Surveys of chimpanzees and other biodiversity in Western Tanzania

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CHAPTER 1: Surveys of Chimpanzees in Tanzania

A.J.Plumptre

Introduction

Researchers in Tanzania pioneered the first studies of the chimpanzee (*Pan troglodytes*) in the wild. Dr Jane Goodall started her research on wild chimpanzees at Gombe Stream, north of Kigoma, on the shores of lake Tanganyika in 1960 (Goodall, 1986; Collins and McGrew, 1988). Soon after this study, several Japanese researchers started to explore the region south of Kigoma under the Kyoto University Africa Primatological Expedition in 1961(Nishida, 1990; Moore, 1992). These explorations (summarized below) led to the development of a permanent research station in Mahale, a large promontory of land into lake Tanganyika, half way along the eastern side of the lake. Both sites continue to undertake research on chimpanzees today making them the two longest studies of chimpanzees in the wild and two of the longest continuous studies of any group of animals in the world. The development of individual recognition by the researchers has meant that we have been able to follow the lives of individuals of this long lived species for 40-45 years and a wealth of information has been generated on these studies including the first findings of tool use and the first examples of intra-species aggression leading to death in chimpanzees (Goodall, 1986; Nishida, 1990). The long term commitment of researchers to these two sites and the information they generated led to the creation of the Gombe Stream and Mahale Mountains National Parks by the Tanzania National Parks (TANAPA).

However, despite the extensive efforts at these two sites we know little about other sites where chimpanzees occur outside these parks. Chimpanzees are an endangered species under the IUCN Red List because of their declining populations across Africa. Tanzania as a signatory to the International Convention on Biodiversity (ratified in 1996) is committed to conserving its biodiversity and particularly threatened species. It is important therefore, that there is a reasonable estimate of the status of chimpanzees within the country and also a good knowledge about where the key sites for their conservation, and key sites for other species occur within the region they occupy. This report summarises the results of recent surveys made outside Gombe and Mahale Mountains National Parks to obtain a better measure of the status and abundance of chimpanzees and to identify sites of conservation value that are as yet unprotected.

Prior surveys of chimpanzees

This report is not the first survey of chimpanzees outside these two parks. There have been several expeditions to western Tanzania since 1961, primarily by Japanese researchers, who have explored various areas where chimpanzees were thought to occur. As a result of their efforts a pretty good idea of the extent of chimpanzee (and other primate) occupancy is known for western Tanzania (Kano, 1971b).

The Kyoto University Africa Primatological Expedition (KUAPE) first started studying chimpanzees at Kabogo point (between Kigoma and Mahale – figure 1.1). The expedition aimed to study chimpanzees living in dry open-forest country as it was believed this was the most similar habitat in which early humans evolved (Moore, 1992). This region is typified by its large expanse of Miombo woodland and gallery forests (see below). Habituation of chimpanzees at Kabogo point proved difficult and in 1963 researchers moved inland initially to the Kasakati basin (Izawa and Itani, 1966; Izawa 1970) but with persistent difficulties here additional camps were established further east in Masito at a site called Filibanga (Suzuki, 1969) (figure 1.1) and also in Mahale at a site called Kasoge. Habituation was only successful at Mahale and therefore long-term research efforts focused here after about 1967 (Nishida, 1968, 1979, 1990; Nishida & Kawanaka, 1972; Nishida, Takasaki and Takahata, 1990).

Figure 1.1. Map of western Tanzania showing locations of national parks (named), forest reserves and games reserves. The names of places referred to in the text are given. The brown line shows the areas where Japanese researchers have located signs of chimpanzees during their surveys.

Kano was the scientist who did most in the 1960s to identify the areas where chimpanzees occur around Mahale. He surveyed the region east of Masito and south towards Mahale from Masito. He also went east to Ntakata forest and Ipumba mountain in the Sitebi highlands and south east to the Wansisi hills (names used here are those given in Kano's reports). We had some difficulty finding some of these places and it is possible names have changed since the 1960s). His results of surveys made between 1965-1967 were published (Kano 1971b; 1972) and generally identified most areas where chimpanzees occur in western Tanzania. Further surveys in the 1970s were made of the northern and southern part of what is now the Mahale Mountains National Park and to the east (Itani, 1990) and in the Ugalla area (Nishida, 1989). Subsequent surveys have been made in the same areas Kano found chimpanzees (Massawe, 1992; Moore, 1992; Ogawa *et al.* 1999a, 2004; Kano *et al.* 1999; Zamma *et al.* 2004; Nakamura, Nishie and Mwinuka, 2005) and further south towards the southern end of Lake Tanganyika (Ogawa, Kanamori & Mukeni, 1997; Ogawa *et al.* 1999b). These explorations further south discovered chimpanzees in the Loazi Forest Reserve and Lwafi Game Reserve near the Zambia border and subsequent surveys have identified that chimpanzees occur between the Tembwa and Kafukoka river basins in the Loazi region (Kano *et al.* 2005).

The areas where chimpanzees have been recorded to occur following this survey work is shown in figure 1.1 within the brown line. Outside this area there are chimpanzees in Gombe Stream National Park, a few still persist in Kwitanga prison forest and there area a few individuals who were introduced to Rubondo Island in Lake Victoria in the 1960s. Many of the initial surveys aimed to identify where chimpanzees were present or absent, however Takayoshi Kano calculated densities of chimpanzees by estimating that he sighted 70% of chimpanzee nests within 70 metres of the paths that he walked and that nests required 180 days to decay (Kano, 1972). Most of the researchers who had surveyed this region pooled their data for surveys in the 1990s and early 2000s to estimate the density of chimpanzees using the same methods (Kano *et al.*, 2005). They estimated that chimpanzee numbers had declined, particularly in the Wansisi hills and the area around Ntakata forest and to the east of this reserve. The estimated population numbers in 1965-67 were about 1,900 individuals and in 1994-2003 were 1,000 individuals (Kano *et al.*, 2005).

Care must be take with these results however. There are potential problems with the methods used and we believe that the results can only be an approximation of the true value. In particular the following aspects need some attention:

1. The distance walked by an observer in these studies is not measured but approximated by marking the path taken on a map (1960s) or with a GPS unit (1990s). These methods do not account for variation in topography in measuring the distance traveled.
2. The assumption is made that all observers see 70% of nests within 70 metres of the path taken without testing this.
3. The path taken is not always a straight line and as a result may be influenced by ease of travel, presence of paths etc. In forests chimpanzees have been recorded to construct nests away from paths (Plumptre and Reynolds, 1997) and as a result it is possible that by following paths researchers may find lower numbers of nests if the same holds in woodland as well a forest. Additionally, chimpanzees in miombo woodlands show distinct preferences for topographical or vegetational features (Hernandez-Aguilar in prep; this report), so informal “transects” can easily be biased upward by a tendency to search where they are expected to be found.
4. The decay rate of 180 days appears to be longer than the rate found at Mahale (Ihobe, 2005) or in this study which would reduce the population estimate.
5. No errors are given around the density estimates and therefore it is difficult to assess whether the population estimates for 1994-2003 are really lower than 1965-67.

This is a huge area though and obtaining any sort of estimate for chimpanzee numbers is extremely difficult. The terrain is rough and in the dry season water is limiting in much of the region making access difficult. We believed that some of the variation in nest density found by the Japanese could be explained by the amount of time they spent in forest compared with woodland. By undertaking large treks across both habitat types they could potentially be increasing the variation in nest densities estimated. It is known that the chimpanzees require forest (gallery and larger blocks) in order to find enough food (Kano 1971a, 1971b, Nishida, 1989) and cannot survive in Miombo woodland alone. Therefore nests are generally clumped near forest and are rarer far from forest although there do seem to be some exceptions to this at some sites and slope plays a role in determining where nests are located (see chapter 8). As a result if a researcher spends more time near forest they will obtain higher estimates of nest density than if they spend most of their time in Miombo woodland. In order to reduce this variation in nest density it is important to stratify the survey so that densities are obtained for forest and Miombo Woodland separately. In this survey we therefore used a different method which aimed to obtain nest density measures for forested areas and also from miombo woodland near forest separately and then use satellite imagery to measure the extent of the forest and woodland to extrapolate density to total numbers of chimpanzees.

Study Area

The areas surveyed are described in the methods (chapter 2). Here we give a brief description of the region where chimpanzees occur and the vegetation types encountered.

The Mahale Mountains and the area around it are recognized as being an outlier of the Albertine Rift mountains in the western Uganda-Kivu-Burundi highlands. Many of the species found here come from central Africa or are similar to those found in the forests in Uganda, Rwanda, Burundi and eastern Democratic Republic of Congo. A study of the birds of this region led Moreau (1943) to suggest that in geological history there had been a barrier to movements of animals from south of Karema (just south of Mahale) and that the Malagarasi river that borders the northern part of the Ugalla-Masito region is a relatively recent barrier. As a result species in the past were able to migrate from the north to this region but not from the south. The postulated barrier was an ancient Rift valley that predated the formation of Lake Tanganyika - the Karema Gap (Moreau, 1943, Nishida, 1990).

This area is characterized by a species rich vegetation (Plumptre *et al.* 2003) which is in part due to the varied topography. The altitudes in this region range from 780 metres to 2,460 metres a.s.l. (Nishida, 1990). Over 1,170 plant species have been recorded in and around Mahale Mountains National Park, with 39 endemic to the Albertine Rift region and at least 9 with IUCN threatened status. Two hundred and fifty bird species have been recorded for this region (N. Baker pers. comm.; Plumptre *et al.* 2003) yet the region has been poorly surveyed for birds. The Tanzania bird atlas records bird sightings in ¼ degree squares and prior to this survey the most common African bird, the yellow-vented bulbul, had not been recorded in three such squares that overlaid the survey region. Only two species are endemic (Kungwe Apalis, *Apalis argentea*, and Regal sunbird, *Cinnyris regia*) and one is classified as threatened (Kungwe Apalis). At least 52 mammal species have been recorded for the region of which six are threatened. Red Colobus (*Pilocolobus badius*) and chimpanzee are two of the threatened mammals.

The Ugalla-Masito area is characterized by a very interesting topography of eroded canyons, cliffs and flat-topped hills (fig. 1.2). This area is the driest part of the chimpanzee range and is dominated by Miombo woodland with *Isoberlinia*, *Julbernadia*, and *Brachystegia* trees. *Brachystegia bussei* is often found on the steep slopes of the eroded canyons and is often used by chimpanzees for nest construction (Nishida, 1990). In the dry season Miombo woodland loses its leaves and trees become bare until the leaves flush after, or sometimes just prior to, the first rains. In the valleys along streams are gallery forests which remain green throughout the year. These forests are where the chimpanzees find much of their food although miombo woodland is also a source of food but it is often more seasonal in nature (Suzuki, 1969). On the flat-topped hills is often found bare rocks, grassland or sclerophyllous vegetation that is adapted to low moisture availability.

Further south the Ntakata-Sitebi highlands and the region around Wansisi hills and towards Mpanda is dominated by higher elevation hills and mountains. Below about 1800 metres the vegetation is Miombo woodland and gallery forest as found in the Ugalla-Masito area but there area also large areas of lowland bamboo (*Oxytenanthera abyssinica*) to the east of Mahale Mountains National Park towards and beyond Mwese to Mpanda. A few small swampy areas occur in the valley bottoms here and people have started cultivating in the recent past along the Mpanda-Mwese-Lubalisi road. Larger blocks of forest occur in and around the Ntakata Forest Reserve. Above 1800 metres altitude the Miombo woodland gives way to high altitude grasslands with montane plants such as *Proteas*, and gallery forest (fig 1.3).

In the area south of Mahale from Wansisi Hills to Loazi there is extensive cultivation along the lake shore with gallery forest following the steeper rivers. Further inland there is an escarpment which leads up to highland grassland and gallery forest with patches of Miombo at lower altitude.

Rainfall

This area is one of the driest sites where chimpanzees occur, particularly in the northern Ugalla-Masito area. Average rainfall in the year varies between 872 mm at Uvinza (mean of 1984-1994; J.Moore), 978 mm at Kigoma (1963-65;Suzuki, 1969), 1012mm at Ugalla (1973-88;Moore, 1992) up to 1818mm at the wettest site in Mahale Mountains National park (1974-88; Moore 1992). The rainfall pattern is unimodal (figure 1.2) with the peak rainfall from November to March and driest period from June to September.

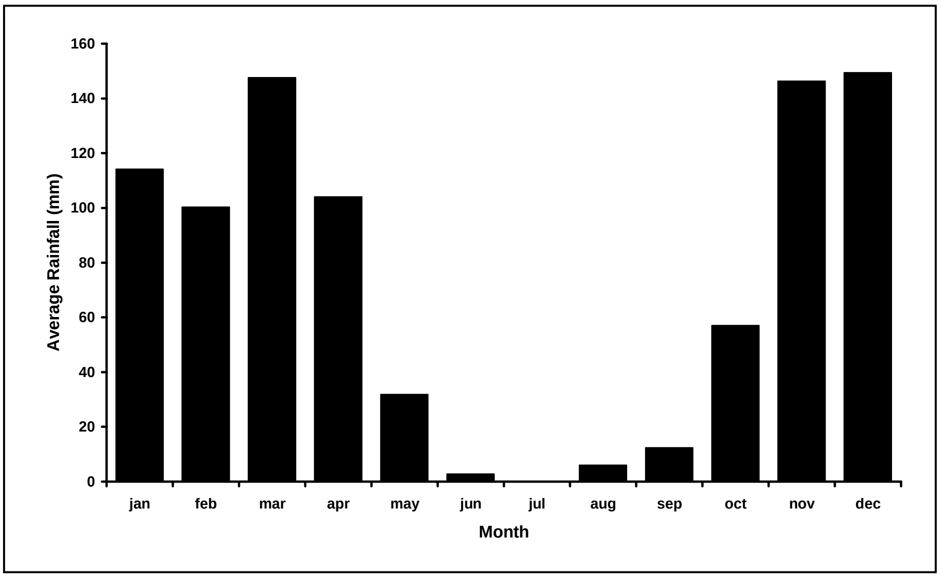


Figure 1.2 Rainfall variation in Uvinza. Average rainfall for a 10 year period (1984-1994) is given for each month.

Structure of the Report

The primary aim of this study was to survey chimpanzee populations across western Tanzania with the dual aim of estimating densities of chimpanzees using line transect methods across their potential range, and the larger goal of estimating numbers of chimpanzees in this country. However, given that field teams were being transported to the remote areas in western Tanzania, it was recognized that it would be very valuable to collect information about other species to help guide the conservation planning for this region. We therefore collected information about the presence and relative abundance of birds and plants and other large mammals (not rodents or insectivores).

Chapter two describes the methods used to survey the chimpanzees and to extrapolate their densities to derive a total estimate of chimpanzee numbers. Chapters three to five then give the results of the chimpanzee survey in three main areas: a) Mahale National Park and the area east of it towards the Sitebi hills and the Wansisi hills; b) Ugalla-Masito region south of Uvinza; and c) the Southern Tanganyika lakeshore. These surveys derive density estimates of chimpanzees for various areas surveyed. Chapter six summarises the results of the biodiversity surveys in the Mahale-Sitebi-Wansisi region. Chapter seven then analyses satellite imagery for the region combined with the survey data for the chimpanzees to derive a habitat suitability model to predict where chimpanzees might be found in the region. This model is then used to extrapolate chimpanzee densities to the whole region to estimate the total number of chimpanzees in western Tanzania. Chapter eight pulls all the results together and makes recommendations for the conservation of this region of Tanzania, one of the more remote and little explored areas of the country.

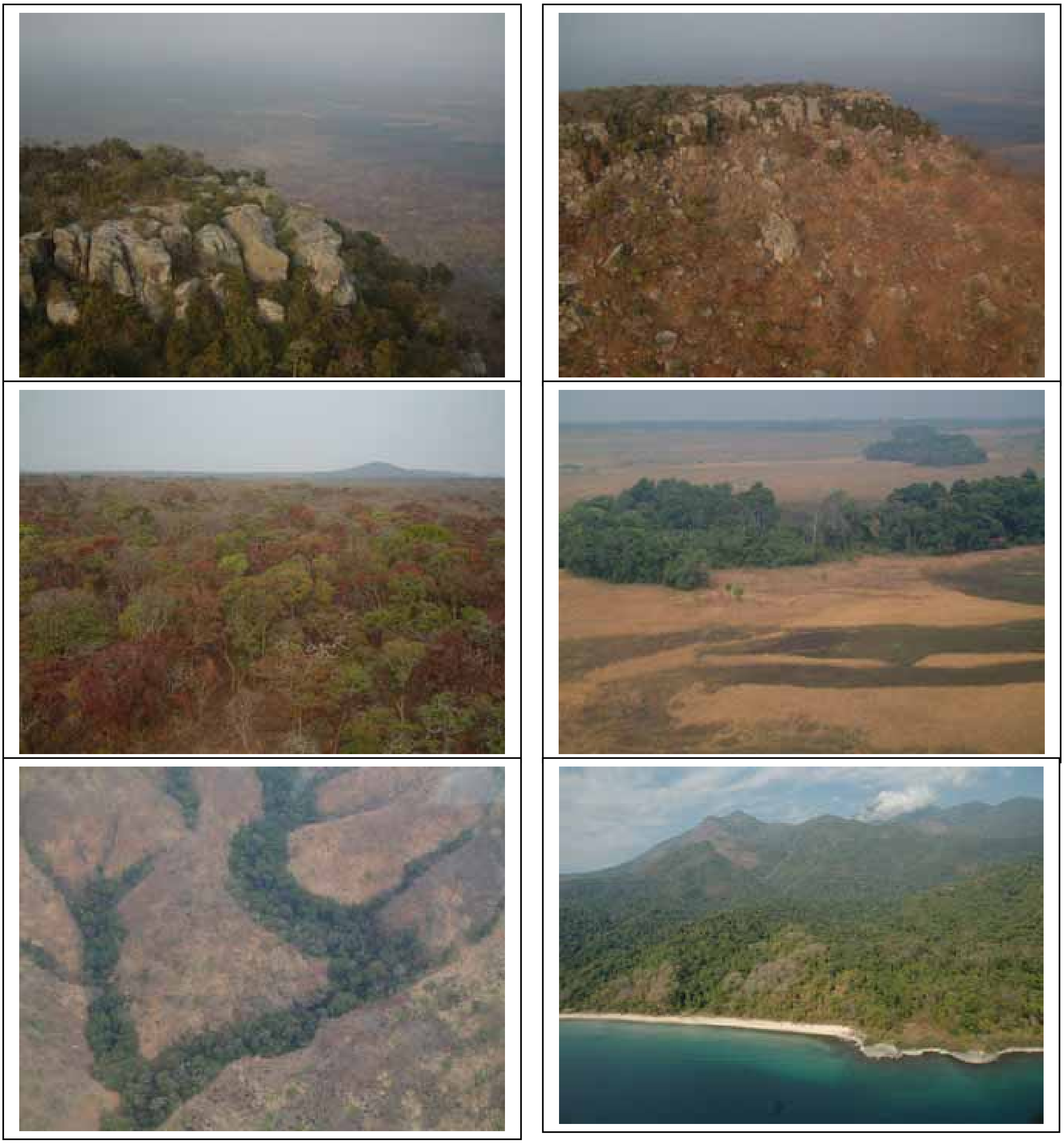


Figure 1.3. Images form the region inhabited by chimpanzees. From top left in a clockwise direction: Images 1 and 2 – Rocky canyon lands typical of the Ugalla-Masito region; Image 3 – montane grassland and gallery forest south of Mahale; Image 4 – Mahale National Park and mt Kungwe, the highest peak; Image 5 – gallery forest in lowland bamboo; image 6 – Miombo woodland with young leaves (red)

CHAPTER 2: Field Methods

A.J.Plumptre, D.Moyer, and S.Kamenya

Introduction

The area to be surveyed extended about 400 km north-south and at its widest was 140 km east-west and totaled an area of about 20,000 km^2. Consequently it was not possible to undertake an intensive survey of the whole region. Instead a three stage sampling process was used to identify where to survey on the ground. Initially an aerial reconnaissance survey was made using the WCS Cessna 182 of the WCS Flight Program to over-fly the region to the north-east, east and south of Mahale Mountains National Park. This was followed up by satellite image analysis to generate habitat type maps that identified the patches of forest and gallery forest in the region. Finally field teams visited the larger patches of forest on the ground east and south of Mahale. Additional socioeconomic surveys were made south of Mahale to further narrow down where field teams would survey on the ground and are reported on in more detail in chapter six.

We believed that chimpanzees would be dependent on forest but would range from the forest into surrounding Miombo woodland based on work by previous researchers in this region (Kano 1971a, 1971b, Nishida, 1989). This is because Miombo woodland, particularly that dominated by *Julbernadia*, is generally poor in species that provide food for chimpanzees, or is very seasonal in its provision of fruit. However, Miombo dominated by *Brachystegia bussei*, and which often occurs on steep slopes, appears to be used more by chimpanzees for nesting if in the vicinity of gallery forest (Nishida, 1989). Miombo woodland tends to lose its leaves in the dry season and is easily distinguished from other types of forest. Using data from Jim Moore, Hideshi Ogawa and Adriana Hernandez's field sites it appeared that chimp nests could be found up to 2 km from gallery forest from analyses made using habitat maps derived from satellite images (see chapter three). The bulk of nests occur within 500 metres of the forest and consequently surveys focused on areas of evergreen forest in the study region and up to 500 metres outside these forests. These included gallery forest along water courses and larger patches of evergreen forest.

Aerial surveys

In September 2004 an aerial reconnaissance was made to help identify key sites to visit with field teams. A three-day aerial reconnaissance was made of the region where chimpanzees are known to occur from previous accounts (see chapter 1). The WCS Flight Program plane, a Cessna 182, was based at Sitalike, in Katavi National Park for the surveys and spent two days overflying Mahale National Park and the region to the east and north (Figure 1). A third day was spent flying over areas south of Mahale down to the south western corner of Tanzania where it meets Zambia at Lake Tanganyika. Every two minutes during the flight, records were made about the habitat type and relative density of human habitation to better plan the ground surveys and to ground-truth satellite imagery. Habitat was classified in categories that could be identified from the plane: evergreen forest, open (<50% canopy cover) and closed (> 50% canopy cover) miombo woodland, bamboo, mixed forest and bamboo, grassland, montane grassland (above 1,700 metres), grassland and bamboo, bamboo and Miombo, rocky, *Protea* moorland, swamps/flooded grasslands, cultivated, and built up areas. Where possible, detail was added to the types of cultivation to help with the habitat classification process (chapter three).

The aerial surveys were not designed to be systematically flown but aimed to explore the region visiting sites that could be of potential interest for chimpanzees (larger tracts of forest) or other aspects of biodiversity (highland grassland, large tracts of forest, highland forest, highland protea moorland) within the large expanses of Miombo woodland and *Oxytenanthera* bamboo (fig. 2.1). Two large refugee camps occurred within the study region, created for refugees from the Burundi civil war, and these areas were avoided during the flight. They can be seen clearly on satellite images.

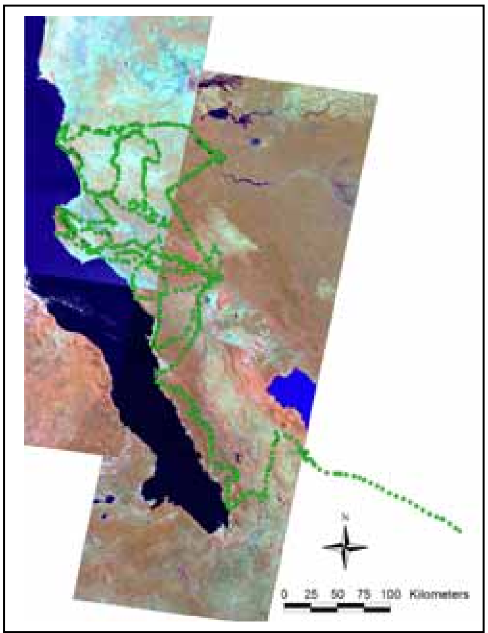


Figure 2.1. Map showing the flight path of the reconnaissance flights over Mahale National Park and the extended landscape to the east and south. Records were made every 2 minutes on the relative density of people and notes made on suitability of habitat for chimps. Each green circle shows where a vegetation recording was made.

From these surveys it became clear there were five areas that are relatively empty of people and have good chimp habitat (Figure 2.2):

1. The Ugalla-Masito corridor which runs from the north east corner of Mahale east to the Ugalla river and to the north of the park towards Uvinza has very few people apart from the refugee camps (see below).
2. The Sitebi highlands to the east of Mahale including Ntakata-Makomayo and further east
3. The Mahale-Katavi corridor to the south east of Mahale down towards the Wansisi hills, including Karobwa forest near Lubalisi.
4. Southern Tanganyika lakeshore forests especially Kala, Mtantwa and Lwazi watersheds
5. The Mahale Mountains National Park.

Area 1 is separated from area 2 by the Mishamo refugee camp and Lugufu plains, which contain Burundian refugees since the 1970s. With the current peace in Burundi this camp is likely to empty within the next few years and although severely affected by people now it could recover with time. There is evidence these people have been poaching wildlife around the camp (Kano *et al.*, 2005; Pers. obs of teams in field). Area 2 and 3 are separated by the Mpanda-Mwese road which continues on beyond Mwese to Lake Tanganyika. This road has settlements along its length which are all fairly recent. We did not aim to survey on the ground in areas of high human population density although we did talk to people about whether they see chimpanzees and where in areas we visited.

Following these aerial surveys we aimed to tackle the region with Tim Davenport leading surveys in area 4 (south of Mahale National park along the lake shore and its watershed) and David Moyer leading surveys in the other four regions. However, between the aerial surveys and the field surveys it became clear that the Ugalla-Masito region had been surveyed in the recent past by Jim Moore and several students of his and was to be partially surveyed by Alex Piel and Fiona Stewart around the time of our work. Hideshi Ogawa had also surveyed this region fairly extensively as well and could help provide information of use. Given the large area to cover, the field teams for the three northern areas decided to concentrate on areas 2, 3 and 5. The results of the chimpanzee surveys are therefore summarized in three chapters (three to five) that cover a) Ugalla-Masito; b) Sitebi highlands, Mahale Mountains Park and Mahale-Katavi corridor and c) the southern Tanganyika lakeshore and watershed. Areas 1,2,3 and 5 have been collectively termed the Greater Mahale Ecosystem.

Figure 2.2. The five survey areas assessed in this report. The areas are bounded in blue-green and aimed to include all areas where chimpanzees had been sighted in previous surveys outside the national parks. Satellite map below shows locations relief and refugee camps. (Worldsat and Jane Goodall Institute)

Field Surveys

Training

The field surveys commenced in August 2005. All personnel who would be involved in data collection were trained in the field data collection methods at Adriana Hernandez's field site in Ugalla. Training included lectures, held in Uvinza, about the methods that would be used and the basics of the analysis of perpendicular distance data. Three teams were trained for the Sitebi-Mahale-Katavi region and one team for the southern Tanganyika region. In addition Alex Piel and Fiona Stewart attended some of the training as they planned to use similar methods for a survey in the Ugalla region. For areas 2,3, and 4 each team comprised of two people who recorded data on large and medium sized mammals, and two botanists (one trained and one assistant). For areas 2 and 3 two experienced ornithologists (David Moyer and Hamlet Mugabe) collected data on bird sightings because this region had been very poorly studied for birds and had few records for the Tanzania bird atlas (N. Baker pers. comm..).

Field data collection methods included training in the use of:

1. Hip chain and topofil thread to measure distance traveled
2. Range finders to measure perpendicular distances when these were greater than 30 metres (30 metre tape measures were provided to each team).
3. Use of GPS units. Garmin II Plus and 12 XL units were used to collect positional data.
4. Completion of data sheets

Four, four kilometre transects were walked running east, west, north and south from the main camp to practice data recording and use of the equipment. These data were included with other data sets to look at chimp nest distribution in relation to the forest and to obtain a density estimate for nests in that region of Ugalla.

Sampling methods

Teams were also trained in how to sample the forest when they were in the field situation. It was decided to focus transect effort on the forest areas because of the need for chimpanzees to be associated with this vegetation type. As much of the forest in this region is in the form of long narrow strips of gallery forest along streams it was necessary to develop a sampling method that could maximize the effort spent in habitat suitable for chimpanzees while not being too biased in the way data were collected. Transects were walked in fixed compass directions from the camp site. These directions were determined in advance from vegetation maps of the area generated by Lilian Pintea of the Jane Goodall Institute (chapter three). When forest patches were met zig-zag transects were walked to maximize the time spent in this forest type before moving towards the next patch of forest. These zig zag transects extended beyond the forest by 500 metres before returning back to the forest. In this way some sampling was made in the woodlands around the gallery forests but most of the effort was concentrated in the forests (fig. 2.3). Densities could be calculated for forest and the surrounding 500 metres of woodland from these data and a satellite image analysis was made (chapter three) that enabled us to measure the area of forest with this 500 metre buffer in the study region. Once a patch of forest had been surveyed with the zig-zag transects a walk was made following a fixed compass direction to the next patch of forest. Data were collected on these walks also and analysed to obtain estimates of nest density in woodland within 2 km of forest separately.

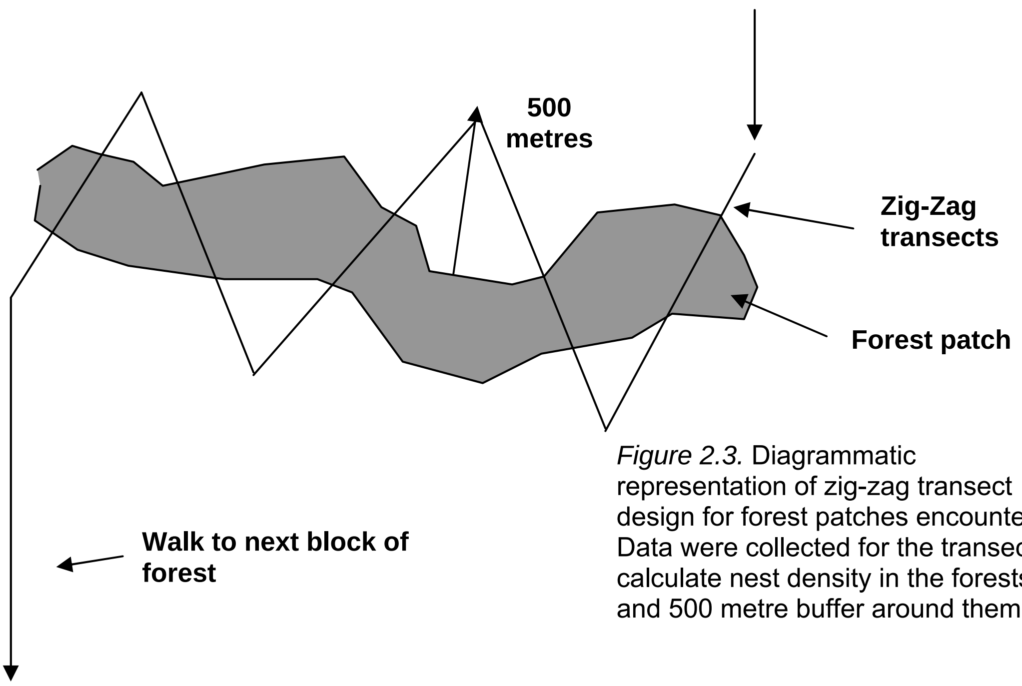


Figure 2.3. Diagrammatic representation of zig-zag transect design for forest patches encountered. Data were collected for the transects to calculate nest density in the forests and 500 metre buffer around them.

GPS positions were taken for any sighting of an animal or its signs (nest or dung of elephant, buffalo and pigs) and also every 250 metres a GPS position was taken with a description of the habitat type. This allowed us to map where teams had visited and also helped ground truth the satellite classifications.

Censusing chimpanzees

Chimpanzees are difficult to census directly because they tend to be shy and secretive and are often missed when walking through forest. They are also rare and live at low densities and so are not often encountered either. However, they make nests in which they sleep and we can use these nests to obtain an index of the population and with correction factors we can estimate the densities of chimpanzees (Plumptre and Reynolds, 1996, 1997; Plumptre, Cox and Mugume, 2002; Plumptre and Cox 2005). Each field team counted chimpanzee nests along the transects they walked and measured the perpendicular distance between the centre of the nest and the transect. Where groups of nests occurred together, each individual nest was measured separately (Plumptre and Cox, 2005). In order to correct nest density to obtain an estimate of chimpanzee density we needed to correct for the production rate of nests and the decay rate of nests. Only one study has measured the production rate of nests in wild chimpanzees which incorporated the construction of nests during the day as well as at night and the reuse of nests (Plumptre and Reynolds, 1997) and therefore we borrowed the value of 1.1 nests per day per nesting individual from this study. Nest decay rates were measured in Ugalla by Fiona Stewart and at Gombe, supervised by Shadrack Kamenya. At these sites 10 fresh nests were located each week for a period of about two months and monitored until they had decayed and were no longer recognisable. Nests were assigned age classifications as follows:

- ***1= New:*** Leaves in cup of nest all green and cup solid
- ***2= Medium:*** Leaves going brown (possibly some green) but nest cup still pretty much intact
- ***3= Old:*** Nest cup disintegrating – most leaves lost and can mainly see gaps between leaves in cup
- ***4= Decayed:*** No leaves left (less than 5%) – twigs left only.

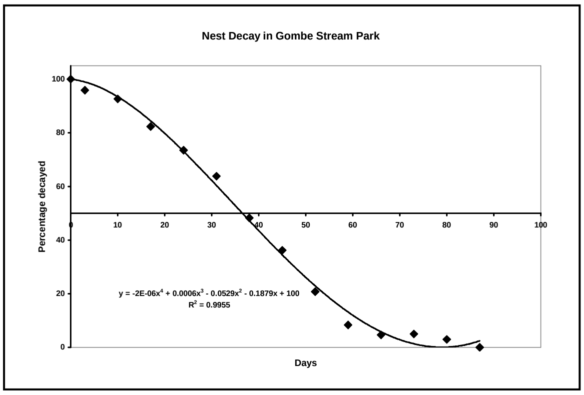
Nests seen on transects were also assigned the same age classifications.

Nest decay rates had been calculated by Ihobe for Mahale Mountains National Park (Ihobe, 2005) and his paper was kindly provided to us by Professor Toshisada Nishida.

Results of the nest decay work indicated that decay rates varied greatly between sites (fig. 2.4). The average time for nests to decay in Gombe was only 36 days. All nests in Gombe were measured in forest habitat. In Ugalla the mean nest decay time was almost three times as long: 97 days. Ihobe recorded a decay time of 131 days but his definition of point of decay included nests without leaves. If he used the same definition as we did above his average time to decay was 49 days, a little longer than the decay rate of nests in Budongo Forest in Uganda (45 days – Plumptre & Reynolds, 1996). The time taken to decay therefore seems to vary between the lake (Gombe and Mahale) where it is between 36-49 days and further inland (Ugalla) – 97 days. In this study most of the surveys were made inland and we therefore used the decay rate of 97 days.

Surveys of other biodiversity

Records were made of all large mammals observed or heard at each site visited by the field teams. Whenever signs (dung) or sightings were made on the transects and reconnaissance walks they were recorded and a GPS position taken. We also interviewed local hunters, who often acted as guides or porters for the teams, about what they see in terms of large mammals. Sometimes it was difficult to pin down exactly which animal they meant as they often had a local name only for the species. For instance it was difficult to separate blue duiker and Suni from their descriptions. However, for the most part this helped increase the list of larger mammal species.



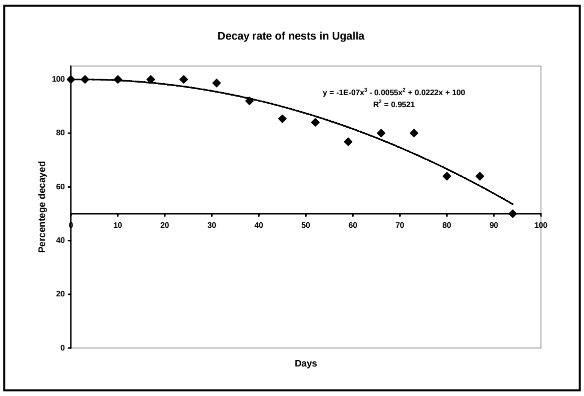


Figure 2.4. Decay curves for nests in Gombe Stream National Park (left) and Ugalla (right). Curves have been fitted to the decay data and the equations of the curves have been given. Where the curve crosses the 50% line is the mean time to decay.

Birds were surveyed by two ornithologists along the same transects and walks between forests used by the mammal teams in areas 2, 3 and 5 and at the training site in area 1. Both ornithologists could identify most birds from their calls and those that they couldn't identify they recorded on portable tape recorders to identify later. Each day a complete list of birds seen or heard was recorded to build up as complete a list as possible for the site over the 4-5 days spent at that site. As well as a measure of species richness we also wanted to collect data on relative species abundances. Therefore at every 250 metre point along the transects (these were marked by the mammal teams with ribbons) they would stop and record all birds seen and heard for a period of five minutes. These point counts were repeated from 6.30 am up to about 1 pm each day. In order to maximize the number of species encountered at a site the point counts would be made initially at every 250 metres but if the transects were passing through a lot of Miombo woodland and the same species of bird were being encountered, the ornithologists would selectively stop at those points that fell in different habitat types.

Botanical teams also were used to survey plants in areas 2, 3, 4 and 5 and at the training site in area 1. These teams also aimed to collect samples and identify species during their time at a site to obtain as complete a species list as possible. Plants were also collected in plots along the transects established by the mammal teams at every 250 metres. All trees were identified within a 20 metre radius of the 250 metre point, all lianas (> 1cm diameter) and shrubs were identified within 10 m radius and all herbs were identified within a 2 m radius circles. The time of year at which the surveys were made was the dry season and bush fires had moved through some of the areas surveyed so that it is likely that the botanical lists for the sites will be lower than might be found at another time of year.

Data analyses

Chimpanzee densities

Chimpanzee nest density was calculated using standard perpendicular distance techniques and the computer software DISTANCE (Buckland *et al.* 1993). Densities were calculated separately for forest and for Miombo woodland/Bamboo habitat within 2 km of forest (transects between forest patches). Some of the areas surveyed were at high altitude and it was found that there were no sign of chimpanzees above about 1900 metres a.s.l. Consequently when calculating the densities of chimpanzees in these two habitat types we omitted surveys from above this altitude. Densities were estimated separately for Mahale Park, east of Mahale, Ugalla-Masito and the southern lakeshore forests separately. Average density for these two habitat types was then extrapolated to the region using the areas of the various habitat types calculated from satellite image analysis (chapter 3). The socioeconomic surveys had already identified where chimpanzees occurred in area 4 so the densities obtained were multiplied by the area of forest in the sites known to contain chimpanzees.

Biodiversity of sites
For each site visited the number of mammal, bird and plant species were calculated and species accumulation curves computed using the software 'Biodiversity Professional'. The number of Albertine Rift endemic birds and threatened birds, mammals and plants were also calculated. These data were then combined to rank the sites surveyed for their relative conservation value and to assess which areas outside the national parks in this part of Tanzania might be suitable for protection and possible expansion of the protected area system.

Satellite Image analysis
Satellite Data
Five Landsat Orthorectified ETM+ satellite images were selected to map the forest and woodland classes in the study area. Each image covered a surface area of 185x185 km with a spatial resolution of 28.5 meter per pixel. Two of the scenes covering Gombe and Mahale National Parks corresponding to WRS Path/Row 172/063 and 172/064 were acquired at the end of the dry season October 1, 2001. The other three scenes corresponding to WRS Path/Row 171/064, 171/065 and 171/066 were acquired at the beginning of dry season May 22, 2002. All images were orthorectified by MDA Federal Inc., former EarthSat, as part of the NASA Global GeoCover dataset. For this study the imagery have been reprojected to GCS_WGS_1984 in decimal degrees.

Because of the differences in vegetation phenology two mosaics were developed: 2001 and 2002. Each mosaic was separately classified and evaluated for classification accuracy. The final 2001 and 2002 forest and woodland maps have been combined to cover the entire study region.

The study area was also covered by dry-season ASTER satellite images at 15-meter resolution acquired between 2001-2003. Each image covered an area of 60x60 km. However, because of the satellite Path/Row overlaps it took fifty images to cover 80% of the study area. Therefore, despite the potential of ASTER imagery to map narrow gallery forests, the main use of ASTER data, in this study, was to understand the seasonal variations in vegetation phenology and the potential sources for classification error.

Reference data
Reference data were developed for each of the mosaics. Because of the large study area and high variance of forest and woodland habitat characteristics, it was necessary to involve a variety of reference data and methods for training and accuracy assessment.
Habitat data collected during the September 2004 aerial reconnaissance survey were used to develop the first version of the vegetation map used to plan chimpanzee surveys. The data were randomly sampled to select 75% of the points for training the classification algorithm and 25% for accuracy assessment. The aerial reference data were complemented with habitat data collected later during the 2005 and 2006 chimpanzee and other biodiversity surveys by WCS, JGI, UCSD and FZS. Additional training sites were identified from oblique aerial photos collected by John MacLachlan, JGI-TACARE project in 2000 and 2005 and JGI/WCS in 2005.

Image Classification

Only two classification classes were required to extrapolate chimpanzee density estimates; Forest and Woodland. However because of similarities in spectral responses between various types of woodlands, forests, agriculture, wetlands and other vegetation types such as bamboo, each spectrally distinctive vegetation class had to be mapped separately and than recoded in larger, generalized classes. Variations in topography, slope, vegetation season, species composition and various stages of burning substantially increased the number of spectral mixture across land cover types.

Table 2.1. Spectral classes that have been identified in the imagery, vegetation types that had a similar spectral response and the final vegetation classes produced by recoding spectral classes mapped.

Spectral Classes Mapped	Similar Spectral Response	Final Class Recoded
Forest riverine narrow	Woodland/Bamboo	Forest
Forest riverine large	Oil Palm/Swamps	Forest
Forest on slopes	Woodland	Forest
Forest on plateau	Woodland	Forest
Woodland steep slopes in the shade	Forest	Woodland
Woodland on plateau	Forest	Woodland
Woodland burned	na	Woodland
Woodland dense	na	Woodland
Woodland open	Grass	Woodland
Woodland leaves off	Grass	Woodland
Woodland bright new green leaves	Forest	Woodland
Bamboo burned	Grass	Other/grass/bare
Bamboo no burned	Woodland	Other/grass/bare
Bamboo bright new green leaves	Forest	Other/grass/bare
Grass no burned	na	Other/grass/bare
Grass burned	na	Other/grass/bare
Grass with rocks	na	Other/grass/bare
Bare/Settlements	na	Other/grass/bare
Agriculture intense	Woodland	Other/grass/bare
Agriculture low	Woodland	Other/grass/bare
Oil palm	Forest	Other/grass/bare
Wetland	Forest	Other/grass/bare
Swamp	Forest	Other/grass/bare
Clouds	na	No data
Cloud shadows	na	No data
Topographic shadows	na	No data
Burned land	na	Other/grass/bare
Water	na	No data

For the 2001 image mosaic covering Mahale and Gombe National Parks, a total of 726 training sites were digitized as polygons of various sizes to capture the spectral variance across land cover classes:

Woodland - 331
Forest - 126
Bamboo - 79
Agriculture, wetland, bare and grassland - 133
Burn, water, bare land, clouds etc. - 57

For the 2002 image mosaic covering the rest of the study area 581 polygons were digitized including:

Woodland – 264
Forest – 114
Bamboo - 79
Agriculture, wetland, bare and grassland - 113
Burn, water, bare land, clouds etc. - 90

Normalized Difference Vegetation Index (NDVI) and Tasseled Cap Transformation (TCP) greenness and wetness indexes have been calculated, added to the six Landsat spectral bands and evaluated for a potential increase in the ability to separate different classes. The assessment showed that NDVI and TCP indexes increased the classification accuracy for the late dry season 2001-10-01 image mosaic only. A supervised classification using Maximum Likelihood parametric algorithm was applied to classify both 2001 and 2002 imagery using ERDAS Imagine software. The maximum likelihood decision rule is based on the probability that a pixel belongs to a particular class. The basic equation assumes that these probabilities are equal for all classes, and that the input bands have normal distributions (ERDAS Imagine Inc.).

CHAPTER 3: Surveys of Chimpanzees East of Mahale Mountains National Park

D.Moyer, A.J. Plumptre, S.Kamenya, S.Athumani, and S.Sikombe

Introduction

The field teams visited several sites in the area east of Mahale Mountains National Park. This area had looked the most interesting from a biodiversity conservation perspective because of the large highland areas in Sitebi, Ntakata and Wansisi which were relatively remote and separated from other areas and hence might contain species of conservation value. Following the surveys of this region in August-September 2005, David Moyer led further teams to Mahale Mountains National Park. The detailed results of these latter surveys will be written up in a separate report but the main findings are compared with the results here to provide a comparison with the park.

Sites surveyed

Nine sites were surveyed for chimpanzees east of Mahale, and three sites within Mahale Mountains National park (Figure 3.1):

East of Mahale Mountains NP

1. Kapalagulu – surveys were made in gallery forest patches and the surrounding Miombo woodland north east of the Kapalagulu airstrip.
2. Ntakata (west) – two teams visited Ntakata Forest Reserve, one focusing on the western side of the forest and some surrounding Miombo woodland.
3. Ntakata (east) – the eastern side of the forest reserve and its Miombo woodland.
4. Lubalisi hills – the hills above Lubalisi village contained gallery forest, Miombo woodland and bamboo. The main forest surveyed was Karobwa Forest.
5. Sitebi (west) – the Sitebi highlands include along range of hills that rise to above 2000 metres. These highlands are potentially interesting for conservation because of their isolation. The habitats included Miombo, gallery forests and highland grasslands.
6. Sitebi (east) – the eastern end of the Sitebi highlands was also visited.
7. Mwese hills – the hills above Mwese town included small patches of gallery forest and bamboo with some patches of Miombo.
8. Lugalla hills – the northern part of the Wansisi hills is called Lugalla. This area is mainly Miombo woodland with gallery forest.
9. Wansisi hills – the southern Wansisi hills are west of the Katavi National park. This region also contains mostly miombo woodland with gallery forest.

Mahale Mountains National Park

1. Kasoge – this area is at low altitude, west of the mountain range near the shore of Lake Tanganyika. It is primarily forest and miombo woodland
2. Kabezi – this area occurs east of the mountain range and includes miombo woodland, bamboo and gallery forest.
3. Mfitwa – this site was near the top of the mountain range in the park and included forest and high altitude grassland.

At each site the surveys focused on walking transects in evergreen forest and up to 500 metres into woodland either side of forest patches. Transects outside forest exceeded this distance where they continued on to other patches of forest.

Figure 3.1. Locations of survey sites in the area east of and within Mahale Mountains National Park (left). The dark line shows the extent of the possible range of chimpanzees within this region. Satellite map shows the basic relief for this region

Results

Effort

A total of 203.3 km of transects were walked in both forest and Miombo woodland with about 1/3 of the transect length in closed forest and 2/3 in woodland. The high proportion in woodland was a result of transects that ran parallel to forest along riverine strips (yet were still within 500 metres) and the ease of movement through the woodland when compared with the forest.

Locations of chimpanzee nests

A total of 1,078 chimpanzee nests were recorded at all these sites allowing a reasonable estimate of the perpendicular data for most sites and vegetation types. Chimpanzee nests were not observed at Sitebi West and Sitebi East or at Mfitwa in Mahale Mountains National Park (Figure 3.2). These are all sites with relatively high altitudes and open moorland/ grassland mixed with woodland and gallery forest. Chimpanzees were reported to be present at lower altitude south of Sitebi West, between Sitebi and Ntakata, between Mwese and Wansisi Hills and also north west of Kapalagulu by local people employed on the surveys but we did not have the time to confirm this.

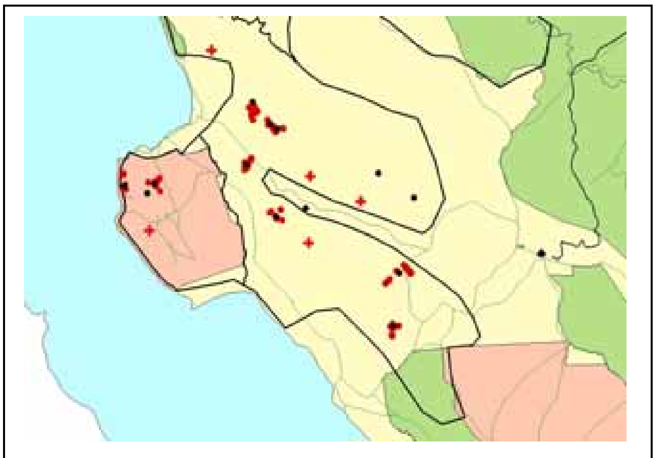


Figure 3.2. Locations of chimpanzee nests recorded (red) and points marking centres of each site surveyed (black). Towns are marked with black houses. Red crosses indicate where chimps were reported to occur by local villagers.

In this region no nests were observed above 1,900 metres altitude a.s.l. and this altitude was therefore used as a ceiling when predicting habitat use for this species in this area (chapter 8).

Analyses of Chimpanzee nest density

Analyses of chimpanzee density were made for each site surveyed where nests were recorded (combining data for both woodland and forest together) and also for two vegetation types: a)closed forest and b) Miombo woodland/Bamboo (combining data from all sites surveyed in this region). Detection curves were calculated separately for each site, although sample sizes were less than the recommended 70 sightings at most sites (Buckland *et al.* 1993). We tried combining data for different sites to improve the detection curve but because of variation between sites it did not improve the estimates. There are therefore large standard errors around the site estimates. Better estimates were obtained from the analysis of nest density in forest and in woodland/bamboo separately (Table 3.1).

Table 3.1 Summary of chimpanzee nest density estimates. Estimates are given for each site and for two major habitat types. The number of kilometers walked, number of nests seen, density of nests and the standard error of the density estimate are given.

Site	Effort (km)	Number of nest groups sighted	Nest density (No/km^2)	Standard Error (No/km^2)	Mean Density Chimps (No/km^2)
Kapalagulu	18.9	65	62	34	0.6
Ntakata (west)	11.6	18	50	34	0.5
Ntakata (East)	11.5	41	81	56	0.8
Lubalisi Hills	12.3	129	346	95	3.2
Mwese Hills	20.0	70	75	34	0.7
Lugalla Hills	15.5	420	509	219	4.8
Wansisi Hills	12.3	60	40	28	0.4
Kabezi	26.0	128	134	98	1.3
Kasoge	19.9	69	137	84	1.3
Closed Forest	68.7	369	151	49	1.4
Miombo/Bamboo	134.6	709	133	53	1.2

There was no significant difference (Z=0.25, P=0.4) between the nest density in closed canopy forest (151 km^{-2}) and the nest density in Miombo woodland/Bamboo (133 km^{-2}). The average density was therefore 142 km^{-2}.

Calculation of Chimpanzee density

In order to convert nest densities to actual density of chimpanzees we need to correct for two factors: the production rate and the decay rate of nests. In the methods chapter we calculated the production rate of nests to be 1.1 per day and the average time to decay to be 97 days. Therefore in the area east of Mahale and at Mahale the density of chimpanzees can be calculated using the following formula:

Density of Chimpanzees = Density of Nests/(Production rate x mean time to decay).

Therefore the mean density of chimpanzees in this region = 142/(1.1x97) = 1.3 km^{-2}.

The estimated densities for each site vary considerably (table 3.1) and it must be remembered that three sites had no signs of chimpanzees in this region. However transects from these sites with no sign were included because we wanted to obtain an average density across the whole survey area rather than only where chimpanzees were present.

A density of 1.3 chimpanzees per square kilometer is relatively high compared with estimates made by Japanese researchers in the past. However it is not dissimilar to estimates from other forests in Uganda (Plumptre, Cox, and Mugume, 2002) which varied between 0,03-3.6 chimpanzees per square kilometre.

Conclusion

Chimpanzees occurred throughout much of the region east of Mahale Mountains national park and within the park. No signs were found of chimpanzees occurring at high altitudes either at the Mfitwa site in the park or in the Sitebi hills to the east. Nest density was generally higher in the park, although two sites, Lubalisi and Lugalla hills had considerably higher nest densities and nest sightings also (table 3.1). Variations in nest densities will be affected by variations in nest decay rates at different sites and it was not possible to measure this everywhere. We have used the most conservative mean nest decay from the three estimates we had but it is possible that some of the dry sites such as at Lugalla hills in particular may have had longer decay times.

The estimate of 1.3 chimpanzees km^{-2} is higher than had been estimated in the past by prior surveys. Our surveys focused on patches of forest and their surrounding Miombo woodland and not in pure Miombo or bamboo habitat which may explain the higher estimate, however our transects did extend up to 1.2 km from forest patches into these more open habitats. When extrapolating to the whole area (chapter 8) we use 1.0 km from forest greater than 30 hectares as a cut-off point to minimize the extrapolation to areas we did not survey to obtain a minimum estimate for chimpanzees for this region.

These surveys did increase the known area where chimpanzees have been recorded to occur in the past. We found chimpanzees much closer to Mwese than had been recorded in the past and heard about possible chimpanzee communities even further east towards the Wansisi and Lugalla hills. It is therefore possible that the population in these hills is not as isolated as once had been thought. An aerial flight between Mwese and these hills did show that small patches of riverine forest still occur between these two areas and it is possible that chimpanzees could be present. Similarly there were reports of chimpanzees from people working with us in Sitebi west at lower altitudes. We were unable to confirm this for certain but these would be further east than previous records if true. If true, chimpanzees could be used as a 'Flagship species' to promote the development of corridors linking Mahale Mountains National Park to the Sitebi highlands and down to the Wansisi hills and further to Katavi National Park. At present people are moving into parts of this potential corridor, particularly around Lubalisi and are starting to cut off the link between Karobwa forest and Mahale National park. Action is needed soon to manage settlement in this area.

CHAPTER 4: Surveys of Ugalla and Masito

A.Hernandez-Aguilar, J.Moore, F. Stewart, A. Piel, H.Ogawa and L.Pintea

Introduction

The Masito and especially Ugalla regions are uniquely important from a scientific perspective, in that they include among the most arid habitats in which chimpanzees have been studied and as such are important for (a) elucidating the limits to chimpanzee socioecological adaptation, and (b) using our interpretation of those adaptations to better understand early hominid behavioral ecology. Information for this chapter is drawn from multiple sources and spans almost a half-century. In Masito, early research was conducted by members of the Kyoto University African Primatological Expedition (KUAPE) in the mid to late 1960s at Filabanga and Kasakati. Attention has since focused primarily in the Ugalla region. Moore and Ogawa have conducted nearly annual surveys and short studies since 1989. Additionally, Hernandez-Aguilar recently completed dissertation work at Issa, spending 20 consecutive months ending in June 2003. Previously-planned research by Piel and Stewart at Ilumba in 2005 was also incorporated into the larger WCS survey. As might be expected, methodological differences make direct comparisons across these studies and with the 2005 WCS survey difficult; however, with 40-years of study from multiple researchers, we can provide a depth of knowledge that is lacking for other non-National Park areas of Western Tanzania (Suzuki 1969; Kano 1972; Itani 1979; Nishida 1989; Massawe 1992; Moore 1996; Ogawa et al. in review).

Sites surveyed

Information comes from two sites in the Masito region and four in Ugalla (see list below). Habitat is broadly similar over all sites in both areas: Miombo woodland with patches of evergreen forest, mostly riverine. These forest islands have only begun to be studied from the perspective of island refugia and as such are of interest for understanding the origins and extent of current biodiversity patterns.

Masito:

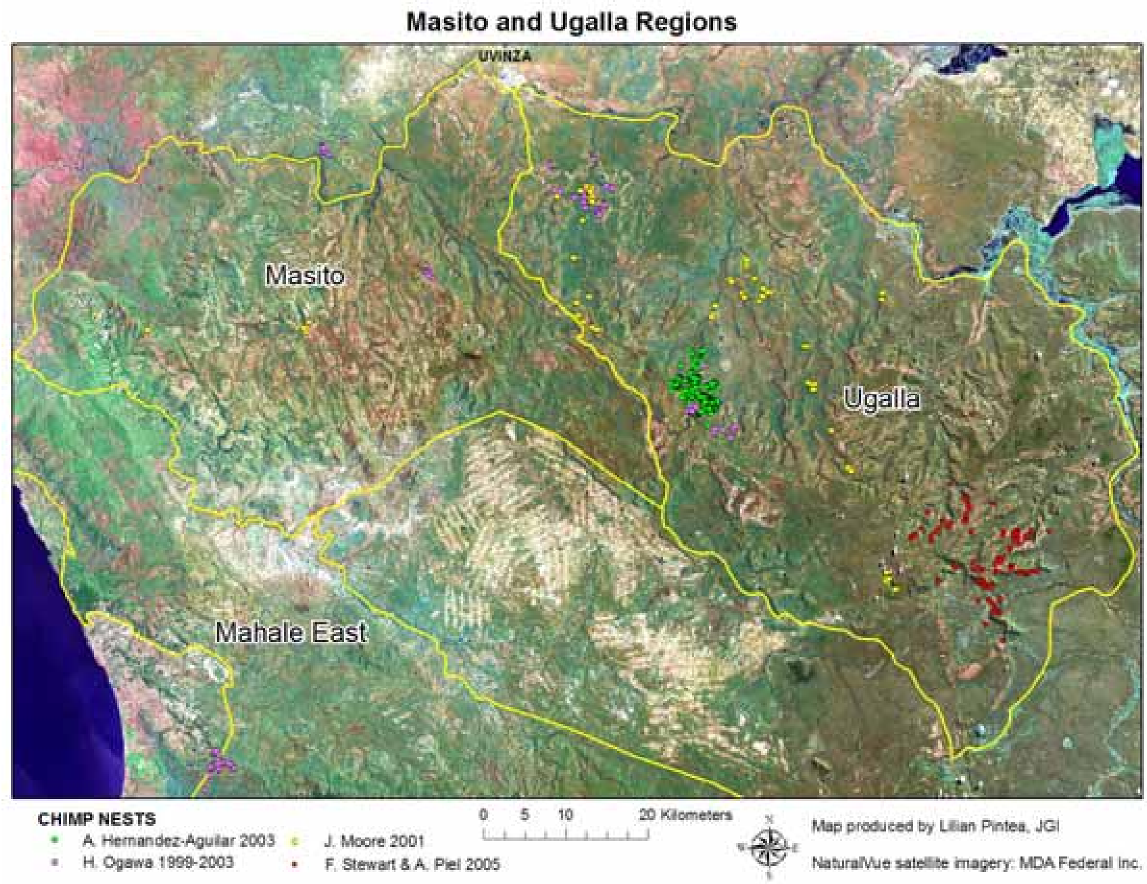
- Filabanga -- Kano (1971) reports on his 11-month study and Moore (unpublished) made a brief survey in 2001; both focused on gallery forest along the Filabanga River and the surrounding Miombo woodlands.
- Kasakati – Several KUAPE researchers have published on aspects of chimpanzee ecology and demography at Kasakati (Izawa 1970, Suzuki 1969) and Moore (unpublished) briefly visited in 2001. The early studies covered hundreds of square kilometers.

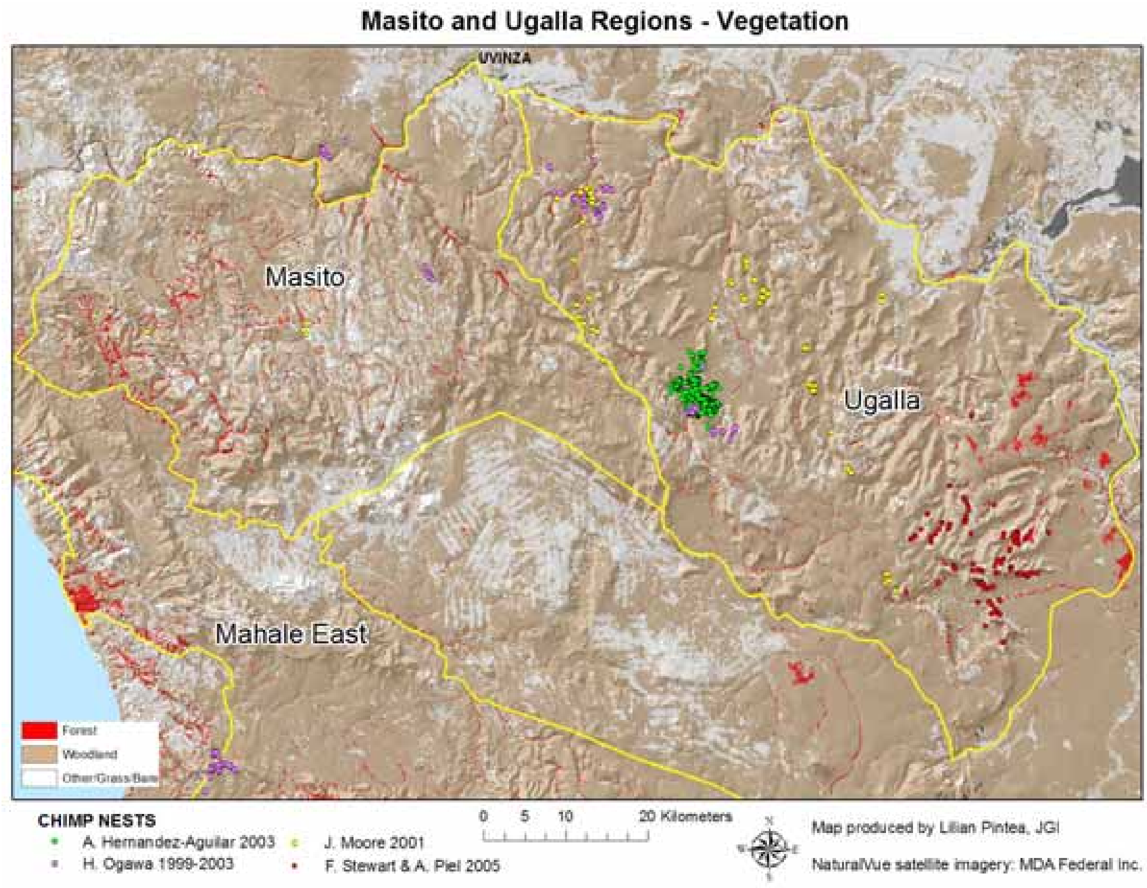
Ugalla:

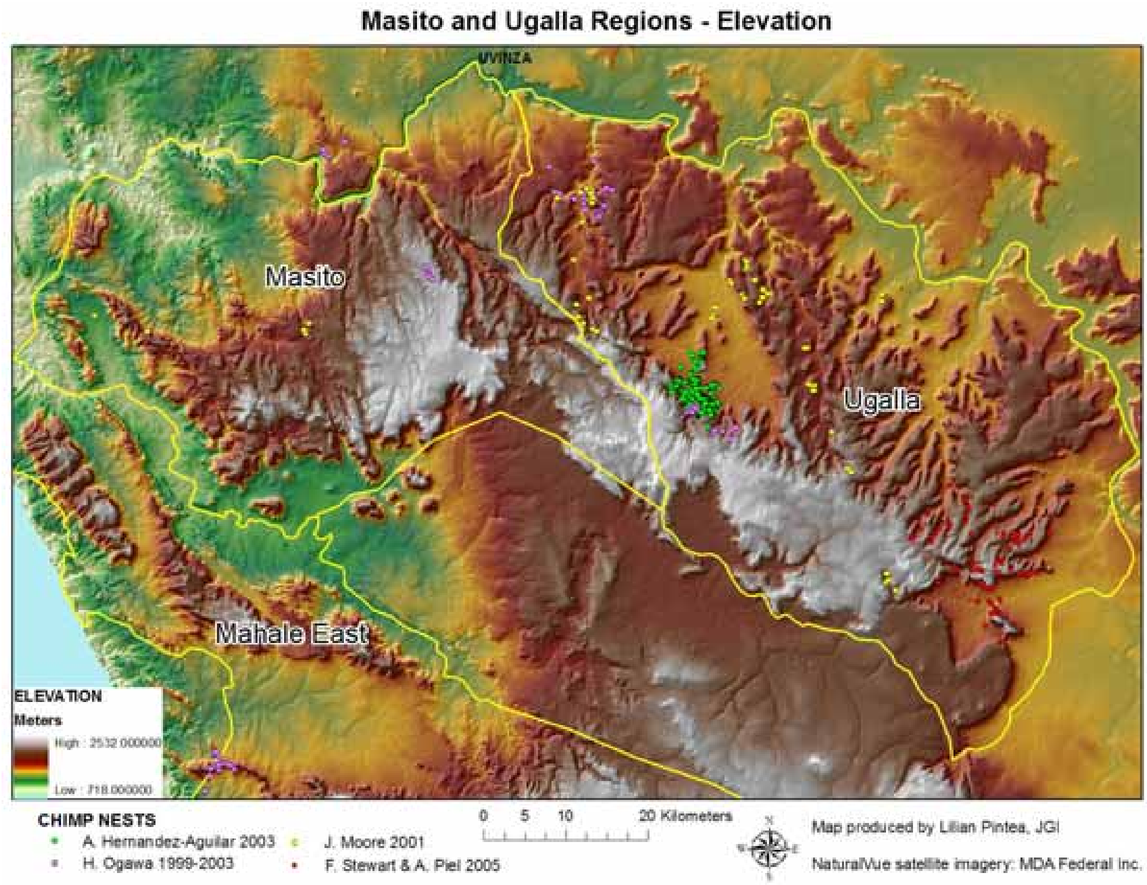
- Nguye – The first campsite south of Uvinza, visited for varying lengths of time by most researchers working in Ugalla. Expansion of shambas southward from Uvinza reached the Nguye River area in about 1997 and chimpanzee use of the site has fallen precipitously since then.
- Issa – Site of dissertation research by Hernandez-Aguilar, on factors influencing chimpanzee choice of nesting sites (cf. comparison with early hominid site placement). Brief surveys by WCS teams and Piel/Stewart in 2005.
- Mttindi/Bhukalai – Extended 'site' studied by Moore (Mttindi) and Ogawa & colleagues (Bhukalai), north and northeast of Issa along the Mogogwesi River.
- Ilumba – Deeply dissected region at the southeast corner of chimpanzee range in Ugalla, surveyed by Piel & Stewart in 2005 and planned site of Piel's dissertation research.

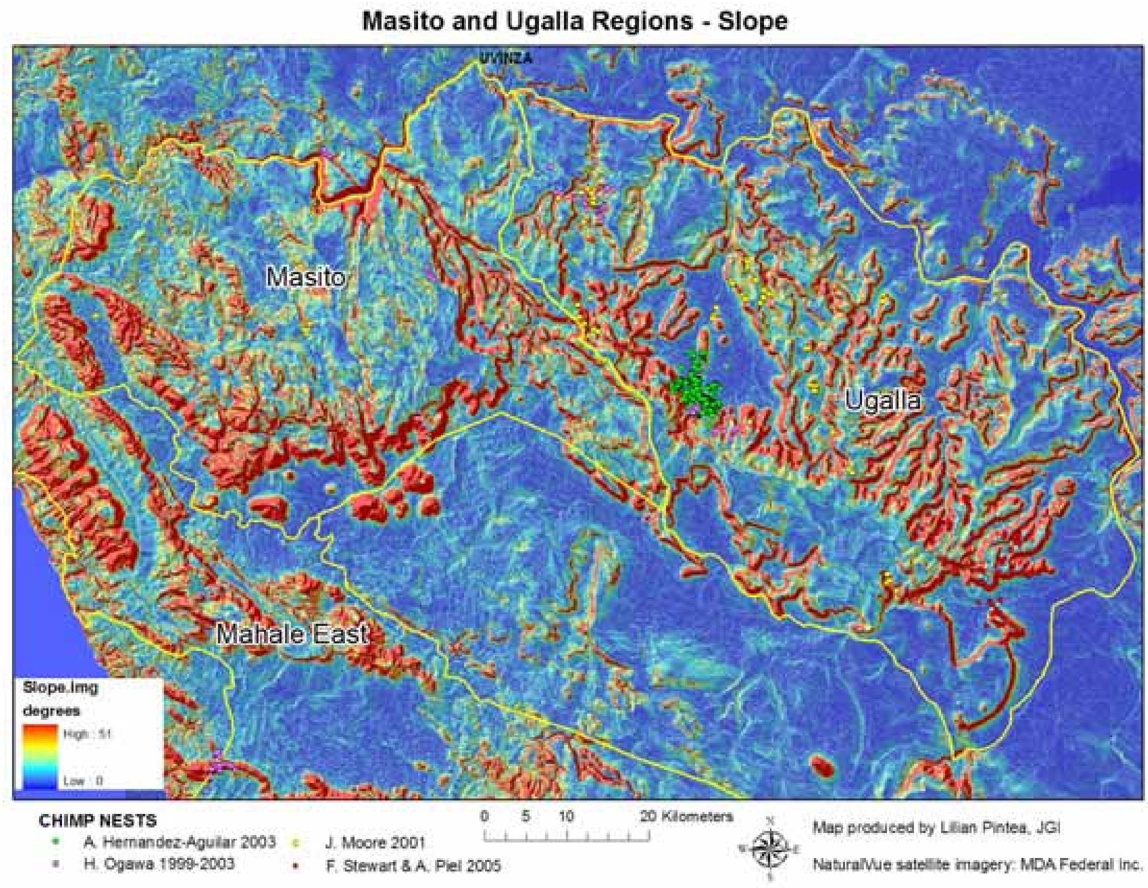
Goals and methods of research varied across sites, with statistically randomized, short, primarily vegetation transects by Moore at Mttindi, Filabanga and Kasakati; longer, less formal walking-route surveys by Ogawa at Nguye and Bhukalai; exhaustive census of approximately 48 km^2 by Hernandez-Aguilar at Issa; and 30 nest transects stratified by habitat type and topography level by Piel & Stewart within a 625 km^2 area at Ilumba. Chimpanzees of the Masito/Ugalla region make extensive use of woodlands for both feeding (Suzuki 1969; Schoeninger et al. 1999; Hernandez-Aguilar 2006) and nesting (Hernandez-Aguilar 2006, Pintea chap. 8, this Report). Multiple researchers using various methods over four decades in Ugalla have all reported the same pattern (see e.g. Itani 1979: 65), and only during the compilation of this Report did it become apparent that this extensive use of woodlands might be unusual relative to chimpanzees outside of Ugalla (see Chapters 3, 5-7). The reason[s] may be methodological, ecological, geomorphological or a combination of these and perhaps other, not yet identified factors (Kano 1971; see below)

Figure 4.1. Locations of chimpanzee nests in the Masito/Ugalla regions. The yellow line shows the extent of the probable range of chimpanzees within this region. The nests overlay over: a) satellite image 2001-2002, b) forest-woodland classes, c) elevation; d) slope.




Masito and Ugalla Regions - Vegetation
UVINZA
Masito
Ugalla
Mahale East
Forest
Woodland
Other/Grass/Bare
CHIMP NESTS
A. Hernandez-Aguilar 2003
H. Ogawa 1999-2003
J. Moore 2001
F. Stewart & A. Piel 2005
0 5 10 20 Kilometers
Map produced by Lilian Pintea, JGI
NaturalVue satellite imagery: MDA Federal Inc.


Masito and Ugalla Regions - Elevation
UVINZA
Masito
Ugalla
Mahale East
ELEVATION
Meters
High : 2532.000000
Low : 718.000000
CHIMP NESTS
A. Hernandez-Aguilar 2003
H. Ogawa 1999-2003
J. Moore 2001
F. Stewart & A. Piel 2005
0 5 10 20 Kilometers
Map produced by Lilian Pintea, JGI
NaturalVue satellite imagery: MDA Federal Inc.



Methods & Effort

Filabanga (c. 5° 22' S, 30° 09' E) *and Kasakati* (c. 5° 26' S, 29° 57' E): Moore and Y. Abeid made brief visits to these sites in 2001, with the primary goal of vegetation surveys and botanical collection. At each site, four vegetation transects were placed beginning 1km from camp and proceeding away from camp in cardinal directions (NSEW). All four at Filabanga and 2 at Kasakati were the planned 1.5km in length; two Kasakati transects could not be completed in the time available as they ran into dense thicket/forest. Perpendicular distances to all nests observed from transects were recorded, and their ages estimated using standard fresh/recent/old/rotten categories (see Chapter 2). Nest densities were calculated using Kano's (1972) formula:

$$\text{Chimpanzees/km}^2 = \{(\#\text{ nests seen}) * (100/\%\text{ nests observed})) * (1/\text{nest duration})\} / \{(\text{transect length}) * (\text{transect width}/1000)\}$$

where Kano assumed 70% of nests within 70m of the transect (140m width) were detected. Kano assumed nest duration of 180 days to complete decay (end of stage 4); we used 260 days as the mean time to nest disappearance (Ogawa *et al*. in review). "Kano (1972) method" estimates are *not* corrected for immature non-nest building individuals or production rates ≠ 1.0.

Nguye and Bhukalai: (05°13.0'S, 30°27.5'E & 05°26.8'S, 30°44.1'E); In 1996 – 1997, Ogawa recorded nests observed from "walking routes" in the vicinity of each locality, a total of 98.7 km at Nguye and 80.8 km at Bhukalai. Note that these surveys predate the arrival of shambas in the Nguye area. Nest densities were calculated using Kano's (1972) method.

Mttindi: (predated GPS; UTM for camp approx. TK 2 370 E 94 115 S); In 1988 Moore did six formal vegetation transects within a 25km^2 square centered on the camp near a small perennial spring. Transects were 2km long and randomly placed (oriented in predetermined cardinal directions from starting points generated by a random numbers calculator and the UTM coordinates on a 1:50,000 map). Perpendicular distances to all nests observed from transects were recorded, and their ages estimated using standard fresh/recent/old/rotten categories (see Chapter two). Nest densities were calculated using Kano's (1972) method.

Issa (5.4245 S, 30.5851 E): Hernandez-Aguilar intensively studied nest distribution in a 48 km^2 area between October 2001 and June 2003. She and her assistants mapped the locations of all observed nests within this area (approx. 5,400), yielding an absolute nest density estimate. Once all nest coordinates have been incorporated into GIS (in collaboration with L. Pintea), it should be possible to sample Issa with "virtual transects"; however such estimates are not yet available and chimpanzee density estimates are based on a modification of the method previously used in Mt. Assirik, Senegal of dividing the mean number of nests found per day by the total number of square kilometers of the sampled area (Baldwin 1979 and Baldwin *et al*. 1982). A total of 5,354 nests were found within the repeatedly sampled area of 48km^2 during 503 days. Since the goal was to count all nests built during a known period of time and because nests of all ages (including decayed or age 4) were recorded, we added the mean time to decay (260 days) to the Baldwin (1979) and Baldwin *et al*. (1982) formula:

Density of chimpanzees (ind/km^2) = (total number of nests/[number of days+mean time to decay])/ km^2 of the sampled area

Ilumba (5.65904 S, 30.9079 E): From August-December 2005 Piel & Stewart made 30 nest transects of 1 to 11 km within a 625km^2 area near the Ilumba River. Transects were stratified according to 2 habitat types (open and closed) and 3 different topographical levels (plateau, slope, valley) with information on GPS, location, and age (in addition to habitat) recorded for each of 654 nests over 82.5 km walked. Perpendicular distances from nests to transect were then entered into the computer program DISTANCE to calculate nest densities in each of the 6 habitat combinations. Chimpanzee densities were then calculated for each habitat type using a mean time for nests to decay to age 4 of 97 days, assuming a production rate of 1.1 in line with this report (see chapter 2). Thus:

Density of Chimpanzees = Density of Nests/(Production rate x mean time to decay).

The resultant densities, 3 within gallery and 3 within woodland, were multiplied by the proportion of slope, valley, and plateau, which were estimated from a topographic map of the study area. L. Pintea (this report) calculated the proportion of gallery and woodland in the Ugalla region to be 2% and 86%, respectively. Under assumption that Ilumba is representative of the greater Ugalla area, these figures were used to control for the proportion of gallery and woodland habitat to reach an overall chimpanzee density estimate for the Ilumba region.

Results:

A total of almost 6,500 nests are included in the density calculations for the seven Masito & Ugalla sites (excluding those used in early published estimates); the sample sizes range from 8 (Mttindi) to over 5,000 (Issa) (see Table 4.1). Because most work at Ugalla has been directed at locating nests for chimpanzee habitat use and distribution, information on areas lacking nests is limited. In 1993, Moore and J. Sept visited the Bulega area; they found very few nests around the periphery of the basin and concluded that chimpanzees rarely use the indicated area. The exact ecological factors responsible are not known.

Table 4.1 Summary of nest density estimates spanning 40 years of research and the methods used to calculate each estimate. Kilometers of transects walked and number of nests recorded are also provided for each of the 7 seven study sites in the Ugalla/Masito region.

Study Site	# Nests	Mean days to decay	# km	Density	Method	Year	Researcher / Source
Filibanga	N/A	N/A	N/A	0.2	Count^	1966	Kano (1971)
Filibanga	25	260	6	0.16	Kano (1972)	2001	Moore
Kasakati	N/A	N/A	N/A	0.49-0.71	Count^	1964-1965	Suzuki (1969)
Kasakati	25	260	3.8	0.26	Kano (1972)	2001	Moore
Masito	N/A	180	N/A	0.17	Count^	1966/67	Kano (1972)
Nguye	146	260	98.7	0.06	Kano (1972)	1999-2000	Ogawa
Bhukalai	134	260	80.8	0.07	Kano (1972)	1999-2000	Ogawa
Mttindi	8	260	12	0.03	Kano (1972)	1988	Moore
Issa	5,354	260	$48km^2$	0.14	Baldwin et al. (1982)	2001-2003	Hernandez-Aguilar
Ilumba	654	97	82.5	0.06	DISTANCE	2005	Piel & Stewart
Ugalla	350	180	250	0.08	Kano (1972)	1966/67	Kano (1972)
Ugalla	350	*260*	250	0.06	Kano (1972)		Calc. from Kano (1972) data

^ Indicates density based on observational estimate of community size and range

Analyses of chimpanzee nest density

Density estimates for chimpanzees in Masito and Ugalla vary by a factor of >4 (Ugalla: 0.03 to 0.14; Masito: 0.16 to 0.71). However, there is more consistency than is first apparent. First, both the KUAPE estimates from the 1960s and Moore's transect data indicate that chimpanzee density at Kasakati (0.26 – 0.71) is greater than at Filabanga (0.16 – 0.2); i.e., for chimpanzees, "Masito" is heterogeneous at a large scale. At Ugalla, all researchers have noted areas with high concentrations of nests as well as areas largely lacking them. For example, Mttindi is an area used regularly but relatively sparsely for nesting (Moore, personal observations). Conversely, for her study of local-scale chimpanzee nest site preferences, Hernandez-Aguilar selected Issa because the area appears to be a "hot spot". In the absence of more data over greater areas, densities of 0.03 and 0.14 can be considered approximate minimum and maximum for Ugalla, with other estimates clustering between 0.06 and 0.08/km^2. These estimates and the total area of the Ugalla region as defined in this report (≈3352km^2) suggests an approximate population size of 200 – 270 (range 100 to 650) total chimpanzees; while lacunae exist they are known to be relatively small. Current estimates from Masito (≈2,407 km^2) come from identified study sites so the regional population density is likely to be at the low end of the range; at 0.2/km^2 there would be about 480 chimpanzees (range 385 to 1,700).

Comparison of methods: Density estimates can be calculated from Moore's data with either the Kano (1972) method or DISTANCE, although the samples are far too small to derive an accurate conversion factor. For two sites, the methods yield similar results: Mttindi 0.02 (DISTANCE) and 0.03 (Kano); Kasakati 0.22 (DISTANCE) and 0.26 (Kano). In each case, the Kano-method estimate is slightly greater. However, at Filabanga one transect ran directly into a localized nest concentration that contained all 25 nests recorded at the site; the resulting DISTANCE estimate of 0.49 is three times the Kano-method estimate (confirming the known danger of using DISTANCE with small samples).

Two large samples can be compared, the Ilumba region using DISTANCE with Kano's 1972 overall estimate for Ugalla. When Kano's estimate is recalculated using a 260 day nest duration time, the resulting estimates are effectively the same, at 0.06/km^2. Taken together these comparisons suggest that the two methods are roughly comparable, with the Kano method perhaps superior if sample sizes are small.

Conclusion

Although similar estimates of percentage evergreen forest across the Ugalla/Masito region might initially suggest a homogenous distribution of chimpanzees, GIS analyses and collaboration among researchers have instead revealed the high ecological and topographical variation within these areas (Piel et al. 2006), and consequently, predicted areas of chimpanzee preference (Pintea, Chapter 8 this report). The causes of this variation are unknown, yet could be an artifact of local forest physiognomy-geomorphology interactions (Hernandez-Aguilar 2006; Pintea Chapter 8, this report). Regardless, extensive use of more open habitats is both important (Itani 1979, Schoeninger et al. 1999; Hernandez-Aguilar 2006) and expected given that forest patches make up only 2-3% of the area, with Miombo woodland dominating the landscape (Masito ≈ 76%, Ugalla ≈ 86%).

The Ugalla area is particularly important in terms of ape conservation for several reasons. First, we have population density estimates from the 1960s, 1990s, and 2005, enabling broad tracking of population status over this period. For example, Kano's Ugalla density estimate from the 1960's (0.08) is similar to the more recent range of 0.06 – 0.07 (see Table 4.1), suggesting that chimpanzees have coexisted successfully with small-scale logging, honey collection, and (mostly illegal) hunting. If true, such mixed wildlife-human use of the Miombo woodlands may provide a model for wildlife and forest management outside of Parks that permits local people to continue traditional uses of the forest in harmony with chimpanzees and (most) other wildlife. However, evidence from *all* sites suggests that agricultural expansion and large-scale, local hunting are increasing at rates that may be unsustainable throughout the Ugalla region. If true, remaining chimpanzee populations that have historically lived sympatrically with humans are under severe threat. It should be noted that while there is great overlap, contemporary density estimates tend to be lower than those obtained (by different methods) in the 1960s for both regions; the evidence for decline is especially strong at Kasakati (though the 2001 sample size is far too small to be sure).

Second, their unique scientific value as “savanna chimpanzees” is likely to continue to draw researchers interested in chimpanzees from a paleoanthropological perspective. Already international collaboration has begun to study aspects of the ecology of this region and their implications for early hominid evolution. In addition to the presence of researchers conferring some degree of protection for local wildlife, the presence of a commercial hunting concession at Ugalla (also called Niensi) further contributes to inter-disciplinary collaboration in the protection of this area. This allows the costs of conserving Ugalla's wildlife to be distributed across a broader constituency than is true for other areas.

Finally, by studying the ecology of Ugalla we can gain an understanding of the minimum requirements to sustain chimpanzees. Such information is essential for understanding whether absence of chimpanzees in other areas is for ecological or anthropogenic reasons. Additionally, long-term research is likely to pay off both with respect to understanding of the Ugalla ecosystem and, simply by the presence of researchers, its protection.

The Masito area is under immediate threat as human population expands southward from the Malagarasi River and eastward from the lake shore. Historically it had large populations of game animals (various KUAPE reports) but these appear to be nearly gone. Access to Kasakati from the lake is easy and the area has real potential for ecotourism, which might help to conserve the remaining wildlife populations.

CHAPTER 5: Surveys along the Southern Tanganyika Lakeshore

T.R.B. Davenport, N.E. Mpunga, A.Massawe, S.J.Machaga and A.J.Plumptre

Introduction

The area south of the two regions reported on in chapters 3 and 4 (what is being termed the Greater Mahale Ecosystem) is much more fragmented with areas of forest, woodland and grassland interspersed with cultivated land. However the discovery of chimpanzees in this region in the 1990s (Ogawa, Kanamori & Mukeni, 1997; Ogawa *et al.* 1999b; Kano *et al.* 2005) meant that further exploration of the area would be valuable. This chapter reports on surveys made from west of Katavi National Park down to the border with Zambia.

Given the large area to be covered, a two-pronged approach was used to identify where chimpanzees occur and to estimate their densities. Initially a team visited villages in the region and asked them about whether they had seen chimpanzees in the region and if so when and where. This information was then used to plan field surveys of the region.

To date the data are still being analysed from these surveys and this chapter summarizes the main findings about chimpanzees in the region.

Sites surveyed

Field teams visited villages along the lake shore and major road arteries in the region to interview people about chimpanzee sightings and whether nests could be found in the vicinity of the villages. Sites visited included:

1. South west of Katavi National Park
2. Upper Ngundwe Catchment
3. Mwene
4. Tembwa catchment
5. Loazi

Sites 2-5 occur towards the southern end of Lake Tanganyika and include a high plateau with gallery forest on the plateau surrounded by grassland (figure 1.3 image 3) and valleys where the rivers flow off this plateau with gallery forest leading down to the lake. Most of the land along the lake shore is settled and farmed with fishing villages and it was necessary to move inland to find areas where chimpanzee sign could be found.

Results

While there were indications of chimpanzees occurring at all of these sites from interviews with villagers, the field surveys failed to find evidence of them South-west of Katavi National Park. However, nests were observed at the other sites (figure 5.1). Most of these sites were in areas of gallery forest and all nests of chimpanzees were found within forest with none observed in surrounding woodland. This may be a result of hunting by local people, who did admit to killing chimpanzees at some sites.

Density estimates for the chimpanzees were made from transect data as in the site east of Mahale (chapter 3). DISTANCE was used to calculate the densities from perpendicular distance data. A total of 71.4 km was walked and 60 nests were found. We fitted the density curve to the perpendicular data for all the nests (combined) and used this to estimate nest density for all sites with nests (2-5) and for each site separately. This assumes that the probability of detection of nests is the same between sites but given the low sample sizes it was not possible calculate separate probabilities from the perpendicular distance data.

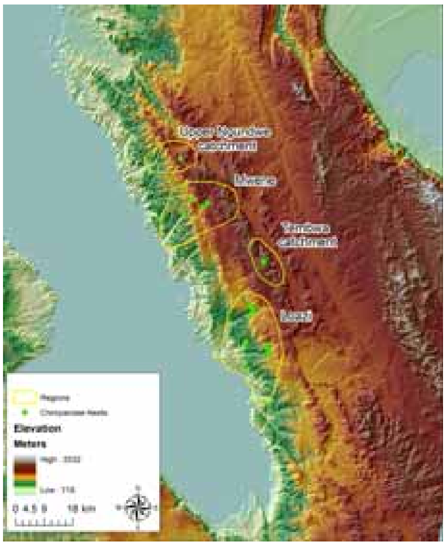


Figure 5.1. The locations of chimpanzee nests found in four of the study sites at the southern end of Lake Tanganyika.

Table 5.1. Results of density estimates for chimpanzees in the southern Tanganyika Lakeshore sites.

Site	Effort (km)	Number of nest groups sighted	Nest density (No/km^2)	Standard Error (No/km^2)	Mean Density Chimps (No/km^2)
Mwene	5.9	2	22	13	0.4
Loazi	40.7	21	27	11	0.5
Upper Ndungwe Catchment	10.0	1	6	6	0.1
Tembwa catchment	14.7	4	17	8	0.3
All sites	71.4	28	11.2	3.1	0.2

Using the decay rate of 49 days on average for a nest to decay, densities of chimpanzees were calculated from the nest density estimates (table 5.1). We used the average decay that had been obtained in Mahale (Ihobe 2005) using the same definitions for a decayed nest that we had used because most of these sites were near the lake shore and probably experience similar climatic conditions. We also used the production rate of 1.1 nests per day (Plumptre and Reynolds, 1996, 1997).

Density of Chimpanzees = Density of Nests/(Production rate x mean time to decay).

Therefore the mean density of chimpanzees in this region = 11.2/(1.1x49) = 0.21 km^{-2}

This average value for density across all southern Tanganyika lakeshore sites was used when extrapolating chimpanzee densities to total numbers of chimpanzees (chapter 7).

CHAPTER 6: Biodiversity surveys in the Greater Mahale Ecosystem

D.Moyer, A.Plumptre, M. Mwangoka, Y. Abeid, H. Mugabe, and G.Gobbo

Introduction

Although the main aim of the surveys reported here was to assess chimpanzee densities and make an estimate of their total population size it was recognised early in the survey planning that it would be useful to collect information about the presence and relative abundance of other species. During the aerial reconnaissance it was clear that the Mahale Mountains and the area towards the Sitebi Highlands and down to the Wansisi hills had a variety of habitats and altutudinal ranges and could potentially be interesting for conservation. This chapter summarises the biodiversity findings for this area. Western Tanzania has been very poorly explored biologically when compared to other areas of the country. The main area where surveys have been made was the Mahale peninsula.

Bird surveys were first carried out there in the 1940's (Moreau 1941, 1943). A total of 600 specimens were collected from around the Mahale ecosystem of which 15 were new forms (subspecies). Sometime later, Moreau (1950) produced a summary of ornithological research in Tanzania, and a fairly comprehensive bibliography up to 1950. From this, it is obvious that very little ornithological research took place in the Mahale area over the next sixteen years. In 1958 and 1959, two biological and anthropological research expeditions from Oxford University visited Mahale. General reports on these surveys were published by Davis (1959), Juniper (1959), and Simkin & Juniper (1961) (cited in Nishida 1990). Several other papers were published on these surveys covering specific groups (see Nishida 1990 and references therein, Ulfstrand and Lamprey 1960). In the late 1940 and early 50s further bird collections were made in the Mahale ecosystem by Thorkild Anderson (J. Fjeldså *in litt.* April 2006). This collection, now housed in European museums, contained several species new to the area and one subspecies new to science (Williams 1950).

In the late 1950's, and throughout the 1960s, the Kyoto University Africa Primatological Expedition (KUAPE) worked to establish a permanent research presence in Mahale with a focus on chimpanzees. A comprehensive primate survey was carried out in western Tanzania and this work led to one of the longest running field research projects in existence (Kano 1971b, Nishida 1990). A detailed summary of work done by Japanese researchers on chimpanzees and other biota, and a comprehensive bibliography of published research on terrestrial and aquatic biodiversity in Mahale, is provided by Prof. Nishida (1990).

More recently surveys of butterflies were made in some of these areas (Kielland, 1990). Plants had also been surveyed in this region by botanists from the Royal Botanic Gardens at Kew (Vollesen and Bidgood, 1994, 1997), in Mahale National Park (Nishida and Uehara, 1981), and in Ugalla (Moore,1994; Abeid, 2003). However, despite this work this region was very poorly known.

Vollesen and Bidgood (1994, 1997) collected many new species to science and to East Africa in their surveys in western Tanzania, finding that 7% of plants they had collected in 1994 and an additional 7% in 1997 were new for Tanzania. They stated that

> *'…it is of utmost importance to gain further knowledge of the forests in the Mahale area to the east and north of the Mahale Mountains proper. These forests of Congolian affinity are quite different from foretss in the rest of Tanzania and support large numbers of chimpanzees……The forests are very diverse and forests almost within sight of each other can be of totally different floristic composition.*' (Vollesen and Bidgood, 1997)

The Tanzania bird atlas (http://www.tanzaniabirdatlas.com/) contains records of birds mapped on 1/4 degree squares across the country. There are very few “blank” squares that do not have records of even the most common species. Most of these are in western Tanzania and three of these blank squares covering the area east of Mahale were filled in during this survey. This region also contains two Albertine Rift Endemic bird species, the Regal sunbird (*Cinnyris regia*) and the Kungwe Apalis (*Apalis argentea*). Regal sunbird is relatively widespread within the Albertine Rift but Kungwe Apalis has only been recorded from western Tanzania and forests in Burundi, southern Rwanda and Democratic of Congo. It has been so rarely recorded that it is classified as Endangered under the IUCN red data book listings.

Although surveys for large mammals in the area have not been specifically carried out, sightings were recorded during chimpanzee surveys by Japanese researchers (Kano, 1971b; Nishida, 1989; Itani, 1990; Nakamura, Nishie and Mwinuka, 2005, Nishida *et al.* 1981). Colobus monkeys in this region are potentially of conservation interest because of their probable genetic isolation from other populations. Two species, *Colobus angolensis* and *Procolobus badius* are present, with the former restricted to the highest altitudes in the Mahale Mountains National park (Kano 1970b, Nishida et al. 1981).

Butterflies are abundant in this region with over 700 species recorded. Thirteen species and 32 subspecies are endemic to the area (Kielland, 1990). All of the endemic species found inside Mahale Mountains National park also occur in the areas to the east of the park. However, there are several species that have been only collected outside the park in the Sitebi-Sifuta Mountains, Ntakata and Kasye forests. Butterflies are probably the best know taxa in this area having been relatively well surveyed in the past.

This survey was focused on large mammals, birds and plants, and data were collected using methods described in chapter 2. The focus here is on biodiversity of Mahale Mountains National Park and the areas to the east in the Greater Mahale Ecosystem. This includes the Ugalla-Masito area, Wansisi Hills Sitebi-Sifuta highlands, Ntakata Forest and the Kakungu Ridge.

Results of surveys

Mammals

Sightings and signs of 21 large mammal species were recorded on the transects in this region with a further 15 recorded from sign or sightings at other times or from interviews with people. A further two species were added to the list for the Greater Mahale Ecosystem (excluding the park) from the literature to give a total of 38 large mammal species (Appendix 1). This compares with a total mammal list for Mahale Mountains National Park of 72 species. Mahale has been surveyed for smaller mammals such as bats, rodents and shrews but not extensively which is why its list is larger.

Most of the sightings from the transects were of primates and the data for some of these species were sufficient to plot relative encounter rates in the Greater Mahale Ecosystem (figure 6.1). In the case of red colobus monkeys it was possible to calculate density estimates from the line transect data. A mean estimate for all transects visited in the twelve sites visited in Mahale Mountains National Park and to the east, and a further site in the training site in Ugalla was 25.0 colobus km^{-2} (n=40 colobus groups, Standard error=8.3). If only closed canopy evergreen forest was assessed then the density increased to 74.6 colobus km^{-2} (n=37 groups, SE=23.4). Most colobus groups were observed in the riverine and small closed-canopy forest blocks and the three that were observed in woodland were very close to such forest so the forest estimate is probably a better estimate to use. Vervet monkeys, Yellow Baboons and Olive Baboons were sighted also but rarely. Olive baboons were only sighted near Uvinza and have probably crossed the Malagarasi river recently because in the psat they were not recorded south of this river (Kano, 1971b).

Several ungulates were either observed directly or their dung was seen. Elephant and buffalo dung was abundant at several sites (figure 6.2). Elephant dung was most abundant within Mahale Mountains National Park while buffalo dung was more abundant outside the park, particularly in the Wansisi hills which lie near the Katavi National Park, a savanna park with a large buffalo population. Elephant dung density for the region was 139 dung piles km^{-2} but we do not have decay rate data to convert this density to an estimate of elephant density.

Globally threatened species were derived from the IUCN Red List (Hilton-Taylor, 2000 and updated lists on the associated website www.iucnredlist.org). Chimpanzees, elephant, lion and red colobus are all threatened species under the IUCN red data book. Sightings of at least one of these animals or their sign (dung/nests/footprints) were made at all sites. Some sites had up to three of these globally threatened species (figure 6.3).

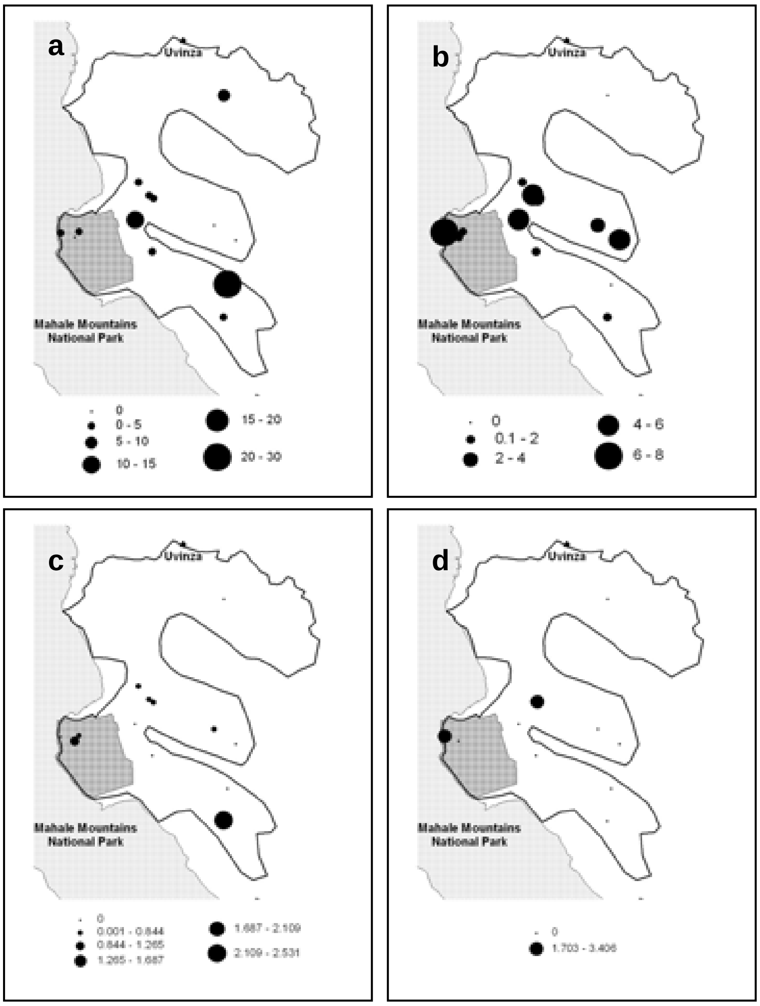


Figure 6.1. Relative abundance (encounter rate per km walked) for four primate species in the Greater Mahale Ecosystem. a) chimpanzee nests; b) Red colobus; c) Blue monkey; d) Redtail monkey

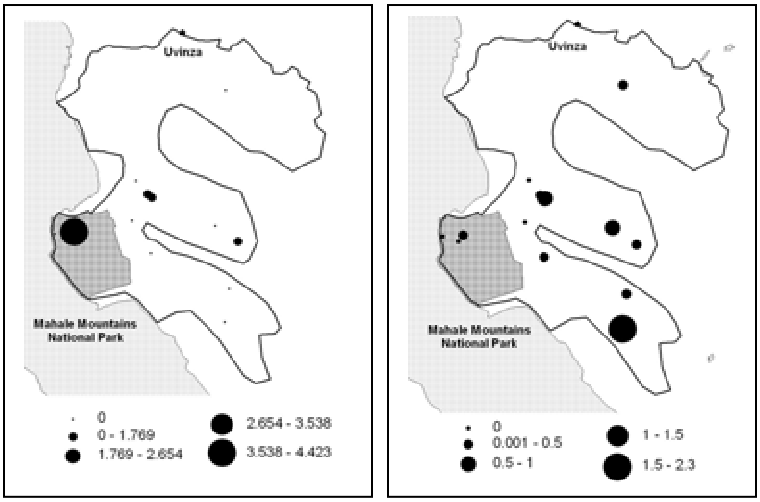


Figure 6.2. Relative abundance (encounter rate per km walked) of elephant dung (left) and buffalo dung (right)

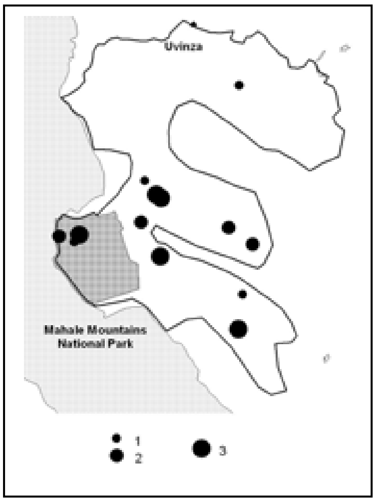


Figure 6.3. Number of globally threatened mammal species.

Birds

A total of 261 species of bird were recorded at 9 sites in the Greater Mahale Ecosystem. We were not able to survey all 13 sites because we only had two ornithologists who could identify most birds from their calls (D.Moyer and H.Mugabe). This compares with a total species list compiled from our observations and the literature of 247 species for the Mahale Mountains National Park (N. Baker pers. comm., D. Moyer in prep.). Species richness was higher outside Mahale Park (fig. 6.4). Two of these birds were endemic to the Albertine Rift (Kungwe Apalis and Regal Sunbird). However if subspecies are also assessed then there are 11 birds in this region that are endemic at the subspecies level to the Albertine Rift (Table 6.1). One species is classed as globally threatened (Kungwe Apalis).

Table 6.1. Bird species and sub species endemic to the Albertine Rift and IUCN threatened species.

Species	Endemic species	Endemic subspecies	Threatened
Kungwe Apalis	1	1	Endangered
Alexander's Akalat		1	
Bamboo Warbler		1	
Brown-chested Alethe		1	
Grey-headed Negrofinch		1	
Lemon Dove		1	
Regal Sunbird	1	1	
Shelley's Greenbul		1	
Yellow-bellied Wattle-eye		1	
Yellow-streaked Greenbul		1	
Yellow-throated Woodland Warbler		1	

The number of species recorded from the daily lists created at each site varied between sites. Sitebi west and Kabezi had considerably higher numbers of species than some of the sites. These numbers have been standardized to 4-5 days of survey effort to make them relatively comparable. The values for species richness and numbers of endemic species have been plotted in figure 6.4. The endemic regal sunbird was only observed at Mfitwa in Mahale Park but the Kungwe Apalis was recorded at all sites apart from Ugalla. This species is probably not as rare as had been thought as it tended to occur in the canopy and sub canopy of fairly open forest patches and was widespread.

Analysing the total observation data by region, we recorded 145 species in Mahale Mountains National Park, 204 species to the east of the park towards the Sitebi and Lugalla hills and 91 species in Ugalla.

Table 6.2. Number of bird species, number of endemic species and number of threatened species for each site surveyed.

Site	Number of species	Endemic species	Threatened species
Ugalla	91	0	0
Kapalagulu	77	1	1
Ntakata East	96	1	1
Lubalisi hills	78	1	1
Sitebi west	107	1	1
Lugalla Hills	76	1	1
Kabezi	105	1	1
Kasoge	73	1	1
Mfitwa	79	2	1

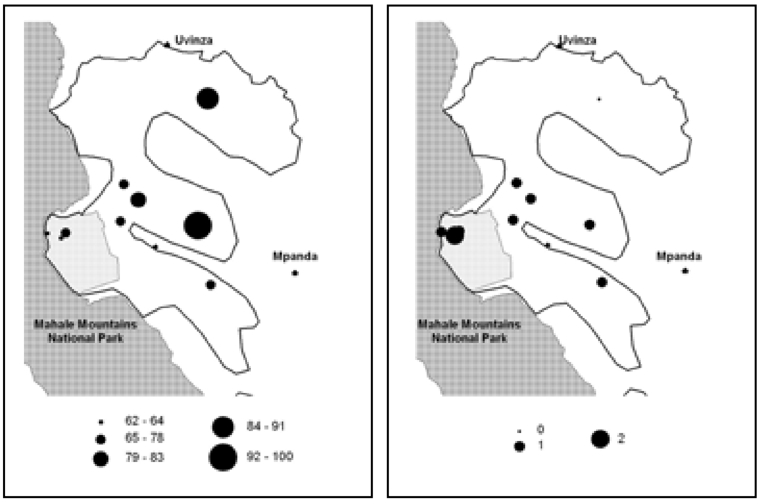


Figure 6.4. Bird species richness (left) and numbers of endemic species (right).

Point count data is useful in that it can give a relative indication of the species accumulation with the number of birds seen (figure 6.5). This differs from the simple presence/absence data recorded in the total daily lists compiled above. With abundance data it can be seen that Kabezi is the most species rich site followed by Lubalisi Hills, Kapalagulu and the Wansisi hills. The higher altitude sites (Sitebi west, Kasoge and Mfitwa) tended to have lower species richness per bird observed. However Sitebi west had the largest total species list recorded (Table 6.2; fig. 6.4) which means that many of its birds are rarely observed and not often recorded on point counts. Noticeably though even after observing 800 birds the curves are not leveling off indicating that bird diversity is likely to be considerably higher than the numbers in table 6.2.

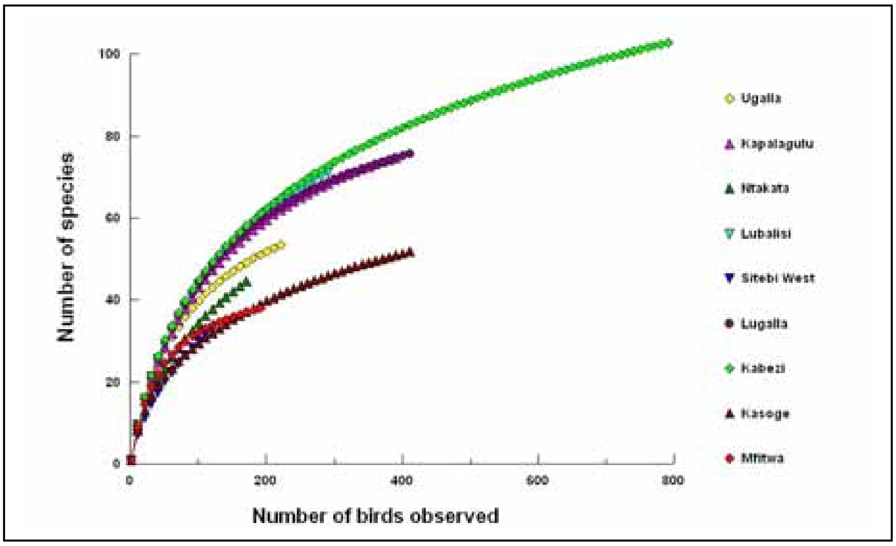


Figure 6.5. Rarefaction curves for the nine sites surveyed.

Cluster analysis was used to assess how related the bird fauna were at the different sites surveyed. The point count data were used to cluster abundances of differenyt species sighted (figure 6.6). The results show that the drier sites (Ugalla, Kapalagulu, Lugalla and Lubalisi) are more similar in their bird fauna. Sites with larger patches of forest also cluster together (Ntakata, Kabezi and Kasoge) and the two sites with high altitude grasslands (Mfitwa and Sitebi west) are separate from the other clusters but not similar either. Overlap between sites is low however, with few comparisons showing more than 50% overlap (fig 6.6).

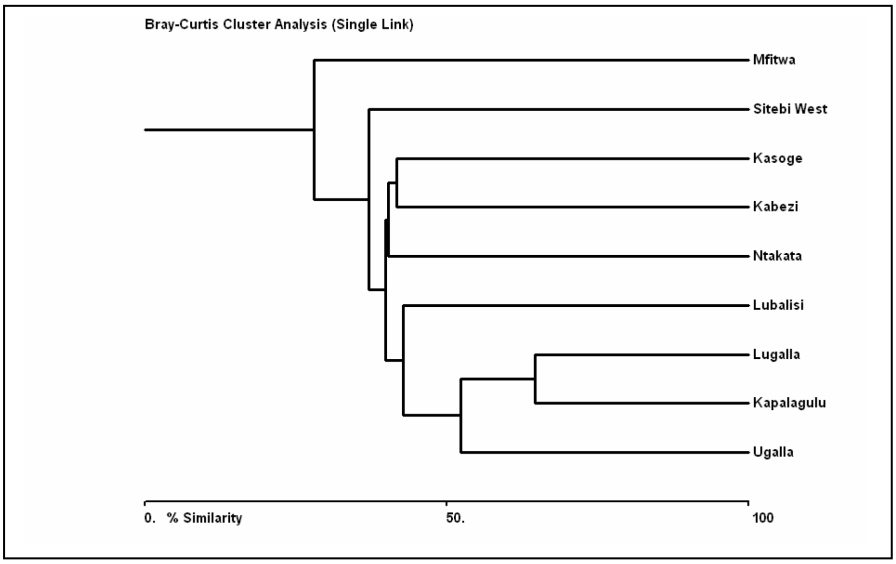


Figure 6.6. Bray-Curtis cluster analysis of the bird communities at the nine sites surveyed.

Comments on selected species

<u>Kungwe Apalis, *Apalis argentea*</u>

The Kungwe Apalis is obviously one of the key birds for conservation as it is endangered and one of the two Albertine Rift endemic species. We were therefore interested in looking at this species in more detail. As it was relatively abundant in the region it was possible to calculate an encounter rate for the species at each site (number per 100 point counts) and map the variation in its distribution (fig. 6.7). This shows that the areas such as Ntakata forest, Lugalla hills and Lubalisi have higher abundances of this species than elsewhere. The habitat requirements of this species were not measured in this study but observations of the bird seem to suggest that it occupies the mid strata and canopy of gallery forests and at the edges of these forests in Miombo woodland. Where it occurs it was relatively abundant and it was found in most of the sites we visited east of Mahale Mountains National Park but was not observed at the Issa training site in Ugalla (although at the time the ornithologists had not seen this species and did not know its call and it may have been present. However neither ornithologist registered an unrecognizable bird call in Issa so if it is present it is likely to be rare).

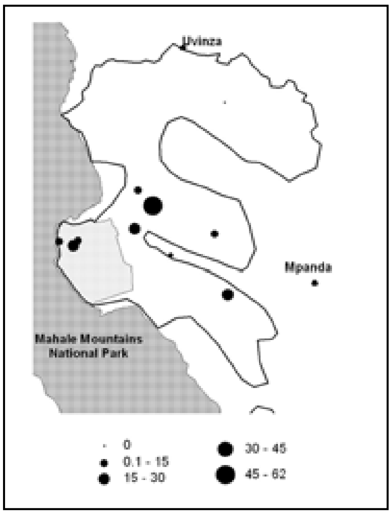


Figure 6.7. Variation in encounter rate (number seen per 100 point counts) of Kungwe Apalis in the nine survey sites.

Observations and sound recordings made during this survey were useful in clarifying the taxonomic status and ecological relationships for several species. Notes on these are presented below.

Kungwe Apalis was first collected and described from riverine forest not far from Mpanda to the east of Mahale (Moreau 1941a). Since then, there has been a lot of discussion in the literature about its taxonomic status (Urban et al. 1997). However, much of this was speculation because the behaviour, calls and habitat preference of this species in the Greater Mahale Ecosystem were virtually unknown prior to this study. Kungwe Apalis was first thought to be a good species (Moreau 1941a, Hall & Moreau 1970) but later authors lumped it with Buff-throated Apalis, *Apalis rufogularis* without much supporting data for this decision (Urban et. al. 1997). Recordings of the calls made during this survey (Figure 6.8) will enable comparisons to be made with calls of the other six subspecies of Buff-throated Apalis currently recognized (Urban et. al. 1997).

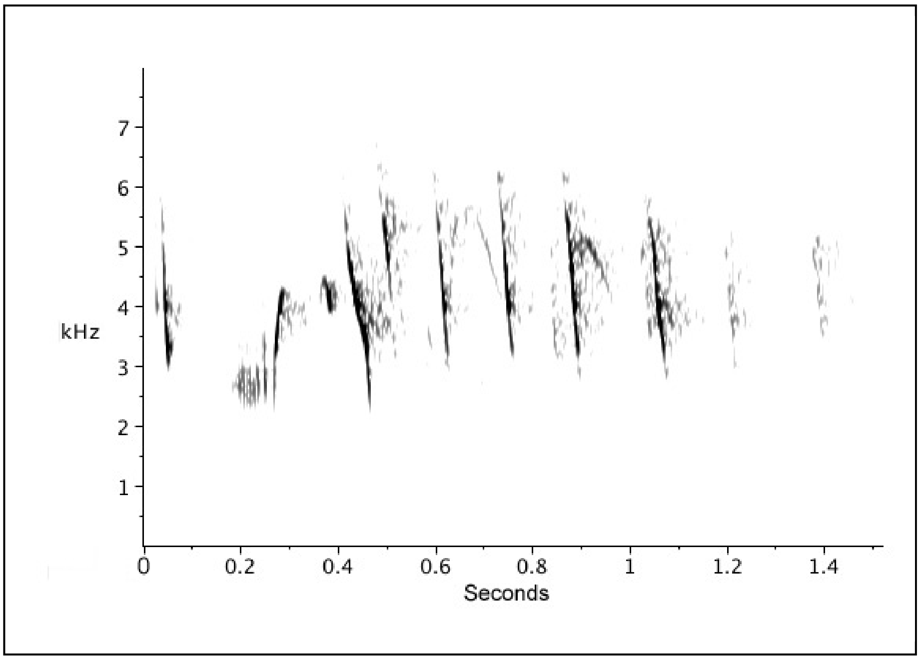


Figure 6.8. Spectrogram of a duet song of Kungwe Apalis. First three notes given by the lead singer and the subsequent seven notes given in response by another individual.

Alexander's (Bocage's) Akalat, *Sheppardia insulana kungwensis*

Moreau (1941b) gave a description of a new robin collected in Mahale at 2400 m on 8 August 1940. In deference to the opinion of Claude Grant, he described this as a subspecies of the Grey-winged Robin-chat, *Cossypha polioptera kungwensis*. Leading ornithologists of the day, R. Moreau, V. van Someren and J. Chapin, later agreed that this specific assignment was not correct because of the shorter tail and longer tarsus of *C. p. kungwensis*. Chapin thought it was a new subspecies of Alexander's Robin-chat, *Cossypha insulana* but Moreau did not agree and named it the Kungwe Robin-chat, *Cossypha kungwensis,* pending clarification of its affinities (Moreau 1943). Macworth-Praed and Grant (1955) listed it as a subspecies of Alexander's Robin-chat, *C. i. kungwensis* following the opinion of J.s Chapin, but later on, Moreau and Benson (1956) placed *insulana* into *bocagei* along with *kungwensis*. Since then, the Kungwe Robin-chat has been considered a subspecies of Bocage's Robin-chat (Hall and Moreau 1970, Britton 1980). The only change along the way was the realization that the Kungwe Robin-chat was in fact an akalat and not a robin-chat at all and, therefore, belonged in the genus *Sheppardia* (Wolters 1983 cited in Prigogine 1987).

Alexander Prigogine (1987) re-evaluated the data in the mid-1980s and came to a different conclusion. He maintained that *Sheppardia insulana* and *S. bocagei* were actually separate species like C. Grant and J. Chapin originally thought. However, his opinion was not followed by the authors of the Birds of Africa (Keith 1992). They follow Hall and Moreau (1970), and preferred to wait until more information on the biology of this species became available before making a final decision on whether to treat *insulana* and *bocagei* as separate species.

Bocage's Robin, *S. bocagei ilyai* was common in gallery forest along the Mbala Stream at 1700 m in the Sitebi-Sifuta Mountains, and several recordings of its song were made. Recordings were also made of the song of the endemic subspecies of Bocage's Akalat, *S.*

bocagei kungwensis at 2400 m in the forest around Mfitwa Mountain, in Mahale Mountains National Park.

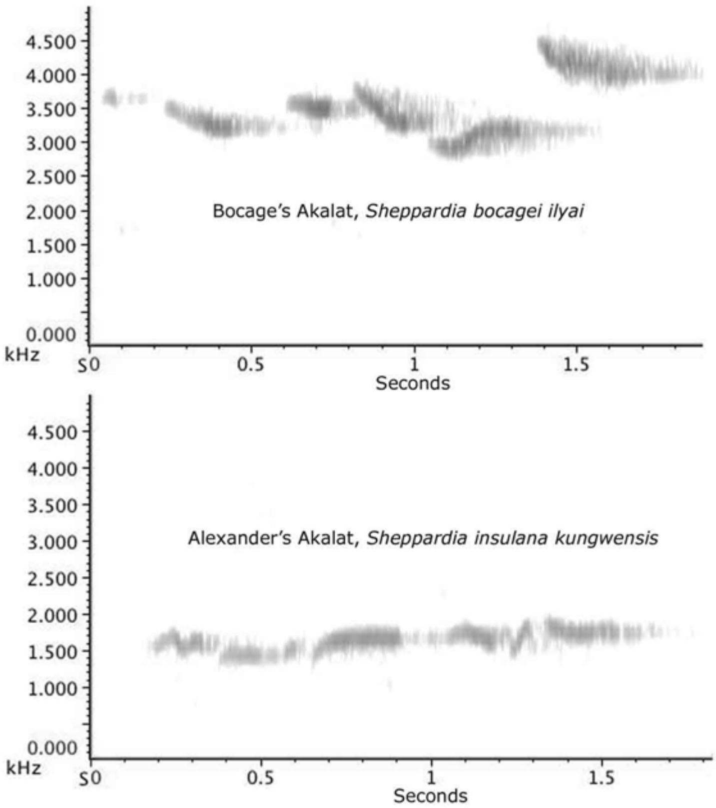


Figure 6.9. Spectrogram of the songs of Alexander's and Bocage's akalats.

Although these two subspecies looked identical, their songs and habitat were completely different. The song of *kungwensis* is virtually identical to the song of *insulana* from Mt. Cameron, whereas the song of *ilyai* is identical to that of *S. bocagei chapini* from northern Zambia and southern Tanzania (Chappuis 2000). The fundamental frequency of the song phrase of Alexander's Akalat is 1257 Hz and the highest frequency is1943 Hz. The fundamental frequency of Bocage's Akalat is 2715 Hz with the highest frequency at 4537 Hz (Figure 6.9). Claude Chappuis (in *litt.*) states that this evidence alone is enough to treat them as separate species.

These two subspecies occur within 60 km of each other, yet are more similar to far distant subspecies in vocalizations and habitat choice than to each other. It is clear from this that they are separate species. So the name of the bird in Mahale should be Alexander's Akalat, *Sheppardia insulana kungwensis*. Bocage's Akalat has not yet been found in Mahale but it almost certainly occurs in the riverine forests in the east of the park. The subspecies of Bocage's Akalat in Ufipa is *chapini* the same at that in northern Zambia (Stjernstedt and Moyer 1982). The Karema Gap is the likely biogeographical barrier that separates these two forms. In spite of a separation long enough for subspecific differences to have arisen, the songs of *ilyai* and *chapini* are virtually identical. Therefore, it is very unlikely that such dramatic vocal differences could have arisen in *ilyai* and *insulana* with no significant ecological or biogeographical barriers separating them.

Shelley's Greenbul, *Andropadus masukuensis kungwensis*

This Kungwe endemic was originally described as a subspecies of the Mountain Greenbul, *Andropadus tephrolaemus kungwensis* (Moreau 1941b). Later, after comparison with specimens from the Albertine Rift forests, it was found to be a subspecies of Shelley's Greenbul, *A. masukuensis kungwensis*, (Hall and Moreau 1964).

Prior to this survey, the voice and ecology of the endemic Mahale subspecies of Shelley's Greenbul were unknown. Observations at Mfitwa Forest, in Mahale Mountains National Park confirm that this is indeed a Shelley's Greenbul. The call and song were very similar to Shelley's Greenbul, *A. m roehli*, from the Udzungwa Mountains in eastern Tanzania. Like other subspecies of Shelley's Greenbul, it was seen bark-gleaning for insects while climbing vertical branches and trunks in a manner similar to that of South American woodcreepers, *Dendrocolaptidae*.

Dwarf galago, *Galagoides sp.*

During this survey a dwarf bushbaby *Galagoides* sp. was discovered in the Sitebi-Sifuta Mountains 60 km NW of Mpanda. This species was first heard on 13 August 2005 in riverine forest at 1700m along the Mbala Stream near the base of Tunda wa Kanyubi Mountain (6°4'39.9"S – 30°32'9.9"E). Recordings of several different vocalizations were made between 13 – 16 August 2005.

On 15 November 2005, this same species of *Galagoides* was found in Mahale Mountains National Park, 80 km to the west of the Sitebi-Sifuta Mountains. It was first heard calling in forest on Mfitwa Mountain, a peak along the Mahale Ridge (6°7'54.6'S – 29°47'38.5"E, 2440 m).

In all three localities, this *Galagoides* sp. was found in montane forest, although of a very different type in each place. The area between Mbala and Mahale Mountains is covered in miombo woodland and extensive pure stands of lowland bamboo, *Oxytenanthera abyssinica* between 900–1200m. This habitat gives way to montane grassland, forest and Montane bamboo, *Sinarundinaria alpinum*, above 1700 m on the eastern side of the Mahale Ridge. The forest at Mbala was a relict patch between 20 – 75 m wide along both banks of the stream where it was protected from annual bush fires that sweep this area. The surrounding habitat was mixed woodland dominated by *Parinari curatelefolia, Pericopsis angolensis, Protea gaugedi*, and *Erythrina abyssinica,* and on steep slopes, grassland dominated by *Hyparrhenia* sp. At Mfitwa, in Mahale Mountains National Park, the forest had a fairly intact canopy with huge trees to 35 m in places. Where valleys reached the ridge, forest was shorter with a 15–25 m canopy. Dominant species included, *Parinari excelsa, Croton megalocarpus, Polyscias fulva, Rapanea pulchra,* and *Ficalhoa laurifolia*. The understory was composed of very dense stands of montane bamboo, making it impossible to see into the canopy from within the forest.

In both Mbala and Mfitwa, dwarf galagos were active right after nightfall. They began each evening with a bout of calling from near their den holes and moved rapidly away through the forest to forage. They called sporadically throughout the night then there was an increase in vocal activity right before dawn when they returned to their den trees. Animals moved horizontally through the forest at both sites with prodigious leaps. The speed and agility with which they maneuvered through thick bamboo stands at Mfitwa was impressive. All observations were from 1–10 m above the ground in the understory and mid-story. At Mfitwa, it was not possible to determine how high they ascended into the canopy as vertical visibility was impeded by the bamboo understory. Typically, animals were first seen between 1–4 m above the ground. They climbed higher to hide and disappeared above the subcanopy at between 6–15 m above the ground.

The acoustic-temporal characteristics of the loud calls were analyzed and compared with other know species of *Galagoides* bushbabies. These were most similar to those made by *G. granti* from eastern Tanzania (Figure 6.10). The nearest know population 700 km to the east in the Udzungwa and Mahenge mountains (Butynski et al. in press). However, we hesitate to confirm the identity of this bushbaby because of a number of differences in ecology from G. granti. Final confirmation will have to await further field and museum investigations.

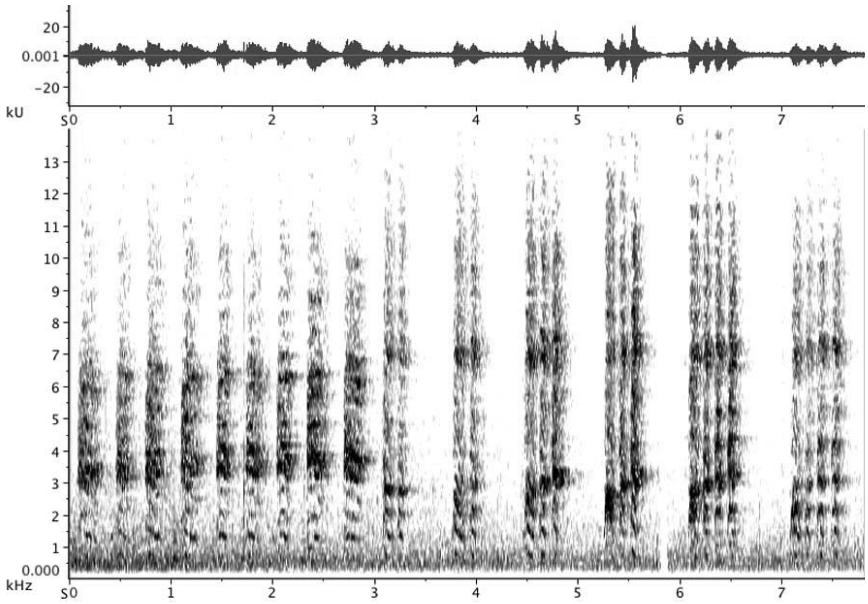


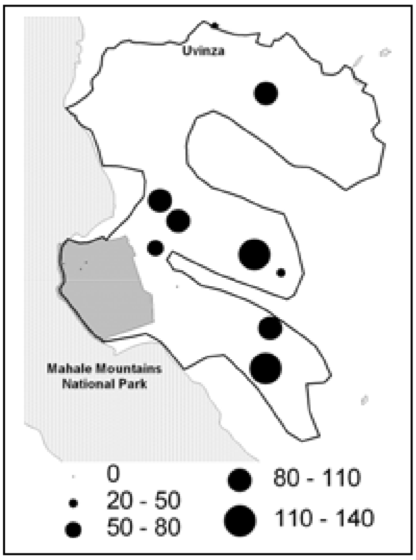
Figure 6.10. Spectrogram of the incremental call of a *Galagoides* sp. from Sitebi-Sifuta Mountains, western Tanzania. Call length = 7.6 seconds. Frequency range = 0.55-13.7 kHz. Fundamental frequency = 0.74 kHz (SD=.017 kHz). Range of unit frequency modulation = 0.55–3.3 kHz.

Plants

Three Tanzanian botanists collected in each of the three survey teams that worked east of Mahale Mountains National Park. All plant species that could be identified with certainty were recorded and collected and anything that could not be identified was also collected. Given the ten sites and large number of samples collected (nearly 1000) the identification of these plants is ongoing. A preliminary identification of species has been made in Dar Es Salaam and the specimens will be sent to Missouri Botanical Gardens for a more complete identification. At present we have been able to assess relative plant richness at each site where collecting took place (figure 6.11). This shows that areas that are relatively close to each other can be quite different in number of species. Some areas had been burnt because it was the end of the dry season when collecting took place and this may account for some of these differences. It would probably be worth sampling this area about one month after the rains when it is likely that many plants will be flowering. However given the limited time spent at each site (4-5 days) it is clear that there are many plant species to be found, the botanists having discovered more than 80 species at most sites.

A report will be made after the identification of all the plant specimens to compare sites in terms of floristic diversity and to assess numbers of new species.

Figure 6.11. The number of plant species recorded at the different sites surveyed east of Mahale.



Conclusions

Although the time spent in this region assessing the biodiversity of the area was limited it is clear that it is a region of conservation importance. The variation in altitude and habitat types from gallery forest, bamboo, Miombo woodland and montane grasslands ensures that there is a wide diversity of mammals, birds and plants with more than 70 bird species and more than 80 plant species having been recorded at most sites visited. We believe this region requires more intensive surveys which would also include areas in Ugalla-Masito.

The results of these surveys were used to help TANAPA and FZS better define where they would work with an EU funded project to conserve the Mahale Mountains National Park and its surroundings. The Greater Mahale Ecosystem has been defined as the area within the black line in figures 6.1-6.8 and conservation efforts will focus on better understanding this landscape and maintaining the connectivity between sites within the landscape, to ensure the long term viability of the species found here.

CHAPTER 7: Prediction of suitable habitat for chimpanzees using remote sensing and GIS

L.Pintea and A.Plumptre

Introduction

The main aim of this survey was to assess chimpanzee densities and make an estimate of their total population size. Previous chapters presented the data, analysis and chimpanzee density results for each survey. In this chapter we extrapolate those results to larger landscapes and calculate the total population size for Mahale, Mahale East, Ugalla and Masito regions using remote sensing, GIS and Element Distribution Modeling tools. Mwene, Loazi, Tembwa and Upper Ngundwe catchment regions have been narrowly delineated using expert knowledge and did not require such predictive distribution modeling.

Modeling Objective and Approach

The study regions were delineated first by expert knowledge using 15 m pan-sharpened NaturalVue satellite imagery, settlements, roads, streams and GPS field surveys. These regions excluded the main human population areas and areas known not to have chimpanzees. However, in the case of Mahale, Mahale East, Ugalla and Masito regions the areas were still too large to extrapolate chimp density estimates to the entire forest and woodland cover. Therefore the main objective of this modeling effort was to map more specifically the environments predicted to be suitable for occupation by chimpanzees.

We chose Mahalanobis distances (M-distance) as the modeling algorithm because it has several advantages over the other methods, such as logistic regression (Knick and Rotenberry 1998). M-distance requires presence data only and is ideal for GIS mapping where the set of habitat variables are highly auto-corellated. It is based on both the mean and variance of the predictor variables, plus the covariance matrix of all the variables, and therefore takes advantage of the covariance among variables (Jenness 2003).

M-distances measures how similar some set of conditions are to an ideal set of conditions (Farber and Kadmon 2002) such as the type of environment at the chimpanzee nest locations. Therefore the algorithm can be used to identify which areas within study regions are more similar to the locations where chimpanzee nests were found.

As the chimpanzee surveys were stratified in forest and woodland habitats we calculated the forest and woodland cover within predicted chimpanzee nesting areas and extrapolated the density estimates for each habitat type.

Data

Occurrence Data

All the survey data for Mahale, Mahale East, Ugalla and Masito regions were combined into one dataset. This nest dataset consisted of 1,439 points. 25% or 359 of available points were randomly selected from the existing set for model validation. The rest 75% or 1077 points were used for prediction. Environmental data, independent variables to be used as predictors for chimpanzee distribution, included distance from forest patches, distance from steep slopes and elevation.

Chimpanzees in western Tanzania use extensively both forest and woodland habitats (Kano 1972; Moore 1992) and their ranges always include some portion of forests and woodland vegetation. However, at the macro-habitat selection level we considered forests to be one of the most important limiting factors because of their significance as a source of food and their limited distribution in the region. A forest cover map was derived from 2001 and 2002

Landsat ETM+ satellite imagery (Chapter 2). We computed a one km buffer around nest locations and assessed the size of forest patches within those buffers. We selected 2.4 ha as the minimum forest area that could because 2.52 ha was the largest patch within 1 km buffer from the nests in Ugalla - a region with the smallest forest patches. All the forest patches below 2.4 ha were removed and Euclidean distances from those forests calculated using ArcGIS (ESRI) software.

Environmental Data
A number of environmental data, independent variables to be used as predictors for chimpanzee distribution, were generated using GIS and remote sensing tools. Priority was given to data that were good predictors and completely covered the study area with consistent mapping methodology.

Distance from forest patches > 2,4 ha was a good predictor for nest densities adjusted by effort (Figure 7.1). The effort dataset consisted of GPS locations at 250 m intervals along the transect lines. A section of the Ugalla dataset did not have GPS records except at the beginning and end of transects. New 250 m interval points were generated in ArcGIS (ESRI) along digitized lines and added to the effort dataset.

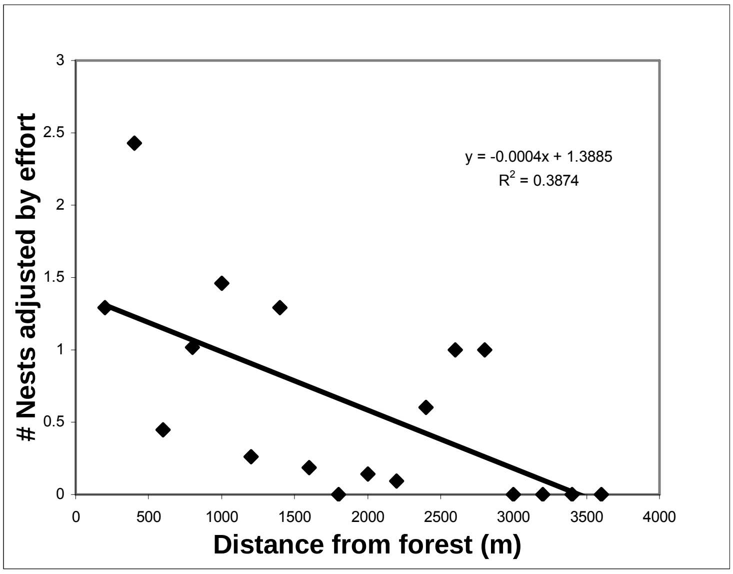


Figure 7.1. The relationship between nest frequency and the distance from forest patches

Another predictor variable that we choose was distance from steep slopes. Chimpanzees in western Tanzania seem to have a preference/selection for steep slopes as nesting sites. Research is under way to try to explain this phenomenon in Ugalla region (Hernandez PhD thesis, in preparation). We derived slopes from 90 m SRTM Digital Elevation Model (DEM) and visually estimated that areas corresponding with steep slopes have values above 20 degrees. We computed the Euclidean distances from those slopes and included it in our modeling effort.

Finally, we choose elevation as another predictor variable because our surveys showed that chimpanzees were absent in forests and woodlands on higher elevations, approximately above 1900 meters. Therefore the final datasets included in the model were: distance from forest patches > 2.4 ha, distance from slopes > 20 degrees, and elevation (Figure 7.2).

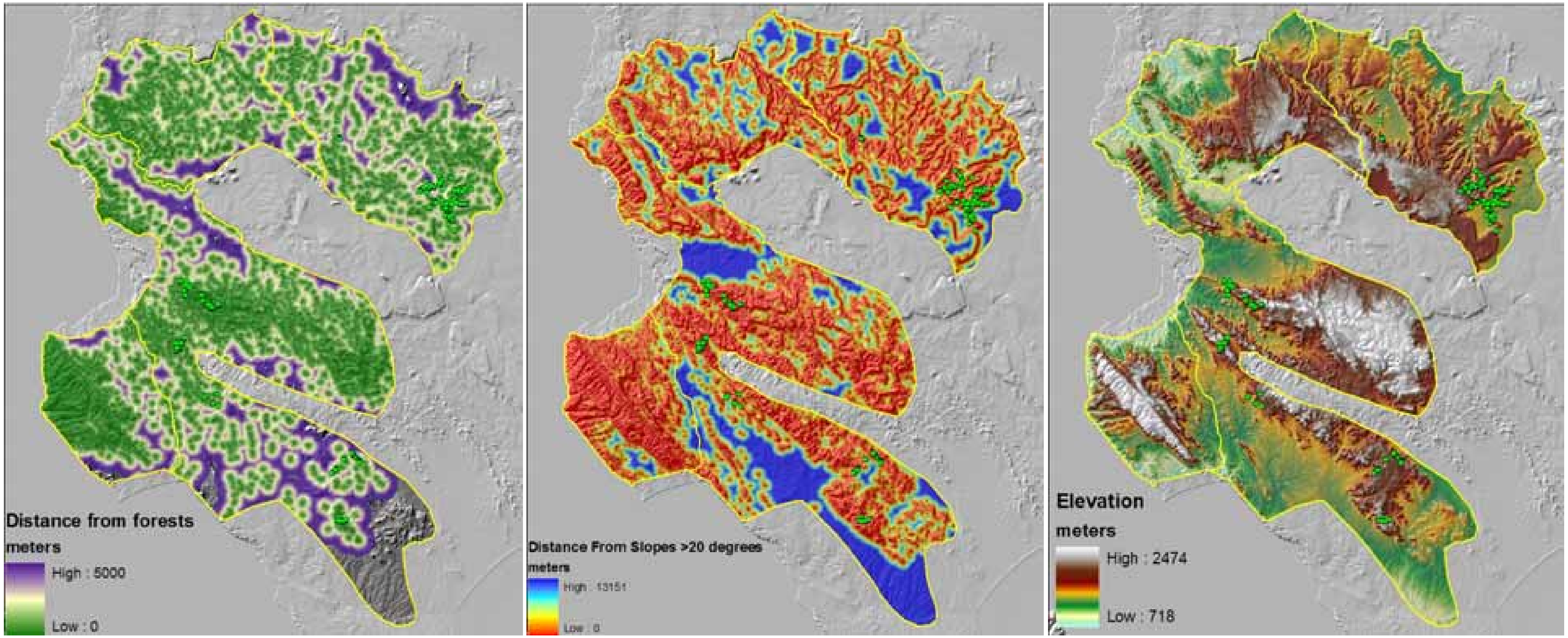


Figure 7.2. Distance from forest patches > 2.4 ha, Distance from slopes > 20 degrees and Elevation overlay with chimpanzee nests (green dots).

Results

Distribution of chimpanzee nests

Chimpanzee nests were observed in this survey throughout most of the Greater Mahale Ecosystem (delineated by the boundary in figure 7.2). However, in much of the Sitebi highlands, east of Ntakata Forest in Mahale East we did not observe signs of chimpanzees, nor did local people confirm their presence there. Consequently for the analyses of chimpanzee numbers we restricted the calculation of suitable habitat to the areas we know or deem it is likely (based upon conversations with local people) that chimpanzees occur. The revised boundary used for this analysis is given in figures 7.3-7.5.

Modeling

The average vector of habitat characteristics at 75% of the nest sites collected was:

1) Distance from forest > 2.4 ha = 527 m
2) Elevation = 1372 m
3) Distance from slopes >20 degrees = 111 m

For each 90 m pixel in the study landscapes the M-distances algorithm computed an index of dissimilarity between conditions at that location and the mean habitat conditions listed above. Figure 7.3 shows the range of M-distances represented as 3 categories of similarity (High, moderate and low selection) to the mean habitat characteristics for the 75% of chimpanzee nesting locations from transect surveys. This map is effectively predicted chimpanzee nesting habitat.

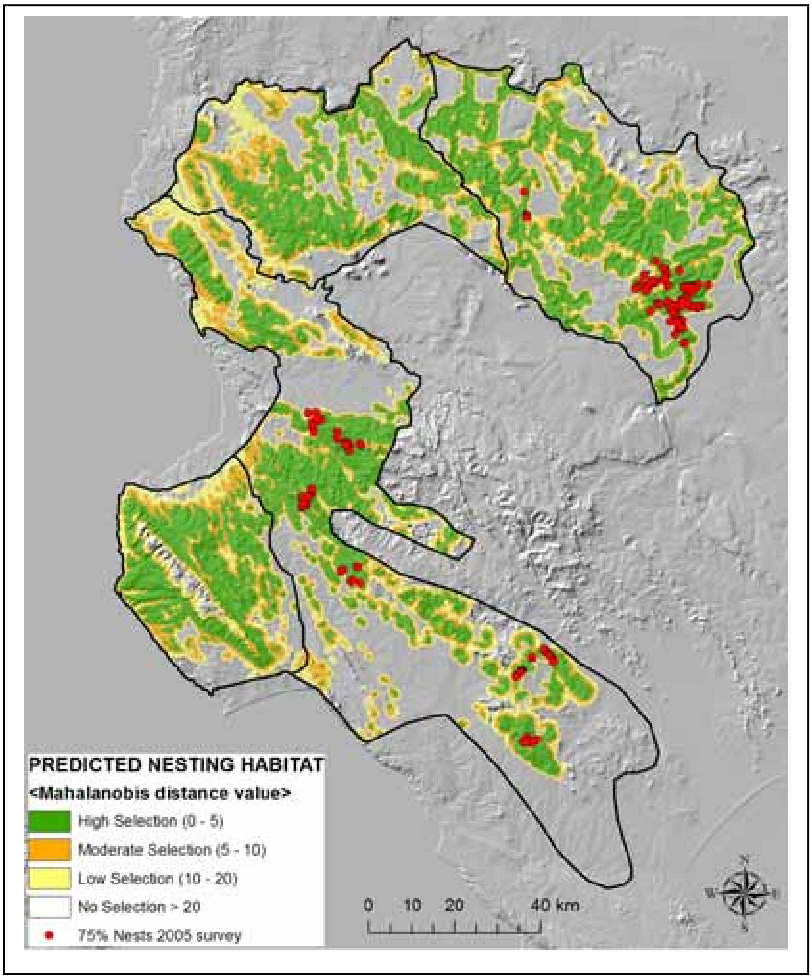


Figure 7.3. Predicted chimpanzee nesting habitats overlay with nests from 2005 surveys (75% modeling set)

Accuracy Assessment

We used two datasets to evaluate the accuracy of chimpanzee nesting habitat predictions: a) 25% of nests (n=359) not used in model development, randomly selected and put aside from the 2005 surveys; and b) historical nest locations (n=355) recorded by Jim Moore and Hideshi Ogawa (Chapter 4) over the last ten years (Figure 7.4).

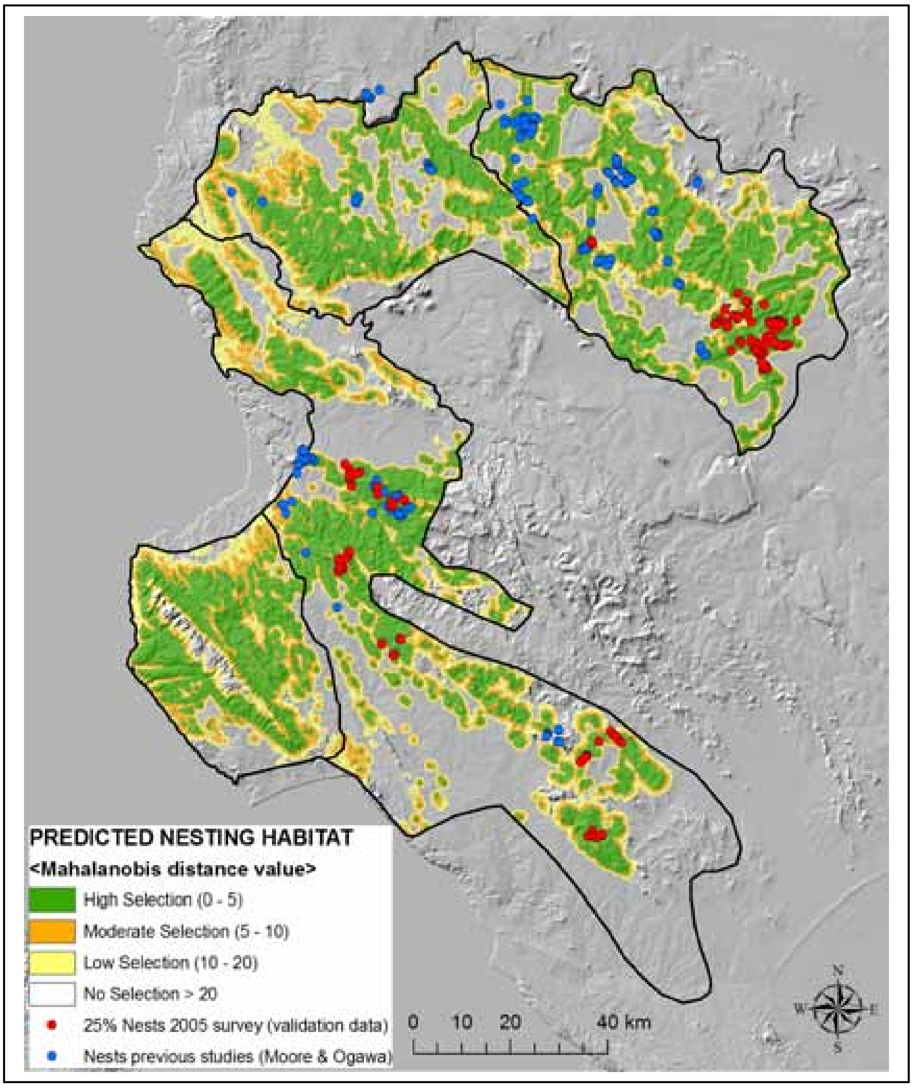


Figure 7.4. Predicted chimpanzee nesting habitats overlaid with nests from 2005 surveys (25% evaluation set) and previous surveys conducted by Jim Moore and Hideshi Ogawa.

The predicted high suitability category contained 85% of actual nests from the 2005 validation dataset and 69% from the previous surveys (Table 7.1). There are several potential reasons why some of the nests especially in the historic dataset were outside of the predicted area. The locations of nests from previous surveys may be inaccurate because most of the nests were recorded on the 1:50,000 toposheets. The focus of the 2005 surveys was on the forest and adjacent woodland habitats. Perhaps previous surveys did not have such an emphasis that resulted in an effort farther from forest patches. Predictions were better if both the high and moderate selection categories were included: 92.2% for 2005 surveys and 84% for historical dataset. Finally errors could be added from the assumption associated with using M-distances e.g. that the mean habitat characteristics at nest sites represent optimal habitat characteristics for chimpanzee nest locations.

Table 7.1. Distribution of chimpanzee nests (25%; n=359) in the test dataset randomly selected from 2005 survey data and nests (n=355) from previous surveys by Jim Moore and Hideshi Ogawa 1993-2003.

M-Distance range	Predicted Nest Suitability	Actual % of nests in range using 25% of 2005 survey data	Actual % of nests in range using historical nests data from Moore & Ogawa
0 - 5	High	85.2%	68.5%
5 - 10	Moderate	7.0%	15.5%
10 - 20	Low	7.5%	13.1%
> 20	No predicted	0.3%	2.9%

Predicting chimpanzee densities

Predicted mahalanobis suitability categories were intersected in GIS with forest and woodland layers from the habitat map: the two major macro-habitats used by chimpanzees in the region. The final habitat layer represented a combination of the M-distances suitability map and the forest and woodland vegetation classes (Figure 7.5).

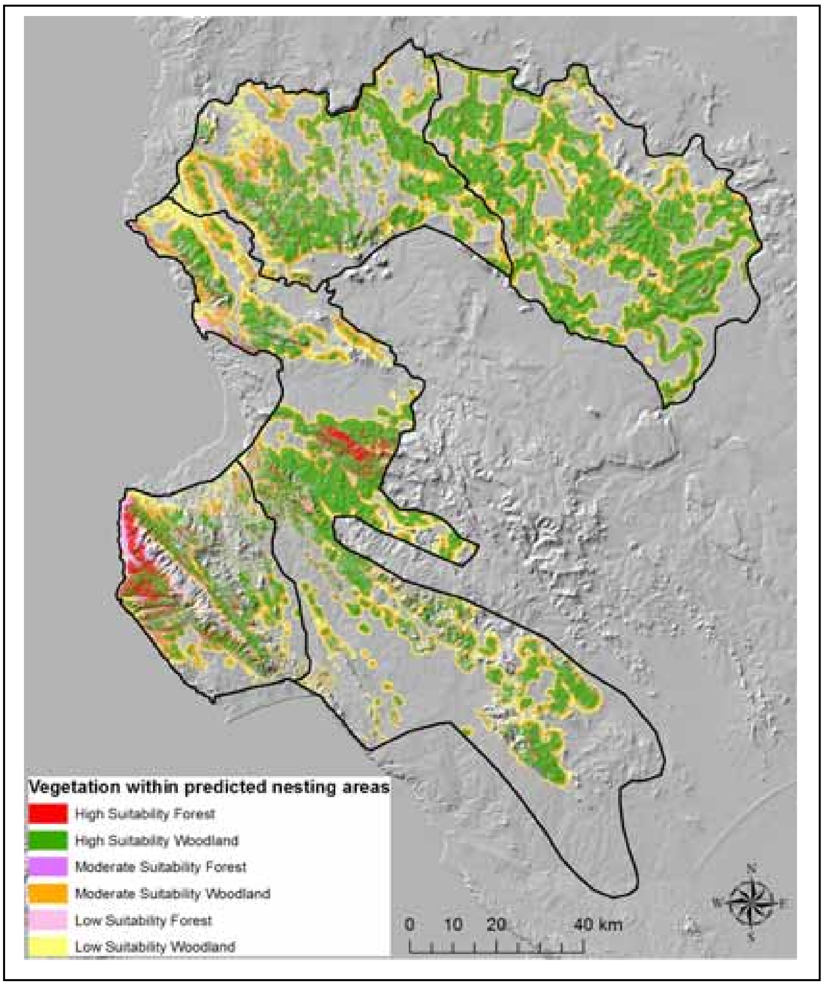


Figure 7.5. Distribution of forest and woodland vegetation within predicted nesting areas

To calculate the number of chimpanzees in predicted areas suitable as nesting sites we used the following chimpanzee densities estimated in previous chapters and M-distances categories (table 7.2):

- Mahale and Mahale East - 1.4 chimpanzees/sq.km for forest areas and 1.2 for woodland areas within **high** suitability category
- Masito and Ugalla – 0.2 chimpanzees/sq.km for both forest and woodland areas within **high** and **medium** habitat suitability category

Table 7.2. Chimpanzee numbers within forest and woodland areas predicted suitable as chimpanzee nesting sites. na = not analysed

Variables \ Region	**Mahale**	**Mahale East**	**Masito**	**Ugalla**	**Total**
Predicted forest areas suitable as nesting sites (km^2)	115		na	na	
Chimpanzee numbers in suitable forest	**160**		**na**	**na**	
Woodland areas suitable as nesting sites (km^2)	313		na	na	
Chimpanzee numbers in suitable woodland	**438**		**na**	**na**	
Total forest and woodland areas suitable as nesting sites (km^2)	427	1059	1054	1645	4,185
Total chimpanzee numbers in suitable forest and woodland	**598**	**1482**	**211**	**329**	**2,620**

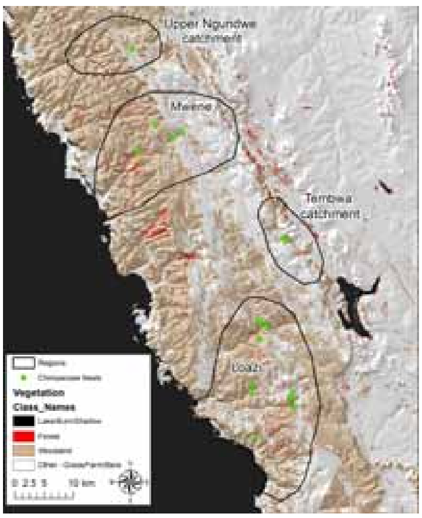


Figure 7.6. Location of nests along the southern Tanganyika lakeshore in relation to habitat.

The Mahalanobis distance method described above was not applied to the Southern Tanganyika Lakeshore because there were few data points to test the accuracy of its application here. Instead the same classification of habitat types derived was applied to this region to calculate areas of forest and woodland (figure 7.6). The total area of forest and woodland in the four sites in this region was 664 km^2 and with a density of 0.21 chimpanzees km^{-2} we estimate that the total population of chimpanzees here is around 140 individuals.

Therefore the total number of chimpanzees estimated for western Tanzania from this study is around 3,700 individuals.

Conclusion

The Mahalanobis distance model proved to be the most useful to map the distribution of environments predicted to be suitable as potential chimpanzee nesting sites. It correctly classified suitable nesting sites in both high and medium suitability for 92.2% of the test data and 84% of nest data collected in previous surveys. Consequently we believe that the maps derived to predict chimpanzee numbers are reasonably accurate.

One of the main constraints of the modeling reported here was that in using Landsat imagery we were constrained by pixel sizes of 28.5 m. Some gallery forest strips are narrower than this distance and hence the analysis of the images might fail to identify these narrow galleries as forest. There is also a seasonal aspect to the analysis with Miombo Woodland losing its leaves in the dry season but flushing with green leaves just prior to the rains. Dry season imagery separates forest and woodland much better than wet season imagery as a result.

It is important to underline that the Mahalanobis distance does not model the distribution of chimpanzees. It models the distribution of environments predicted to be suitable as chimpanzee nesting sites. The distribution maps produced in this chapter are spatial models and not a direct representation of where chimpanzees are. As such there is some degree of uncertainty with areas which are predicted suitable or unsuitable. This means that the modeling results should not be used beyond the goals of this chapter. Other applications such as reserve site selection would have to revise the assumptions and suitability of the model to meet the new goals. In particular we recommend improving forest and woodland vegetation layers by adding multi-seasonal satellite imagery to capture the differences in vegetation condition at the beginning, middle and end of the dry season.

The number of chimpanzees estimated for the region are higher than previous estimates (Kano et al. 2005) but not greatly different. They also match reasonably well where we have some idea about chimpanzee numbers such as in Mahale Mountains National Park where semi and fully habituated chimpanzees have been recognized as individuals and the size of communities are known. We therefore have some confidence in the estimates.

CHAPTER 8 : Conservation Implications

A.J. Plumptre, D.Moyer, and L. Pintea

Chimpanzee numbers for Tanzania

The chimpanzee is only found in the west of Tanzania, within the survey area we covered and in Gombe Stream (and its surrounding area) and Rubondo National parks. Gombe is known to have about 93 individuals (L.Pintea pers. comm.) and Rubondo's population is unknown. These surveys indicate that the numbers of chimpanzees in Tanzania are higher than had previously been estimated. Previous estimates had come to figures of around 1,900 in 1965 down to about 1,000 individuals in 2002-3 (Kano et al. 2005) but our estimates total 2,600 individuals (or 2,700 including Gombe and Rubondo). There are several reasons why we might have estimated a larger chimpanzee population but the primary one stems from the need to undertake line transect surveys rather than following paths and easier routes (reconnaissance walks), which is the method that has traditionally been used in this region. Wherever we have extrapolated the densities we obtained from transects to the whole area where chimpanzees are know to occur, we have tried to be conservative in our estimates and hence we are fairly confident that we are not exaggerating the numbers. It is possible that the numbers could be higher than this as a result.

Of the 2,700 chimpanzees for western Tanzania only 600 are estimated to occur in Mahale Mountains national Park, 100 in Gombe and Rubondo and an additional 330 in Tongwe East Forest Reserve (Ugalla) and possibly 40-50 in Loazi Forest Reserve in the south. Consequently at least 60% of chimpanzees in western Tanzania are found outside protected areas. This is an issue of conservation concern because this species is classified as endangered and people are beginning to move into this area and cultivate in the valleys between the hills, causing the loss of habitat, particularly riverine forest habitat which tends to be found in these valleys and has fertile soils (A. Plumptre and D. Moyer pers. obs. From aerial surveys). This is the primary habitat required by the chimpanzees which can use the Miombo woodland also but need to have access to forest as well.

Biodiversity of the Greater Mahale Ecosystem

The Greater Mahale Ecosystem (GME) has been defined by this study and a workshop with TANAPA and FZS to include the Mahale Mountains National Park and the area defined by the boundary line to the east of the park that is shown in all the maps produced in this report. FZS have EU support to promote conservation of this larger ecosystem. The GME has three main areas: a) the Ugalla-Masito area; b) the Ntakata forest and Sitebi highlands; and c) the corridor to Katavi National park via the Wansisi hills. The brief surveys of the biodiversity of the GME show that it is rich in species for the three taxa surveyed (mammals, birds and plants) and that it would be useful to undertake more surveys of the region in future. The Mahale – Ntakata – Sitebi highlands area in particular seems to be rich in species and also to contain more endemic and threatened species. This is probably due to the greater variation in altitudinal range in this region.

The Kungwe Apalis, one of only two Albertine Rift endemic species and the only endangered bird species recorded from this area, was relatively abundant east of Mahale Mountains National park and within the park. It is probably more numerous than had previously been estimated but it is confined to a small area of unprotected habitat (outside the park) and hence is still at risk. Whether it should remain classified as 'Endangered' or could be moved to 'Vulnerable' needs further survey work and an assessment of the potential population changes taking place. Comparisons between calls recorded for this species in Tanzania and Rwanda and between specimens collected from these countries need to be made also because we believe that the calls are probably different and therefore the species that has been recorded in Nyungwe National Park in Rwanda may not be this species. If true this would mean that the Kungwe Apalis is only found in the Greater Mahale Ecosystem.

Analysis of the calls and habitat use makes us believe it is possible that there may be a new Galago species to be found in the region and it is likely that several of the plant species we collected may prove to be new species. Surveys of small mammals, amphibians and reptiles would probably also find new species.

Human impacts in the Greater Mahale Ecosystem

While on the transect surveys we collected data on signs of human use of the areas we surveyed. Information on poaching (poachers sighted, snares, pitfall traps), harvesting of NTFPs (rattan, poles, firewood, medicinal plants), timber harvesting (pitsaw sites, stacked timber) and bee hives were recorded. The Greater Mahale Ecosystem area is relatively remote and uninhabited for the Albertine Rift while the southern Tanganyika Lake shore has greater pressures from the surrounding population. These impacts can be summarized by plotting relative encounter rates of signs along transects (figure 8.1).

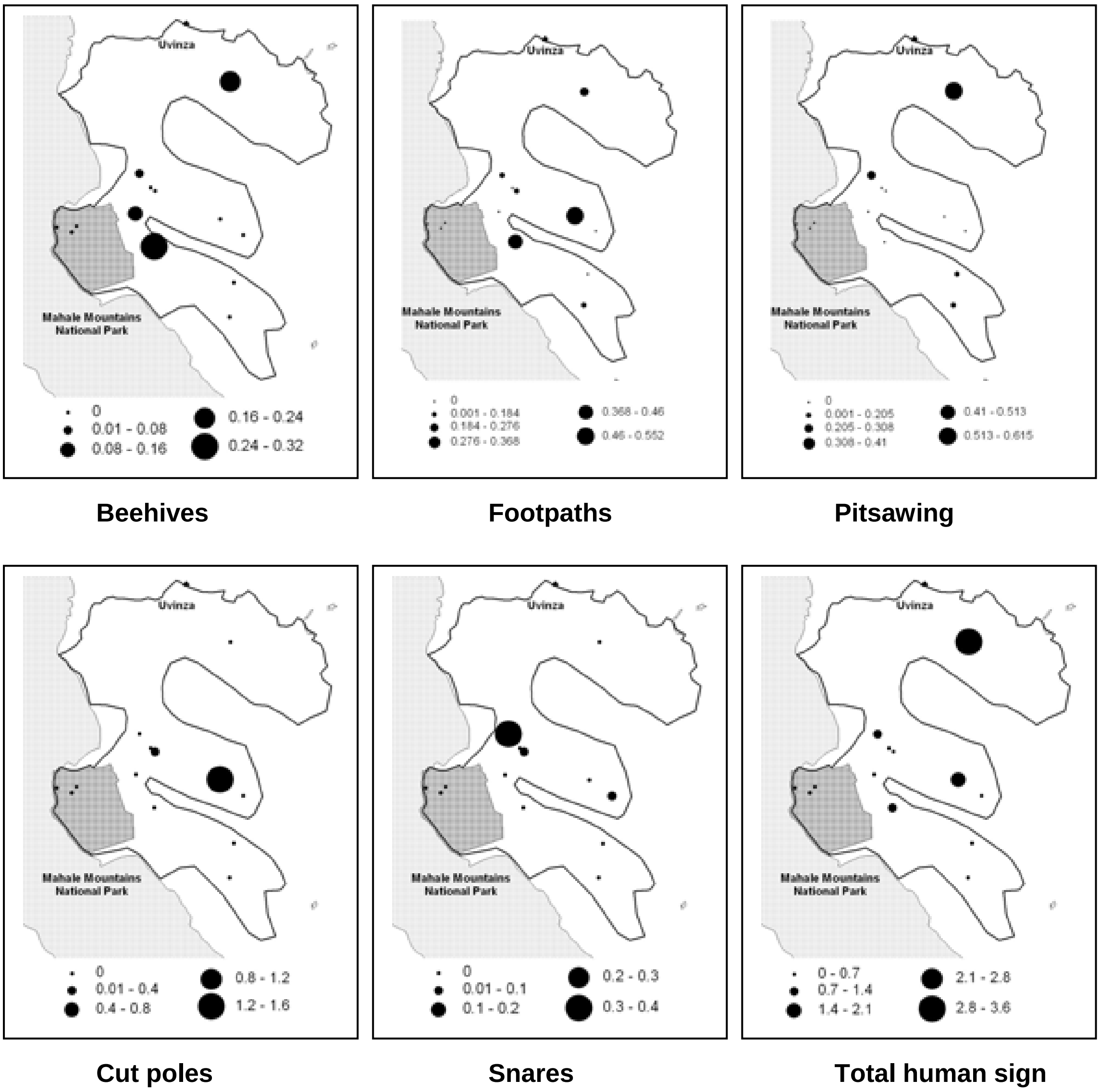


Figure 8.1. Encounter rates of sightings of human activities per km walked in the Greater Mahale Ecosystem. The sightings of all human caused signs were summed to calculate an encounter rate of total human signs.

Signs of timber harvesting were high in the Tongwe Forest Reserve in Ugalla with many cut trees, harvested for timber. As a result the one site we surveyed in Ugalla dominates the total human signs map. Setting of snares to trap wildlife was not very common (in comparison to other sites we have surveyed in the Albertine Rift) and they tended to be more abundant where surveys were made nearer human settlements. However, it was clear that the large mammals in the region were being hunted and they showed a lot of fear of people when encountered. Our guides told us that much of the hunting was being carried out by the Burundian refugees who had access to guns but we were unable to confirm the truth of these statements. Flying over the region we did not see many large mammals. In general, however, human impacts in this part of the Albertine Rift were much lower than in other sites. This is because this region is relatively remote and comparatively fewer people live here at the moment. It is mainly the large camps for Burundian refugees, which house most people in the region and these are predicted to empty over the coming years, although it is likely that people will move in and use the vacated land to cultivate. It is primarily the industrious Sukuma people who are moving in and expanding cultivation in the area, particularly large areas of rice cultivation near Katavi National Park.

While surveying around Lubalisi we came across a mining company that is exploring the region for minerals. In the past the region had been explored for gold but little had been found. Now they are exploring for other minerals such as titanium, copper and zinc. A brief meeting with the manager of the camp indicated that they had some reason to believe that the area was proving to contain sufficient quantities of some of these minerals and would likely be mined in the future. The area where they are exploring is effectively the corridor that links Mahale Mountains National Park to the north and east of the Greater Mahale Ecosystem (figure 8.2).

Figure 8.2. Map of the Greater Mahale Ecosystem showing the location of the road to Lubalisi village and the mining concession that could eventually block the corridor to the east and north if not managed properly.

Conservation of the Greater Mahale Ecosystem

It is clear that this region is of global conservation value and it is probable that this is true for the South Tanganyika lake shore also. The GME is presently relatively intact but people are moving into the region and it is probably only in the next 5-10 years that this area will be possible to save as one intact region. Already the road from Mpanda west through Mwese to Lubalisi and Kapalagulu is becoming better used and it has been constructed up to the lake shore. If settlement occurs along this road it will separate the Ugalla-Masito and Ntakata-Sitebi hills from Mahale Mountains National Park and the Mahale – Wansisi hills region. Similarly, any discovery of a good seam of minerals and the subsequent mining of this region might also lead to the cutting of the corridor linking these areas. However, controlled mining may allow some form of management of the area provided mined areas are rehabilitated to ensure that part of the corridor always remains functional. A mining concession would also allow a large area of land to be kept relatively free of people. As it is unlikely that conservation practitioners will stop any mining if a good source of minerals is discovered, we would advocate that conservationists work with the mining companies to find a compromise to ensure that much of the ecosystem remains functionally connected.

Chimpanzees are a good ‘Umbrella species’ for the GME because they range over most of the area and because of the long history of research on this species in the region. The connectedness of the landscape is needed in order to maintain the gene pool necessary for this species to maintain viable populations because over most of the GME the populations are spares and at low density. Managing the GME for this species and maintaining the functionality of the corridors within the landscape would also benefit several other landscape species, such as Elephants, African Wild Dog (reported to occur here), and some of the large antelope species such as Roan, Sable, Kudu and Eland.

The information in this report is being provided to TANAPA and FZS who are developing plans for the management of the GME. TANAPA is committed to the conservation of this region and is excited about the ideas of maintaining the links from Mahale Mountains National Park to Katavi National Park and within the wider GME. Currently there is some EU support for conservation in this region but it will need much larger support to have the GME fully recognized and managed as a conservation area. We hope that this report will go some way to promoting the importance of this region for conservation which can help justify more financial investment in the region, not only for the wildlife but also for the people living in this remote and poorly developed region of Tanzania.

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Appendix 1. Large Mammals of the Mahale National Park and the Greater Mahale Ecosystem (excluding park). Mammals reported but for which no signs were observed are marked with '?'. Data are from this survey and the literature.

Common Name	Species name	Greater Mahale Ecosystem	Mahale Mountains National park
Primates			
Chimpanzee	*Pan troglodytes schwenfurthii*	1	1
Red Colobus	*Pilioclobus oustaleti tephrosceles*	1	1
Angolan Colobus	*Colobus angolensis*		1
Yellow baboon	*Papio cynocephalus*	1	1
Vervet monkey	*Cercopithecus aethiops pygerythrus*	1	1
Red-tailed Monkey	*Cercopithecus ascanius*	1	1
Blue monkey	*Cercopithecus mitis doggetti*	1	1
Greater galago	*Otolemur crassicaudatus*	1	1
Senegal galago	*Galago senegalensis*	1	1
Dwarf forest galago	*Galagoides sp. To be identified*		1
Bats			
Singing fruit bat	*Epomops franqueti*		1
Epauleted fruit bat	*Epomophorus labiatus*	1	1
Tomb bat	*Taphozous* sp.		1
Serotine bat	*Eptesicus* sp.		1
Shrews			
Chequered elephant shrew	*Rhynchocyon cirnei*	1	1
Rufous elephant shrew	*Elephantulus rufescens*	1	
Four toed elephant shrew	*Petrodromus tetradactylus*	1	
?	*Crodidura sp. 1*		1
?	*Crocidura sp. 2*		1
?	*Sylvisorex sp. 1*		1
Hares/Rabbits			
Cape Hare	*Lepus capensis*	1	1
Rodents			
Sun squirrel	*Heliosciurus sp.*		1
African giant squirrel	*Protoxerus stangeri*		1
African dormouse	*Graphiurus murinus*		1
Crested porcupine	*Hystrix africanus*	1	1
Climbing mouse	*Dendromus nyikae*		1
Giant Pouched rat	*Cricetomys gambianus*	1	1
Common cane rat	*Thryonomys swinderianus*	1	
Common mole rat	*Cryptomys hottentotus*	1	
Groove-toothed rat	*Otomys sp.*		1
Brush-furred mouse	*Lophuromys flavopunctatus*		1
Soft-furred mouse	*Praomys sp.*		1
African Wood mouse	*Hylomyscus*		1
Common mouse	*Mus sp.*		1
Narrow-footed woodland mouse	*Grammomys sp.*		1
Carnivores			
Side-striped jackal	*Canis adustus*	1	1
Wild dog	*Lycaon pictus*	?	1
Zorilla	*Ictonyx striatus*		1
Ratel (Honey badger)	*Mellivora capensis*	1	1

Common Name	Species name	Greater Mahale Ecosystem	Mahale Mountains National park
African clawless otter	*Aonyx capensis*		1
Spot-necked otter	*Lutra maculicollis*		1
Slender mongoose	*Herpestes sanguinea*		1
Dwarf mongoose	*Helogale parvula*	1	1
Banded mongoose	*Mungos mungo*		1
White-tailed mongoose	*Ichneumia albicauda*		1
Bushy-tailed mongoose	*Bdeogale crasicauda*		1
Spotted hyaena	*Crocuta crocuta*	1	1
Common genet	*Genetta genetta*		1
Blotched genet	*Genetta tigrina*		1
Small forest genet	*Genetta sp.*		1
African civet	*Civettictis civetta*	1	1
Serval	*Felis serval*	?	
African wild cat	*Felis sylvestris*		1
Leopard	*Panthera pardus*	1	1
Lion	*Panthera leo*	1	1
Ground pangolin	*Smutsia temminickii*		1
Aardvark	*Orycteropus afer*	1	
Ungulates			
Bush hyrax	*Heterohyrax brucei*		1
Southern Tree hyrax	*Dendrohyrax arboreus*		1
African elephant	*Loxodonta africana*		1
Common zebra	*Equus burchelli*	1	1
Hippopotamus	*Hippopotamus amphibius*		1
Bush pig	*Potamochoerus larvatus*	1	1
Common warthog	*Phacochoerus africanus*	1	1
Giraffe	*Giraffa camelopardalis*		1
African buffalo	*Syncerus caffer*	1	1
Bushbuck	*Tragelaphus scriptus*	1	1
Greater kudu	*Tragelaphus strepsiceros*		1
Eland	*Taurotragus oryx*	1	1
Bush duiker	*Sylvicapra grimmia*	1	1
Blue duiker	*Cephalophus monticola*		1
Suni	*Neotragus moschatus*	1	1
Klipspringer	*Oreotragus oreotragus*	1	1
Southern Reedbuck	*Redunca arundinum*	1	
Waterbuck	*Kobus ellipsiprymnus*	1	1
Topi	*Damaliscus lunatus*		1
Kongoni (Lichenstein's Hartebeest)	*Alcelaphus buselaphus*	1	1
Roan antelope	*Hippotragus equinus*	1	1
Sable antelope	*Hippotragus niger*	?	1