Udzungwa Ecological Monitoring Centre
(Udzungwa Mountains National Park)

Annual Technical Report
Year 1 (December 2006-December 2007)

Museo Tridentino
di Scienze Naturali

Table of contents

Summary

The Udzungwa Ecological Monitoring Centre (UEMC) is a facility of the Udzungwa Mountains National Park (UMNP) established in 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 first year technical report (December 2006-December 2007), 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 monitoring programme established in 1997 in Mwanihana forest and results in terms of diurnal primates' relative abundance from data collected by UEMC in comparison with previous data are reported. Mean values are grossly consistent with previous results, and despite large inter-observer variations they indicate that for most species primate populations have remained stable, i.e. they did vary with any meaningful trend over the years. A possible exception might have occurred with the yellow baboons, that appear to be decreasing. Data collected for the red duiker also show a possible decrease that similarly to that observed for baboons might 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. Recommendations stress the need for careful inter-observer comparisons and reliability checks if real trend are to be distinguished from the noise associated to different data collection by different observers. The report provides management and conservation recommendations based on the monitoring results.

In addition to this baseline monitoring, during the first year UEMC implemented a pilot school education programme; hosted 46 people (with 10 spending more than 10 days) that allowed to raise up to 17% of the funds needed; networked with several organization including Conservation International's TEAM programme that will involve long-term biodiversity monitoring possibly from 2008; in consultation with UMNP Ecology Dept., additional activities such as ranger-based monitoring and Sanje mangabey demography monitoring have been planned. With the planned construction of the hostel in 2008 (that will accommodate up to 24 students) it is hoped that collaboration with local and international Universities for higher education, field-based training will begin.

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.

Contact details:

For UEMC and Trento Museum
Francesco Rovero
francesco.rovero@mtsn.tn.it

For UMNP/TANAPA
Joram Mponjoli, Park Ecologist
joramponjoli@yahoo.com

Web-site: www.udzungwacentre.org

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 first year technical report, and it is aimed at presenting the monitoring data collected and other activities, as well as summarize the short and medium-term plans so that it can also serve as a strategic document. The report is prepared by Trento Museum, 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. An hostel (with dormitory and restaurant) will be built in 2008 to accommodate up to 24 students and visiting researchers.

In addition to Trento Museum's contact person (Dr. Rovero), UEMC's personnel employed by Trento Museum for the first year was composed by: UEMC coordinator (Amani Kitegile), the school education officer (only last 6 months), the field assistant, the gardener, the house-keeper, and four watchmen. One or two more people are expected to be recruited for the management of the hostel. With increased monitoring and park assistance activities, an additional experienced field assistant will also be required.

UEMC required nearly 100 million Tsh (ca. 90,000 $) to be established and operational. The hostel is expected to cost in the range of 60 million Tsh (54,000 $). Running expenses for the first 13 months of operations amounted to about 20 million Tsh, of which about 3.3 million (or 16.5%) were raised internally from fees to visiting researchers. Trento Museum is committed to cover the basic running costs and basic monitoring activities (in the range of

15 to 20 million Tsh per year) through institutional funding, whilst for additional components (e.g. the ranger training) external funding from agencies needs to be sought.

2. Summary of activities planned and activities implemented

This section provides and overview of activities implemented 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 important recommendations spanning from the results of primate and duiker monitoring representing the key technical assistance provided to UMNP, in addition to the census data that are directly shared on monthly basis. The UEMC technical personnel (Dr. Francesco Rovero, Trento Museum's person in charge of UEMC, and Mr. Amani Kitegile, UEMC project coordinator) consulted closely with UMNP park ecologist and chief park warden on the specifics of ecological monitoring. These included especially the on-going primate monitoring programme (Mwanihana forest only), the planned Sanje mangabey demographic monitoring and the planned ranger-based monitoring to be implemented throughout the park. Being a process rather than an activity, advisory increased as UEMC took-off with its operations along the year. Whilst the continuity of this process was somewhat altered by the change in personnel in the Ecology Dept., it is expected that with the begin of ranger training planned for year 2 (2008), the technical assistance will become a more continuous process.

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

UEMC took-up and strengthened the primate monitoring programme both in Mwanihana (UMNP) and Uzungwa Scarp Forest Reserve, thus raising data for both TANAPA and Forestry Division.

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

During this first year, UEMC hosted both long-term researchers and several short-term researchers and other guests. A total of 46 people have been hosted, of these, 36 spent up to 10 days, while 10 people spent more than 10 days and up to 3 months, giving a total of 384 person/night spent. This does not include Trento's personnel that uses one of the 3 researchers' houses on fairly continuous basis.

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

This component partly relates to the provision of technical advisory discussed above: ranger-based training has been planned in conjunction with the Ecology Dept. and funds are been sought by Trento museum for initiating this programme in year 2. Regardless of additional

funding, that would allow for extensive field training and supervision of the trainees in the field, UEMC-based training will be ensured in 2008 at least to set-up an initial protocol.

5. *Organize education activities for school children.*

This component was successfully initiated capitalizing on Trento museum's experience with the "Watu na Msitu" project conducted 2004-2007 around the Uzungwa Scarp Forest Reserve, and in consultation with UMNP' Community Conservation Services.

6. *Establish a database on Udzungwa biodiversity.*

This component is yet to be planned in details. It is however expected that it will become much more relevant after 2-3 years of operations when more data will be raised and the need for establish a data-base will be crucial. This is reinforced in view of the TEAM project (see below), and other initiatives by individual long-term researchers that intend to geo-reference the data collected (e.g. T. Jones for large mammals, F. Rovero for camera-trapping data, M. Menegon for amphibians and reptiles). The UEMC web-site has a page in towards this goal where useful documents such as checklists have started to be posted (e.g. the Udzungwa mammal checklist).

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

UEMC gathered the interest of monitoring and biodiversity inventory programmes because of the logistic set-up that is now in place, allowing for field work to be conducted more easily. This was conducive to the foreseen initiation of the programme of the TEAM network (Tropical Ecology, Assessment and Monitoring), and the EDIT-ATBI (All Taxa Biodiversity Inventory), that at the time of writing (march 2008) are both at the planning stage and agreements with Tanzanian partners. TEAM (www.teaminitiative.org) is a programme of Conservation International that proposes to implement permanent protocols in Mwanihana forest for monitoring climate, primates, terrestrial vertebrates, amphibians, vegetation, leaflitter, butterflies and birds. EDIT-ATBI is an EU-funded project for performing inventories of as many taxa as possible from biodiversity-rich sites, and in the Udzungwa it proposes to target mainly invertebrates.

Dialogue to plan the ranger-based monitoring mainly occurred internally with UMNP, but also with a similar programme established by ABRU in Mikumi National Park. Future efforts should be made to link with other forest parks in the country (e.g. Mahale, Gombe, Kilimanjaro, Arusha) and their existing or planned monitoring programmes, in order to facilitate standardization, training, information-exchange.

The creation of the web-site (www.udzungwacentre.org), brochures, and support from scientists conducting research from the UEMC have also greatly helped implementing this component.

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

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.

Refer to the planned ranger-based monitoring. The involvement by UMNP of village scouts already in place for joint patrol schemes could be also conducted for ecological monitoring.

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 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 and 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.

Among the planned activities by UEMC there is a study on the impact of firewood collection that WWF might fund for implementation in 2008.

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 in Mwanihana forest are planned in the study about to be proposed to WWF and follows pilot disturbance transects done in 2006 in the framework of a Cepf study (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.

The habituated group at the Njokamone site continues to be followed from a permanent camp-site because of a tourist visit scheme being initiated in 2007; this group, together with adjacent, semi-habituated groups offer an excellent set-up to collect demography data on regular basis. A proposal by UEMC designed in collaboration with Trevor Jones and the park has been already approved by UMNP, but current level of funding and personnel did not allow implementation. UEMC and UMNP will hopefully be able to start this programme in 2008.

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 7 (above) and the need for networking with similar parks in the country.

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.

UEMC has not contributed to this, as it was a FBD project in conjunction with SUA, but it would be glad to support future efforts. This however ties to the in-place vegetation monitoring through 1 ha plots initiated by Dr. Andy Marshall ("Valuing the Arc" project) and to be continued possibly under TEAM programme or directly by UEMC (see planning). Since data collected by the TEAM programme will be obviously available to UMNP/UEMC, all protocols included in the prospected TEAM programme including the vegetation monitoring will be a great and long-term contribute to ecological monitoring in UMNP.

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 covered above. TBA has been contacted and they expressed interest to be involved in the Udzungwas, which will hopefully be renewed once the hostel is in place.

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 through provision of information to visiting researchers.

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 proposed to be implemented throughout Mwanihana forest.

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

UMNP has scattered climate data that should be organized and analysed. TEAM will implement a climate monitoring protocol.

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).

Whilst primate censuses by UEMC coordinator, Amani Kitegile and one assistant (usually Ruben Mwakisoma) begun in December 2006, data considered here are from April to November 2007 (11 repetitions), because censuses during the first four months were needed for training of the observer and because preliminary analysis found that data from this period (in terms of species' identification, group sighting distances, and encounter rates) might have been biased by the inexperience of the observer. The subsequent sampling (April until November) is summarized in the table below that updates the sampling effort in Rovero et al. (2006). Msolwa transects was re-opened in August 2007 and census continued there in Septemer 2007, after an interruption of 7 years.

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
UBP	August - October 1998	6	6	8	6
CAS	October 1999 - February 2000	15	15	14	11
ARM	May - September 2001	5	5	6	-
FR	July 2002 - January 2003	13	14	14	-
ASM1	February-August 2003	14	14	13	-
ASM2	February-December 2004	20	20	19	-
AK (UEMC)	April-November 2007	11	11	11	5
All observers		84	85	85	22

Following Rovero and Mtui (2006), the analysis of sighting distances of primate groups in class intervals of 10 m is used as a gross comparison of consistency between observers. Friedman's test for related samples was not significant (Chi^2= 6.09, d.f.=6, p=0.41) when the latest sampling period was added to the previous distributions. This result indicates that there are no significant differences between observers in their estimates of distances between them and the primate groups detected. Whilst this does not allow to draw conclusions on inter-observer reliability to sight primates, that can only be ensured by frequent inter-observer reliability checks, it does provide a useful indication on the strip width that was effectively sampled. Should this differ significantly between observers, then census results would likely differ as well. Graphs below (Fig. 1) are for the three most commonly sighted species, i.e. red colobus, Angolan colobus and Sykes' monkey.

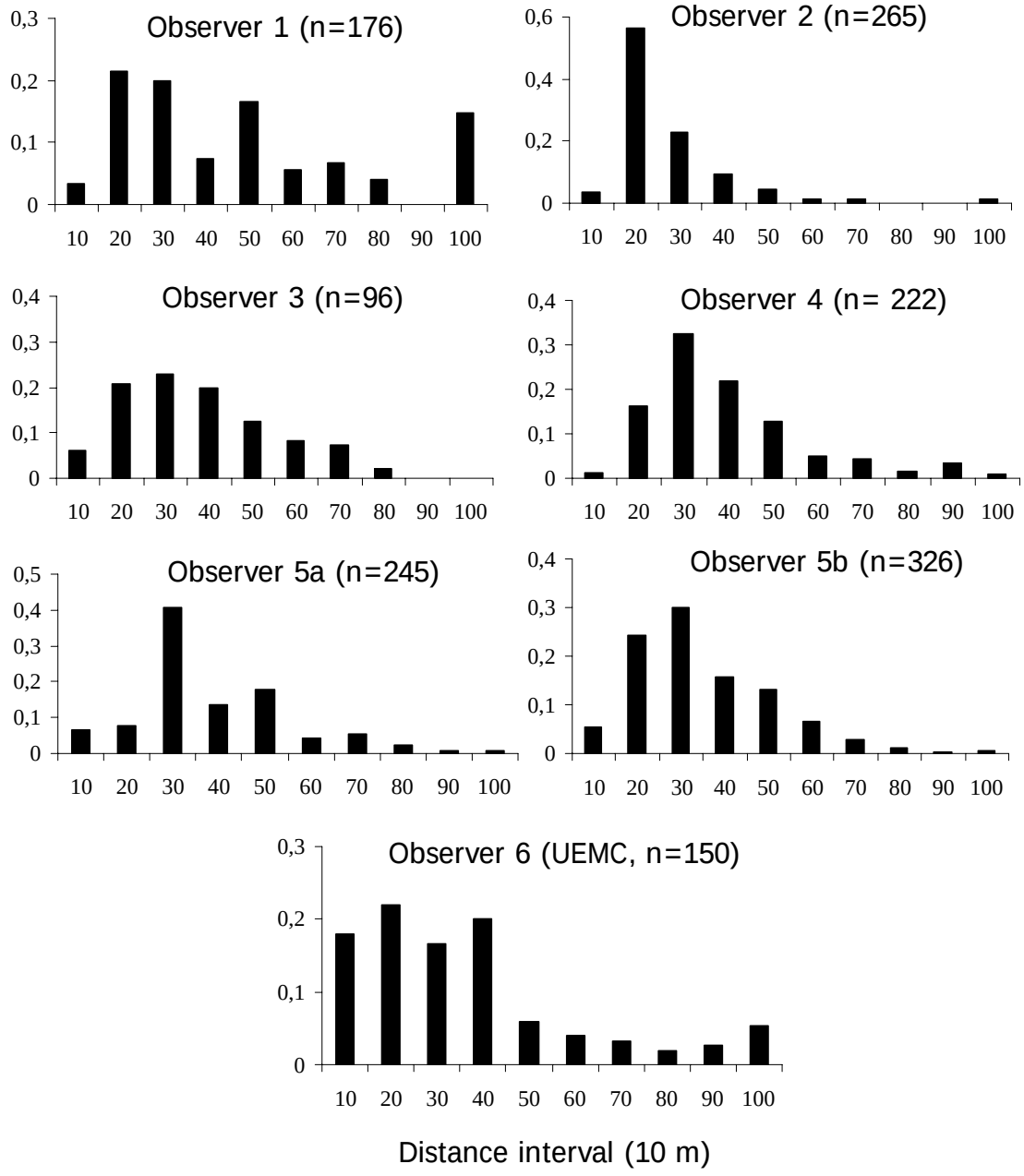
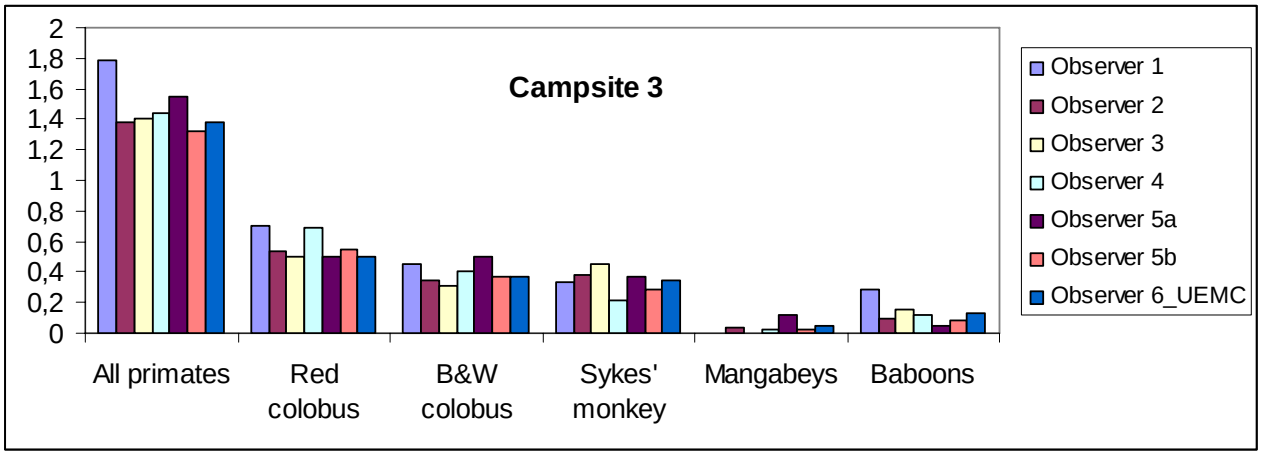
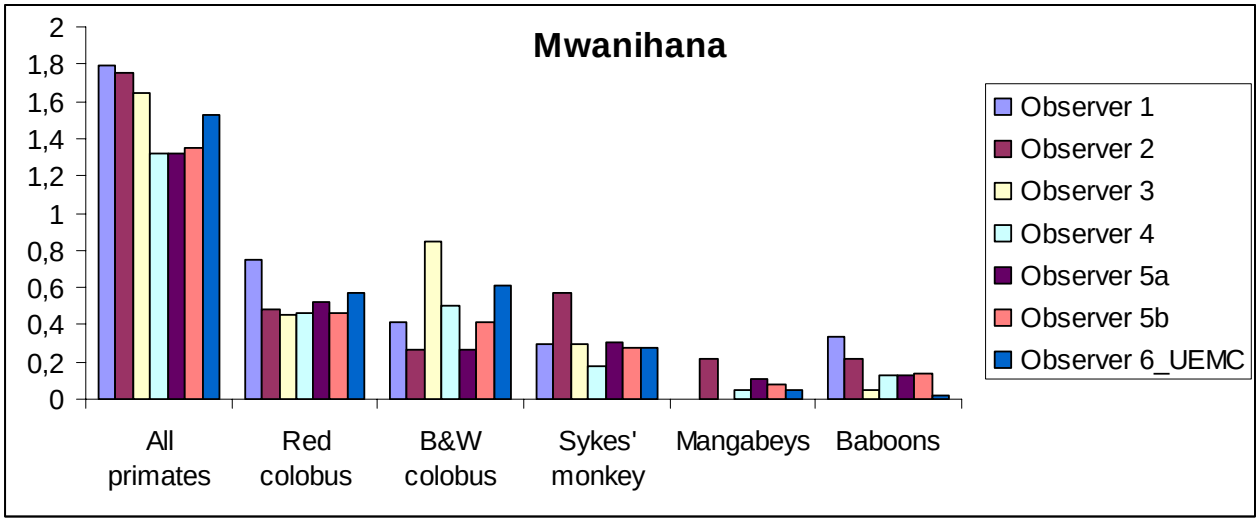
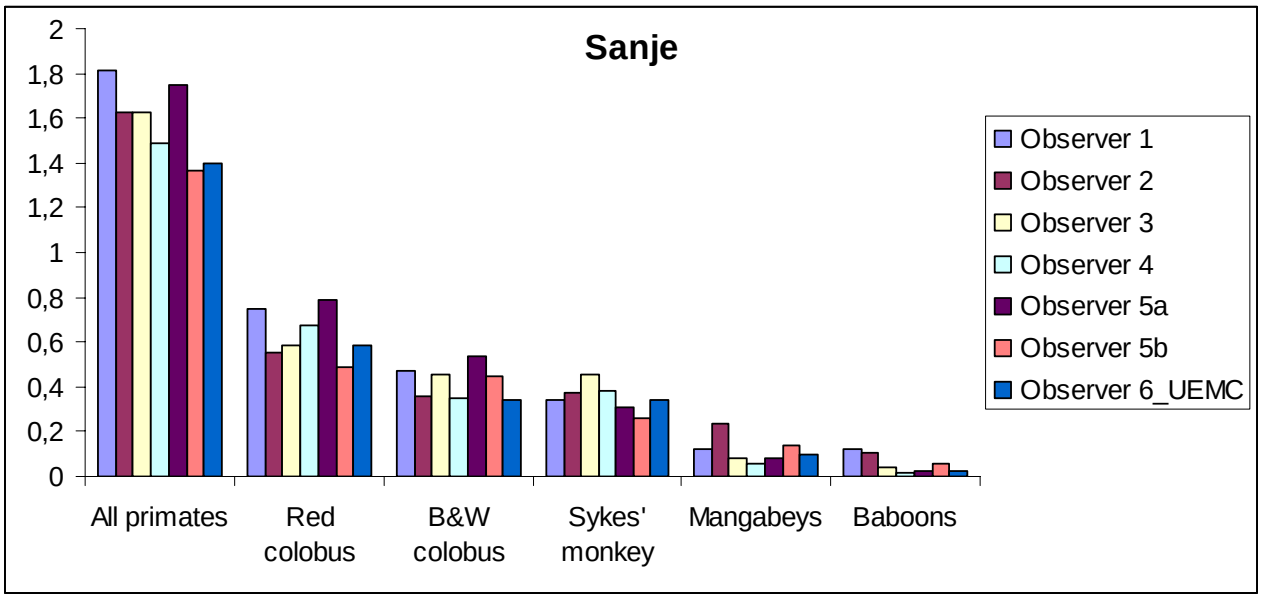


Fig. 1. Frequency distribution of sighting distances of primate groups lumped in 10 m classes, and used to assess inter-observer consistency in their estimates of sighting distance

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.







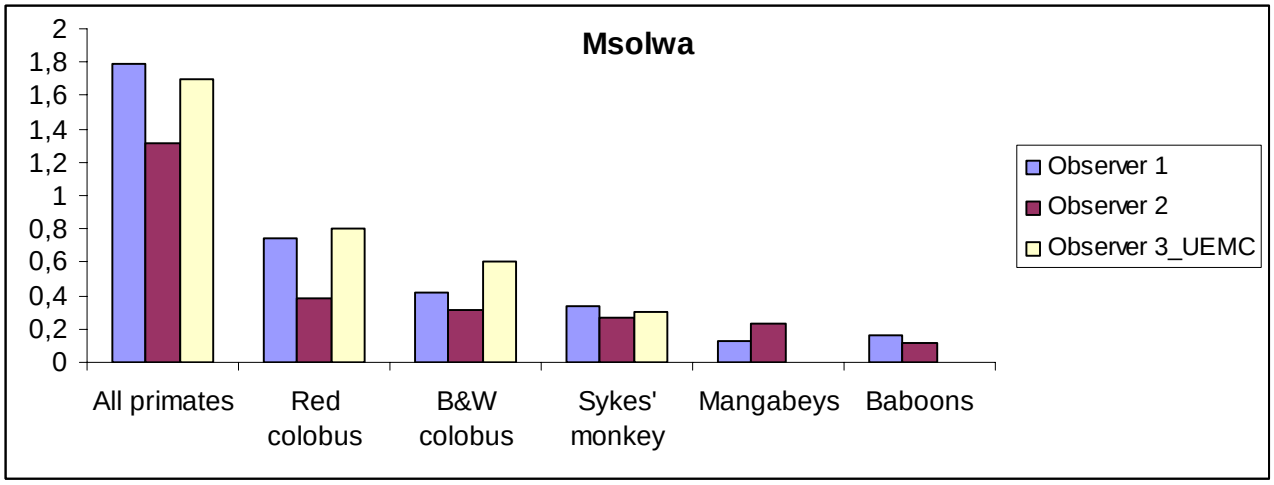


Figure 2. Results of primate monitoring expressed as the mean number of primate groups seen per km of transects for all four transects from 1998 until 2007 (the last set of data being collected by UEMC). Data for the fourth transects (Msolwa) were collected by only three observers.

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 on the Sanje transect probably as a result of more extensive evergreen and semi-evergreen forest 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 possible exception of 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.

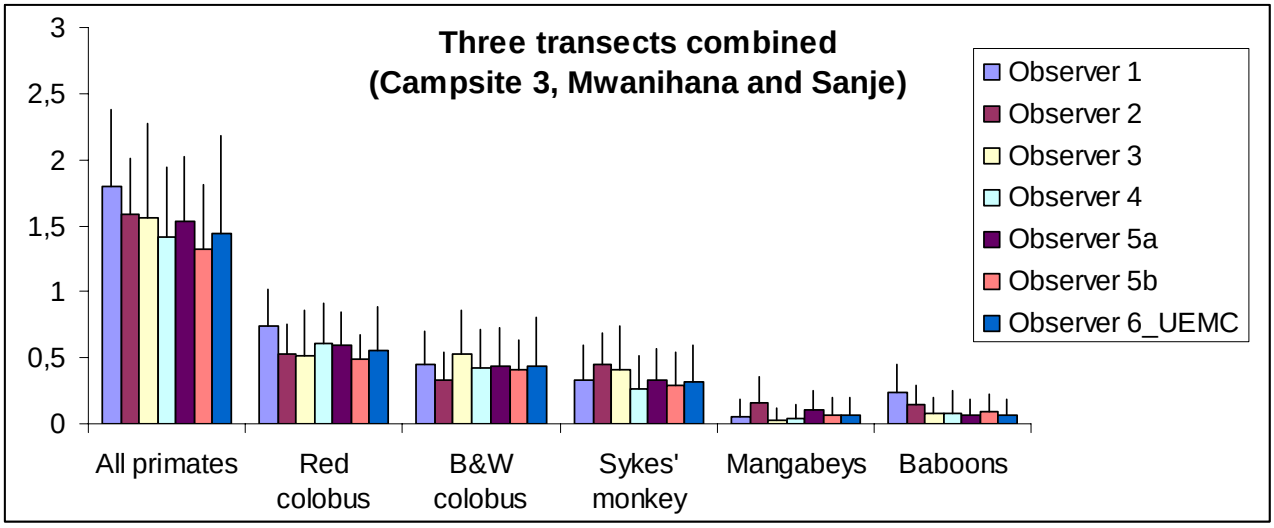


Figure 3. Results (mean number of primate groups seen per km and standard deviation) of primate census pooled for 3 transects from data collected from 1998 until 2007 (the last set of data being collected by UEMC)

Differences among observers are significant for all species except the Angolan colobus. However, Bonferroni's post-hoc multiple comparisons indicate that differences are due to only one observer diverging from one or more other observers. This is the same pattern observed in a previous analysis (Rovero and Mtui 2006). 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 = 6,247)	P (differences between observers)	Post-hoc significant at P<0.05
Red colobus	2.88	0.010	Ob 2 vs Ob 1
Angolan colobus	1.39	0.219	None significant
Sykes' monkey	2.41	0.028	Ob 2 vs Ob 4, 5
Mangabeys	3.50	0.002	Ob 2 vs Ob 3,4,6
Baboons	4.64	0.000	Ob 1 vs Ob 2,3,4,5,6
All primates	2.44	0.026	Ob 2 vs Ob 1

The key result of relevance here is that UEMC data do not diverge consistently from previous mean values 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 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. The presumed temporal trend observed for baboons is partly due to higher values reported by Observer 1 (1998) but it might also be consistent with a reduction in relative abundance. 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 (A.

Kitegile and A. Mtui, pers. comm.). 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 need to be investigated more fully.

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 on 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 planned by UEMC (see section on plans).

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 10 repetitions were obtained during 2007.

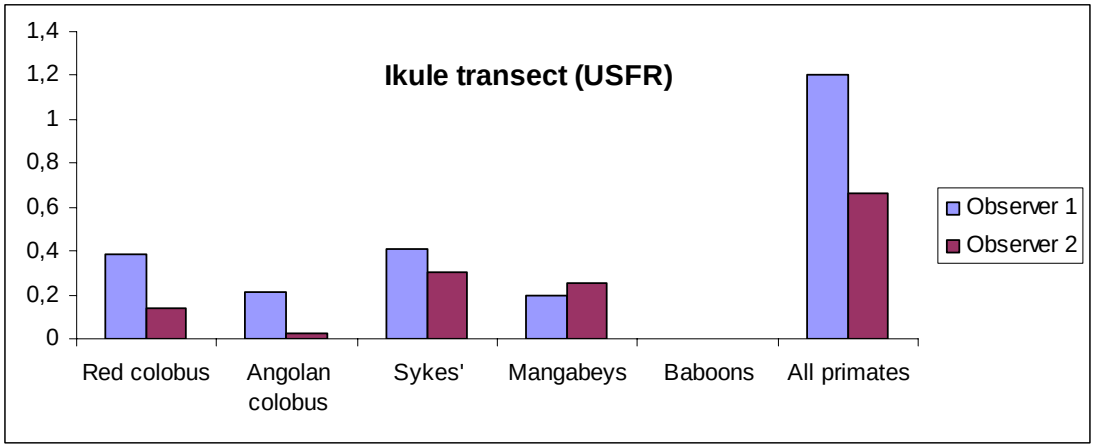
Results for each transect, and the four transects combined are presented in the following charts (Figure 4). UEMC data are referred to as "Observer 2". For all transects, encounter rates obtained by Observer 2 were generally lower. However, analysis run on the combined data indicates that differences are not significant except for the Angolan colobus (Table 4). It would be surprising if the lower rates of detection of primate groups by Observer 2 reflect a real decrease in populations, given the relatively short period of time between his samples and those by FR and AM. These differences more likely reflect differences in experience between the observers.

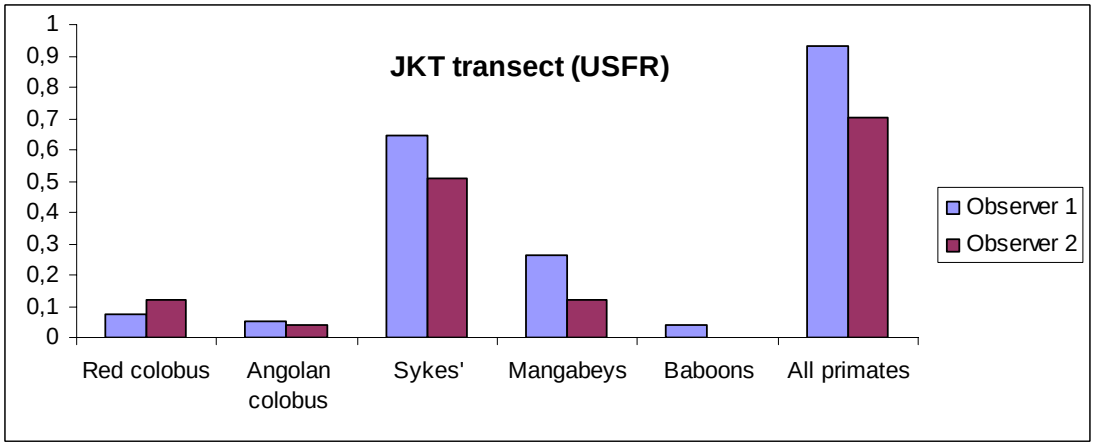
Table 4. Results of ANOVA and post-hoc comparisons on primate census results
obtained by different observers in USFR

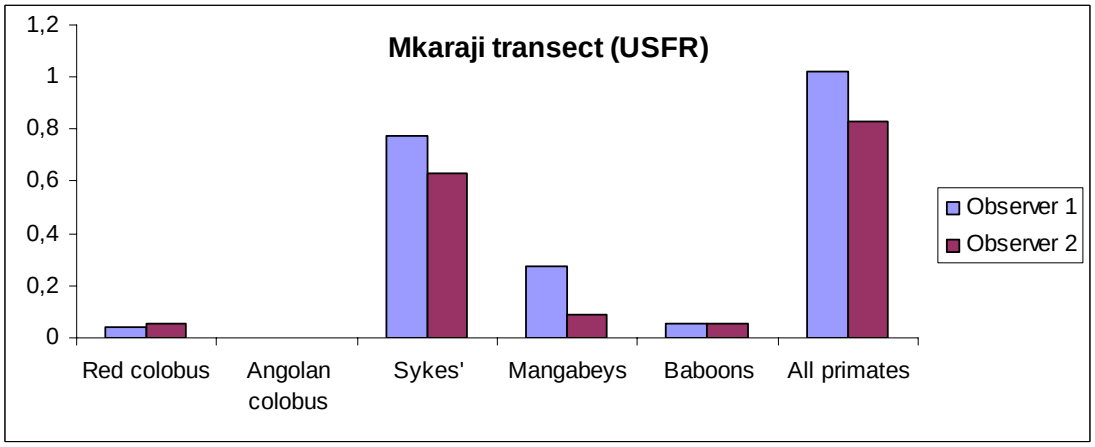
Species	F (df = 1,92)	P (differences between observers)
Red colobus	1.94	0.166
Angolan colobus	4.73	0.032
Sykes' monkey	2.03	0.158
Mangabeys	0.63	0.431

Baboons	0.20	0.659
All primates	6.26	0.014

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







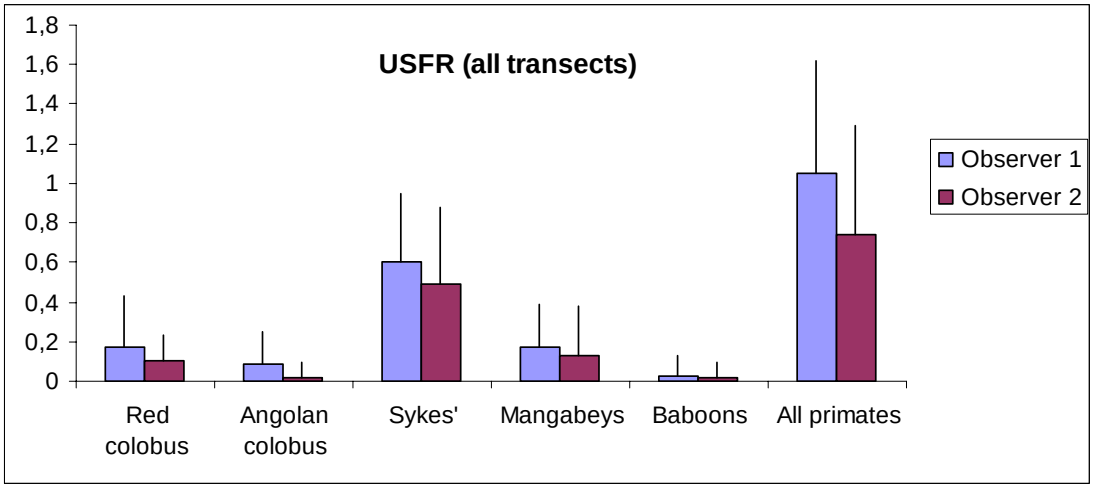


Figure 4. Primate census results obtained in USFR

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.

Results of sightings of duikers are shown in Figure 5 for Observer 1 (F. Rovero: 2002-2003), Observer 2 (A. Mtui: 2004) and Observer 3 (A. Kitegile-UEMC: 2007, refer to primate transects for the number of repetitions). Statistical tests reported in Table 5 indicate that the differences between observers are not significant. However, there are large differences between observers and overall, when data from each transects are pooled, they indicate a clear declining trend in the relative abundance of this duiker from 2002 to 2007. 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 tourist and possibly less patrolled, which may well result in relatively more encroachment occurring there.

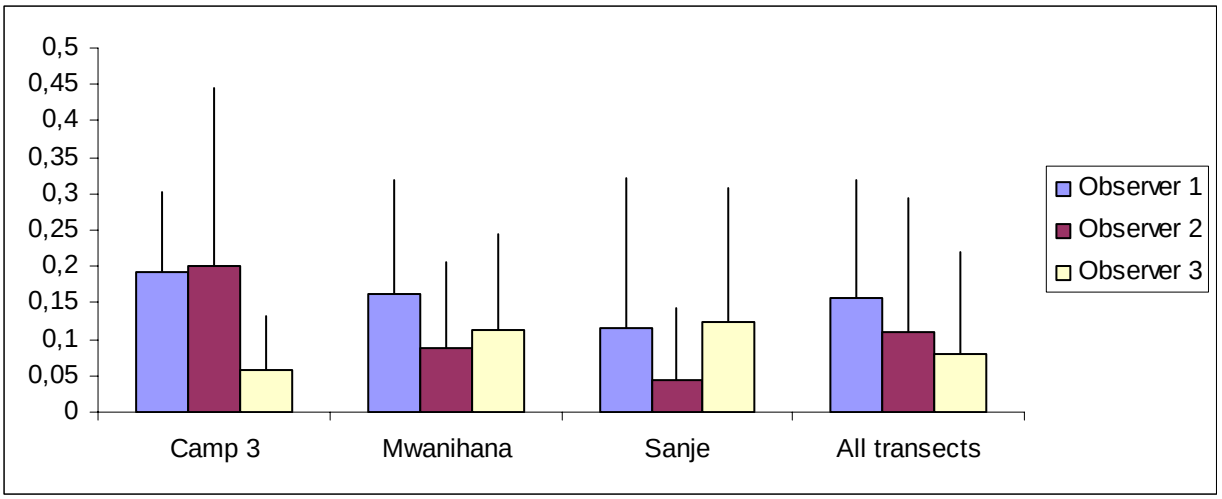


Figure 5. Results of Harvey's duiker census (individual encounters per km walked) by 3 observers along three transects in Mwanihana forest.

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

Species	F (df = 2,41)	P (differences between observers)
Campsite 3	2.38	0.106
Mwanihana	1.48	0.242
Sanje	1.21	0.310
All transects	1.91	0.152

4.4. Management and conservation implications from primate and duiker monitoring

The monitoring data collected by UEMC, albeit still related to a short period of time, when cumulated to previous data allow for the following, simple conclusions that are relevant to both park management and future monitoring efforts:

1) Overall results of primate monitoring suggest that the relative abundance of most species is stable; Sanje mangabeys are not adequately censused with line-transects and therefore results from the scarce and very variable data obtained for this species are difficult to interpret; ad-hoc monitoring should be implemented for this critical species.
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. Should additional observers be involved, then intense training and frequent reliability checks have to be done.
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. 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. It is therefore hoped that the newly established Kilombero Nature Reserve will result in improved protection as soon as possible.

5. School education activities

UEMC initiated this pilot programme with four nearby primary schools in Mang'ula, namely Mlimani, Mwaya, Mgudeni and Msalise primary schools. Preliminary activities included: lectures on environment education to the school children, school trees nurseries, tree planting around the schools and study tours. From September to December 2007 the Centre organized tours to the UMNP for students from two schools, Mlimani and Mwaya primary schools. Students from the school in Chita (adjacent to Uzungwa Scarp) also visited the UMNP through Trento Museum's "Watu na Msitu" project.

UEMC also helped establishing tree nurseries in each of the four primary schools. With the support of WWF Udzungwa project, the centre supplied equipments such as polythene tubes, wheel barrows, pruning knives, watering canes, spades and seeds of different indigenous and ornamental tree species. A total of 25,200 seeds of different species such as *Khaya anthothea* (Mkangazi), *Gmilina arborea* (Mfudufudu), *Cendrlla odorata* (Mwlezi), *Sena siamea* (Mjohoro) and *Accesia mangium* (Mkessia) were planted in all four tree nurseries. Out of these seeds only a total of 13,200 seeds (52%) developed into seedlings, of which 2,796 have been plated in the different school areas as follows.

Schools	*Seedlings raised*	*Seedlings planted*
Mwaya	3133	820
Mlimani	4142	1546
Mgudeni	3790	380
Mang'ula a	2135	50

The lectures given by the UEMC's school education officer were on various environmental issues, such as forest and park protection, wildlife conservation, tree nurseries preparations and importance of tree planting around schools areas. A total of 68 lectures with a total of 45 lecturing hours have been given to the four schools, and these lectures has been delivered to a total of 1078 students of all schools, in assistance of 15 school teachers.

6. Activities planned from year 2

In addition to continuing the baseline monitoring of primates and duikers as reported, UEMC plans to implement/initiate the following components in 2008:

Ranger-based monitoring. Following consultation with UMNP staff, plans are to train rangers (and possibly, village scouts) operating from the ranger posts of Lumemo (SE), Ruipa (SW), Udekwa (W), and Mbatwa (N) on monitoring data collection. This means covering all main areas except for Mwanihana where systematic monitoring is already implemented directly from UEMC and park HQs.

The monitoring activities chosen are in line with the requirements of being cheap, simple, and repeatable. Data collection will be along transect routes, 6 km-long, set along pre-defined trails to count signs and sightings of medium to large mammals. Walked by two trained rangers from each ranger post. In selected forests, transects to record human disturbance will also be set, according to a simple protocol that has been successfully deployed in several forests of the Eastern Arc Mountains. One km-long transects placed from the forest edge towards the forest interior, where all stems above 5 cm diameter at breast height and within a strip width of 5 m each side of the transects will be counted and divided into live stems and cut stems. Results give an index of disturbance in terms of building pole and timber removal.

Depending on funding available, the first 6 months of data collection should be jointly conducted with experienced trainers from UEMC/UMNP and carefully evaluated, before the team of trained rangers will continue on monthly basis. Data will be handled to the UMNP Ecology Dept. and UEMC at the end of each month and a systematic way to process data will be implemented.

Sanje mangabey demography monitoring. This will consist of focal group follows of at least 3 habituated/semi-habituated groups of Sanje mangabey in Mwanihana forest (near the Njokamone site). Amani Kitegile with at least one trained field assistant or ranger will follow the groups, for 5 days or otherwise until a complete count of the groups is obtained, and record demography data (age/sex composition). The count will be repeated at least every 3 months. The activity will be done from the permanent campsite at Njokamone.

Impact of human disturbance in Mwanihana forest. The proposal is for repeating the study that Dr. Nyundo of the University of Dar es Salaam conducted in 2005 in collaboration with UMNP and with funding from WWF-Tanzania Programme. The study consists in sampling the dung beetles in areas with and without disturbance and assessing the differences in species' composition and abundance to derive an indication of the impact of human disturbance, particularly due to firewood collection. Details of this study are reported in Nyundo et al. (2006). This study will be coupled with disturbance transects established in Mwanihana forest as described above. Plans are to conduct this study during July-October 2008 under funding from WWF-Tanzania Programme.

External projects, fund-raising and networking. UEMC will facilitate the implementation of external projects expected to start in 2008, namely the TEAM monitoring protocols and EDIT/ATBI. Agreements between the parties are currently being conducted. In consultation with TANAPA and other agencies, Trento Museum will continue fund-raising to allow for the most appropriate accomplishment of UEMC mandate, especially in regard to ranger-based monitoring, networking and training courses organized with other parks for training and standardization of protocols, and collaboration with the Universities (SUA and UDSM) in Tanzania and elsewhere to facilitate practical courses and field-based higher education training.

This latter component is yet to be implemented but already SUA has shown interest in using UEMC facilities for conducting the research projects by B.Sc. students M.Sc. students. As already mentioned, the completion of the UEMC structure with the hostel will greatly

facilitate this activity that could also be extended to foreign Universities organizing international training programmes. The Tropical Biology Association would be an ideal partner in this regard.

References

Museo Tridentino di Scienze Naturali 2007. Conservation status, connectivity, and options for improved management of southern Forest Reserves in the Udzungwa Mountains, Tanzania: urgent need for intervention. Unpublished report to Critical Ecosystem Partnership Fund. http://www.cepf.net/xp/cepf/static/pdfs/udzungwa_mtsn_report_may2007.pdf.

Nyundo B.A., Mtui A. and Kissaka H. 2006. An assessment of ecological and socio-economic impacts caused by collection of deadwood, medicinal plants and cutting of grass for thatching in Udzungwa Mountains National Park. Report to TANAPA and WWF.

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.

Acknowledgments

Funds to establish the UEMC were from the Autonomous Province of Trento through Trento Museum and from the Margot Marsh Biodiversity Fund. Running costs for year 1 were covered by Trento Museum through funds from the Autonomous Province of Trento. Trento Museum and UEMC personnel is grateful to TANAPA for the invaluable support: we thank the wardens and staff at the UMNP and especially the Chief Wardens, Mr. Timbuka and Mr. Mushi and Park Ecologists/acting Ecologists Mr. Banga, Mr. Tesha and Mr. Mponjoli; Tanzania National Parks' Director General, Mr. Bigurube, the Director for Resources Conservation and Ecological Monitoring, Mr. Kishe and the Ecological Monitoring Manager, Mr. Lejora. Thanks also to the Forestry and Beekeeping Division for permission to work in Uzungwa Scarp. We are also grateful to all researchers and scientists that visited or stayed at UEMC, especially the long-term researchers and collaborators Trevor Jones and Andy Marshall. Thanks are extended to the Tanzania Forest Conservation Group for facilitating Trento Museum's work in Tanzania. Members of the Advisory Committee (Dr. Davenport, Dr. Keyyu, Prof. Madoffe, Dr. Nyundo and Dr. Struhsaker) are thanked for their commitment to help providing strategic advisory to UEMC.

Appendix 1. Encounter rate (ER) values (mean and standard deviation primate group sightings per km walked) for each observer and transect (T1-T4) from censues conducted in Mwanihana Forest, Udzungwa Mountains National Park, Tanzania. Density estimates (groups/km^2) for *P. gordonorum* are computed using data by FR and ASM only and are given in Italic (in parenthesis is the number of encounters with groups used for computing the estimate, details in Rovero et al. 2006). The last set of data (AK) was collected by UEMC.

Species	Observer	Campsite 3	Mwanihana	Sanje	Msolwa
P. gordonorum	1	0.71 ± 0.10	0.75 ± 0.45	0.75 ± 0.23	0.75 ± 0.22
	2	0.53 ± 0.30	0.48 ± 0.22	0.55 ± 0.13	0.39 ± 0.17
	3	0.50 ± 0.35	0.45 ± 0.37	0.58 ± 0.38	
	4	0.68 ± 0.39	0.46 ± 0.22	0.68 ± 0.25	
		5.4 ± 3.4 (28)	*3.8 ± 2.7 (21)*	*4.8 ± 2.6 (25)*	
	5a	0.5 ± 0.2	0.52 ± 0.23	0.79 ± 0.21	
		4.1 ± 2.3 (23)	*4.5 ± 2.2 (25)*	*6.9 ± 2.8 (33)*	
	5b	0.55 ± 0.21	0.45 ± 0.15	0.45 ± 0.18	
	6 (UEMC)	0.50 ± 0.30	0.57 ± 0.42	0.59 ± 0.29	0.80 ± 0.45
C. angolensis	1	0.46 ± 0.43	0.42 ± 0.13	0.47 ± 0.16	0.42 ± 0.20
	2	0.35 ± 0.21	0.27 ± 0.22	0.36 ± 0.21	0.32 ± 0.20
	3	0.30 ± 0.21	0.85 ± 0.34	0.46 ± 0.19	
	4	0.39 ± 0.42	0.50 ± 0.35	0.35 ± 0.25	
	5a	0.50 ± 0.22	0.27 ± 0.23	0.54 ± 0.35	
	5b	0.38 ± 0.25	0.43 ± 0.22	0.41 ± 0.25	
	6 (UEMC)	0.36 ± 0.34	0.61 ± 0.49	0.34 ± 0.17	0.60 ± 0.29
C. mitis	1	0.33 ± 0.26	0.29 ± 0.29	0.34 ± 0.3	0.33 ± 0.13
	2	0.38 ± 0.19	0.57 ± 0.31	0.38 ± 0.16	0.27 ± 0.21
	3	0.45 ± 0.27	0.30 ± 0.41	0.46 ± 0.33	
	4	0.24 ± 0.27	0.18 ± 0.01	0.39 ± 0.35	
	5a	0.38 ± 0.24	0.3 ± 0.17	0.31 ± 0.29	
	5b	0.29 ± 0.27	0.30 ± 0.29	0.27 ± 0.22	
	6 (UEMC)	0.34 ± 0.34	0.27 ± 0.24	0.34 ± 0.27	0.30 ± 0.21
C. sanjei	1	0	0	0.13 ± 0.19	0.13 ± 0.14
	2	0.03 ± 0.09	0.22 ± 0.23	0.23 ± 0.21	0.23 ± 0.18
	3	0	0	0.08 ± 0.13	
	4	0.03 ± 0.10	0.01 ± 0.11	0.06 ± 0.12	
	5a	0.11 ± 0.16	0.11 ± 0.13	0.08 ± 0.17	
	5b	0.03 ± 0.08	0.08 ± 0.13	0.11 ± 0.16	
	6 (UEMC)	0.05 ± 0.10	0.05 ± 0.10	0.10 ± 0.18	0
P. cynocephalus	1	0.29 ± 0.1	0.33 ± 0.26	0.13 ± 0.19	0.17 ± 0.2
	2	0.10 ± 0.13	0.22 ± 0.16	0.11 ± 0.13	0.11 ± 0.13
	3	0.15 ± 0.14	0.05 ± 0.11	0.04 ± 0.1	
	4	0.14 ± 0.19	0.13 ± 0.21	0.02 ± 0.07	
	5a	0.09 ± 0.12	0.13 ± 0.13	0.02 ± 0.07	
	5b	0.09 ± 0.12	0.13 ± 0.15	0.06 ± 0.11	
	6 (UEMC)	0.14 ± 0.17	0.02 ± 0.08	0.02 ± 0.08	0