. If there are inflorescences in the leaf axils, then it is a branch rather than a compound leaf.
7. In compound leaves, the color and texture of the petiole and rachis tend to be different from that of the branch while the color and texture of a branch tends to be the same as that of thicker branches.

It is usually easier to fold the stem than to try to fold all of the leaves:
If the leaf tips stick out of the newspaper, fold them over or they will be broken off and lost. If you fold large leaves, one can sometimes put two large leaves on a sheet rather than one. Length, width, shape, upper surface, and lower surface are still observable.

With the long leaves of palms and large ferns, take an apical section, a mid-section, and a basal portion with pinnae. State in the field notes the length of the leaf, length of the petiole, number of pinnae, and the arrangement of the pinnae (i.e., regular, staggered, or irregularly spaced) if the specimen does not show it. For palms, describe the position of the inflorescence in relation to the leaves, also whether species are solitary or colonial, and include samples of stem spines and bark. Each specimen, at a minimum, should consist of an apex, a base, a mid-section, selected parts of the inflorescence, stem, and petiole base. Photographs are very useful.

A representative specimen of large plant may require additional sheets for completeness. Even some temperate plants, such as *Heracleum* (Apiaceae) require several sheets for representative parts of leaves, stems, flowers and fruits. In general do not overcrowd sheets. Multiple-sheet specimens contain far more information than fewer overcrowded sheets. Large fruits should be cut into one inch thick slices, both longitudinally and transversely. It is preferable to have the fruits attached to the branches when the specimen is mounted. The one inch
has been established as the maximum recommended thickness for mounted specimens at MO.

It is useful to mark multiple sheets of the same specimen with the same letter. This letter is not put in the label data, rather it is used simply to facilitate reassembling the collections after they are dried. Put the letter anywhere on the sheet, but not after the number (i.e., 1832A) as this designates a mixed and divided collection.

Fold large leaves so base and apex can be seen.
Part of the inflorescence, stem, flowers, etc., may be put on top of a leaf without losing any information as long as the shape, dimensions, and surface of the leaf can be seen. Even if parts are dried separately, they can be mounted together.
When folding large leaves, always start with the largest portion of the leaf, and then the smaller parts on top; e.g., large cordate leaf: base, fold apex, then petiole and inflorescence on top. For leaves with basal lobes, do not fold the base over, it makes it more difficult to see the shape of the leaf and to measure the lobes. Start folding large leaves with the lower surface up. The lower surface generally has more taxonomic characters than the upper.

For large symmetrical leaves such as Araceae, one side of the blade up to the midrib may be removed. In the field notes describe the cross section of the petiole, whether round or flattened,

and whether it has ribs or sharp angles (particularly in *Anthurium* and *Philodendron* (Araceae). Sometimes it is necessary to use multiple sheets.

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On large plants include at least part of the stem and one complete petiole. The stem can be sliced in half longitudinally to make it thinner. Roots and other thick or bulky plant parts can also be split to hasten drying. Bulbs or corms can be cut longitudinally or sliced crosswise, depending on what characters need to be shown. In Cyclanthaceae the leaf base and petiole base are very important as
is the depth of the leaf division. Indicate the latter in field notes, e.g., blade divided halfway to the base, or simply cut off one side of the blade above the point of division if necessary.
It is very useful to preserve flowers of Iridaceae, Lentibulariaceae, Burmaniaceae, Zingiberaceae, Orchidaceae, and Marantaceae in a 50% alcohol solution with a few drops of glycerine in whirlpacks or vials for later study. The glycerine prevents the material from completely drying if the fluid should be lost or evaporate. Put the collector's name and number on a piece of paper in the vials using an alcohol-proof marker, ink, or pencil.

In Passifloraceae it is important to cut open at least one flower on each sheet so that the internal structure is observable. In other families with few large flowers, e.g., Cactaceae it is useful to add cut-open flowers to each specimen, whenever possible. When collecting delicate aquatics it is sometimes best to carry a flat pan, fill it with water and float the plant onto the paper. Some collectors prefer using a piece of good quality white paper which can then be glued onto the herbarium sheet and the specimen can be tacked with glue or library tape to
hold it to the paper. Other collectors use regular sheets of newspaper, or plain newsprint, or wax paper when available and float the plant onto it. The specimens generally come off easily with a little scraping with a scalpel blade or knife.
If there is a shortage of newspaper specimens may be combined and sorted into separate sheets later. Write "____ specimens" or "divide into ____ specimens" on the edge of the newspaper. This should only be done when absolutely necessary. Each specimen must be transfer red to a separate newspaper before drying.

PRESERVING PLANTS BEFORE DRYING
Most plants will deteriorate after two or three days if they are not dried or preserved in some fashion. If they are refrigerated, they can be kept a day or two longer. A 15 to 20 cm tall bundle of plants in newspapers can be preserved with about one liter of 50% solution of isopropanol or ethanol and water. Some collectors prefer higher concentration of 60 - 70% alcohol. If the plastic bags do not have holes, the specimens may be stored this way for several months. Holes or opening the bag may reintroduce mold spores and allow evaporation of the
alcohol. Any loss in concentration of alcohol may result in mold. Lower concentration of alcohol may be used for shorter storage time, but the percentages have not been worked out. (Steven Tillett, Univ. Central de Venezuela, pers. comm.).

A 30% formaldehyde solution can also be used to preserve specimens before drying. At least 1.5 liters of solution are needed to preserve a 15 to 20 cm bundle of plants. A formaldehyde solution is much poorer at penetrating a bundle of plants than an alcohol solution; however, plants preserved in formalin seem to have insect resistance after drying. Formalin is highly toxic. Avoid any direct contact of the skin with the solution and always work in a well-ventilated area and avoid the fumes.

Formalin should be the solution of last resort. Always follow label directions.
After the preserving solution is added to the bag of plants, the bag should be turned several times to evenly distribute the alcohol or formaldehyde. It is best to store bags flat, and then to turn them the next day and again the following day. This insures the alcohol or formaldehyde will thoroughly penetrate the bundle.

When pressing specimens to be preserved in alcohol or formaldehyde, number the newspapers with a black china marker or other marker which is not soluble in the preserving solution. Test all markers (including other colors of china markers) with your alcohol or formaldehyde solution. Over time inks from many markers and pens will disperse into the paper, effectively erasing any data or numbers. Pencil can also be used but it may be difficult to read. Ball point pens are not at all permanent. Some inks that do not bleed at low preservative concentration will do so at high concentration. Labels stored with plants preserved in chemicals may eventually have to be replaced, as the ink often blurs.

In drying plants preserved in alcohol or formaldehyde straighten any creases or folds in the newspaper. Otherwise it will be more difficult to open them once they are dried. Once after collecting for several days, a shipment of additional alcohol failed to arrive. Additional plants were preserved for four days by combining 1/2 of the already fully alcoholed bundles with ½ bundles of fresh plants. The bundles were placed so that the moist plants were above the fresh ones. Alcohol was added when it arrived and no plants or collecting time was lost.

DRYING AND SORTING

When building a press, always keep the numbered side of the sheets up. It saves time in the long run. Mark the press so you know which side is the top without opening it (always placing the straps on the same way is one method).

Do not turn around every other sheet to balance the press. It wastes time. Do 20 to 40 sheets and then reverse the direction of the newspaper folds as necessary. Try to make the change at the end of a collection number. It helps as you are pressing to put large fruits, stems, etc., on different parts of the sheet to balance them. When breaking down a press, keep separate any sheets not fully dried with their corrugates, etc., as a unit. Do not scatter them in among another press that is being built. Two sequences interspersed are more time consuming to sort numerically later.

Experience has shown Example No. 1 is the best way of combining sheets. Have the open edge of the newspaper on the same side. It is best for the specimens and the easiest to handle. The logic of Example No. 2 is that if pieces fall out they will still be in the outside sheet. But this package does not have as much structural stability. When it is handled and carried, more damage is done in the long run. Try picking up the same specimens as arranged in examples one and two with the one hand and you will understand. In Example No. 1, the sheets press together slightly, holding the material firmly and protecting it. You can also open both sheets with one motion and see the plant and label. With Example No. 2, you first have to move the top sheet and then you have to move the second sheet to see the plant and label. This takes more time and the extra handling also
results in more damage. To look at the specimen and labels of Example No. 3, you have to open several sheets. You cannot do it with one motion because you do not know how many sheets to lift at one time. Example No. 3 is very difficult to process and to study.

A few collectors put extra sheets around each individual sheet. It does more harm than good. It has less structural stability than the first method. Also, the specimens have to be handled more to open and look at them. But it does pay to put extra newspaper sheets around a few extra big specimens.

It is always useful to make packets out of newspaper to hold loose fruit or flowers which would otherwise easily fall out and be lost.

As you are breaking down the press, hold the open side of the newspaper higher. Then loose pieces will tend to slide to the safer folded edge. If there are many loose flowers or fruits, tap the edge slightly to move the parts closer to the folded edge. As you are breaking down the press, open the first sheet of each collection and put the remaining sheets in as you are doing it. Much more time is saved later than is lost doing it. Each sheet is most easily moved in the direction of the old. That way the newspaper will not flop open because of movement through the air. Once the plants are all dry, put them into numerical order. Then all specimens of a collection will be

together. It will save time and confusion. This is also a good step for catching mixed collections, rechecking the number of labels needed if necessary, and other miscellaneous problems.

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If there are specimens without numbers, write "specimen in bundle between number XX and number XX." This is especially important when sorting someone else's plants if you cannot solve all of the problems. Otherwise, the collector may not be able to solve the problem later, either. After they are in numerical order, pull out the set that is to stay in the country of origin. In some cases all specimens are shipped out of the country first, then after processing a return-to-country-of- origin set (RTCO) is returned by mail later. Almost always, it is better to leave the set in the country, avoiding all the costs and problems of shipping, customs, accidents, etc. Be certain to keep both sets in numerical order as you are doing this. Always note in your field book if you have left a set or will mail a set, and if extra labels are needed for the set left in the country of origin.

Mark each collection minus the institution that has received a specimen (i.e., -CR, if a set was left there). At later steps always mark the remaining sheets minus the sheet that was pulled out (i.e., -MO if MO's sheet was mounted, -US if a sheet was sent to a specialist at US), this prevents duplicates from being sent on exchange to institutions that already have a sheet. Send all of the specimens and separate fruits of a collection in the same shipment. Once a collection is identified, one specimen is mounted, and the balance are sent on exchange. If additional sheets or separate fruits from the same collection are received later, it is impossible to know where the collection was previously sent. It helps in sorting if "Separate Fruit or parts" is marked on the newspaper.

If there is a possibility that the plants will be fumigated later with a microwave oven, do not use staples, paper clips, or other metal objects.
Mark specimens with irritating hairs or resins, such as *Mucuna* (Fabaceae), *Opuntia* Cactaceae), *Sterculia* (Sterculiaceae), *Urtica* (Urticaceae), and *Toxicodendron* (Anacardiaceae), with warnings on drop tags or on the outside of the bundle and the edge of the newspaper.

To wrap bundles of plants use four pieces of full-sized paper. Overlap half of two sheets. Place a bundle of plants at least six inches thick onto the paper and fold the edges of the paper firmly around the specimens and tape closed or tie with string. Do not use valuable corrugates or old genus covers to ship plants. Label each bundle with the name of the collector and the number range contained in the bundle. Many overlapping number ranges without an indication of the collector can cause confusion if bundles arrive from two or more collectors at the same time.

When shipping plants in newspaper, pack bundles of wrapped plants tightly in boxes rather than loosely. Even though a slight amount of damage may be incurred when packing the boxes tightly, plants in loosely packed boxes are much more easily damaged during shipping and the boxes more prone to being crushed.

Reheating the paper wrapped bundles over dryers, packing them in tightly sealed boxes or plastic bags (with PDB or Napthalene if available) reduces insect damage during storage or during the long trip back to the home institution. Always pack specimens to withstand the possibility of moisture or pest damage. Surface mail from some countries may be 3 to 12 months.

With the shipment send details of any special arrangements made with the host country and or other collectors (such as where duplicates are located or where they are promised to be distributed). Project coordinators need to know these arrangements before they process the plants, not after they are distributed and not available to satisfy agreements made by the collector. MO sometimes stamps
special agreements on the edge of the newspaper of each collection.

With the shipment, also include some kind of shipping invoice so that the receiving institution knows what is in the boxes and why they are being sent. These invoices should include the sender's name and address, receiver's name and address, list of enclosed items, number of boxes (copies of the invoice should be in each box), and any special instructions or conditions. It is also helpful to know how the plants have been chemically treated (i.e., formaldehyde, alcohol, insecticides, etc.).

DRYING SYSTEMS

Warning

Fire is a constant danger. If the drying system is close to where you are sleeping or working, TAKE a smoke detector. It is best if the plants can be dried in a separate building or fireproof area. If not, extraneous flammable materials such as paper or alcohol should be kept out of the area. Closely monitor presses and dryers if placed in or near private homes or field stations; fires do happen.

Types of Systems

There are basically two types of drying systems. The first is a **convection syste**m, which is easier and cheaper to build, and can use a wider variety of heat sources. The second is a **forced-air syste**m, which is more complicated and expensive to build but tends to be safer, and when properly designed is usually more efficient.

Convection System

In the convection system the plant presses are placed over a heat source. The warmed, dry air rises, passes through the channels in the corrugated cardboard, and carries the moisture away. A convection dryer can be made safer by putting screen, chicken wire, or mesh between the press and the heat source. Most fires start when the press loosens as it dries and pieces fall out onto the heat source. But also remember one must have easy access to the heat source to change bulbs, add fuel, clean out fragments and dust periodically, and for any other general maintenance procedures. The press should never be put too close to the heat source. As the material in the press dries, it becomes more flammable and may ignite.

The heat source may be light bulbs, electric heating strips, kerosene stoves or lamps, propane, or any other source of heat. Propane is very readily available in most places and has been underused in the past. But note that at an elevation of over 2,000 m you may need an adjustable burner to compensate for the reduced oxygen content of the air. Note also that some types of kerosene stoves fluctuate too much to be used. Specimens can be dried by putting them over the back of a propane gas stove to enable the convection currents from the oven to dry the plants. One botanist had his plants dried over the oven of the local baker. Another collector who had only half a dozen specimens every few days dried them over the exhaust tube of a kerosene refrigerator! If you have a generator or other motor running constantly, always consider the possibility of devising some sort of
arrangement for taking advantage of this waste heat.

The system is most efficient if both the heat source and the sides of the presses are enclosed by the walls of the drying rack. Block off any part of the rack that does not have a press on it. Heat should not escape except by going through the plant press.

Portable Convection Systems

People have made portable convection driers from numerous different materials. If you use canvas for the sides, fire resistant canvas, which is available in the U.S., is less of a hazard. Canvas has a tendency to be blown against the heat source and to ignite. Botanists who are traveling cross-country with intermittent stops for collecting have tied their presses upright on the roof of the vehicle to let the presses air dry. This may not work with some aluminum corrugates.

Sometimes it is possible to mount presses in front of a car radiator to take advantage of air movement when the vehicle is in motion, and radiated heat from the radiator when the vehicle has stopped (some botanists put canned food in the engine compartment to heat while driving, and stop for lunch without setting up the stove!).

Baffle System
If the heat is not evenly distributed in the dryer, an aluminum panel constructed above the heat source will allow better distribution. This aluminum baffle must either be well supported throughout its length or have the edges turned up to prevent it from sagging. A double baffle system distributes the heat still more evenly or allows a reduced distance between heat source and press.

Forced-air System
In the forced-air system the heat source is separate from the specimens and a fan is used to blow the air across the heat source and then through the presses. It is safer because the heat source does not have to be directly under the presses.

Catalytic Driers
Catalytic driers, which should be the safest, have been completely unusable in the tropics. The fuel has been unavailable or it has been so dirty that it ruined the catalyst immediately.

Oven Drying
Placing presses inside a closed oven is not feasible. Oven heat is often too moist and will encourage mold. The temperature cannot be satisfactorily regulated - if not dried long enough the plants will mold, if dried at too high a temperature, too fast or too long the plants will darken and crumble. Utilizing the warm air from the oven by placing the press above the open oven door may work.

Space Limitations within the Press
When press materials are the limiting factor, one may be able to dry a few more specimens by putting two thin specimens, such as thin grasses, *Utricularia*, small herbs, or small ferns, together between the blotters. If you use this method with thicker stems or fruits, it will result in shrivelled leaves and unevenly pressed specimens. Also, if you double up too many specimens, even the thin sheets may not dry occupying the press materials for another day.

Space Limitations within the Dryer
If drying space is a problem, make a special effort to section thick fruits, stems, etc. It will speed drying. It will also result in fewer shriveled leaves and flatter specimens. A second layer of presses can be put over the first if they are separated by sticks laid lengthwise.

SORTING AT MO
If you have to work on the specimens before they are labeled, add the collector's name to the newspaper. If the collections from several collectors are mixed together, two months or two years later it may be impossible to determine whose collection are which. They then become so much useless trash.
It is most efficient to sort the plants to family at the same time the labels are inserted. Combining the two steps takes only slightly longer than either step by itself. The first step is to put all the labels of a number with any separate fruits, stem sections, etc. Then when going through the collection, you will be reminded there are separate parts, etc., when there are no labels for the collection.
It is much more efficient sorting specimens on herbarium carts than on an equal amount of counter space. Sitting at a table with a cart beside the table, there are 14 linear feet of space within reach. Fourteen feet at a counter means walking up to 14 feet every time a specimen is

sorted. Separate stacks of larger families (Rubiaceae, Fabaceae, Asteraceae, ferns, Melastomataceae) are placed on a
table next to the work space. On the cart the rest of the families are intercalated in alphabetical order.

Always keep the numbered side of the newspaper up. Frequently notes are written on the edge of the newspaper and it is time consuming to check both sides, or they are missed. Never separate the only label to be sent with the gift for determination, etc., and leave behind specimens without labels. Not only is it more difficult to get a label made without the original, frequently it is impossible, particularly on older collections. Often it is not even known whose collection it is. Replacing labels is becoming much easier with computer label production, but it is
nearly impossible to replace labels if the collector is unknown or if the collection originated at another institution.

With multiple-sheet specimens or separate fruits, each component should have a label before they are sent to mounting or to another institution. When working with specimens always keep the newspaper, the plant, and labels together. If you
take only the plant to another area, an interruption may occur that will cause you not to be able to put the label and plant back together.

Sorting plants to family and working on all of one family at a time is more efficient than working on a few at a time. It also puts less wear and tear on the herbarium and literature. Determinations tend to be more accurate and one can update the herbarium at the same time.

MOUNTING NOTES

Always use the best quality materials available for mounting specimens. Since the lifetime of a specimen is nearly indefinite if properly stored, it only makes sense to use mounting materials (label paper, mounting paper, glue, etc.) which will not deteriorate over time and will last as long as the specimen.

If working on an ecological or anthropological project in which a reference herbarium is to be established, it is recommended that only good quality 100% rag mounting paper be used. It is better to store plants in newspaper than to mount them on poor quality paper. Never mount plants with scotch tape or other kinds of temporary tapes, and never staple plants to the mounting paper. Acid-free rag paper and permanent ink should be used for making labels.

PACKING CHECKLIST

General:

Passport and Visa
Hand Lens
Airline Ticket
Entry Permit
Travelers Checks
Collecting Permit
Money and Credit Cards
Vehicle Papers
First Number
Business Cards
Field Book
Ruler
Paper and Envelopes
Maps
Keys
Pens, Pencils and Eraser
Spare Glasses

Markers
Expense Notebook
Tags for Living Collections
Language Dictionary
Address Book
Book or Reading Material
(something to do while waiting)
Medicines (antibiotics, malaria pills, etc.)

Field Day Checklist:
Hand Lens
Day bag or Vest with Pockets
Hat
Compass, Map, and Altimeter
Clippers and Sheath
GPS Receiver
Machete and Sheath
Pocket Knife
Knife and Sheath
File
Raincoat
Canteen or Water Bottle
Snake Antivenom or Serum
Binoculars
Watch
String
Jacket
Emergency Kit
Fish Hooks
Lighter or Matches
Lunch, Candy
Insect Repellent (good for starting a fire in an emergency)
Suntan Lotion
Collecting Bags
Newspaper or Small Plastic Bags (for small specimens)
Camera and Extra Batteries
Film
Small Field Notebook
Climbing Equipment
Clipper Poles
Vials for Flowers, etc.
Needle and Thread
Safety Pins
Small Flashlight
Tissues
Field Press
Strap
Bandaids
Moleskin for blisters
Emergency Space Blanket
(also good for signaling help in emergencies)

Sleeping Supplies:
Sleeping Bag & Pillow
Air Mattress, Pad, or Camp Cot

Hammock and Rope for Hammock
Mosquito Net
Pajamas
Alarm Clock
Plastic or Tarp
Ground Cloth
Rope

Collecting Supplies:
Newspaper
String
Large Plastic Bags
Extra Collecting Bags
Small Plastic Bags
Burlap Bags for Bundles
Alcohol or Formaldehyde

Miscellaneous Supplies:
Backpack
Flashlights
Extra Light Nylon Duffle Bag
Batteries
Lantern
Mantles
Cook Stove
Immersable Heating Coil (for boiling water)
Fuel
Tent
Duct Tape
Sewing Kit
Safety Pins
Cup, Bowl, Plate, Spoon, Fork, Knife
Water Filter
Purifying Tablets

Toilet Articles:
Toothbrush
Toothpaste
Dental Floss
Soap
Deodorant
Wash Cloths
Shaver
Shaving Lotion
Towels
Laundry Soap
Toilet Paper
Feminine Needs

Clothes:
Short Sleeve Field Shirt
Field Shirts
Field Pants
Field Socks
Underwear

Shoes & Tennis Shoes
Thongs or Flip-flops
Boots
Handkerchiefs
Sweat Shirts
T-shirts
Sweaters
Coat or Jacket
Leather Field Belt
Swim Suit
Dress Pants
Dress Socks
Dress Shirts

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