Udzungwa Ecological Monitoring Centre
(Udzungwa Mountains National Park)

Annual Technical Report
Year 2 (January - December 2008)

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) operation since end of 2006 with the aim of 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. This is the second year technical report (January - December 2008), 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. Results for Mwanihana forest, despite inter-observer variations, indicate that for most species primate populations have remained stable, i.e. they did not show meaningful trend over the years. The possible exception of declining yellow baboon in Mwanihana is confirmed by the data-set updated to 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 previous data that abundance of the canopy-dependent monkeys and the red duiker is dramatically lower than in Mwanihana because of more severe effects of human impact, and albeit statistically non-significant, data reveal declining abundance. 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 2008 UEMC initiated the following projects: (1) ranger-based monitoring scheme for large mammals, with 2 transects established at each of five ranger posts throughout UMNP. Rangers were trained with theoretical and practical sessions on data collection, which is planned to begun in 2009. (2) Study of dung beetles to assess human disturbance related to firewood collection at the eastern edge of Mwanihana forest. Results were compared with a baseline study conducted in 2005 and show no significant changes in dung beetle diversity and abundance patterns. This confirms the negative impact of firewood collection despite the number of days that people is allowed to enter the park was decreased from two days to one. (3) Sanje mangabey demography study, through collection every 4 months of group size and age/sex composition of 5-6 groups in Mwanihana forest. Albeit initial, the study gave promising and consistent results for this endemic and flagship monkey that is not properly counted by line-transect censuses.

Additional achievements of UEMC in 2008 include: continued and strengthened the environmental education programme; finalize processes for the foreseen initiation of TEAM programme (Tropical Ecology, Assessment and Monitoring Network of Conservation International); in 2008 UEMC overall hosted 12 long-term researchers, and houses were used for much longer periods than in 2007, allowing in the last quarter of 2008 (when UEMC was fully booked) to raise internal fees up to about 30% of the running costs; UEMC continued to network with organization including the EU-ATBI project for a possible All Taxa Biodiversity Inventory Site in Udzungwa. Technical design and tender for expansion of UEMC to have a dormitory and dining block were finalized and construction begins in February 2009. The 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 second year technical report, and it is aimed at presenting the monitoring data collected and other activities, as well as summarize 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.

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

Whilst this is not a management nor a financial report, the following information are summarized to complete the background to the UEMC functioning. The UEMC consists of four buildings: one includes an office, store and large seminar room, and the remaining three are researchers' houses, each with two double-bed rooms and toilet. The procedures to build the hostel - consisting of a dormitory block for accommodating 24 beds in 4 rooms, dining block and toilet block - are currently (February 2009) being finalized and funds already allocated.

The staff working at UEMC and employed In addition to Trento Museum's contact person (Dr. Rovero), UEMC's personnel employed by Trento Museum either directly or through TFCG during the second year has been composed by the following 12 persons: UEMC coordinator (Arafat Mtui, as Amani Kitegile resigned in August 2007 to take-on a permanent position at SUA), the logistic and environmental education coordinator (Baraka De Graaf), a school education officer, three field assistants, the gardener, the house-keeper, and four watchmen. One or two more people are still expected to be recruited for the management of the hostel.

UEMC required nearly 100 million Tsh (ca. 90,000 $) to be established and operational in 2006. The hostel is estimated to cost (beginning of 2009) in the range of 65 million Tsh (54,000 $). Running expenses for the second year of operations amounted to about 25 million Tsh, of which about 3.3 million were raised internally from fees paid by visiting researchers – representing 13% of overall costs, but up to 30% in the last quarter and as an

estimate based on bookings for 2009. Trento Museum is committed to cover the routine running costs and monitoring activities through institutional funding whilst for additional components (e.g. the ranger-based monitoring) external funding from agencies has been secured.

2. Summary of activities planned and activities implemented

This section provides and overview of activities implemented during both years 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. was discontinued at times because of shuffling of personnel at both UEMC (coordinator resigned in August 2008 and the position could not be resumed until late December) and UMNP. The key activity in this context has been the starting of the ranger training for implementing park-wide 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 monitoring programme both in Mwanihana (UMNP) and Uzungwa Scarp Forest Reserve, thus raising data for both TANAPA and Forestry Division. However, monitoring in USFR still proved challenging due to remoteness and difficult to access one of the transects in the Army area (JKT). Some monitoring had to be paused during the period the UEMC coordinator was not in place.

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

In 2008 UEMC overall hosted 12 long-term researchers, and houses were used for much longer periods than in 2007, allowing in the last quarter of 2008 (when UEMC was fully booked) to raise internal fees up to about 30% of the running costs. As a consequence, the number of visitors hosted for short time decreased firmly. Towards the end of 2008 UEMC was equipped with satellite internet connection and solar panels to back-up electricity in the office and for the use of Internet. This greatly enhanced the services provided to guests.

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

As planned, this programme begun in the second half of year 2 thanks to a small grant provided by Rufford foundation. The programme is on-going (details below), with transects being established at all 5 remote ranger posts and training workshops organized in January 2009.

5. *Organize education activities for school children.*

This programme continued steadily in 2008 and benefited greatly from the presence of Baraka de Graaf, Environmental Ecucation Coordinator, who gained experience with the "Watu na Msitu" project conducted by Trento Museum during 2004-2007 around the Uzungwa Scarp Forest Reserve.

6. *Establish a database on Udzungwa biodiversity.*

This component remains to be planned in details. It is confirmed that with the beginning of TEAM (and possibly EDIT-ATBI) projects, data collected will be entered in standard data-bases. The page in UEMC web-site with lists of project and publications was regularly updated. Plans to set-up a GIS lab together with the Park Ecologist were discussed and Trevor Jones (long-term Udzungwa researcher based at UEMC) helped to set-up an initial procedure and structure to manage GIS data (from raw data to GIS layers, map and final products) in collaboration with Nick McWilliam of East Anglia University-ABRU.

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

After preliminary meetings between CI's representatives and TAWIRI and TANAPA, CI decided to launch the Udzungwa (Mwanihana forest) as first site in Africa of the TEAM network (Tropical Ecology, Assessment and Monitoring). Monitoring activities are planned for mid-2009, however an initial, start-up grant was given to Trento Museum to purchase the necessary equipment. The EDIT-ATBI project (EU-funded project for performing inventories of as many taxa as possible from biodiversity-rich sites) is still in preparatory phases.

3. Inaugural stakeholders' workshop recommendations and follow-up in year 1-2

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 followed-up. Standardization of monitoring protocols through workshops and networking with other forest National Parks/Forest Reserve would be desirable.

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.

As pointed in the first year report, UEMC is helping with monitoring in USFR, but consultation with Forestry Division for the involvement of communities has not been done, nor it is logistically feasible given the distance between UEMC and USFR (170 km), and would require an ad-hoc project and additional funding.

4. Impact of firewood collection on biodiversity, 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.

5. Habitat disturbance monitoring through disturbance transects; it was recommended that Frontier-Tanzania's widely used protocol, already implemented in western Udzungwas, is adopted.

Disturbance transects have not repeated yet, as focus in 2008 was placed on the dung beetle assessment. The rationale is that disturbance from firewood collection is not picked-up by disturbance transects (measuring pole and tree cutting) that were, instead, more relevant to the much more encroached Forest Reserves (Museo Tridentino di Scienze Naturali 2007).

6. 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.

As planned in year 1, demographic monitoring of Sanje mangabeys in collaboration with Trevor Jones, has begun (details below).

7. 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. Joint planning with Tanapa's ecological monitoring strategy should be performed.

8. Remote vegetation monitoring: what has been done and the way ahead; it was reported that there are now maps that cover a span of 60 years across the Eastern Arc Mountains to be used for assessing forest changes.

This partly ties to the on-going vegetation monitoring through 1 ha plots established by Dr. Andy Marshall in 2006 ("Valuing the Arc" project) and to be continued both under TEAM programme (for a sub-set of plots monitored annually) and by the same project with re-measurement of all plots scheduled for 2010-2011.

9. 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 is dependent among construction of the hostel which will be completed by mid- 2009.

10. Biodiversity surveys of least known areas in the Udzungwa range (priority areas). Recommendations on least known areas were provided by researchers, including Iyondo and Matundu Forests, Mount Luhomero, the UMNP (especially for amphibian and reptiles), areas of dry forests.

This is a component that UEMC can facilitate both directly and through provision of information to visiting researchers The extent of areas covered by biodiversity surveys is expanding every year thanks to the increasing research presence in the area. In 2008, for example, a large expedition by Rovero, Jones, Bowkett and others was conducted in remote parts of Luohomero forest, western UMNP.

11. Amphibian monitoring; it was noted that most of Critically Endangered species in the Udzungwas are amphibians and, thus, a protocol for monitoring these species should be in place.

TEAM programme includes amphibian monitoring, although this is not scheduled initially as the protocol is still being refined.

12. Other issues raised by the participants were: surveying coarse wood debris for forest floor monitoring, water level monitoring, meteorological data collection.

Available climate data have not being collected in a systematic fashion, however the automatic climate station that is planned to be set in Mwanihana under TEAM will fill some gaps in this context.

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). Following resign by Amani Kitegile (AK) in August 2008, data collection continued by a researcher working with Rovero, Davide Gatti (DG). Due to the small number of repetitions achieved, this data-set was not used for analysis. From 2009, census is being resumed by the new coordinator, Arafat Mtui (ASM), who had collected data in 2003-2004.

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

		Transect			
Observer	Period	T1	T2	T3	T4
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
8- DG(UEMC)	September-November 2009	6	6	4	3
All observers		99	99	98	33

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.

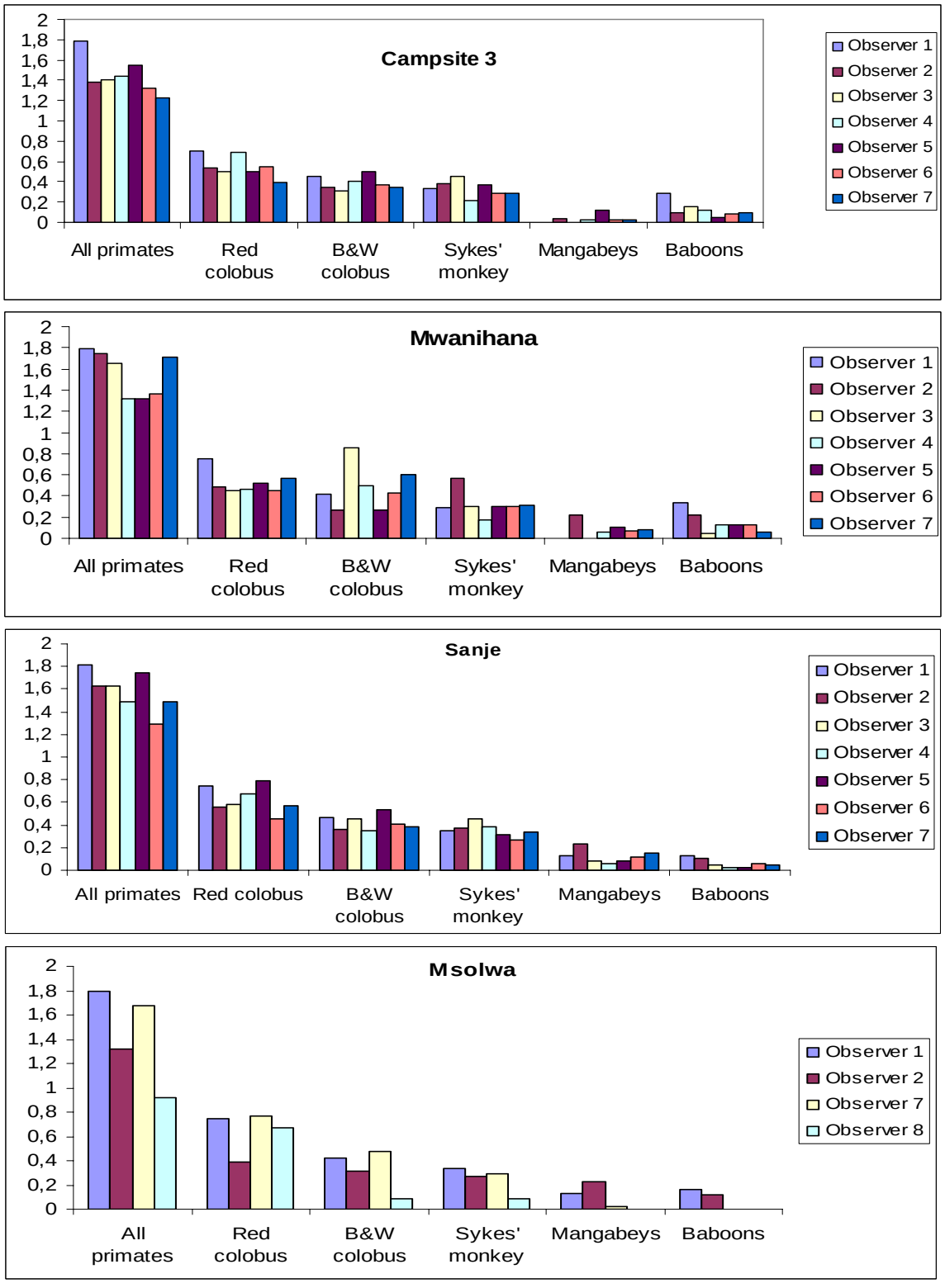


Figure 2. Results of primate monitoring expressed as the mean number of primate groups seen per km of transects for all four transects from 1998 until 2008 (the last 2 sets of data being collected by UEMC). Data for the fourth transects (Msolwa) were collected by only three observers.

The data series updated with results obtained by UEMC was compared to that analyzed in Rovero et al (2006) and Rovero and Mtui (2006), and led to similar conclusions:

- There are no dramatic differences in primate relative abundance between transects, but some are notable. For example, red colobus appear more abundant along the Sanje transect probably because of larger extent of evergreen and semi-evergreen forest found there.
- There are marked differences between results from different observers (and thus between periods of time) but these do not reflect any obvious temporal trends (with the confirmed exception of the decreasing trend observed for the baboons, see below), 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 three 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.

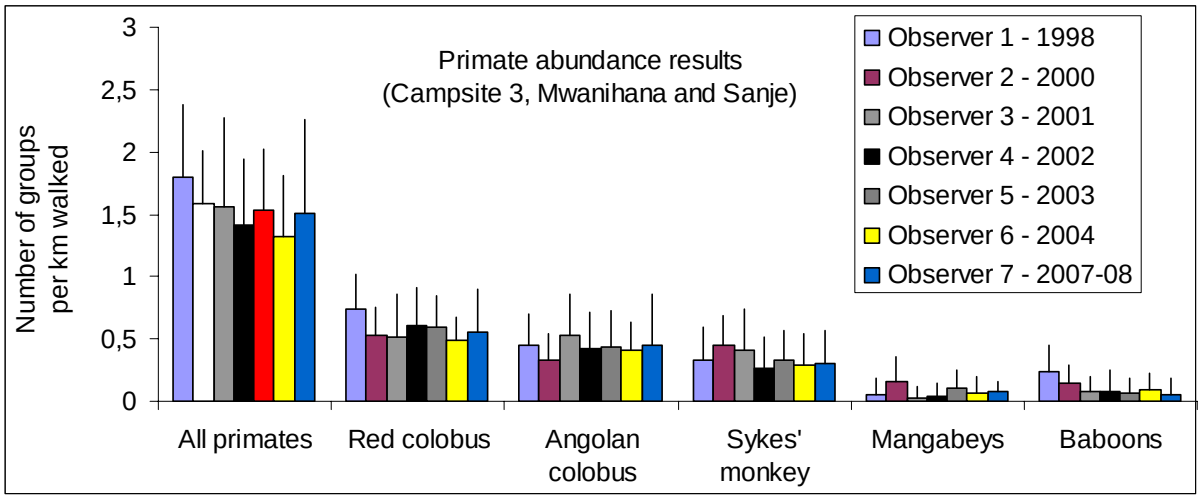


Figure 3. Results (mean number of primate groups seen per km and standard deviation) of primate census pooled for 3 transects from data collected from 1998 until 2008 (the last 2 sets of data being collected by UEMC)

Differences among observers in primate's encounter rate were significant for all specie except the Angolan colobus. Differences for the comparison applied to all primates were marginally non-significant (P=0.54; Table 3) However, Bonferroni's post-hoc multiple comparisons indicate that statistical differences are due to only one observer diverging from one or more others. This is the same pattern observed from previous analysis (Rovero and Mtui 2006, UEMC 2008). 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 = 6,285)	P (differences between observers)	Post-hoc significant at P<0.05
Red colobus	2.55	0.020	Ob 1 vs Ob 2
Angolan colobus	1.48	**0.184**	None significant
Sykes' monkey	2.54	0.020	Ob 2 vs Ob 4, 6
Mangabeys	3.32	0.004	Ob 2 vs Ob 4,6,7
Baboons	5.82	0.000	Ob 1 vs all, Ob 2 vs 7
All primates	2.09	**0.054**	Ob 1 vs Ob 6

The key result of relevance here is that updated UEMC data did not diverge consistently from previous data for any species, even though there had been nearly 2.5 years of gap in systematic data collection. This might indicate that in the time-span considered, the population of primates censused at Mwanihana has not changed consistently.

The pattern revealed by statistic analysis confirms the one already noted that Observer 2 (1999-2000) seemed to have produced more biased results than others. Interestingly, this observer received the least training (T. Struhsaker pers. comm.) supporting the hypothesis that variations could indeed reflect inter-observer differences.

It is worth nothing that the presumed decreasing trend noted for baboons during year 1 (UEMC 2008) is here confirmed through a larger data-set for Observer 7. This presumed declining trend is due not only to the higher values reported by Observer 1 (1998) versus all others, but also by higher values of Observer 2 versus Observer 7. As noted in the previous report, baboons are mainly found in the lower elevation, miombo habitat, and from there they frequently go outside the park to raid maize and banana crops, where they are chased and sometimes killed by people (UEMC 2008). 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. Even though data from Msolwa transect have not been analysed statistically, the decline appear to have been dramatic in this area, as no baboons were recorded by Observer 7 and 8 (in 2007-2008) 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.)

The lumping of data explained above did not include the Msolwa transect because of the limited sampling conducted there, that was due to the greater distance from Mang'ula to the starting point of this transect and thus logistical constraints. However, the relatively high abundance of the red colobus found there (see charts and values in Appendix 1) is consistent with data obtained by Observer 1 (1998). Whilst it is not consistent with data obtained by Observer 2, this is not surprising because the results of Observer 2 also differed for the other transects. Such higher abundance might reflect larger areas of evergreen, closed canopy forest, which is the preferred habitat of this species. Sanje mangabeys were heard very frequently at Msolwa by UEMC's observer, and they might be very abundant there in spite of no sightings during the few censuses conducted there. This reinforces a

previous conclusion that line-transect censuses are not effective for determining the abundance of this highly terrestrial and very elusive species. To circumvent this problem, ad-hoc monitoring of habituated and semi-habituated groups of Sanje mangabeys has been initiated in 2008 (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. Twenty-three repetitions in each of three transects were obtained during 2004-2005 by F.R. and others (mainly Arafat Mtui). UEMC continued this protocol and 16 repetitions were obtained during 2007-2008, totaling 39 repetitions per transect line.

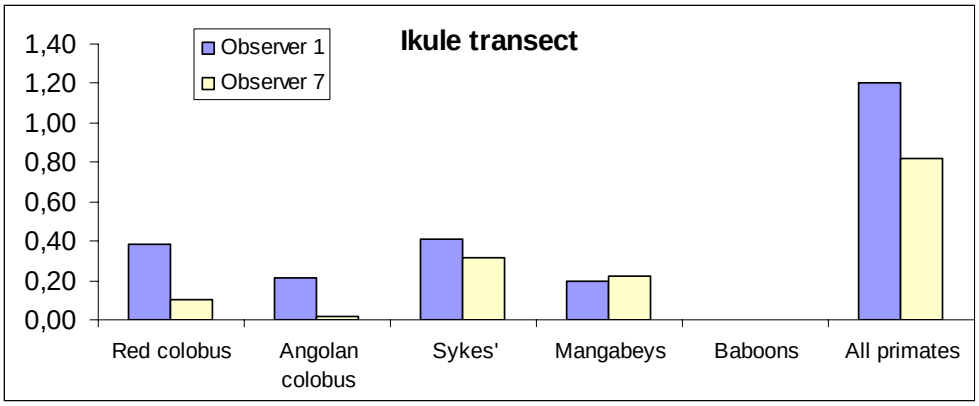
Monitoring was constrained by the remote location of USFR against the available budget and manpower. Moreover, census in the JKT transect, which is inside an area of the Forest Reserve managed by military station, continued to be made difficult by the JKT management as they did not now always granted permission to conduct census. This is despite regular FBD permit granted to UEMC personnel and regular payment of fees done prior to each trip to USFR.

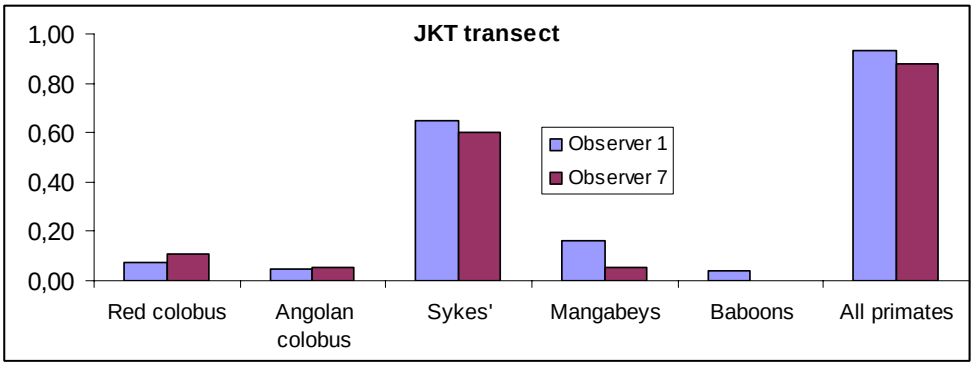
Results for each transect, and the four transects combined are presented in the following charts (Figure 4). UEMC data are referred to as “Observer 2”. For all transects, encounter rates obtained by Observer 2 were generally lower, and differences were significant for both colobus monkeys (Table 4). As indicated in the previous report (UEMC 2008), it is still premature to draw any conclusion in terms of trends, given the relatively short period of time between data collection.

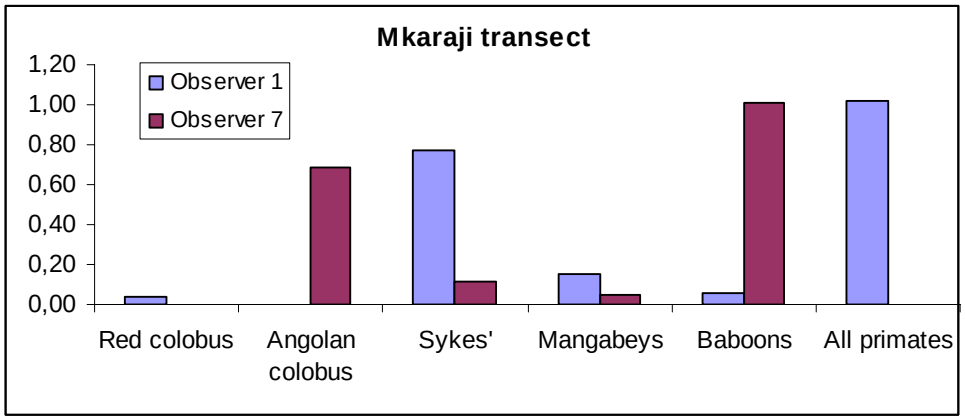
Table 4. Results of ANOVA and post-hoc comparisons on primate census results
obtained by different observers in USFR

Species	F (df = 1,107)	P (differences between observers)
Red colobus	4.85	0.029
Angolan colobus	7.08	0.009
Sykes’ monkey	1.08	0.298
Mangabeys	0.35	0.553
Baboons	0.28	0.597
All primates	1.71	0.193

However, USFR does need to be monitored closely, as human encroachment was found to be very high, including hunting of monkeys and tree cutting (Museo Tridentino Scienze Naturali 2007, A. Kitegile, unpublished data) and therefore a decrease in mammal abundance may well be occurring should encroachment and hunting continue at current levels.







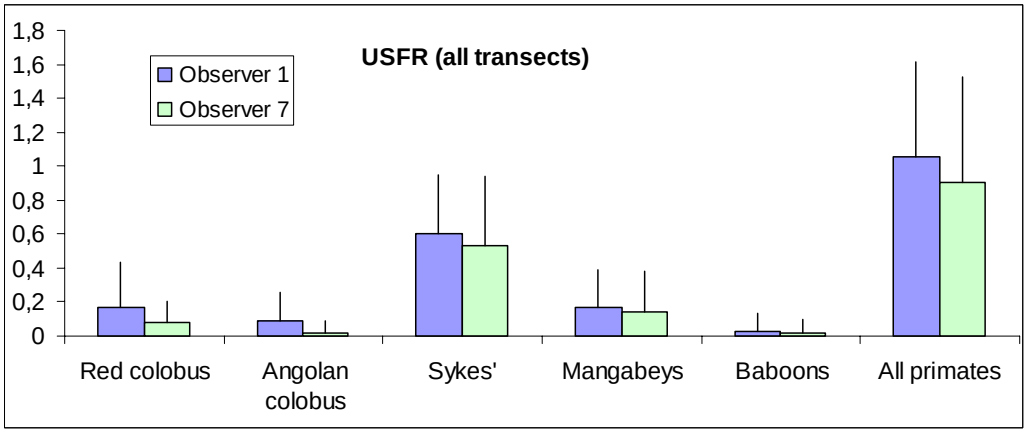


Figure 4. Primate census results obtained in USFR by two observers

4.3. Harvey's duiker monitoring in Mwanihana forest

Along with primate census, all sightings of duikers were also scored, at least beginning from transects conducted by Rovero and Mtui (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 (F. Rovero and UMNP 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) and Observer 3 (A. Kitegile and A. Mtui - UEMC: 2007-2008) for a total of 53 repetitions per transect line. Statistical tests reported in Table 5 indicate that the differences between observers are significant only for Campsite 3. When data from each transects are pooled, even though not significant, the declining trend from 2002 to 2007 that was noted in the previous report seems confirmed. 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 saw much less duikers at Campsite 3 than Mwanihana and Sanje relative to the other observers might indicate that more patrol effort is needed along this transect. It should be noted here that whilst all the 3 transects run along tourist trails, Campsite 3 is much less visited by tourists and possibly less patrolled, which may well result in relatively more encroachment occurring there.

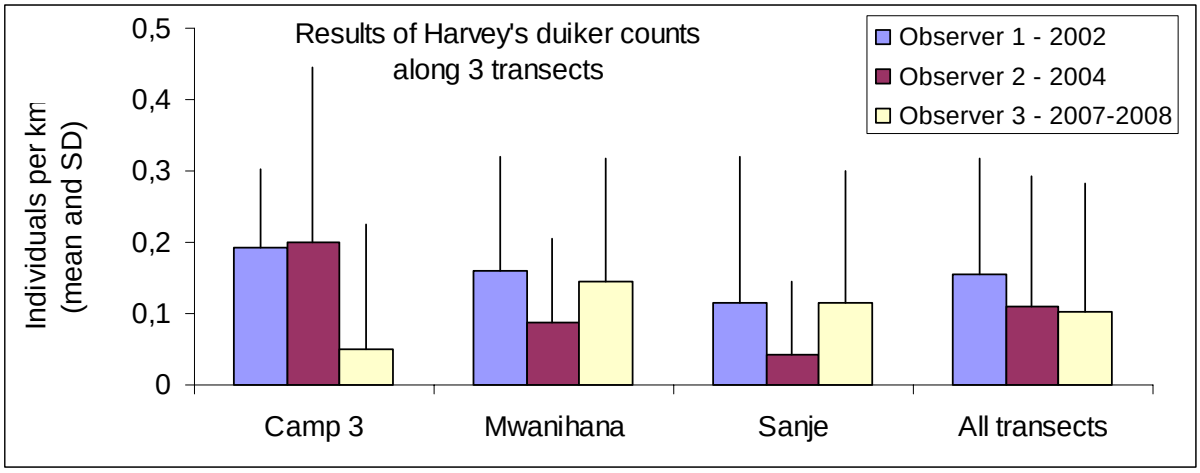


Figure 5. Results of Harvey's duiker census (individual encounters per km walked) by 3 observers along three transects in Mwanihana forest.

Table 5. ANOVA results of inter-observer differences in Harvey's duiker census results

Species	F (df = 2,50)	P (differences between observers)
Campsite 3	3.51	<0.05
Mwanihana	1.15	0.32
Sanje	1.13	0.33
All transects	1.20	0.30

Harvey's duiker monitoring in USFR

Although sightings of Harvey's duiker in USFR are very occasional (on average it has been sighted 19 times, i.e. once every 6 walks), there is now a sufficient set of data – obtained from 39 repetitions – for temporal comparison (Figure 6). There seems to be a more clear declining trend than in Mwanihana, although differences for all transects are marginally not significant, possibly because of the large amount of zero scored (ANOVA F1,92=2.650, P=0.11).

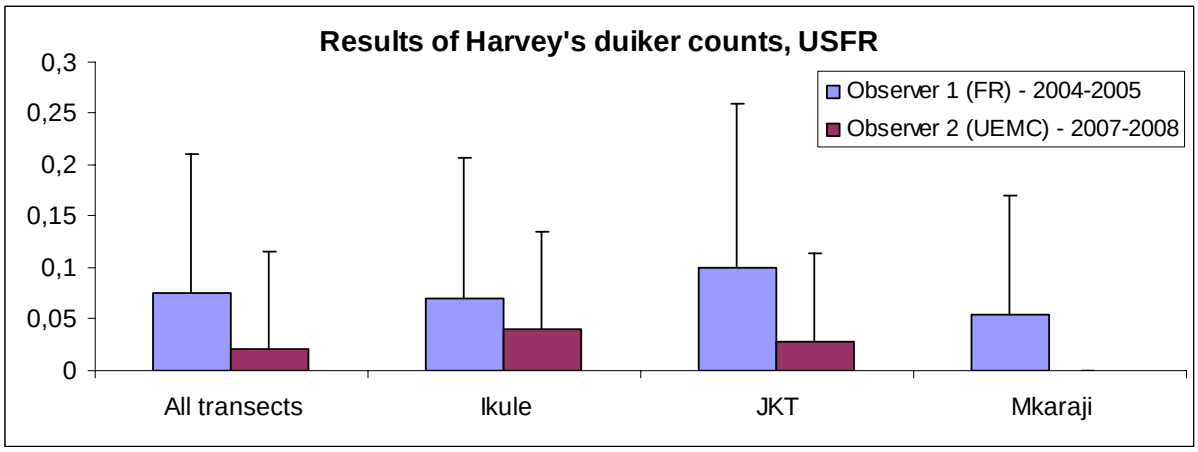


Figure 6. Results of Harvey's duiker census (individual encounters per km walked) by 2 observers along three transects in Uzungwa Scarp Forest Reserve.

As reported earlier, hunting in USFR is severe, and therefore it is not surprising that Harvey's duiker is much less abundant (less than half) then in Mwanihana.

4.4. Management and conservation implications from primate and duiker monitoring

The updated set of data obtained since last report 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, except for the possible decline of

baboons. For Sanje mangabeys, demographic monitoring through groups counts was inititated in 2008 and it is presented below.

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. Now that the programme is run by UEMC and UMNP, this should be more easily ensured than before. The resuming at the end of 2008 of census by Arafat Mtui - who has been involved in monitoring before and extensively trained - should ensure data consistency in the future.
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 also gives an indication of serious decline for this duiker which should be taken into account for planning additional patrolling efforts, as suggested above.
5) Data from USFR confirms the dramatic 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. As recommended elsewhere, unless full protection is given to this forest these species are bound to decline. The comparison between the two forests indicate once again that UMNP conducted a very effective law-enforcement.

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 plan is to conduct 4 counts per year, i.e. one every quarter of 3-4 groups. Two sessions of about 3 weeks each were conducted during August-September 08 and again December 08-January 09.

Twenty-five counts of 9 groups obtained altogether during the 2 sessions resulted in 10 good counts of 5 groups, of which at least 4 groups were re-counted (Figure 7). 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), one group at Sanje and one group at Msolwa.

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. Albeit preliminary, results are interesting in that four groups could be recounted with very consistent figures both in terms of total counts and of age classes. Beyond any meaningful conclusion at this early stage, it is recommended that the programme continue with the periodicity planned (4 counts per year).

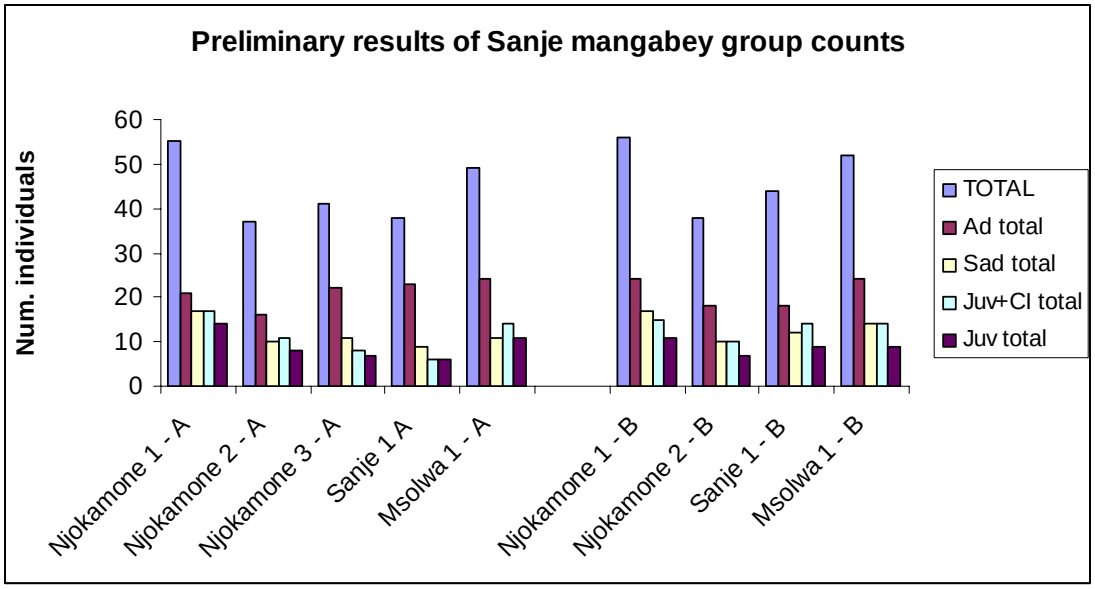


Figure 7. Preliminary results of Sanje magabey group counts in Mwanihana forest obtained in 2 periods. The name of the group (location) is on the X-axis. A refer to the first count (August 2008), B refers to the second count (December 2008). Data are by UEMC and T. Jones.

6. Ranger-based monitoring of large mammals in UMNP

The project begun in July 2008 under one year funding from Rufford Foundation devoted to establishing transects and training/supervising rangers. Two transects for censusing large mammals, 6 km in length and marked with aluminium tag every 100 m, were prepared from each of the following ranger posts: Lumemo (SE), Ruipa (SW), Udekwa (W), Mbatwa (N) and Kidatu (NE), as shown in the map (Figure 8). Transects sample a variety of habitat types, from lowland deciduos 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 the transects and record data using a standard form (Figure 9).

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. Following the initial trial census and on-site training, actual census will be conducted from January to June 2009 with two census transects per month done under technical assistance from the project team that will visit each post monthly. By ensuring data collection quality, in this way a baseline set of data will be gathered before data collection by rangers can continue independently.

However, it was observed that the current shortage of rangers may prevent censuses to be done at the planned frequency, if at all. This problem could be overcome by careful re-arranging of ranger duties (with relatively more time for a number of rangers allocated to monitoring), by decreasing the frequency of census, or by involving VGS (Village Game Scouts).

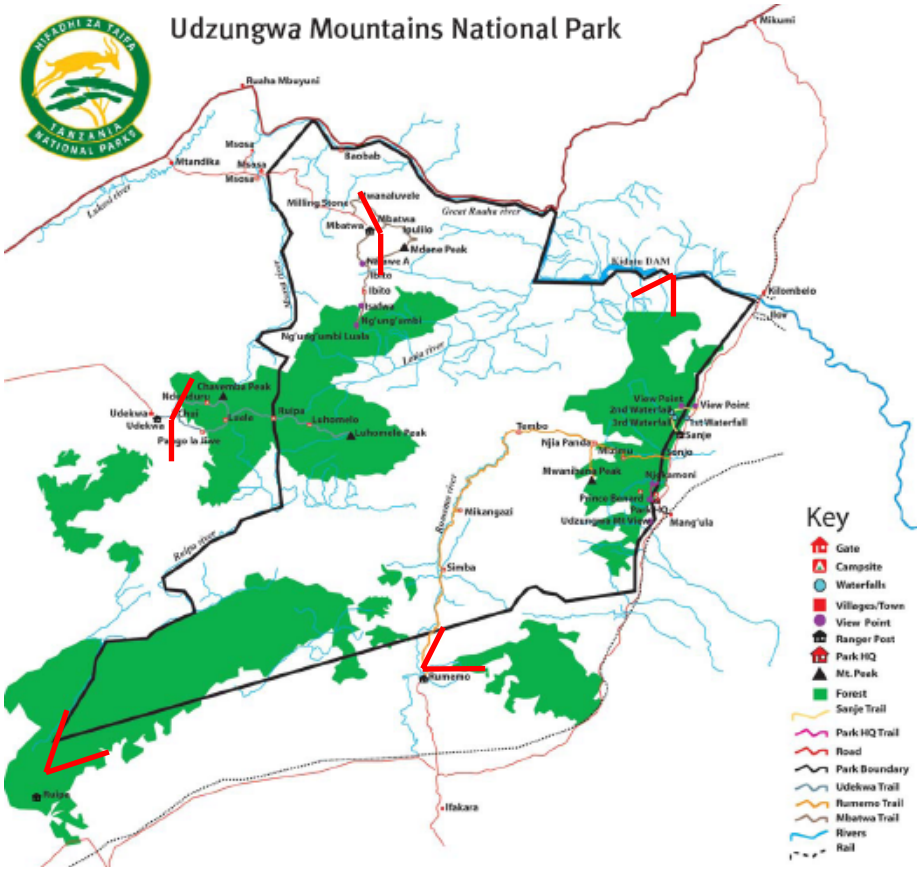


Figure 8. Map of the park showing the transects for large mammals monitoring (thick red lines), 2 from each of five ranger posts.

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

8. Impact of human disturbance on Mwanihana forest.

This component was dune under a small grant from WWF-TPO for UEMC and Dr. Nyundo to repeat the study conducted in 2005 by Nyundo et al. (2006). We conducted an assessment of the dung beetle community at the edge of Mwanihana forest. Like other invertebrates, dung beetles are excellent indicators of the status of the biodiversity of the forest floor. They were therefore used to assess the impact on the park's biodiversity of dead wood removal, a practice allowed in this area of the park since its establishment in 1992. Dung beetles were collected through pitfall traps set along 8 sites (12 traps in each site), and kept for 24 hours. Sampling was repeated 3 times at each site within a month. Of the 8 sites (Figure 10), 2 were in undisturbed areas (control = L1), 3 in moderately disturbed areas (L2) and 3 in heavily disturbed areas (L3). The level of disturbance (amount of deadwood removal) was inferred from the abundance of human population in settlements adjacent to the forest. The baseline assessment in 2005 found decreased abundance from control to moderately disturbed sites of dung beetles collected, but highest abundance at most disturbed sites.

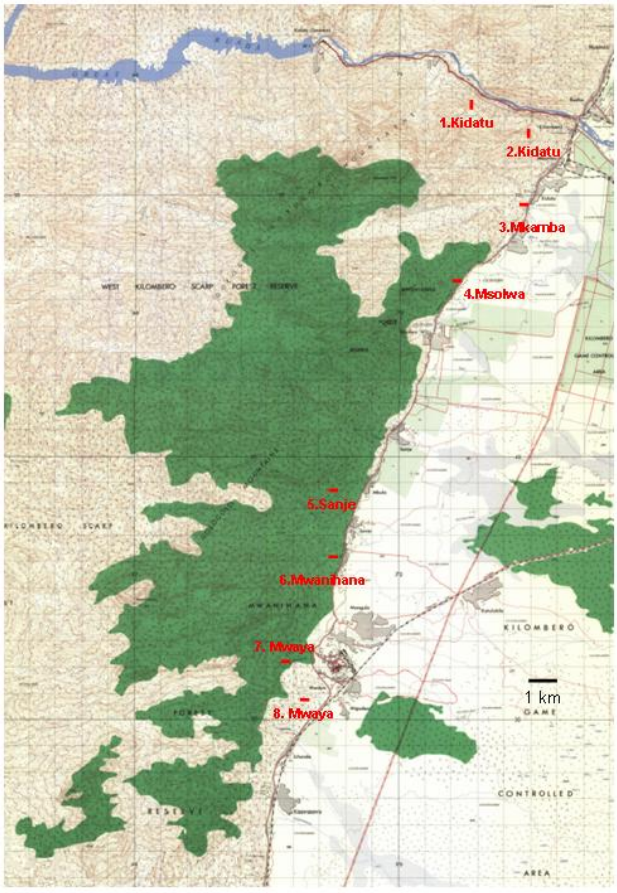


Figure 10. Topographic map (scale 1:10,000) of Mwanihana forest with locations of the 8 transects along which dung beetle were collected

Dung beetle species' diversity was impoverished in areas of the forest that were more intensively utilized (L3 versus L2), thus clearly revealing the negative impact on biodiversity of firewood collection. The present study found similar trends in dung beetles abundance and species diversity as revealed in 2005, except that diversity was lowest at control sites

(L1) and not intermediate, probably because one control site at Lumemo, in a different forest, was not repeated given the potential bias of sampling different dung beetle communities. The increased abundance and diversity at disturbed versus control sites is considered an effect of vegetation and forest floor alteration creating a greater number of ecological niches for dung beetles.

In general, the results indicate that there has not been significant changes in the negative effects on dung beetles of dead wood removal for firewood, contrary to expectations following the halving in the number of days that communities are allowed to enter the park (from two days to one day per week). Complementary data were also reviewed and helped putting results in a broader context. Results of disturbance transects conducted in 2006 (counts of timber tree, pole cuts, snares and other signs of encroachment), albeit not providing any information on forest floor biodiversity, indicate that the park is well protected from illegal encroachment, especially when compared to southern forests in the Udzungwa.

The most important recommendations from this study is that more efforts should be put into helping communities to become self-sufficient for energy sources if the negative effects of collecting firewood in the National Park are to be decreased and eventually stopped. In particular, the "once-per-week" firewood collection policy should be seriously reviewed, and alternatives explored, such as access restricted to selected zones or establishment of a system (e.g. provision of individual entry permits) to control the amount of firewood collected.

Full details are provided in a separate report (Rovero et al. 2008). The general importance of this study is that it adds to the disproportionately few studies that have been conducted on the impact of human disturbance in a landscape where high human pressure and outstanding biodiversity co-exist.

9. 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 steadily throughout 2008 with the aim of consolidating successful activities and thus increase its effectiveness. Preliminary activities included: lectures on environment education / awareness raising to the school students, school trees nurseries, tree planting around the schools, study tours. 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 200, so UEMC a roughly reached 1000 students. Prior to beginning the programme, a meeting was held with the District Education Officer and the District Executive Director to present the work planned and gather inputs.

With the support of Tanapa, UEMC has taken one class from every school on a field trip to the Sanje falls, in the National Park. Trips were greatly appreciated by the students, and they involved about 40 students each time, for a total of 200 students involved in 2008. With the support of WWF, UEMC has managed to support four school tree nurseries with material and training to raise seedlings. In 2008, about 5000 seedlings were raised in the four schools.

Plans for 2009 are to expand the profile of activities to benefit a greater number of students and community's members. Activities planned are the following:

In-school, classroom activities:

1. Routine environmental education lesson
2. Plays/acts with the students
3. Music performances

Outdoor school activities

1. Nature walks (in the National Park and in the rubber plantation)
2. Cinema (where both students and family members can attend)
3. Talks/Open Seminars (held in UEMC)
4. Self learning

Nature walks: UEMC will take a class to visit the Udzungwa National Park and the rubber plantation. To compare natural forest and man made forest. The student will be given different activities to look out for and to do whist on this walk.

Cinema: Making a free cinema on a large open area (a football pitch is an ideal place). This activity will be conducted in the evening so the images can be seen clearly on the screen. The cinema will show wildlife documentaries, and documentaries about energy efficient stoves, bricks and about conservation.

Talks/Open seminars: UEMC will invite speakers to give a seminar on conservation and research issues (e.g. Researcher staying at UEMC, Park's staff, etc).

Normal lessons: Standard lessons on different environmental topics and solicit questions; debates, by grouping a certain amount of students and giving them various topics for discussion.

Plays/Drama: Using actors, to make plays about conservation and the importance of conservation. This also needs a large open place where people can gather to watch the play. Plays are always interesting and amusing. This could be a good way to spread a message.

Music: Getting the student's to create choirs/band that play/sing environmental conservation songs. This doesn't just have to be choirs or bands, but the student can make rap songs, hip hop, and reggae but grab other student's attention. This can be a fun way for students to learn things but also to educate.

10. Activities planned for year 3-4

UEMC plans to conduct the following activities in 2009/2010:

- continue primate and duiker monitoring with the standard, monthly frequency in Mwanihana and USFR;
- continue the Sanje mangabey demography monitoring on quarterly basis;
- plan on repeating the dung beetle study in 2010 or 2011 (i.e. every 2-3 years)
- complete ranger-based training and initial monitoring, by conducting 6 months of supervised data collection, and monitor continued data collection by rangers throughout 2009; support the park ecologist for data summary and analysis; depending on results, write a project summary to share with other relevant programmes within Tanapa (especially forest parks);

- finilize planning/networking for beginning training activities at the hostel in collaboration with national and international Universities, and related programmes such as TBA and Pennsylvania State University.

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