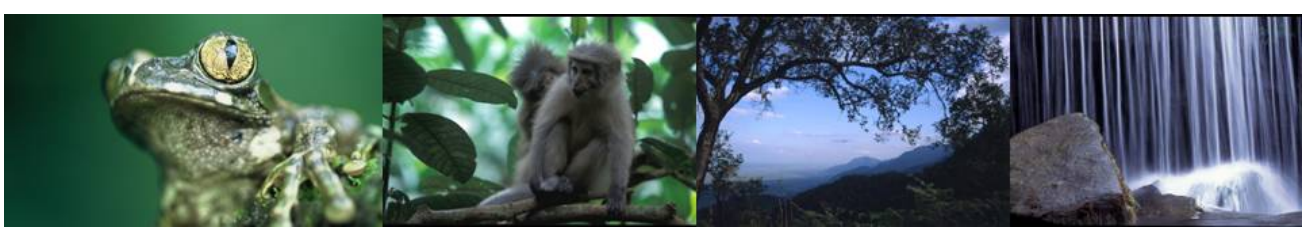
Udzungwa Ecological Monitoring Centre
(Udzungwa Mountains National Park)

Annual Technical Report
Year 3 (January - December 2009)

Museo Tridentino
di Scienze Naturali



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Summary

The Udzungwa Ecological Monitoring Centre (UEMC) is a facility of the Udzungwa Mountains National Park (UMNP) in operation since end of 2006 with the aim of promoting and facilitating biological research and monitoring in order to increase our understanding of the Udzungwa Mountains, and to utilize this information to develop more effective conservation management and community education plans that will improve the long-term conservation of the UMNP and the adjacent Forest Reserves. This is the third year technical report (January - December 2009), and it is aimed at presenting the monitoring data collected and other activities conducted, as well as summarize the short and medium-term plans so that it can also serve as a strategic document.

UEMC continued the primate and duiker monitoring programme in Mwanihana forest (UMNP) and the southern Uzungwa Scarp Forest Reserve, and the relative abundance data collected were compared to previous data collected by researchers since 1998. The latest set of data makes a significant contribute, and results for Mwanihana forest show that while for most species populations have remained stable, a decline may be happening for colobus at some portion of the forest. An other possible exception is declining yellow baboon in Mwanihana is that was already noted in the previous report (2008). Data collected for Harvey's red duiker also show a decline that similarly to that observed for baboons is probably be due to human disturbance. Monitoring in the southern Uzungwa Scarp Forest Reserve confirms dramatically the previous data, i.e. that abundance of the canopy-dependent monkeys and the red duiker is way lower than in Mwanihana because of more severe effects of human impact, with some population now facing local extinction. The report provides updated management and conservation recommendations based on the monitoring results.

In addition to the primate and duiker long-term monitoring programme, during 2009 UEMC continued or initiated the following projects: (1) ranger-based monitoring scheme for large mammals, with a first series of results presented here and constituting a satisfactory baseline upon which plan project continuation. (2) Sanje mangabey demography study, completed through collection of one year of data; results are shown here and are the first attempt to monitor the demography of this elusive and Udzungwa flagship species. (3) The standardized biodiversity monitoring programme which is part of TEAM network initiated in Udzungwa, based at UEMC, and the first year of data collection was completed successfully.

Additional achievements of UEMC in 2009 include: continued and strengthened the environmental education programme; UEMC hosted 9 long-term researchers plus a number of guest researchers visiting for short time, adding up to a total of 80 guests accommodated in the 3 years of operation. The fees for accommodation in 2009 contributed to about 20% of the running costs; the new hostel (dormitory and dining blocks) was completed in 2009 and officially inaugurated in February 2010. The hostel will enhance UEMC's capacity to organize and facilitate training and higher education. This report was compiled by Dr. Francesco Rovero (Trento Museum) in consultation with UEMC technical personnel, and UMNP/TANAPA's Ecological Monitoring Dept., and it was revised by the UEMC Advisory Committee.

1. Background and report aim

The Udzungwa Ecological Monitoring Centre (UEMC) is a facility of the Udzungwa Mountains National Park (UMNP) that was inaugurated on the 10th of November 2006. The establishment of the UEMC was promoted and funded by Trento Museum of Natural Sciences in partnership with Tanzania National Parks (TANAPA). The UEMC has been donated to Tanzania National Parks (TANAPA) with the agreement that Trento Museum will manage the UEMC until 2011.

The aim of the UEMC is to promote and facilitate biological research and monitoring in order to increase our understanding of the Udzungwa Mountains, and to utilize this information to develop more effective conservation management and community education plans that will improve the long-term conservation of the UMNP and the adjacent Forest Reserves. Other than providing accommodation and research resources to visiting scientists, the activities originally planned include delivering technical advice to TANAPA (especially UMNP's Ecology Department), the Forestry Division, implementing monitoring programmes, organizing courses for rangers, scouts, park ecologists and university students, promoting school education programmes for school children, and networking with other biological field stations in the tropics and organizations supporting monitoring centres.

This is the third year technical report, and it is aimed at presenting the monitoring data collected and other activities, as well as summarizes the updated short and medium-term plans so that it can also serve as a strategic document. The report is prepared by Trento Museum in collaboration with UEMC technical personnel and UMNP/TANAPA's Ecological Monitoring Dept., and it is revised by the Advisory Committee. Previous reports can be found in the UEMC website (UEMC 2008, UEMC 2009).

1.1. Summary of UEMC set-up, personnel and financing

Whilst this is **neither a management nor a financial report,** the following information are summarized to complete the background to the UEMC functioning. Currently, the UEMC consists of 6 buildings: one includes an office, store and large seminar room and next to it are three researchers' houses, each with two double rooms. The structure was expanded in 2009 with a newly made hostel (officially opened in February 2010) consisting of a dormitory block (four rooms each with three double-deck beds) and of a dining hall, with kitchen and two stores. This new structure is dedicated to enhancing training capacity.

The staff working at UEMC, in addition to Trento Museum's institutional representative (Dr. Rovero), includes: UEMC coordinator (Arafat Mtui), the logistic and environmental education officer (Baraka De Graaf), a school education officer (Skola Mwasenga), two field assistants, one gardener, 2 house-keepers, and four watchmen. In view of running the hostel, UEMC recruited two more watchmen and one more gardener towards the end of 2009. In addition, UEMC hosts the TEAM project that begun in mid-2009, and is run by a staff of 4 people, including a site manager, 2 field technicians and a driver.

2. Summary of activities planned and activities implemented

This section provides and overview of activities implemented until the end of 2009 against those that were originally planned, with details for each component - including ecological monitoring data - being presented in following sections. It also compare these with the recommendations provided by the 40 participants that attended an informal discussion on the inauguration day in November 2006 that was aimed at gathering suggestions on ecological monitoring strategies and activity planning.

1. *Provide advisory and technical assistance to the UMNP/Ecology Department on all issues related to ecological monitoring.*

The report contains recommendations from the updated analysis of primate and duiker monitoring data. Provision of technical advisory to UMNP Ecology Dept. The key activity in this context has been the collection of the first set of data by park-wide, ranger-based monitoring of large mammals.

2. *Implement ecological monitoring protocols in conjunction with the Ecology Department in the UMNP and with the Forestry Division in the Forest Reserves.*

UEMC continued the primate monitoring programme both in Mwanihana (UMNP) and Uzungwa Scarp Forest Reserve, thus raising data for both TANAPA and Forestry Division. All data collected by TEAM project in Mwanihana forest within UMNP since 2009 are also readily available.

3. *Facilitate visiting researchers and conservation agencies through providing accommodation, information, research facilities (Internet, computers, etc.).*

In 2009 UEMC hosted 9 long-term researchers plus a number of guest researchers visiting for short time, adding up to a total of 80 guests accommodated in the 3 years of operation. The fees for accommodation in 2009 contributed to about 20% of the running costs. Other resources provided remained unvaried, except for the establishment of a GIS-database (see below).

4. *Organize training courses in ecological monitoring to rangers, park ecologists and students.*

The ranger-based monitoring programme is on-going (details below), and involved additional training on use of GPS and GIS capacity done in conjunction with the establishment of the GIS database. The new hostel will allow to begin in 2010 additional training courses.

5. *Organize education activities for school children.*

This programme continued and consolidated in 2009 with the 5 primary schools that were already involved since 2007. Activities ranged from lessons in class and visits to the park (and also to Mikumi National Park) to special events such as cinema nights and the celebration of the World Environmental Day (June 5th) that was held at Mang'ula village.

6. *Establish a database on Udzungwa biodiversity.*

In July 2009, with help from Trevor Jones and Nick McWilliam (East Anglia University, UK) the Udzungwa GIS database was established on a dedicated computer based at the office, and available for use by any researcher. The database is designed (a) as a tool to aid research and conservation work and (b) as an on-going facility to be developed in a participatory way. It is available to all users in the spirit of open scientific and management collaborations. Details on the database structure and access are available at the UEMC website (http://www.udzungwacentre.org/mrd.asp?code=22).

7. *Promote external collaborations and networking with other monitoring programmes, ecological centres and field stations in the tropics.*

The key contribute to this objective is the initiation of the new ecological monitoring project through the TEAM (Tropical Ecology, Assessment and Monitoring) network. Although based at UEMC, this project is run independently from UEMC routine activities. However, given the great relevance to UEMC activities and biodiversity assessment in UMNP, the report will provide a summary of data collected during the first year of monitoring.

3. Inaugural stakeholders' workshop: follow-up in years 1-3

1. Existing primate monitoring protocols in UMNP; the importance of continuing existing practice was emphasized.

2. Ranger-based monitoring protocols and training needed; highly recommended component that can be linked to village monitoring teams, there is a need to disseminate a standardized monitoring protocol to all stakeholders.

Both recommendations have been consolidated. Standardization of monitoring protocols extended to other forest National Parks/Forest Reserve remains an important objective. The new hostel could now facilitate workshops towards this goal, however funding remained a constraint.

3. How to implement monitoring in Forest Reserves; it was noted that there is very limited personnel and resources by the Forestry Division to implement monitoring, however, training is fundamental and community scouts should be involved.

UEMC continued with monitoring primates and ungulates in USFR, and the updated results presented here, indicating dramatic declines in population abundance show the importance of this effort. Plans are to present the results widely to FBD and other stakeholders in mid-2010, and this will hopefully trigger coordinated action towards more patrolling and participatory monitoring.

4. Impact of firewood collection on biodiversity (and more generally, habitat disturbance monitoring), how to continue previous work and start long-term monitoring program; the need for WWF and Park Ecologist involvement was recommended to repeat the protocols initiated.

UEMC conducted in mid-2008 the study on the impact of firewood collection funded by WWF. No more work has been conducted on this during 2009, while the repetition of the study during 2010 is currently being planned.

5. Sanje mangabey long-term monitoring; the UMNP's Ecology Department has been conducting an habituation program with one group since 2002 and this is on-going.

Th study initiated in mid-2008 on demography monitoring of Sanje mangabeys was conducted until mid-2009 with 4 repeated counts of a number of groups. The results are presented in this report.

6. Standardizing protocols according to Hotspot-wide monitoring initiative; the importance of TANAPA implementing a centralised data-base of monitoring data was recognized.

This links to the objective 2 (above) and the need for networking with similar parks in the country. In July 2009 a meeting was held between F. Rovero, I. Lejora (TANAPA) and J. Keyyu (TAWIRI) to discuss possible avenues for nation-wide training in ecological monitoring. It was discussed the current lack of standardized procedures in forest parks and the possibility to use UEMC to fill this gap once the hostel will be ready. At present, lack of funds has prevented this plan from being implemented.

7. General UEMC management issues, plans and funding; the recommendations included: need for networking with several NGOs working in the area, approach Tropical Biology Association (TBA) for training schemes, creating a web-site and other advertisement material.

Most of this was accomplished since year 1. Initiation of training programmes such as TBA will initiate in 2010 given the availability of the new hostel.

4. Ecological monitoring results: primate and forest antelope monitoring

4.1. Primate monitoring in Mwanihana forest

UEMC adopted the Primate Monitoring Programme established in 1997 in Mwanihana forest, and transects details are reported below (Table 1, see also Rovero et al. 2006). Transects are repeated every two weeks by one observer that walks slowly (1 km per hour) and records all sightings of primate groups, together with its position, distance to each group, number of individuals (when possible) and observer's position along the transect.

Table 1. Characteristics of four transects used for primate censuses in Mwanihana Forest, Udzungwa Mountains National Park, Tanzania

Transect	Length of transect (km)	Altitude (m a.s.l.)	Gross forest type and portion along the line (km)
T1 (Camp Site 3)	4.0	350 - 800	Deciduous (0.8 km), semi-deciduous (0.6 km), open area (0.4 km), evergreen (2.2 km).
T2 (Mwanihana Trail)	4.0	320 - 590	Deciduous (1.4 km), semi-deciduous (0.4 km), evergreen (2.2 km).
T3 (Sanje Falls)	3.7	330 - 700	Mixed deciduous and semi-deciduous (0.8 km), evergreen (2.9 km).

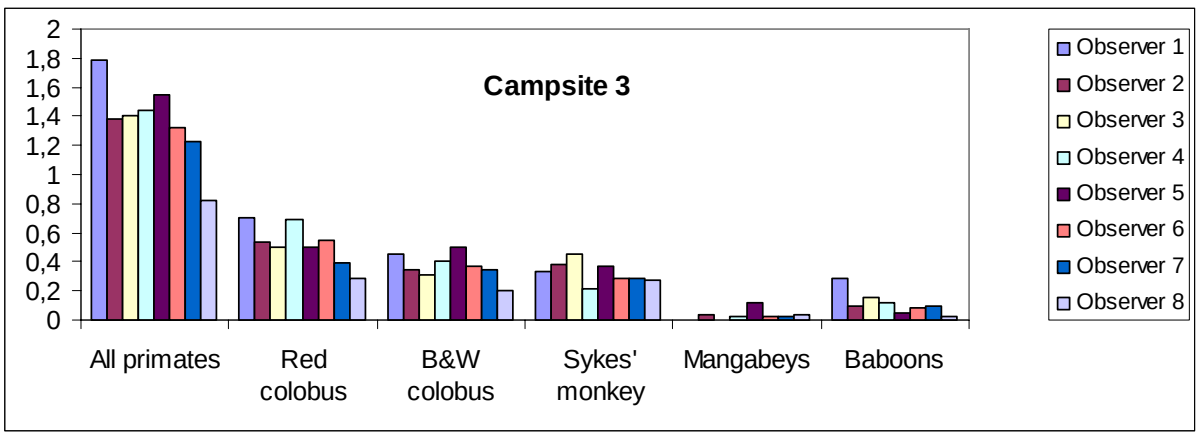
T4 (Msolwa)	4.0	330 - 600	Mixed deciduous and semi-deciduous (1 km), evergreen (3 km).

The updated list of data collectors over the years is presented below (Table 2). The series presented in previous report is updated with the consistent data-set (n=83 census walks) collected by Arafat Mtui (Obsever 8). This ensures consistency with data collected earlier by Mtui during 2003-2004 (Observer 5 and 6).

Table 2. Number of primate censuses conducted by each observer in Mwanihana Forest, Udzungwa Mountains National Park, Tanzania

N°	Observer	Period	Transect			
			C3	MW	SJ	MSO
1	UBP	August - October 1998	6	6	8	6
2	CAS	October 1999 - February 2000	15	15	14	11
3	ARM	May - September 2001	5	5	6	-
4	FR	July 2002 - January 2003	13	14	14	-
5	ASM1	February-August 2003	14	14	13	-
6	ASM2	February-December 2004	20	20	19	-
7	AK (UEMC)	April 2007-August 2008	20	19	20	13
9	ASM3 (UEMC)	December 2008-October 2009	21	21	21	20
	All observers		114	114	115	50

The results of primate group sightings are summarized as the mean encounter rate with primate groups (groups seen per km of transect walked) and are reported in the following graphs (Figure 2) for all observers since 1998 and for each transect.



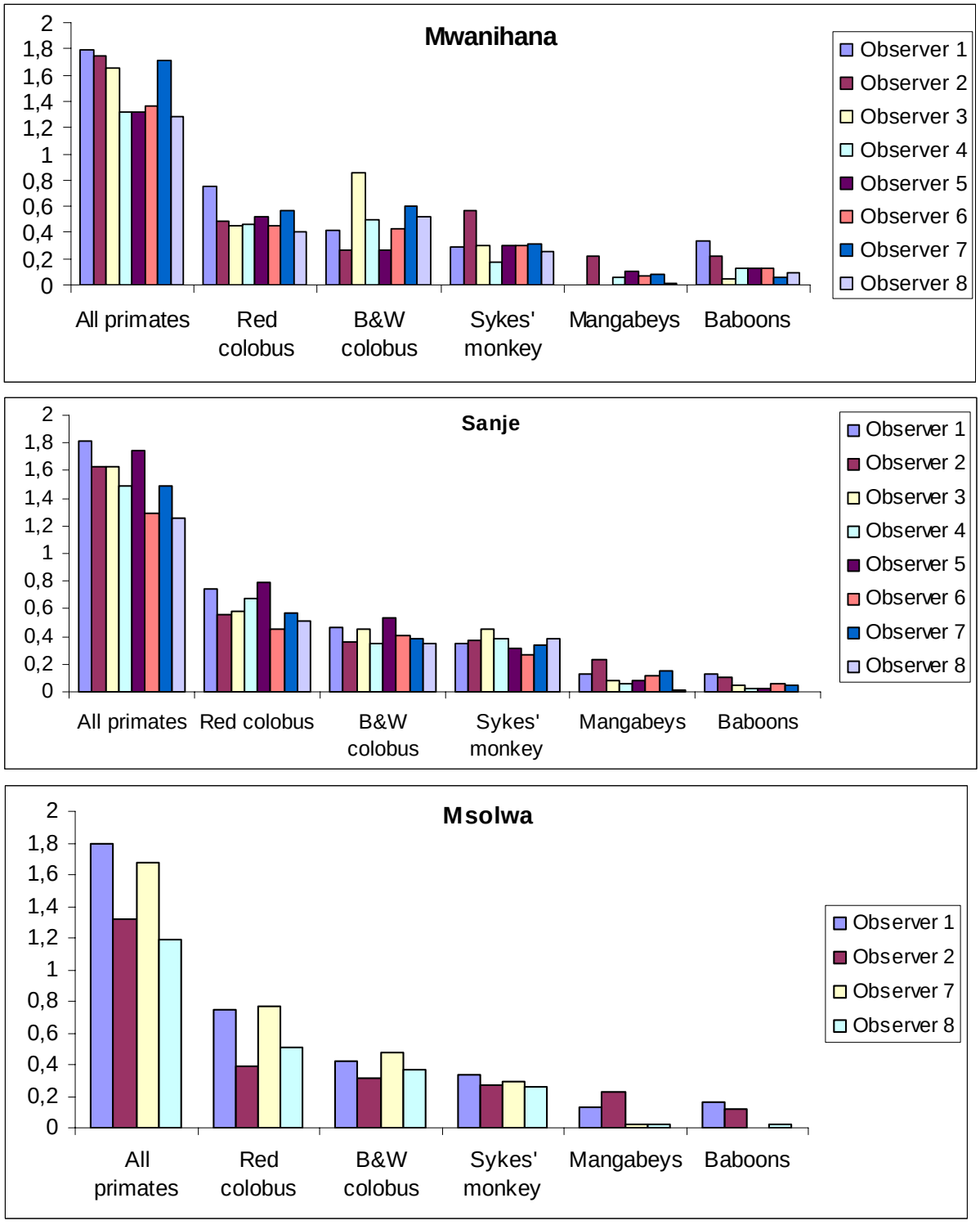


Figure 2. Results of primate monitoring expressed as the mean number of primate groups seen per km of transects for all four transects from 1998 until 2009 (the last 3 sets of data being collected by UEMC). Data for the fourth transects (Msolwa) were collected by only three observers.

The differences in abundance between species and between transects (related to the different proportions of forest habitat represented) have been discussed in

previous reports and elsewhere (Rovero et al. 2006). Of focal attention here is the temporal variation within species and transects.

The inclusion of the latest data-set collected in 2009 is critical and indicates some clear differences, as follows:

1. At campsite 3 it appears an overall decline for all primates that seems determined by the two colobus and baboons.
2. A decrease in both baboons and mangabeys emerges for Mwanihana transect.
3. At Msolwa, where census work done in 1998-2000 was resumed in 2008, the relative abundance of mangabeys and baboons seem also to have decreased.

These results are solid exceptions to the pattern emerged from previous data, i.e. that the differences between results from different observers (and thus between periods of time) do not reflect an obvious temporal trends but, rather, inconsistencies in data collection abilities or natural fluctuations due to ranging patterns of the primates in relation to the census transect.

To simplify the analysis (and following Rovero and Mtui 2006), data from the four transects were lumped across transects and statistical tests (one-way Analysis of Variance followed by Bonferroni post-hoc comparisons run using SPSS package) were run on this lumped distribution (Figure 3). This lumping is justified by the fact that all three transects traverse a similar range in variation of gross habitat types, from deciduous/semi-deciduous to semi-evergreen and evergreen forest, and comparable altitudes, all starting at the base of the forest (300 m asl) and reaching altitudes between 600 and 1000 m. Up to 2008, the lumping did not include Msolwa transect, however with the growing data-set this transect is now included.

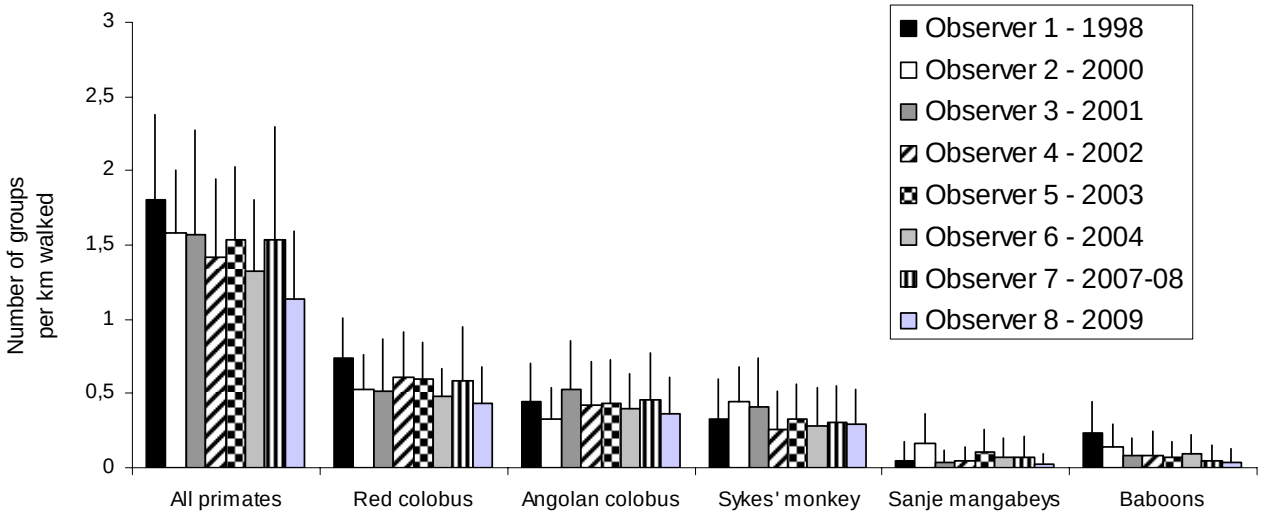


Figure 3. Results (mean number of primate groups seen per km and standard deviation) of primate census pooled for 3 transects from data collected from 1998 until 2009 (the last 3 sets of data being collected by UEMC)

Differences among observers in primate's encounter rate were significant for all specie except the Angolan colobus (Table 3). Bonferroni's post-hoc multiple comparisons help assessing if these differences reveal meaningful, temporal trends or not. In comparison to the analysis of previous years, the inclusion of the latest set of data determines a greater number of statistical differences between pairs of observers. These Statistical results are summarized in Table 3.

Table 3. Results of ANOVA and post-hoc comparisons on primate census results obtained by different observers

Species	F (df = 7,380)	P (differences between observers)	Post-hoc significant at P<0.05
All primates	5.916	**<0.01**	Ob 1 vs Ob 6,8; Ob 8 vs Ob 5, 7
Red colobus	4.563	**<0.01**	Ob 1 vs Ob 5,8; Ob 8 vs Ob 4,5,7
Angolan colobus	1.915	0.066	None significant
Sykes' monkey	2.527	=0.015	Ob 2 vs Ob 4, 6,8
Mangabeys	5.495	**<0.01**	Ob 2 vs Ob 3,4,6,7,8
Baboons	8.359	**<0.01**	Ob 1 vs all but Ob 2; Ob 2 vs 7,8;

The trend that emerges for all primates shows a *drop* in 2009 (rather than a progressive decline) in relative abundance that is mainly due to an apparent decline in red colobus, mangabeys and baboons. The fact that is a drop rather than a decline is evident from the paired comparison, with Observer 8 being different from most of previous sets. This same pattern of differences indeed applies to the red colobus. Whether this result reveals a true, consolidated decrease will need additional data to be assessed, and therefore caution is needed before taking misleading conclusions.

However, the pattern observed for campsite 3 for both colobus over the years does appear as a *true decline*. Anecdotic instances of poaching with armed guns have been collected in latest years by various researchers working in the area. Campsite 3 is also crossing the area of forest used by the large settlement of Mwaya; there are also rumours that hunters from Kiberege village (10 km south along the park edge) can easily access the highest part of the forest for setting snares and hunt with guns. Such disturbance may have increased colobus' shyness and/or force them to move to other parts of the forest, thus resulting less detected from the transect.

Similarly complex is to comment about the apparent decline in mangabeys and baboons. These species are not easily detected from transects, being terrestrial and – for the baboon – only found in the lower, miombo portion of most transects. The shyness of mangabeys, in addition, makes them especially elusive from transect lines. Nevertheless, the possible decline in baboons fits with earlier evidence. The miombo forest where they occur is also the most and increasingly frequented by firewood collectors, who might also have a negative impact on the detection of baboons by increasing their shyness. It is also possible that more snare trapping occurs in the miombo because of its proximity to roads and villages. If this is occurring, baboons would be particularly vulnerable because of their terrestrial habits. All of these possibilities still require additional data to be investigated appropriately.

The inclusion in the statistical analysis of data from Msolwa transect may confirm the firm decline that baboons faced in this area, as no baboons were recorded by Observer 7 and very few by Observer 8 (2007-2009) along this transect. Msolwa is the northern-most portion of Mwanihana forest, possibly the least patrolled, and the area where illegal encroachment by Wahehe hunters living in the area has been reported (F. Rovero and collaborators, unpubl.). This is also an area where occasional evidences of poaching are collected by researchers and rangers. For example, a freshly-used hunter camp with dry skins of Abbott's duiker was found along the Gologolo slopes, at about 1500 m asl., by the staff working for TEAM project in September 2009 (F. Rovero pers. comm.). Despite the extensive work conducted throughout the forest, equivalent evidences of poaching have not been found in central portion of the forest (Mwanihana-Sanje area). This may explain why the more significant changes are found at campsite 3 and Msolwa transects.

Interpreting the results for Sanje mangabey remains difficult, and while we maintain the importance of recording this species during transects, the ad-hoc demography monitoring conducted in 2008-2009 may also help assessing trends. It is however a much more difficult and resource-consuming method (see below).

4.2. Primate monitoring in Uzungwa Scarp Forest Reserve

The same line-transect technique used for censusing primates in Mwanihana was also used in the Uzungwa Scarp Forest Reserve (USFR) beginning in 2004 by F.R.; 23 repetitions in each of three transects were obtained during 2004-2005 by F.R. and others (mainly Arafat Mtui). UEMC continued this protocol: 10-14 repetitions were obtained during 2007-2008, and 7-9 repetitions in 2009 (Table 4)

Monitoring was generally constrained by the remote location of USFR against the available budget and manpower. Moreover, census in the JKT transect, which is inside an area of the Forest Reserve managed by military station, had to be discontinued due to problems and delays to obtain permits, and a new transect (called TAZARA) was initiated. The high-elevation, Kitolomero transect was also discontinued from 2007 because it needed camping and too much costs.

Table 4. Results of ANOVA and post-hoc comparisons on primate census results obtained by different observers in USFR

			Transect					
N°	Observer	Period	Ikule	Mkaraji	JKT	Kitol	Tazara	All
1	FR+ASM	July 2004 - June 2005	23	21	22	20	na	86
2	AMANI	January 2007 - June 2008	14	14	10	na	na	38
3	ASM	January-September 2009	9	9	na	na	7	25
All			46	44	32	20	7	149

Results for each transect, and for all transects combined are presented in the following charts (Figure 4-5). For all transects, the declining trend that emerged with the previous 2 data-sets is confirmed, and for the two colobus and the baboons the decline is dramatic, (statistical results in Table 5). In contrast with the preliminary trend emerged in the 2008 report, the last data-set confirms that heavy poaching and habitat disturbance is threatening the colobus to alarming states. Given the seriousness of these results, a special report that combines data with other researchers was recently compiled (Rovero et al. 2010) and the reader is referred there for further details.

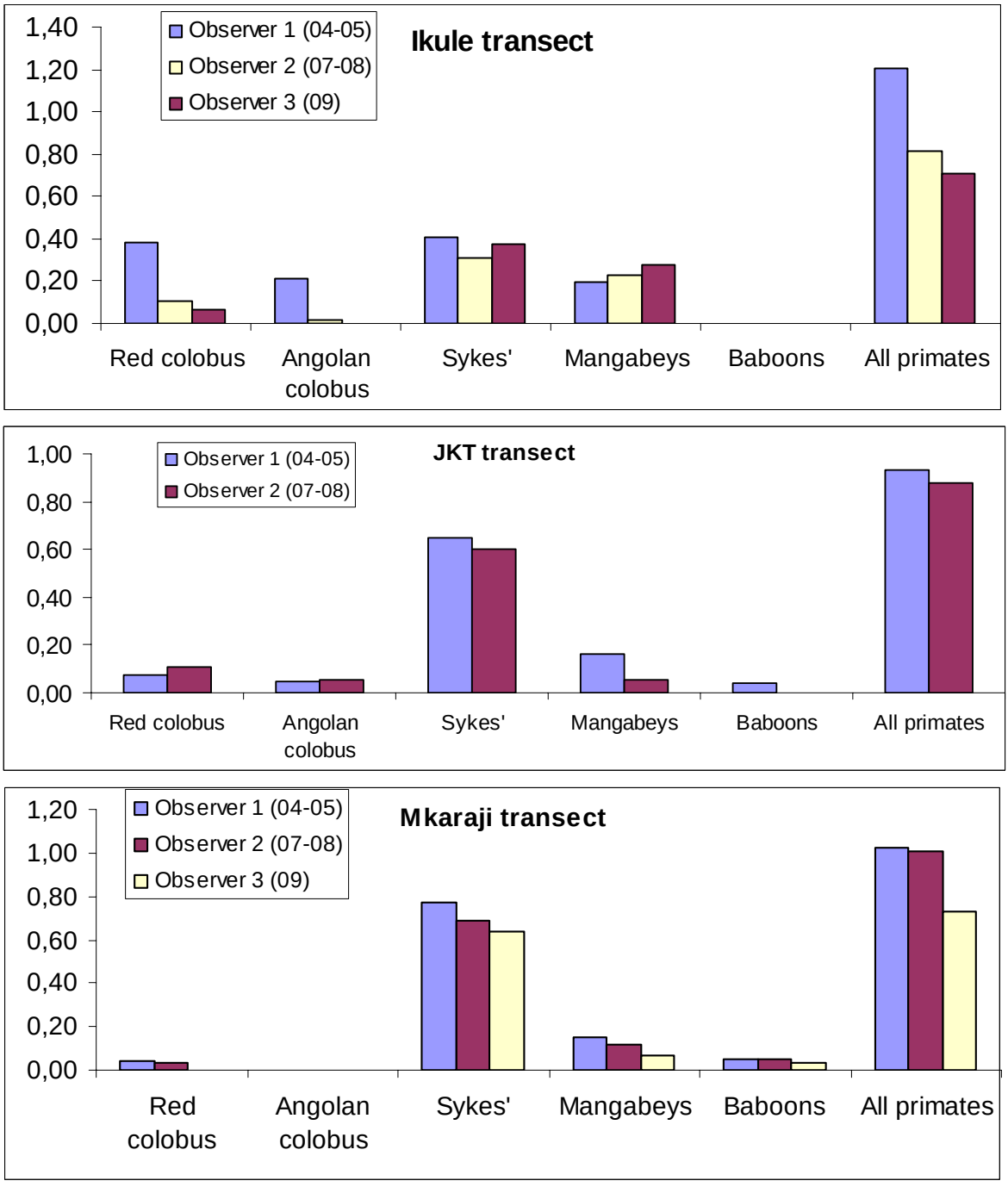


Figure 4. Primate census results obtained in USFR by three observers: results for each of three transects

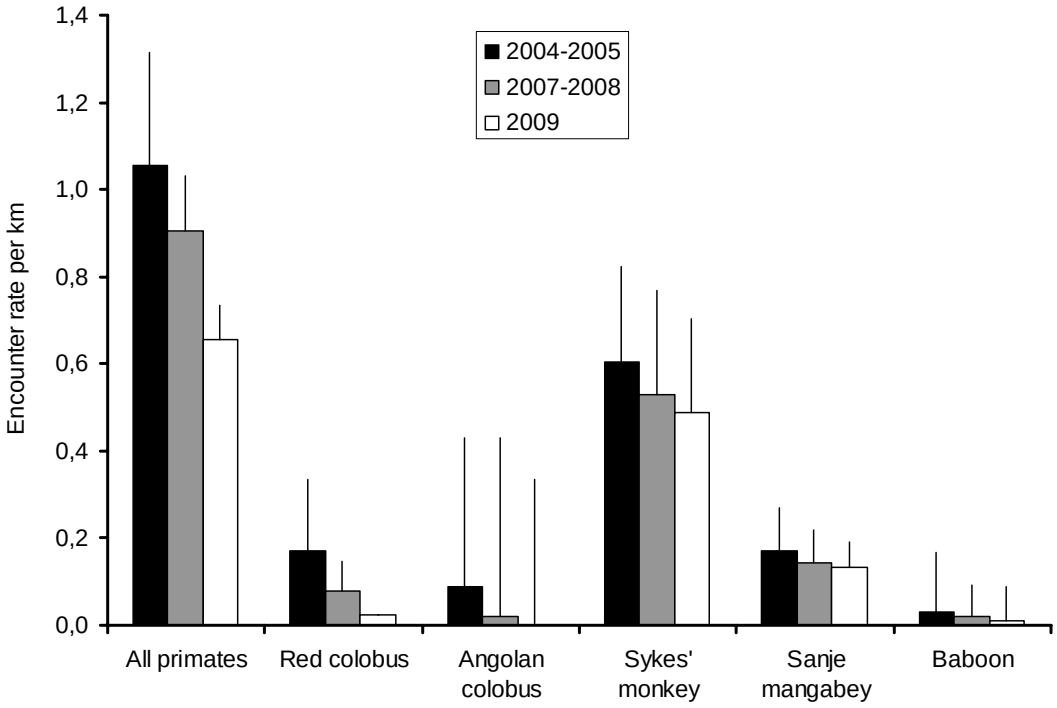


Figure 5. Primate census results in USFR: pooled transects

Table 5. Results of ANOVA on primate census results (all transects pooled) obtained by 3 observers in USFR

Species	F (df = 2,131)	P (differences between observers)
All primates	4.29	**<0.02**
Red colobus	6.10	**<0.01**
Angolan colobus	6.94	**<0.01**
Sykes' monkey	1.16	=0.32
Mangabeys	0.31	=0.73
Baboons	0.45	=0.64

4.3. Harvey's duiker monitoring in Mwanihana forest

Along with primate census, all sightings of duikers were also scored beginning from transects conducted in 2002. The Harvey's (red) duiker *Cephalophus harveyi* is the only forest antelope species that is sighted in the day and frequently enough to be monitored through line-transects. Other species such as suni, blue duiker, and Abbott's duiker are either very rare or crepuscular/nocturnal, and we found that others techniques are best suited for their monitoring, such dung counts and camera-trapping. Whilst these techniques are either more challenging methodologically or more costly, data on the Harvey's duiker alone seems very useful for monitoring and management purposes since this is the most common antelope, it is snared by hunters even in the National Park (UEMC, unpublished

data) and thus together with being an indicator of human disturbance it represents an indicator of forest floor ecosystem health, being likely affected by firewood collection.

Updated results from the report of year 1 are shown in Figure 5 for Observer 1 (F. Rovero: 2002-2003), Observer 2 (A. Mtui: 2004), Observer 3 (A. Kitegile and A. Mtui - UEMC: 2007-2008) and Observer 4 (A. Mtui: 2009) for a total of 73 repetitions per transect line. Statistical tests reported in Table 6 confirm the trend highlighted in the 2008 report, i.e. that the differences between observers are significant only for Campsite 3. Differences between observers when all transects are pooled are marginally non-significant (P=0.07) and it overall appears a declining trend from 2002 to 2009 that was already noted in the previous report.

Table 6. ANOVA results of inter-observer differences in Harvey's duiker census results

Species	F (df = 3,71)	P (differences between observers)
Campsite 3	4.21	**<0.01**
Mwanihana	0.93	=0.43
Sanje	1.02	=0.39
All transects	2.38	=0.07

As observed with primates, and even more so for the often rapid fleeting duikers (making their detection quite difficult), inter-observer differences may play a big role here, however this trend is to be taken very seriously as it might indicate that snaring of duikers or other disturbance possibly associated with firewood collection might have negatively impacted this species. That Observer 3 and 4 saw duikers less frequently at Campsite 3 than Mwanihana and Sanje relative to the other observers might indicate the possible higher snaring activity occurring here, also speculated to interpret the decline in the colobus. Similarly low frequency of sightings than recorded at Campsite 3 was scored by Observer 4 at Msolwa (0.06 duiker per km walked), where instances of poaching were also occasionally recorded.

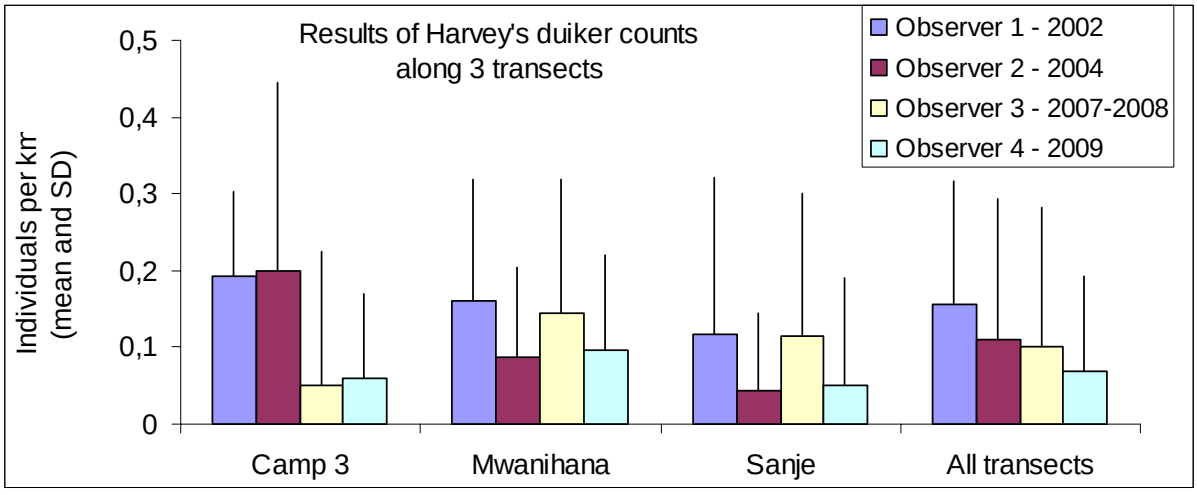


Figure 6. Results of Harvey's duiker census (individual encounters per km walked) by 3 observers along three transects in Mwanihana forest.

4.4. Harvey's duiker monitoring in USFR

Although sightings of Harvey's duiker in USFR are very occasional, the available data-set reinforces the one presented earlier and confirms the low, and probably declining abundance of this antelope (Figure 7). This is particularly dramatic for the most degraded transect, Mkaraji, that run just above Ikule village, as duikers *were never seen* during the last 2 series of census. The trend therefore highlights a more clear decline than in Mwanihana, and differences, that in the 2008 report were marginally non-significant are now statistically significant (pooled transects: $F_{2,124}=4.01$, $P<0.03$).

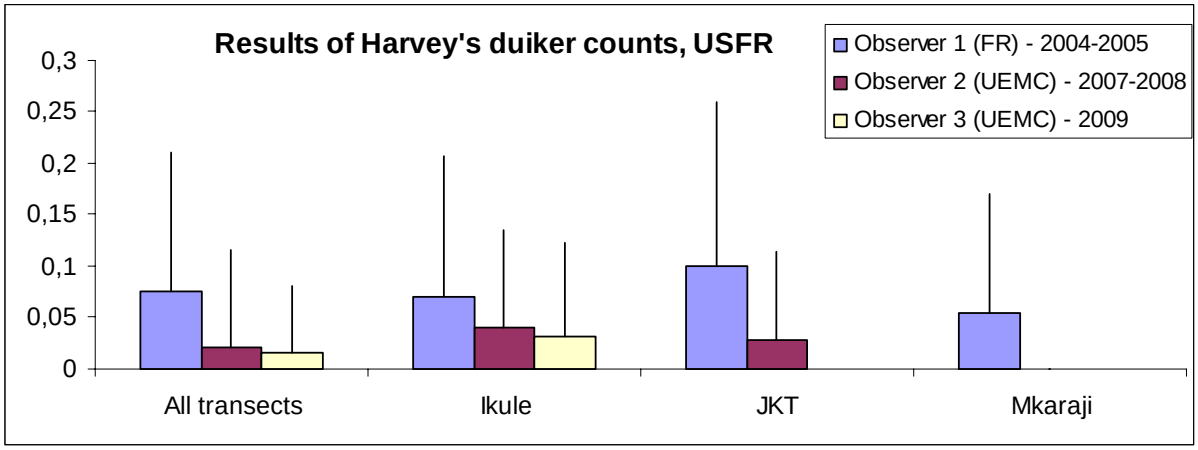


Figure 7. Results of Harvey's duiker census (individual encounters per km walked) by 2 observers along three transects in Uzungwa Scarp Forest Reserve.

As reported earlier and elaborated in Rovero et al. (2010), hunting in USFR is severe and has increased dramatically in recent years.

4.5. Management and conservation implications from primate and duiker monitoring

The updated set of data obtained since last report is consistent and re-enforces the conclusions reached before relevant to both park management and future monitoring efforts:

1) In Mwanihana forest within UMNP, overall results of primate monitoring suggest that the relative abundance of most species is stable, however there may be a decline at campsite 3 (southern part of the forest) that needs to be verified with future data. The possible decline of baboons at most transects suggested earlier is confirmed

from the last data-set. The updated results for Sanje mangabeys do not still highlight a meaningful trend.

2) Inter-observer differences in data collection remains a big issue when interpreting trends, and the only solution is to ensure that the same one or two observers continue the monitoring in the longer run. With the programme run by UEMC, this should be more easily ensured than before.
3) Baboon is the only species for which there appear to be a declining trend with time, which might be due to human disturbance given the conflict between people and baboons. This should be verified with more data and more analysis and raise the need for more patrol at the park edge as well as ad-hoc public awareness initiatives.
4) Harvey's duiker monitoring has confirmed the possible, serious decline for this duiker at Campsite 3. As this fits with the results for primates, this area, together with Msolwa, should be taken into account when planning additional patrolling efforts.

5) For Uzungwa Scarp Forest Reserve, the continued monitoring has revealed the dramatic situation of under-protection of this forest, with marked differences with Mwanihana in the abundance of the canopy-dependent colobus and the red duiker. Declines in the abundance of these species during the period they were monitored are not surprising given the severe encroachment recorded. Unless full protection is given to this forest as a matter of urgency, these species are bound to decline and some populations may already be in the verge of local extinction. The comparison between the two forests indicates once again that UMNP has conducted efficient law-enforcement in Mwanihana forest despite the greater density of adjacent human population.

5. Monitoring of Sanje mangabeys

This programme aimed at collecting demography data of Sanje mangabey. It was conducted by a team of field assistants led by Richard Laizzer and supervised by the park Ecologist/UEMC and Trevor Jones. The initial plan of conducting 4 counts per year was achieved, and a total of 6 groups could be counted adequately. The four counts were conducted in September 2008, December 2008, March 2009 and June 2009.

Thirty-six counts of 8 different groups obtained altogether during the 4 sessions resulted in 19 good counts of 6 groups during each session (Figure 8). A "good count" is defined when at least 90% of the animals in the group were thought to be counted. In few occasions, the totality of animals was counted. Following the first session aimed at locating best groups for counts, the team focussed on the 3 groups at Njokamone (above the park HQs - where the habituated group for tourist viewing is found), two groups at Sanje and one group at Msolwa. The total group count ranges are: 55-62 animals (Njokamone 1), 49-52 (Msolwa), 38-41 (Sanje 1), 44-50 (Sanje 2), 36-38 (Njokamone 2), 41-44 (Nkokamone 3). The chart in Figure 8 shows the key demography results including ratios of infants to adult females (that indicates natality) and of juveniles to adult females (that indicates recruitment).

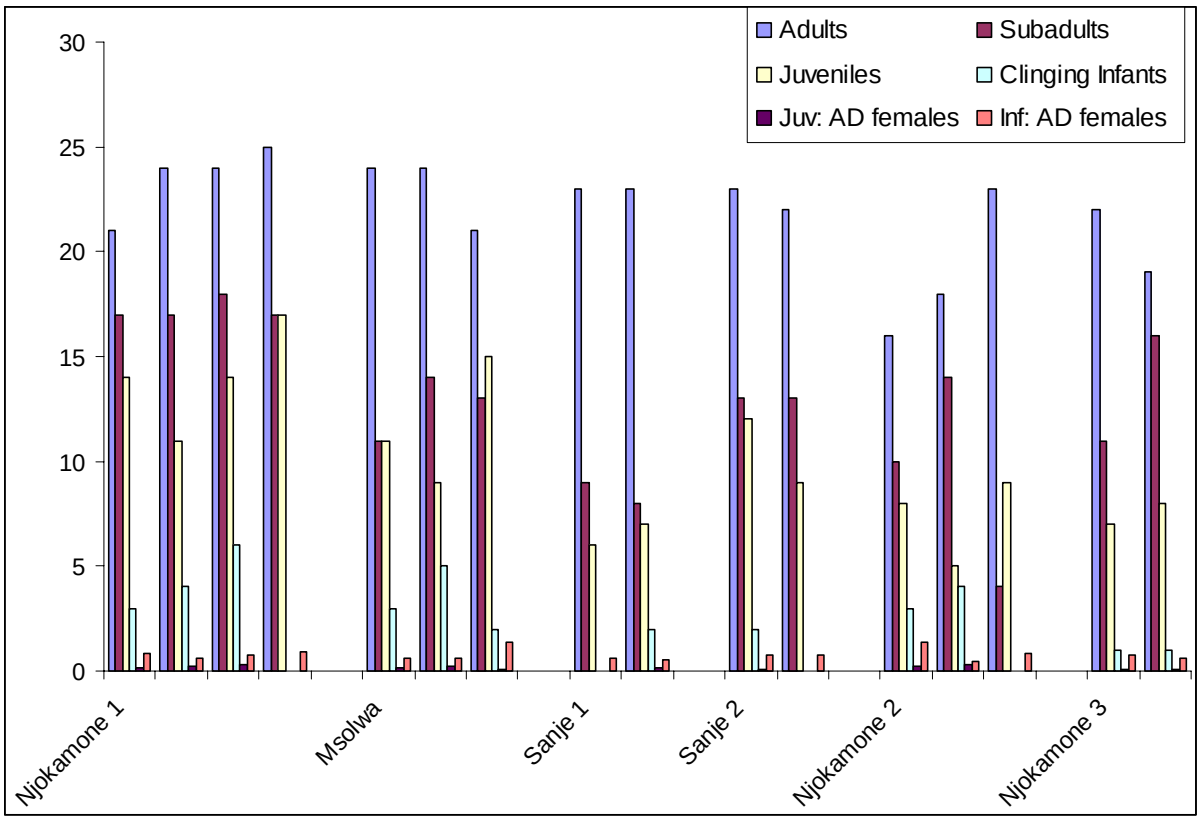


Figure 8. Preliminary results of Sanje magabey demography monitoring in Mwanihana forest obtained through 4 counts. The name of the group (location) is on the X-axis. Data are by UEMC and T. Jones.

Thanks to the long-term experience of Richard Laizzer, who worked on this species as an assistant of Trevor Jones since 2002, the programme worked really well despite the shyness of the mangabeys. The results are interesting in that the abundance of age classes are consistent with time, despite the impossibility of being 100% sure when a total count is done. Deciphering count bias from true changes remains a problem and will need additional data to be assessed better.

6. Ranger-based monitoring of large mammals in UMNP

This programme begun in 2008 with transect establishment and training of rangers. As shown in the map in Figure 9, two transects for censusing large mammals, 6 km in length and marked with aluminium tag every 100 m, were established from each of the following ranger posts: Lumemo (SE), Ruipa (SW), Udekwa (W), Mbatwa (N) and Kidatu (NE). Transects sample a variety of habitat types, from lowland deciduous and semi-deciduous forest (Ruipa and Lumemo) to woodland (Kidatu), wooded grassland, moist and dry forest (Udekwa and Mbatwa). In parallel with transect establishment, the project team (two field assistants from UEMC and UMNP) trained rangers to walk transects and record data using a standard form (Figure 10). Presentation of the programme and theoretical training was conducted through two seminars for 35 rangers (of the 40 currently stationed at UMNP) given at UEMC in January 2009. Topics included importance of monitoring, data recording and analysis, use of GPS.

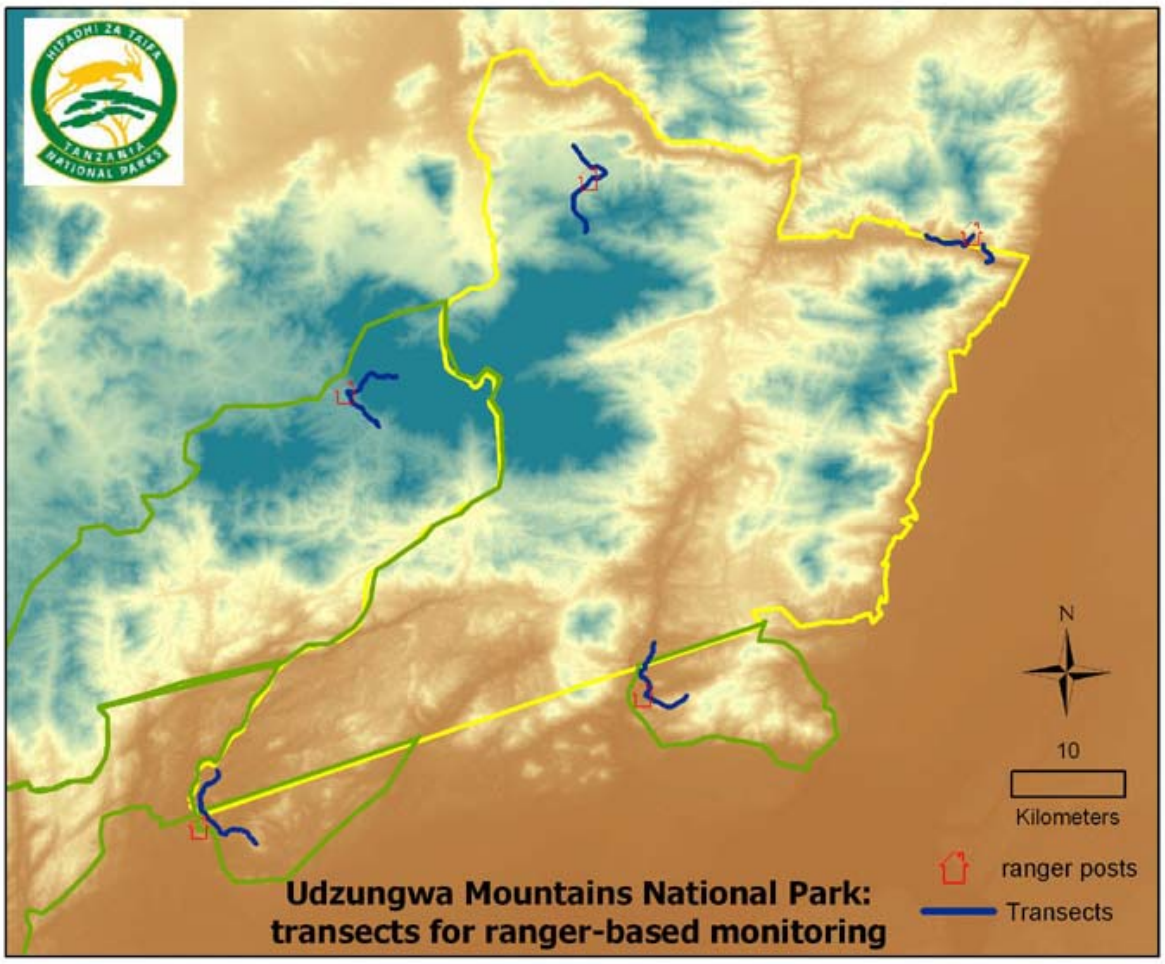


Figure 9. Map of the park (background layer shows elevation, blue being higher altitude) with transects for large mammals monitoring (blue lines), 2 from each of five ranger posts.

UMNP LARGE MAMMAL MONITORING DATA COLLECTION FORM **Form num**_____

Ranger post_____ Transect_____ Date (dd/mm/year)____/_____/_____Time start (hh/mm)_____

Data collectors: rangers_____village scouts_____ Time end (hh/mm)_____

Climate: clear sky □ few clouds (<25%) □ cloudy (>50%) □ rain □ Notes:_____

Time	Position	Species	S	H	D/T	Num.	Dis: 10	Dis: 50	Dis: >50	Behaviour: feeding, moving, resting.
7:15	150 m	Buffalo	x			16		x		Moving

S= seen, H=heard, D/T= dung or track, Num= number of individuals seen or tracks or dung piles;
Dis= distance of sightings: within 10 m, within 10-50 m, further than 50 m.

Figure 10. Form for large mammal monitoring by rangers
(the version used is in Swahili)

Actual census was conducted from January 2009 with transects repeated monthly by rangers under technical assistance from the project team that were visiting each post monthly. Results of data collected until August are presented here. Four repetitions of 10 transects were realized, for a total of 206 km walked. The total number of records collected was 620, divided as follows: 169 dung, 315 tracks, 131 sightings plus vocal records. Records were assigned to 19 different species, however due the uncertainty in species identification (especially from tracks and dung), records were compiled using the following species or group of species:

Species/group	Num. of records
Forest primates	72
Baboon	22
Buffalo	84
Elephant	92
Forest antelope/duiker	154
Other ungulates	49
Bush pig	71
Leopard	22
Lion	24
Hyena	8
Civet and small carnivore	7

We analysed data by computing an index of relative abundance as the number of records collected per 10 km of transect walked (Figure 11).

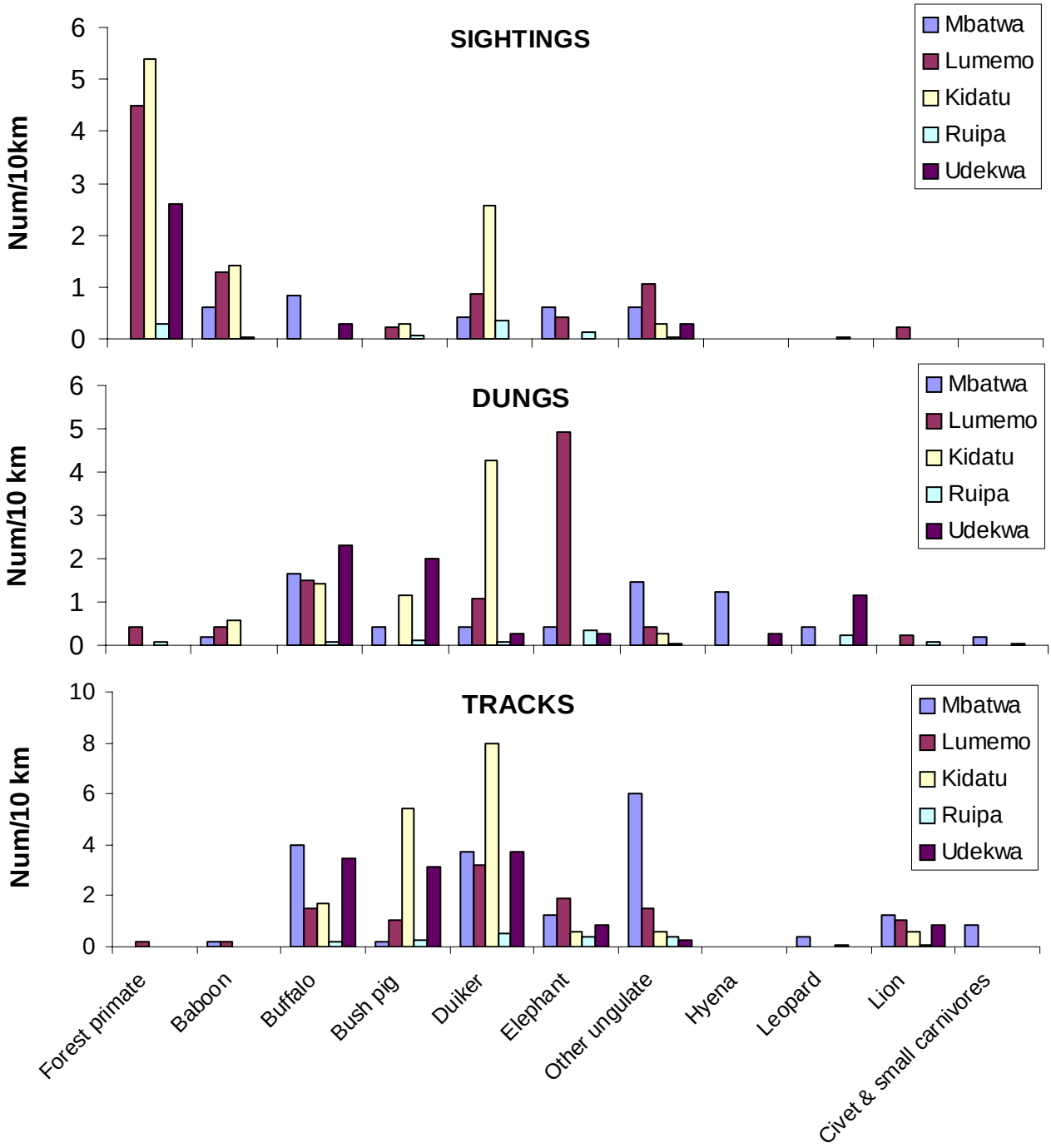


Figure 11. First results of ranger-based monitoring of large mammals conducted between January and August 2009. Data are number of records per 10 km of census. Two transects were walked from each of 5 ranger posts, for a total of 620 records collected.

The results obtained so far constitutes a satisfactory baseline of data to continue and improve the programme. For some species, especially the carnivores, the records are too few to give any meaningful trends in terms of abundance and differences between ranger posts. Identification bias may also have occurred, for example between lion and leopard, and between the various antelopes (hence the grouping into forest duiker versus other, usually larger ungulates). However, by ensuring participation of trained assistants during census, bias in interpreting dung and tracks should have been minimized. The different type of

record give different indications: for example, forest primates were detected through sightings especially at Lumemo, Kidatu and Udekwa where portion of transects are in good canopy forest. There is some interesting concordance in the relative abundance of some species detected through different records, for example the duiker (which most frequently will be the Harvey's red duiker) being detected with greater abundance at Kidatu through all 3 data-sets (sightings, dungs and tracks). Good concordance in the detection of track and dung counts also resulted for buffalo, bush pig and, to a lesser extent, elephant.

Overall, the programme has given some interesting, albeit initial results and it deserves to continue. The proper continuation will require continued commitment by UEMC and UMNP to training and allocation of resources and time for rangers to become progressively more responsible and competent to run this programme. The initial plan of handing over to ranger data collection responsibility after August 2009 did not work out because of various reasons, including shortage of rangers at each post, need for additional training, scarce willingness by rangers to take on full responsibility for this exercise. It was therefore jointly decided that a trained assistant from UEMC/UMNP should always participate to census walks. This will ensure data quality and standardization of timing.

7. TEAM biodiversity monitoring in Mwanihana

Since 2009, Udzungwa is one of the site of TEAM network, a pantropical series of sites all implementing standardized protocols. The project is run by Trento Museum under TAWIRI and Tanapa permits, and based at UEMC to which it contributes with rent and logistic support (for example satellite internet). Field sampling was implemented in Mwanihana, and the protocols implemented are summarized below (see http://www.teamnetwork.org/en/protocol for detailed protocol description); the final location of sampling points and plots is shown in Figure 12.

Terrestrial vertebrates: 60 camera-trap points have been implemented through sampling 3 arrays of 20 camera-trap sites, sequentially. Twenty digital camera-traps (model Reconyx RM 45 Rapid Fire) have been used, each set to work for 30 days. The camera-trap were distributed at a density of 1 camera every 2 km^2. Locations were pre-loaded in a GPS unit and actual points were located in the field by the field team.

Vegetation: 6 vegetation plots, of 1 ha each, have been sampled by measuring all trees and lianas above 10 cm DBH (diameter at breast height). Plots were already established by Dr. Marshall and colleagues in the framework of the Valuing the Arc project. Measuring implied camping in the proximity of the plot for 7-10 days. Each tree was tagged when the plot was established; we measured DBH (recording the increment due to growth) and recorded the condition of the tree, if changed. Data were recorded in data collection forms. New recruits, i.e. trees that reached 10 cm DBH since the plot establishment, were newly tagged, identified and measured.

Climate: the automatic climate station provided by Campbell Scientific was set-up initially in proximity of the UMNP headquarters, to ensure the proper functioning and easy access. Temperature, humidity, rainfall and solar radiation were measured continuously by sensors mounted on a tripod and powered by a battery charged by solar panels. Data were recorded into a data-logger and saved on a memory card. The climate tower will be moved by June 2010 in the chosen site inside Mwanihana forest, at an elevation of about 1200 m a.s.l. (see map).

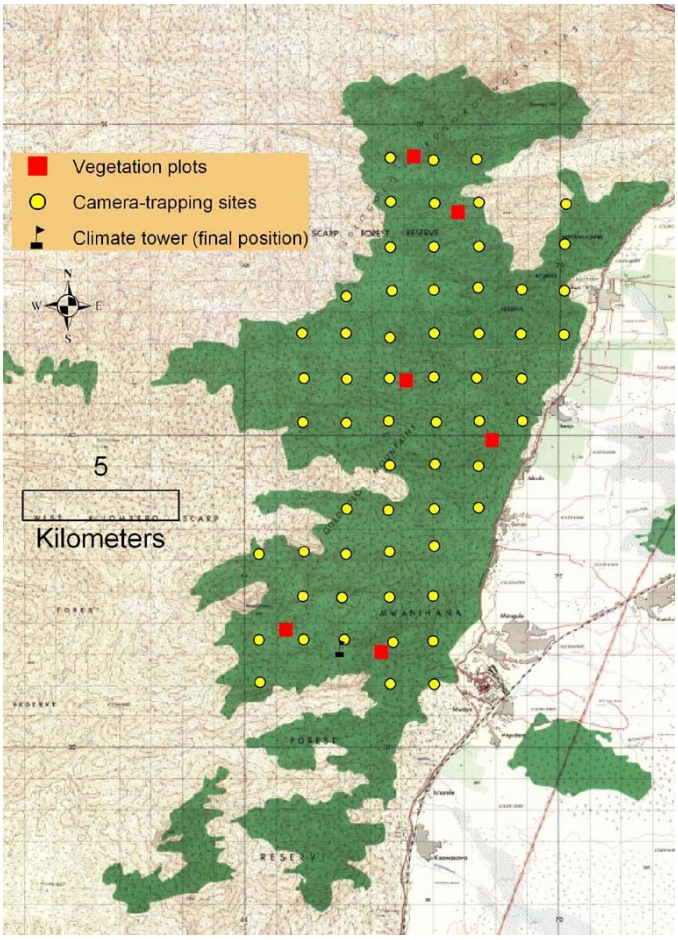


Fig. 1. Map of Mwanihana forest, Udzungwa Mountains National Park, with final locations of TEAM sampling points: 60 camera-trap points, 6 vegetation plots and 1 climate recording tower

The first year of data collection was completed successfully. All data collected under TEAM projects are uploaded in near real time in the web portal (http://www.teamnetwork.org) and are freely available. Moreover, through yearly report to TAWIRI and Tanapa, a summary of data collected will be available to the relevant agencies such as UMNP.

8. School education activities

UEMC initiated this programme towards the end of 2007 with five nearby primary schools in Mang'ula, namely Mlimani, Mwaya, Mgudeni, Mang'ula A and Msalise primary schools. The programme continued successful throughout 2009, class lessons on environmental education were carried out regularly, and other activities included continuing school trees nurseries, tree planting around the schools, study tours, poster competitions and other games. The environmental programmes worked with standard 5 and 6 classes in each school, each class receiving one teaching period of 40 minutes per week. The average number of students per class is 120, so UEMC roughly reached 1200 students in 2009.

With the support of Tanapa, UEMC has been taken one class from every school on a field trip to hike in the National Park. Trips were greatly appreciated by the students, and they involved about 40 students each time. With the support of WWF, UEMC has managed to support four school tree nurseries with material and training to raise seedlings. In 2009, about 12,500 seedlings were raised in four schools. Also, UEMC were able to support them with materials and precisely 40 pcs of polythen, 8 hoes, 8 pruning knives and 3 pcs of horse pipe.

Among the most appreciated activities, besides school trips to Sanje falls and one trip to Mikumi National Park, have been the cinema nights shown to five villages adjacent UMNP, during which nature documentary and photographic portfolios are projected in large screens. Finally, the programme hosted the World Environmental Day (June 5th) that was held at Mang'ula village. Preparation of this event involved planning with UMNP community conservation warden, and liaising with the District Education Officer, Ward Education coordinator, and village chairmen to present the initiative. Subsequently, meetings and workshops with primary school teachers were held to plan the activities in details. The celebration was a success, with hundreds of people participating.

9. Activities planned for year 4-5

UEMC plans to conduct the following activities in 2010/2011:

- continue the primate and duiker monitoring with the standard, monthly frequency in Mwanihana and USFR;
- continue to support and facilitate the ranger-based monitoring, including by allocating one trained assistant to help collecting data at least once per month per ranger post;
- pending funds availability, resume the Sanje mangabey demography monitoring on quarterly basis;
- repeat the dung beetle study in 2010 or 2011 (i.e. every 2-3 years) and test alternative ways to assess the impact of firewood collection;
- initiate training activities at the hostel in collaboration with national and international Universities, and related programmes. A first visiting group will in fact come in May 2010 from Pennsylvania State University, as part of a research and study abroad programme on land-use planning around UMNP in collaboration with Tanapa/UEMC, WWF, SUA and other partners;
- continue to pursue the need for standardizing monitoring in forest parks initially by holding a stakeholders' workshop;
- related to the point above, facilitate discussion on sustainable alternatives to the current firewood collection policy.
- continue and expand the environmental education programme, by increasing the number of schools involved and by including secondary schools in the programme.

References

Relevant reports for downloading and a complete list of references for research conducted in Udzungwa can be found in the UEMC website. Directly relevant to this report are the following:

Rovero F., Struhsaker T.T., Marshall A.R., Rynne T.A., Pedersen U.B., Ehardt C.L., Butynski T.M. and Mtui A.S. 2006. Abundance of Diurnal Primates in Mwanihana Forest, Udzungwa Mountains, Tanzania: a Multi-observer Comparison of Line-transect Data. *International Journal of Primatology*, 27: 675-697.

Rovero F. and A. Mtui 2006. Comparing multi-observer, line transect data for primate monitoring: a case from the Udzungwa Mountains of Tanzania. Proceedings of the 21st Congress of the International Primatological Society. International Journal of Primatology, 27 (Special Issue): abstract #350.

Rovero F., Mtui A., Kitegile A., Nielsen M., Jones T., 2010, *Uzungwa Scarp Forest Reserve in crisis. An urgent call to protect one of Tanzania's most important forests*, Dar es Salaam, Tanzania.

UEMC (Udzungwa Ecological Monitoring Centre) 2008. Technical report, year 1 (December 2006-December 2007). Unpublished report to Tanzania National Parks. Available at http://www.udzungwacentre.org/mrd.asp?code=23

UEMC (Udzungwa Ecological Monitoring Centre) 2009. Technical report, year 2 (December 2006-December 2007). Unpublished report to Tanzania National Parks. Available at http://www.udzungwacentre.org/mrd.asp?code=23