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Source: Primate Conservation, 22(1) : 97-105

Published By: Conservation International

URL: https://doi.org/10.1896/052.022.0108

Primate Conservation 2007 (22): 97–105

Census and Conservation Assessment of the Red Colobus (*Procolobus rufomitratus tephrosceles*) on the Ufipa Plateau, Southwest Tanzania: Newly-discovered, Threatened and Extinct Populations

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Abstract: Surveys were carried out in the last remaining forests of southwest Tanzania's Ufipa Plateau to determine the presence, distribution and abundance of the red colobus *Procolobus rufomitratus tephrosceles*. In 2002, we investigated the Chala and Misheta forests. Chala was in poor condition, and no primates were seen, although it is not known if red colobus ever existed there. There was almost no natural forest remaining in Misheta, and we consider its red colobus population to be now extinct. Analysis of satellite imagery revealed that the Nsangu Forest no longer exists, and we assume its population is also now extinct. In August 2006, a previously undocumented red colobus population was discovered in Mbuzi, 55 km north of the only other extant population in Mbizi. Complete count censuses were performed in Mbuzi and Mbizi. A total of 1,217 individuals were recorded in Mbizi and 137 individuals in Mbuzi, giving a combined total of 1,354 individual Ufipa red colobus. Mean group size in Mbizi was 40.56 (n = 30; SD = 6.57; range 30–56) and in Mbuzi was 34.25 (n = 4; SD = 13.07; range 24–50). The Mbuzi subpopulation may no longer be viable and the subpopulation of Mbizi may be declining. Both forests are heavily degraded and require urgent conservation attention.

Key Words: red colobus, *Procolobus rufomitratus tephrosceles*, census, distribution, Ufipa, Tanzania

Introduction

Red colobus are represented by five species and eighteen taxa in evergreen forests across equatorial Africa (Struhsaker 1975, 2005; Kingdon 1997; Grubb *et al*. 2003). None of these taxa is sympatric (Struhsaker 2005) and most comprise a single geographical population. A conspicuous exception however, is the variously named Uganda, Central African or ashy red colobus *Procolobus rufomitratus tephrosceles*, thought to be restricted to five discrete forests, but spread across 1,000 km of East Africa (Rodgers 1981). These distinct populations are found in western Uganda in Kibale, and in western Tanzania in Biharamulo on the southwestern shores of Lake Victoria, Gombe and Mahale Mountains on the eastern shores of Lake Tanganyika, and Mbizi and Misheta on the Ufipa Plateau (Rodgers 1981; Rodgers *et al.* 1984).

Struhsaker (2005) described the conservation status of *P. r. tephrosceles* as 'Vulnerable' throughout its range, with perhaps the only viable population being in Kibale with at least 17,000 individuals. However, long-term studies have indicated significant declines in Kibale's red colobus numbers, including a >43% decline over 24–30 years (Mitani *et al.* 2000; Struhsaker 2005) and a 40% decline in 28 years in a different part of the forest (Chapman *et al.* 2000). Similarly, red colobus group sizes declined by almost 50% over a 25-year period (Stanford 1998). At least some of these declines are the result of predation by chimpanzees *Pan troglodytes* (Watts and Mitani 2002), with between 16 and 40% annual red colobus mortality attributed to them (Wrangham and Bergmann-Riss 1990). There are insufficient data for Mahale, although in one small portion of the forest the red colobus population was stable between 1996 and 2002 (Uehara 2003) in an area where chimpanzee predation is between 1 and 9% per year (Ihobe and Uehara 1999; Boesch *et al.* 2002).

The southernmost population of *P. r. tephrosceles* has previously been subject to just one investigation; by Rodgers *et al.* (1984), who studied the status of Mbizi Forest and its red colobus population in early April 1980. A census produced an estimate of 250 individuals in the ~15% of the forest surveyed, although a total population was not determined as there were no data on red colobus density in the remaining 85% of the habitat. This study also reported the presence of another population of *P. r. tephrosceles* in the Misheta forests (Fig. 1), although no further information was reported (D. Moyer and

R. Stjernstedt, in Rodgers *et al.* 1984). A third subpopulation was subsequently recorded in a forest patch near the village of Nsangu during an ornithological survey (Moyer and Stjernstedt 1986). No estimates have been made of the abundance or full extent of the distribution of either the Misheta or Nsangu subpopulations, and there have been no subsequent investigations of any of the red colobus in Ufipa.

Mbizi Forest sits on the escarpment overlooking Lake Rukwa. Described as a relict montane cloud forest (Kerfoot 1963), it reaches 2,441 m above sea level, and experiences frost more than 50 nights a year. As a consequence, its red colobus population endures ecological conditions very different from those of the other four populations. Although regarded as the same taxon as those further north, they are geographically isolated by 350 km. The Mbizi animals differ from all other *P. r. tephrosceles* in having longer and thicker body hair, giving a woolly appearance, and shorter tails and a greater incidence of stump tails. These two characteristics are presumably indicative of adaptation to the cold (Rodgers *et al.* 1984). They also differ in having longer grayish cheek whiskers and usually a fuller red cap extending more down the forehead and the side of the face (Rodgers *et al.* 1984). Comparative genetic analyses will reveal how close the populations are.

In order to ascertain the current conservation status of all red colobus subpopulations in Ufipa, as well as to make comparisons with data obtained 26 years earlier and assess current habitat quality, we investigated all the forests in Ufipa known to have red colobus, as well as an additional one that we had heard may have harbored red colobus. We subsequently carried out complete counts employing sweep census techniques of all known red colobus subpopulations, and also assessed human impacts we recorded along the transects.

Methods

Study sites

All the montane forests investigated in this study are found on the Ufipa Plateau in Rukwa Region, southwest Tanzania (Fig. 1). They are separated by a range of vegetation types, the most notable of which is a unique forb-rich montane grassland that forms a mosaic with sparse woodland and savanna (Rodgers *et al.* 1984). Mbizi (spelt with a 'z' in the local KiFipa language and an 's' in KiSwahili) incorporates 2,930 ha of montane 'cloud' forest between 2,100 to 2,441 m above sea level, and within the 3,248 ha Lyambo Hills Forest Reserve. It is 14 km north of the town of Sumbawanga on the escarpment overlooking Lake Rukwa (7º40'S, 31º40'E) within the administrative district of Sumbawanga Urban. The vegetation and conservation of Mbizi have been reported elsewhere (Mtuy and Mkude 1974; Ruffo and Mabula 1987; Kikula 1979; Rodgers *et al.* 1984; Davenport 2002, 2005). Mbizi represents the easternmost portion of congolian forest in Tanzania and is characterized by 40 meter-high *Euphorbia obovalifolia* trees protruding through the canopy. The forest has been heavily logged over the years, and is especially susceptible to burning. Nsangu sits on the same escarpment 35 km southeast of Mbizi (08º03'S, 31º53'E), whereas the Misheta forest patches (08º17'S, 31º34'E) lie on the west-facing escarpment overlooking Lake Tanganyika, some 55 km to the south of Mbizi. Mbuzi Forest is situated on the eastern ridge of the Ufipa Plateau in Nkansi District, 14 km northeast of Chala and 54 km northwest of Mbizi (07º29'S, 31º32'E). This forest has no official protection status and covers just 611 ha between 1990 and 2.122 m above sea level, the highest point being the peak of Mt. Kisusi.

Study methods

Different methods were employed to determine the distribution and abundance of red colobus in Ufipa. The first sought to ascertain presence/absence of red colobus in various forests, and the second was employed to census the monkeys and assess human activity. The continuing presence of red colobus in the Misheta forests and speculation about their presence in Chala were investigated by TD in November 2002, when both forests were visited on foot. Subsequently, orthorectified LandSat5 TM satellite images (CSIR, South Africa; p171r065) acquired on 12 July 2006, were analyzed using ArcView 3.2 and ERDAS 9.1 software to confirm the amount of forest cover in Misheta and to investigate forest cover in Nsangu. The presence of red colobus in Mbizi has been known (Rodgers 1981; Rodgers *et al.* 1984) and monitored (Davenport 2002, 2005) for some time, and in Mbuzi Forest was verified by sight on the 26 August 2006.

In order to ascertain the red colobus population in Mbizi and Mbuzi as accurately as possible, the 'complete count' method, accepted as being the most accurate primate census technique, was used (Struhsaker 1981; Whitesides *et*

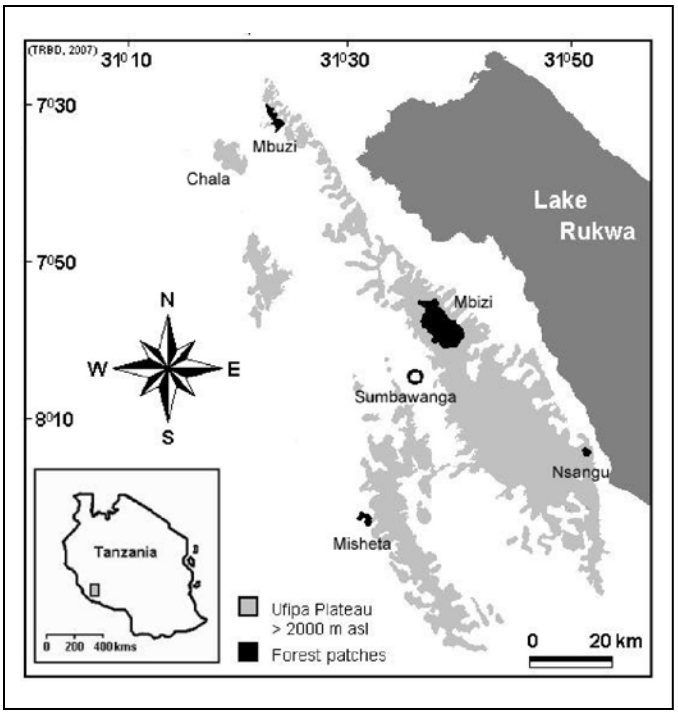

Figure 1. Map of Ufipa Plateau, southwest Tanzania, showing red colobus sites and the location of Mbizi and Mbuzi.

al. 1988; Plumptre and Cox 2006). This method was made easier by the small total areas of each forest, and the fact that they are heavily degraded and interspersed by open pasture. To increase accuracy, collection methods were based on direct observations of individual animals only, thus adapting the gorilla census methods developed by Harcourt and Fossey (1981) and McNeilage *et al.* (2001), who carried out complete counts of indirect sign. In this way, the aim was to arrive at a population number that was neither an estimate nor extrapolation based on density, but an absolute figure (Davenport *et al*. in press).

The censuses were carried out over 12 days in Mbizi (9–20 August 2006) and three days in Mbuzi (26–28 August 2006). In each case, four teams (each consisting of one experienced WCS member of staff and one local hunter from a village adjacent to the forest) walked parallel pre-planned linear transects 100 m apart. Transects were usually perpendicular to the length of discrete forest patches. Using compass and GPS units (Garmin 3+), the teams followed the same direction but taking the path of least resistance when necessary, rather than cutting through thick understorey. When a team encountered a red colobus group, enough time was taken to allow an accurate count of individuals in the group before continuing along the transect. Unlike other species (Davenport *et al.* in press) and contrary to previous reports (Rodgers *et al.* 1984) the colobus rarely moved far and usually permitted close inspection of the entire group; a process facilitated by the severely degraded nature of the forests. Total counts were made and the number of clinging infants in the group, time, vegetation type, GPS location, altitude and association with other species were recorded.

Grid reference positions of each group were also recorded by GPS every 15 minutes upon sighting. All observation data were also geo-referenced and accompanied with a distance and compass bearing between the observers and the animals. Discrete groups were generally easy to identify. However, to avoid confusion, the direction they moved during the encounter was recorded and cross-checked *a posteriori.* Groups were considered unique if they were recorded more that 200 m apart at the same time, and subsequently moved in different directions, and/or they were also seen at the same time by different observation teams, spending more than 75% of the observation time at a distance of at least 200 m apart. This was also verified *a posteriori.* In addition, all signs of human activity within each forest, such as saw pits, charcoal pits, tree felling, cultivation, traps and burned areas were recorded and GPS locations taken.

Results

The presence/absence survey in Misheta revealed that there is little if any forest left of any consequence in the area. The few remaining indigenous trees were found in narrow stream gullies, but no monkeys were seen and neither did it seem possible that any could still inhabit the site. Remote imagery of the whole area confirmed the absence of any forest stands, and we must assume that the Misheta population of red colobus is now extinct. The survey in Chala revealed that there are no red colobus in the forest, and that forest quality is extremely poor. It is unclear if the monkey ever existed in Chala. Remote image analysis demonstrated that there are no forest patches left in or near Nsangu, and this was corroborated by aerial observations (D. Moyer pers. comm.). We assume therefore that the Nsangu population of *P. r. tephrosceles* is also now extinct. The continuing presence of red colobus in Mbizi was already known (Davenport 2005). However, rumors from village hunters of red colobus in Mbuzi Forest were confirmed by sightings on the 26 August 2006. This represents a new and previously unrecorded population of *P. r. tephrosceles*.

During the census, 174.4 km of transect were walked in Mbizi and 18.3 km in Mbuzi. Table 1 provides information on all the groups found in both forests and the maximum number of individuals (and clinging infants) counted in each group. A total of 34 distinct groups of red colobus were encountered during the census; 30 groups in Mbizi and four in Mbuzi. A population of 1,217 *P. r. tephrosceles* individuals were recorded in Mbizi and 137 individuals in Mbuzi, giving a combined total of 1,354 for the Ufipa red colobus population. The mean group size recorded in Mbizi was 40.56 (n = 30; SD = 6.57; SE = 1.20; range 30–56 individuals) and in Mbuzi was 34.25 (n = 4; SD = 13.07; SE = 6.54; range 24–50 individuals). A total of 53 clinging infants were counted in Mbizi, giving a mean of 1.77 infants per group across all groups (n = 30), and a mean of 3.79 infants per group, amongst groups in which infants were recorded (n = 14). The ratio of infants to group size ranged from 0 to 20.6% with a mean of 4.36%. In Mbuzi, a total of 15 clinging infants were counted in just one of the four groups seen, giving a mean of 3.75 infants per group across all groups (n = 4). The ratio of infants to group size ranged from 0 to 30% with a mean of 7.5%.

Of the 34 groups encountered, 6 (17.6%) were found feeding alongside Sykes' monkeys *Cercopithecus mitis*, the only other diurnal primate in these forests. This represents a basic total rate of association similar to the 19.6% documented in Kibale by T. T. Struhsaker (in Rodgers *et al.* 1984). Figures 2 and 3 show the location of all *P. r. tephrosceles* groups recorded in Mbizi and Mbuzi, respectively. The monkeys rarely moved more than 200 m from a central fixed point in a day, and on many occasions two discrete groups were found 200 to 300 m apart (Table 1; Figs. 2 and 3). In Mbizi, red colobus were mainly concentrated in the southern section, and in Mbuzi the few groups were found in the central south. According to many inhabitants of villages surrounding Mbizi, red colobus are still occasionally hunted. Despite this, however, they were not shy of humans, rarely moving away and usually just continuing to feed.

A variety of human activities were observed in the two forests. Large numbers of sawpits and snares were recorded in both. Mbizi has been heavily degraded in the past by logging, fire, charcoal burning, and hunting. At the moment, these activities seem to have reduced slightly since two forest

guards began patrols in late 2005. However, there was still much evidence of cultivation, with gardens of marijuana, tobacco and garlic inside the forest, as well as tree-felling for firewood collection, and evidence of burning. Mbuzi is being further fragmented by considerable cultivation of beans and wheat, logging for timber and fuel, and fires that burn regularly. Despite heavy hunting pressure in both forests, a few other mammals of interest were recorded. In Mbizi these included red duiker *Cephalophus harveyi*, bush duiker *Sylvicapra grimmia*, large spotted genet *Genetta maculata*, bush pig *Potamochoerus larvatus*, serval *Felis serval*, chequered elephant shrew *Rhynchocyon cirnei*, and in Mbuzi there was evidence of leopard *Panthera pardus*, bushpig and bushbuck *Tragelaphus scriptus*.

Discussion

Whilst an estimate of the population size of red colobus *Procolobus rufomitratus tephrosceles* in 15% of Mbizi has been made (Rodgers *et al.* 1984), this study is the first complete assessment of the distribution, conservation status and abundance of the southernmost population of *P. r. tephrosceles* across Ufipa. The value of red colobus monkeys as indicators of forest condition has been well documented (Struhsaker 2005; Marshall 2007; Marshall *et al*. in press). A number of authors have demonstrated a strong correlation between a decrease in *P. r. tephrosceles* density and group size, with declining habitat quality (Skorupa 1986, 1988; Struhsaker 1975, 1997; Chapman and Chapman 1999; Chapman *et al*.

Table 1. Group identity number (ID), location (Grid reference) in decimal degrees, maximum number of individuals counted (∑) per group and in parentheses the maximum number of infants counted per group (In), and ratio of infants to adults as a percentage (%In), in the Mbizi and Mbuzi Forests.

ID	Grid reference	∑ (In)	% In	ID	Grid reference	∑ (In)	%(In)
	Mbizi						
1	S7.89904 E31.69218	31	0	23	S7.87702 E31.68776	35	0
2	S7.88995 E31.67359	32 (4)	12.9	24	S7.88170 E31.66586	35(1)	2.9
3	S7.88023 E31.67464	38 (5)	13.2	25	S7.88099 E31.68995	49	0
4	S7.88961 E31.68224	30	0	26	S7.88469 E31.67229	56(7)	12.5
5	S7.86249 E31.65258	40	0	27	S7.87575 E31.67677	37	0
6	S7.89356 E31.67520	37 (1)	2.7	28	S7.85347 E31.65170	33	0
7	S7.84841 E31.65325	39 (2)	5.1	29	S7.88993 E31.68959	41	0
8	S7.88213 E31.68091	49 (5)	10.2	30	S7.87654 E31.66232	36(3)	8.3
9	S7.90193 E31.68434	44	0		*Total*	*1217(53)*	
10	S7.89427 E31.67757	42 (2)	4.8		*Mean*	*40.56*	4.36
11	S7.87525 E31.68810	40 (4)	10			(SD=6.57; SE=1.20)	
12	S7.88907 E31.67806	35	0		**Mbuzi**		
13	S7.89173 E31.66530	45 (5)	11.1	31	S7.50955 E31.38645	50 (15)	30
14	S7.90657 E31.68165	47	0	32	S7.51039 E31.38574	40	0
15	S7.89958 E31.67044	34 (7)	20.6	33	S7.51060 E31.38017	23	0
16	S7.88583 E31.65797	46	0	34	S7.50866 E31.37732	24	0
17	S7.88422 E31.66057	40 (2)	5		*Total*	*137 (15)*	
18	S7.87177 E31.65880	48	0		*Mean*	*34.25*	7.5
19	S7.88407 E31.66187	49	0			(SD=13.07;SE=6.54)	
20	S7.88136 E31.67744	50	0		**Ufipa Total**	**1354 (68)**	
21	S7.88125 E31.65471	36	0		**Mean**	**39.82**	**4.73**
22	S7.88688 E31.67228	43 (5)	11.6			**(SD=7.60; SE=1.30)**	

2000, 2006). Gillespie and Chapman (2001) meanwhile, demonstrated a relationship among group size, day range and food availability, but not necessarily between any two variables alone. They showed that red colobus can be food limiting and deplete forest patches.

The status of *P. r. tephrosceles* in Ufipa seems representative of the condition of Ufipa's few remaining forests. Our data have shown that two subpopulations of *P. r. tephrosceles* in Ufipa, those in Misheta and Nsangu forests, are now almost certainly extinct. The discovery of a previously unknown subpopulation in Mbuzi is encouraging. However, it was clear even before the census was carried out that this 'new' subpopulation and its habitat were also at risk of imminent extinction. Rukwa is the furthest administrative region from Dar es Salaam, with limited resources for the environment (Davenport 2002). The fact that so little of Ufipa's natural forests now remain, and that their flagship species is now seriously threatened, is unfortunately understandable.

Many primate census methods have been developed and compared (Struhsaker 1981, 2002; Brockelman and Ali 1987; Plumptre and Cox 2006; Rovero *et al.* 2006). Given the small and highly fragmented nature of both Mbizi and Mbuzi forests, we were able to perform a complete count, thus ensuring a very accurate population estimate. This method relies on locating every group and ensuring that each is unique (Davenport *et al.* in press). The survey protocol we used, however, in small fragmented forests with relatively immobile study animals, give us confidence that most, if not all, currently existing groups (and individuals within them) were located and counted as accurately as possible. Interestingly, Rodgers *et al.* (1984) reported that most groups they observed were shy of humans, with a flight distance of about 65 m. The dense nature of the forest and the fact that the monkeys disappeared into the forest on seeing humans hampered their research. This was not the case during this study, with the monkeys rarely moving away, usually continuing to feed, and thus permitting complete counts to be made with relative ease. We estimated an average flight distance of <30 m.

Our data show that a total of at least 1,354 red colobus survive on the Ufipa Plateau, with 1,217 in Mbizi and 137 in

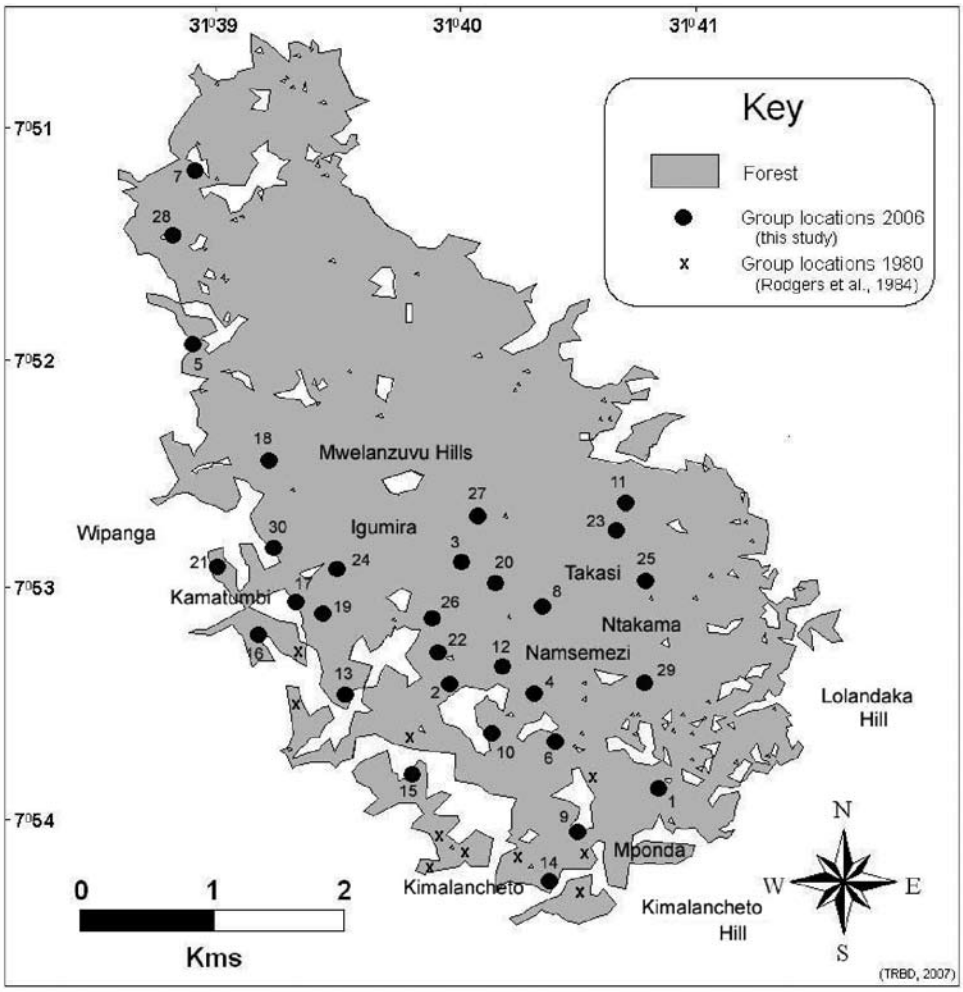

Figure 2. Map of Mbizi Forest showing locations of all groups encountered in this study and in the last study of 15% of the forest 26 years earlier. Group numbers correspond to the data in Table 1.

Mbuzi. These numbers are low, and it must be assumed that this southernmost population of *P. r. tephrosceles* is severely threatened. Mbuzi's total of 137 individuals is far below the long-term minimum effective breeding population (Harcourt 2002), and it is probable that this subpopulation is no longer viable. The mean group size of 34.25 is low and is similar to that of 30 for heavily logged forest in Kibale (Chapman *et al.* 2000). With just four groups remaining and an unmanaged forest being cut down for agriculture, there are few grounds for optimism unless immediate action is taken.

A total of 1,217 animals in Mbizi is more than had been anticipated given the amount of forest degradation observed over the last seven years (Davenport 2005). As no estimate of the total population of Mbizi was made in the previous study in 1980 (Rodgers *et al.* 1984), it is difficult to make categorical statements on population trends. However, some simple comparative analyses are possible, based in part on the map in Figure 2 and the figures in Table 2. Rodgers *et al.* (1984) reported 10 groups with a mean of 25 individuals per group occurring in 15% of 3,000 ha of Mbizi. Figure 2 illustrates the approximate location of the groups they counted, as well as the location of all groups recorded in this current study. It would seem from the map that in 1980 there were more groups in the 15% (known as 'Kimalancheto') than were recorded in 2006. This is corroborated by the group density (Table 2) which was 2.22 groups/km² in 1980, but 1.02 groups/km² in 2006 for the entire forest and 0.75 groups/km² for approximately the same 15% of forest studied in 1980. This represents a 66.2% reduction in group density in Kimalancheto. However, individual density for the same area seems to have remained stable, being 0.018 individuals/km² in 1980 and 0.018 individuals/km² in 2006. The value for the entire forest meanwhile, was little higher at 0.024 individuals/km². The difference between the reduced group density and the stable individual density in Kimalancheto may be explained by the difference in mean group size, which in 1980 was estimated at 25 animals per group, but in 2006 was 41.5 for Kimalancheto, and 40.56 for the entire forest.

Although these data seem to suggest that the total red colobus population is stable in terms of overall numbers of individual monkeys, there are a number of reasons why we believe this may not be the case. Firstly, mean group size (25) in 1980 was an estimate, made because entire groups were difficult to see. It is possible that these were conservative estimates and the real mean group size was larger. Today the forest is relatively easy to walk through, indicative not of a return to a more primary and clear-understorey condition, but because the forest patches have been greatly reduced by charcoal manufacture, fuelwood collection and burning. Secondly, comparisons of areas photographed during the 1980 census (T. T. Struhsaker pers. comm.) with the same areas in 2006 reveal extensive habitat degradation over the last 26 years. With such a marked reduction in forest condition in Kimalancheto, and continued hunting, it is unlikely that the population would have remained stable. Finally, there is a much reduced group density (Table 1) and when coupled with habitat loss and the possibility of group size under-estimates, it is more likely that there has been a reduction in total population size, both in Kimalancheto and Mbizi as a whole. This is, however, conjecture.

The vast majority of *P. r. tephrosceles* groups in Mbizi were located in the south and west of the forest (Fig. 2), with none in the more northeast or near the forest edge in the southeast. Mbizi is made up of small inter-connected forest patches which are generally larger and wetter in the south, and smaller, drier and more degraded in the north and east close to the escarpment overlooking Lake Rukwa. The southwest also has taller trees and is lower in altitude, and thus presumably warmer. The northeast is more remote and less visible from the road to Sumbawanga. It has probably been more extensively hunted as a result. According to local villagers red colobus used to inhabit all portions of the forest, and it is probable that a number of factors, including habitat heterogeneity and vegetation structure (Oates *et al.* 1990; Rovero and Struhsaker 2007) due to forest damage, are influencing this distribution.

Comparisons with data on *P. r. tephrosceles* collected over 28 years in Uganda's Kibale Forest (Chapman *et al.* 2000; Mitani *et al.* 2000; Table 2) further highlight the precarious situation of the Ufipa red colobus. In unlogged portions of Kibale, group density was recorded from 5.46 to 5.5 groups/km². Even heavily logged areas had between 3.08 and 4.43 groups/km², all considerably greater than the 1.02 and 1.53 groups/km² in Mbizi and Mbuzi respectively. Similarly, individual densities in unlogged parts of Kibale of between 1.063 and 0.56 indivs/km², although greatly reduced over 28 years, in part due to predation by chimpanzees, and the densities in heavily logged forest of between 0.567 and 0.292 indivs/km², are all considerably higher than the 0.24 and 0.045 indivs/km² recorded respectively in Mbizi and Mbuzi. Clearly the Ufipa animals now exist at very low individual densities. Interestingly, although the mean group size of 34.25 (n = 4) in Mbuzi is undoubtedly low, the mean group size of 40.56 (n = 30) in Mbizi is more comparable with the Kibale figures of 40 and 41 for unlogged and lightly logged forest. Given the highly disturbed nature of Mbizi (Rodgers *et al.* 1984; Davenport 2002, 2005) and the fact that most colobines have been shown to demonstrate significantly smaller group sizes in heavily disturbed areas (Marshall *et al.* in press), this is perhaps surprising. However, Struhsaker (1975) and Skorupa (1988) recorded average group sizes of 50 and 47 in unlogged and lightly logged parts of Kibale respectively, and it may be that these figures are more representative of the norm, and the Mbizi mean group size does reflect a reduction. Only long-term monitoring will shed more light on this.

A total of 53 clinging infants were observed in Mbizi. This equates to 1.76 infants per group and represents a mean ratio of infants to adults in a group of 4.36%. In Mbuzi, we saw 15 clinging infants, equating to 3.75 per group and a mean ratio of 7.5%. However, all infants in Mbuzi were seen in one large group of 50 individuals. That the majority of groups in Mbizi had no infants is of interest. We are confident that very few, if any, infants were missed and so must seek an alternative explanation. A reduction in food availability has been

Table 2. Group density, individual density and mean group size for the Mbizi and Mbuzi forests, and comparisons with figures for different parts of Kibale in western Uganda, and Mbizi in 1980.

	Kibale 1981 Chapman *et al.* (2000)	Kibale 1997 Chapman *et al.* (2000)	Mbizi 1980 Rodgers *et al.* (1984)	Mbizi 2006 This study	Mbuzi 2006 This study
	Group density (groups/km²)				
Unlogged	5.46	5.5	—	—	—
Lightly logged	5.78	4.35	—	—	—
Heavily logged	3.08	4.43	2.22	1.02 (0.75)	1.53
	Individual density (individuals/km²)				
Unlogged	1.063	0.56	—	—	—
Lightly logged	0.71	0.459	—	—	—
Heavily logged	0.567	0.292	0.018	0.024 (0.18)	0.045
	Group size (mean)				
Unlogged	—	40	—	—	—
Lightly logged	—	41	—	—	—
Heavily logged	—	30	~ 25	40.56 (41.5)	34.25

Figures in parentheses indicate analysis for groups 6, 9, 10, 13, 14, 15 from the same 15% of the forest surveyed in 1980.

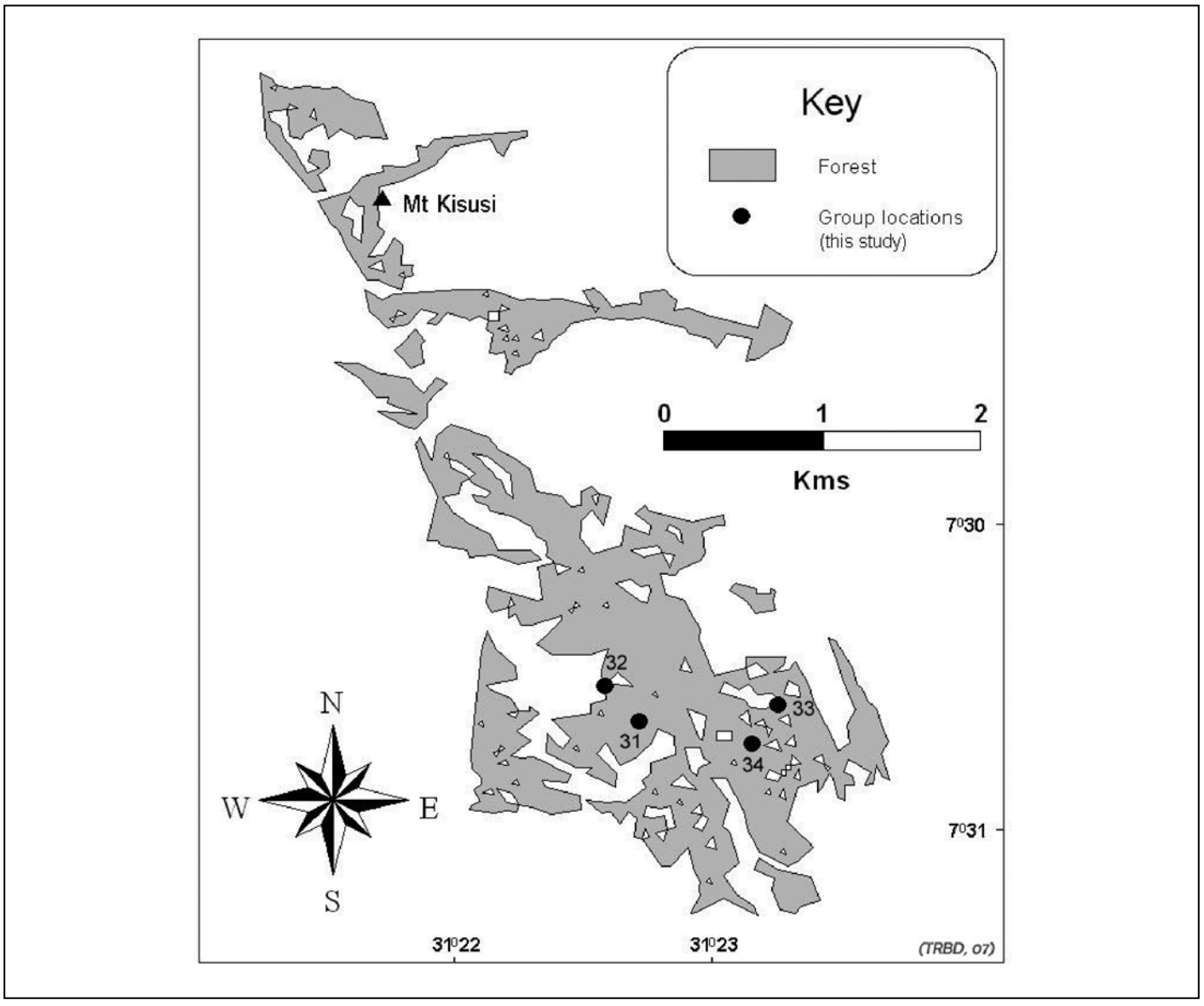

Figure 3. Map of Mbuzi Forest showing locations of all groups encountered in the study. Group numbers correspond to the data in Table 1.

documented to lead to increased infant and juvenile mortality (Chapman *et al.* 2000), and although seasonality cannot be ruled out, it is likely that this reflects a stressed population.

The main human impacts recorded in both Mbizi and Mbuzi were logging, hunting and agricultural encroachment. Hunting of bush pig, bushbuck and red duiker continues, and hunters were observed and snares found in the forest. The fact that all these species still survive in Mbizi is, however, a great surprise given the hunting intensity and forest damage. Two red duiker were seen, and whilst it is assumed that they are *Cephalophus harveyi* further work is planned to confirm this. *Procolobus r. tephrosceles*, meanwhile, is still hunted although it was difficult to know to what extent. We were given a skull and a skin from hunters who claimed that the skin is used for witchcraft. However, it is also hunted for food and the extent of this is the subject of on-going research. Burning and fire, caused mainly by hunters, pastoralists and neighbouring subsistence farmers, and originating from both inside and outside the forest are a major threat to the integrity of both Mbizi and Mbuzi. Mbizi's forest grassland mosaic with exposed ridges and finger-like extensions of forest becomes more rapidly isolated by fire, and therefore more accessible to human disturbance (Rodgers *et al*. 1984; Davenport 2002). The many footpaths and one motorable road that run through the forest also continue to contribute to fragmentation (Davenport 2005).

There needs to be immediate intervention if Mbuzi is not to be lost completely following the recent fate of both the Misheta and Nsangu forests. The forest patch is very small, isolated and has no protected status or management. It is also being rapidly fragmented by the cultivation of beans and wheat, logging, and regular burning. The forest still has value as a water catchment for a number of communities, especially the adjacent villages of Swaila and Majengo, and is also the only source of fuelwood and non-timber forest products for these villages and beyond. Mbizi meanwhile, is the only remaining montane forest of any size in Ufipa, the only source of water for Sumbawanga's growing population, and probably the last refuge for the red colobus in Ufipa. Unsustainable human activities such as clearing for agriculture, hunting, charcoal manufacture, and burning need to be much better managed (Davenport 2002). Red colobus are selective folivores (Gillespie and Chapman 2001), sensitive to habitat degradation, and are very vulnerable to hunting (Struhsaker 1975, 1997, 2005; Waltert *et al.* 2002). Management that protects closed-canopy, old growth forest is essential for the survival of this sensitive forest primate (Marshall 2007). In the case of the last remaining forest patches of Ufipa, such management is also needed for the future of Sumbawanga's vital water resources, and needs to begin immediately.

Acknowledgments

This work was funded by the Wildlife Conservation Society through its Southern Highlands Conservation Programme. Special thanks to Karen and Dan Pritzker and an anonymous donor. Research permission was granted by the Tanzania Wildlife Research Institute, Tanzania Commission for Science and Technology, Tanzania Forestry and Beekeeping Division, and Sumbawanga Municipal Council. Buto Kilasa, Sylvanus Kimiti, Atupele Mwamtobe, Obadia Mwaipungu, Willy Mwalwengele, and Alex Mnakabenga provided valuable field assistance. Thanks to Daniela De Luca, Tom Struhsaker, Kirstin Siex, Francesco Rovero, Andrew Marshall, Guy Picton Phillipps, David Moyer, Tim Caro, Monique Borgerhoff Mulder, and the anonymous referees for advice and/or comments on various drafts of the manuscript.

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Received for publication: April 2007
Revised: September 2007