The Arc Journal

Tanzania Forest Conservation Group

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Know your hotspot

Read about the latest research results from the Eastern Arc and Coastal Forests of Tanzania and Kenya

Find out about:
Mangabeys helping to restore forest habitats;
A potentially devastating spider mite lurking in the Uluguru Mountains;
Joint forest management succeeding in the Udzungwas
Why mice love forests
And much, much more....

This edition is dedicated to sharing the results of recent studies carried out by student researchers in the Eastern Arc and Coastal Forests with support from the Critical Ecosystem Partnership Fund.

About the Critical Ecosystem Partnership Fund

The Critical Ecosystem Partnership Fund (CEPF) is a global program that provides grants to nongovernmental and private sector organizations to protect vital ecosystems. CEPF focuses on biodiversity hotspots, the Earth's biologically richest yet most endangered areas. Together, the hotspots harbour half the diversity of life yet they have already lost 86 percent of their original habitat. The convergence of critical areas for conservation with millions of people who are impoverished and highly dependent on healthy ecosystems for their survival is also more evident in the hotspots than anywhere else. CEPF support equips nongovernmental groups and other sectors of civil society to conserve their environment and influence decisions that affect lives, livelihoods, and, ultimately, the global environment.

CEPF has invested US$ 7.1 million in the conservation of the Eastern Arc Mountain and Coastal Forest (EACF) biodiversity hotspot of Kenya and Tanzania. CEPF has supported 102 projects in the region as well as supporting two global project's whose scope includes the EACF. Amongst these projects, CEPF supported a student grants programme through BirdLife International. The programme provided grants to 25 students from academic institutions in Kenya and Tanzania to undertake conservation-related research in the hotspot. The results of 11 of the research projects supported through the CEPF Student Grant's programme are presented in this edition of the Arc Journal.

CEPF funds 25 local students through the CEPF Grants for Student Research programme

George Eshiamwata & Paul K. Ndang'ang'a
BirdLife International –African Partnership Secretariat

In East Africa, one critical area that needs to be addressed is individual and institutional capacity building to nurture scientists ready to face today's conservation biology challenges. When the Critical Ecosystem Partnership Fund (CEPF) launched its five-year, US$ 7 million conservation programme in the Eastern Arc Mountains and Coastal Forests of Kenya and Tanzania, one of its targets was to build local capacity in terms of conservation-related research.

CEPF set aside US$ 200,000 exclusively for Kenyan and Tanzanian post graduate students to conduct research within the hotspot. This programme was launched in the last quarter of 2006 with the aim of ensuring that a comprehensive and complementary suite of Small Grant projects was in place to address connectivity issues, biological knowledge of sites and the conservation of threatened species.

Since 2006 there has been an overwhelming interest in this programme from students in Kenya and Tanzania. A total of 68 proposals have been submitted since its inception. The high demand has overstretched the available funding and only 25 applications could be funded. Of the 25 grantees, 12 are from Kenya and 13 from Tanzania. Upon successfully completing their thesis work, the student grant programme will have contributed to 20 Masters and 5 PhD degrees from seven local universities in Kenya and Tanzania as well as 3 Universities abroad. The fruits of this investment are already being seen. For instance, one student project has led to the re-discovery of the Ornate Shovel-snout Snake (*Prosymna ornatissima*) in the Uluguru Mountains after 80 years. Findings that demonstrate impact on connectivity and biological knowledge are becoming clear as the students complete their work. Out of the 25 projects, four are contributing towards efforts to increase connectivity while the rest are contributing to our biological knowledge of molluscs (2), insects (3), plants (8), birds (3) and mammals (4).

The CEPF student grant scheme was intended to contribute towards filling gaps in our knowledge of the species and sites following the main CEPF investment, which supported over 100 projects. It is gratifying to note that student grantees have contributed significantly to new information on key sites and threatened species. Some of the sites that had not previously received any investment from CEPF but which were included in the CEPF student grant's programme are: Kaya Mtswakara,

Kaya Waa, Mwache Forest Reserve, Shimba Hills, Gongoni Forest Reserve and Marafa forest. At least two students are mobilising follow-up funds from other sources to enable them to carry out follow-up work including implementing some of the innovative recommendations they made through their research. Additionally, most of the student grantees interacted and worked with protected area personnel and enlisted the support of members from local communities as field assistants, enumerators or guides thus contributing to a greater awareness of the hotspot's biological values and conservation challenges.

The onus is now on the beneficiaries under this grant to sustain their research interest, make use of the linkages they have established with local universities and their research counterparts abroad to develop, strengthen and nurture the networks developed and continue to explore and sustain cross-institutional collaborations and keep the legacy of the CEPF programme going. It is anticipated that students will make use of the "who is working where" information circulated regularly to engage, foster linkages and learn from other researchers working within the region; explore other funding opportunities to continue with their research careers and help bridge the existing gaps in information.

This programme brought to the fore some of the issues hampering research at some sites including insecurity whereby some of the grantees were forced to change their study sites due to security issues. Another observation that was made during the implementation of the programme was that researchers, students and sometimes institutions lack appropriate equipment. In this regard, prior arrangements were made whereby all the equipment purchased by grantees will be donated to the host academic or research institutions. It is anticipated that the institutions will then be in a better position to make this equipment available for use by future students.

One key lesson from this project is that funding can never be enough to satisfy the large demand to implement research and conservation activities. However, developing priorities for funding and using a transparent, timely review process to identify the best grant applications is one of the best and most cost-effective mechanisms to maximize rapid results.

Of course this could not have been achieved without the tremendous support of the academic staff from the respective Universities who have worked with the students at all stages from proposal writing to the implementation of their fieldwork, analysis and theses writing. The Eastern Arc and Coastal Forests Coordination Unit members (BirdLife International – Regional Office, Nature Kenya, Wildlife Conservation Society of Tanzania, the International Centre for Insect Physiology and Ecology, the Tanzania Forest Conservation Group and the World Wide Fund for Nature- East African Regional Programme Office) who besides their normal routine work found time and resources to review all these grant applications and to provide technical and administrative support throughout the duration of this programme.

Christopher Sabuni from Sokoine University is one of the students who has been supported by the CEPF student grants programme

List of projects supported through the CEPF student grants programme

Project Title	CEPF contribution (US$)	Grantee	Level	University
The proximity of the farms to Arabuko – Sokoke forest influences the diversity of insect pollinators and fruit set.	7750	Kenneth Njoroge Mwangi	MSc	University of Nairobi
Beekeeping for forest conservation: Filling a knowledge gap at Arabuko Sokoke Forest, Kenya	9182	Susan Sande Okoth	PhD	University of Pretoria
Effects of Joint Forest Management Institutional Arrangements on Forest Condition and Local Livelihood	8025	Simon Deus Lugandu	PhD	The Open University of Tanzania
Abundance and Diversity of Small Mammals in Disturbed and Undisturbed Forests at Uluguru Mountains	8326	Elikana Kalumanga	MSc	University of Dar es Salaam
Bird-habitat relationships of some Kenyan coastal forest bird species	5487	Bernard Cheruiyot Soi	MPhil	Moi University
Cedrela mexicana impacts on indigenous trees diversity in Kimboza Forest Reserve, Morogoro Tanzania	3985	Charles Patrick	MSc	University of Dar es Salaam
Assessment of Species Composition and Diversity of Small Mammals at Saadani National Park	5044	Christopher Sabuni	MSc	Sokoine University of Agriculture
Density and Inter-fragment Dispersal of Bird Species in Three Coastal Forest Fragments, Kenya	9108	Simon Nganda Musila	MSc	Kenyatta University
Ecological Dynamics and Conservation Importance of the Eastern African Coastal Forests ecosystems in Tanzania.	8021	Mligo, Cosmas	PhD	University of Dar es Salaam
The ecology and molecular characterizarion of the endangered and endemic *G. taitensis* (land snail) of the Taita Hills, Kenya.	9389	Ann Njeri Mwaura	MSc	Kenyatta University
Distribution, diversity and population status of herpetofauna in lower Tana River forests, Kenya.	8439.29	Julius K. Nguku	MSc	Nairobi University
The distribution, diversity and populations status of Land snails from Shimba Hills National Reserve, Kenya.	6712	Mercy Nelima Ndalila	MSc	University of Nairobi
Impact of Human Disturbance On Coastal Forests: The Case Study Of Tong'omba Forest Reserve In Kilwa District, Tanzania.	4920	Hassan Senkondo Chikira	MSc	Sokoine University of Agriculture
Ecological Survey Of The Golden Rumped Elephant Shrew (*Rhynchocyon Chrysopygus*) In The North Coastal Forests Of Kenya.	6833	Grace Wambui Ngaruiya	MSc	University of Nairobi
Conservation status of threatened endemic birds in Gongoni coastal forest reserve, Kenya	6778	Maurice Ogoma	MSc	University of Bremen
Land use dynamics and human impacts on conservation status of *Warburgia stuhlmannii* in Dakatcha and Marafa forests	5458	Mercy Mwanikah	MSc	Moi University
Potential and Constraints Of Eco-Tourism In Improving Nature Conservation and Livelihoods	5520	Rehema A.Shoo	MSc	Sokoine University of Agriculture
Assessment of Rare Plants and Restoration Potential through Seed Bank in Zaraninge Coastal Forest, Bagamoyo District Tanzania	7080	Nancy Eliad Pima	MSc	Sokoine University of Agriculture
The status of invasive plant species at Udzungwa Mountain National Parks	4900	Mzeru Deogratias Paul	MSc	Sokoine University of Agriculture
Quantifying the Abundance, Distribution and Local Use of Rare Plant Species in East Usambaras Tanzania	5920	Linda Stephen Kiluma	MSc	Sokoine University of Agriculture
Assessment of the biodiversity of tetranychid mites in the Eastern Arc Mountains and East African Coastal Forest Mosaic Hotspot	3375	Faith Jebet Toroitich	PhD	North-West University of South Africa
Role of the Tana crested mangabey (*Cercocebus galeritus galeritus* Peters) in forest regeneration	5739	Kimuyu Duncan Maingi	MSc	Moi University
Vegetation response to climate change and human impacts in the Eastern Arc Mountains	5640	Cassian T. Mumbi	PhD	University of York
Assessment of Carbon Sequestration in Agroforestry Systems for Improved Livelihood in Uluguru Mountains	3,713	Wilson Ancelm Mugasha	MSc	Sokoine University of Agriculture
Willingness to pay for irrigation water: A case of Southern Uluguru Slopes, Tanzania	3,929	Aloyce Mpiri	MSc	Sokoine University of Agriculture

Evidence of seed dispersal by Tana crested mangabeys

Kimuyu Duncan Maingi
Moi University, Department of Wildlife Management

Introduction

The riverine forests along the Tana River are part of the Eastern Arc and Coastal Forest biodiversity hotspot. However, the forests have suffered severe disturbance resulting in the creation of over 70 isolated forest fragments. Major causes of fragmentation include: harvesting and utilization of different forest products, clearing of forests for agriculture, changes in river flow regimes resulting from the construction of upstream dams and natural die back due to changes in the river course. Forest fragmentation poses a serious potential threat to the area's biodiversity especially to endangered primates such as the Tana River Red Colobus (***Procolobus rufomitratus***), and the Tana River Crested Mangabey (***Cercocebus galeritus galeritus***). Due to the increasing need to restore and maintain the connectivity of these forest fragments it is critical to examine agents of natural regeneration. Seed dispersal can contribute to restoring and maintaining forest connectivity along the Tana River.

Seed dispersal and seedling establishment are crucial stages in the life history of plants. Dispersal allows seeds to escape high density-dependent mortality that characterizes the environment beneath the parents' crown. Other advantages associated with dispersal include colonization of suitable sites such as gaps created by natural tree falls as well as human disturbance. Seed dispersal is a critical process in maintaining the structure, composition and diversity of plant communities and may influence regeneration of previously disturbed forests. Plants depend on animals that consume their fruits for seed dispersal as the animals depend on plants for food. Understanding these mutuality relationships is a critical step in appreciating the direct economic and conservation consequences of the ecological roles of various plant and animal species.

Primates have been reported to contribute significantly to seed dispersal. It should be noted that primate species contribute to seed dispersal differently. In this study, I report the contribution of Tana crested mangabey to seed dispersal and forest regeneration. The Tana crested mangabey is a frugivore. Like other frugivores, it ranges widely and can move between forest patches through non-forested corridors. This makes them a potential candidate for investigations concerning seed dispersal. The current study focused on a single group of mangabeys refered to as the Mchelelo West group. The group consisted of 49 individuals at the beginning of the study. Its range included Mchelelo West (17 ha) and Guru South (45 ha) forest fragments which were once separated but have since then become contiguous.

Methods

I observed feeding behavior of mangabeys through complete day follows done three days in a week for a period of three months. I observed the treatment given to various food items, particularly seeds, and the distance moved while handling a specific food item. I also recorded defecation ***ad libitum***. Defecated fecal clumps were treated in two ways; (i) fecal samples were collected and analyzed in the laboratory for presence of seeds. Seeds extracted from dung were identified to species level, counted and examined under a dissecting microscope to determine their physical condition (whether destroyed or intact), (ii) some dung samples were left intact at the deposition sites within the forest. Sites of fecal clump were marked with a red flagging tape and monitored the day after establishment and subsequently on a weekly basis to establish activities of secondary dispersers or seed predators, and also to examine whether the seeds had the potential to germinate.

Results

Mangabeys were observed to move across Mchelelo west and Guru South forest patches. Figure 1 illustrates their movement patterns across the two forests.

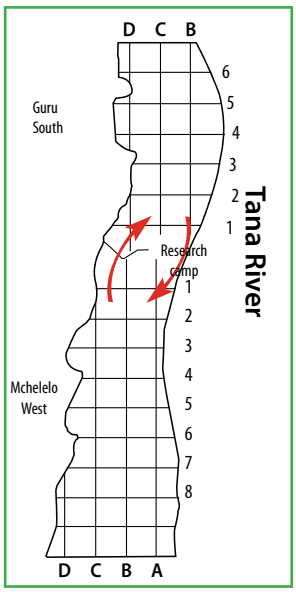


Figure 1: Movement of Mangabeys across the two forest patches

Mangabeys are primarily frugivores. They feed on both ripe and unripe fruits from various food plants. Figure 2 illustrates the frequency with which mangabeys ingested various food items.

During the entire period of study, mangabeys fed on 27 different plant species. Table 1 illustrates the preference ranks for the top ten tree species fed on by mangabeys. Distance moved while handling various plants ranged from 0 m to 20 m. However, dense foliage and difficulty in determining whether seeds were swallowed or held in cheek pouches precluded detailed quantification of the proportion of seeds handled in different ways. Figure 3: illustrates cheek pouch use in managabeys. Fruits were swallowed, spat out or dropped under the parent tree at some distance from the parent tree. Generally, the small seeds were swallowed while the medium sized and large seeds were either spat out or dropped after the pulp was swallowed.

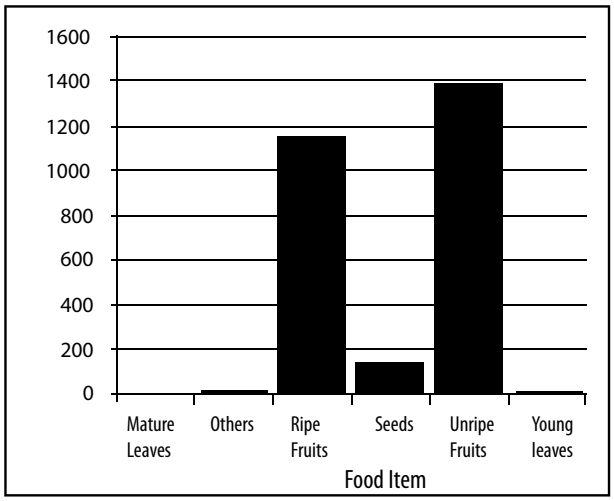


Figure 2: Frequency of various items in mangabeys' diet

Table 1: Preference ranks for the major fruit tree plants during the study period

Tree Species	Measured values		Rank		Rank difference	Remarks
	Usage	Availability	Usage	Availability		
Phoenix reclinata	977	20.25	1	6	-5	preferred
Hyphaene compressa	428	40.38	2	1	1	avoided
Acacia robusta	256	37.22	3	2	1	avoided
Oncoba pinosa	201	36.75	4	3	1	avoided
Zizipus pubensis	176	8.81	5	8	-3	preferred
Ficus sycomorus	168	28.00	6	4	2	avoided
Mimusops fruticosa	146	8.94	7	7	0	preferred
Chytranthus obliquinervis	49	3.16	8	9	-1	preferred
Sorindeia madagascariensis	43	1.31	9	10	-1	preferred
Rinorea elliptica	36	21.63	10	5	5	avoided

Figure 3: Illustrating use of cheek pouches by mangabeys

Mangabeys were observed to defecate randomly within the habitat during the day. However, the number of defecations was highest at sleeping sites compared to adjacent areas. A total of 1485 seeds belonging to 13 different plant species (apart from ***Ficus spp***; whose seeds were not counted) were extracted from 64 dung samples. Figure 4 illustrates seeds extracted from a single dung pile. Ninety nine percent (1475) of the seeds extracted were intact (no observable physical deformities). A total of 55 dung piles were marked and monitored to establish their post dispersal fate. It was established that dung beetles act on the dung almost immediately, moving it away from the original site or burying it at the original site. Figure 5 shows the activities of dung beetles. Germination was recorded for 30 (55%) out of 55 dung piles which were being monitored. Figure 6 shows seeds germinating from a dung pile.

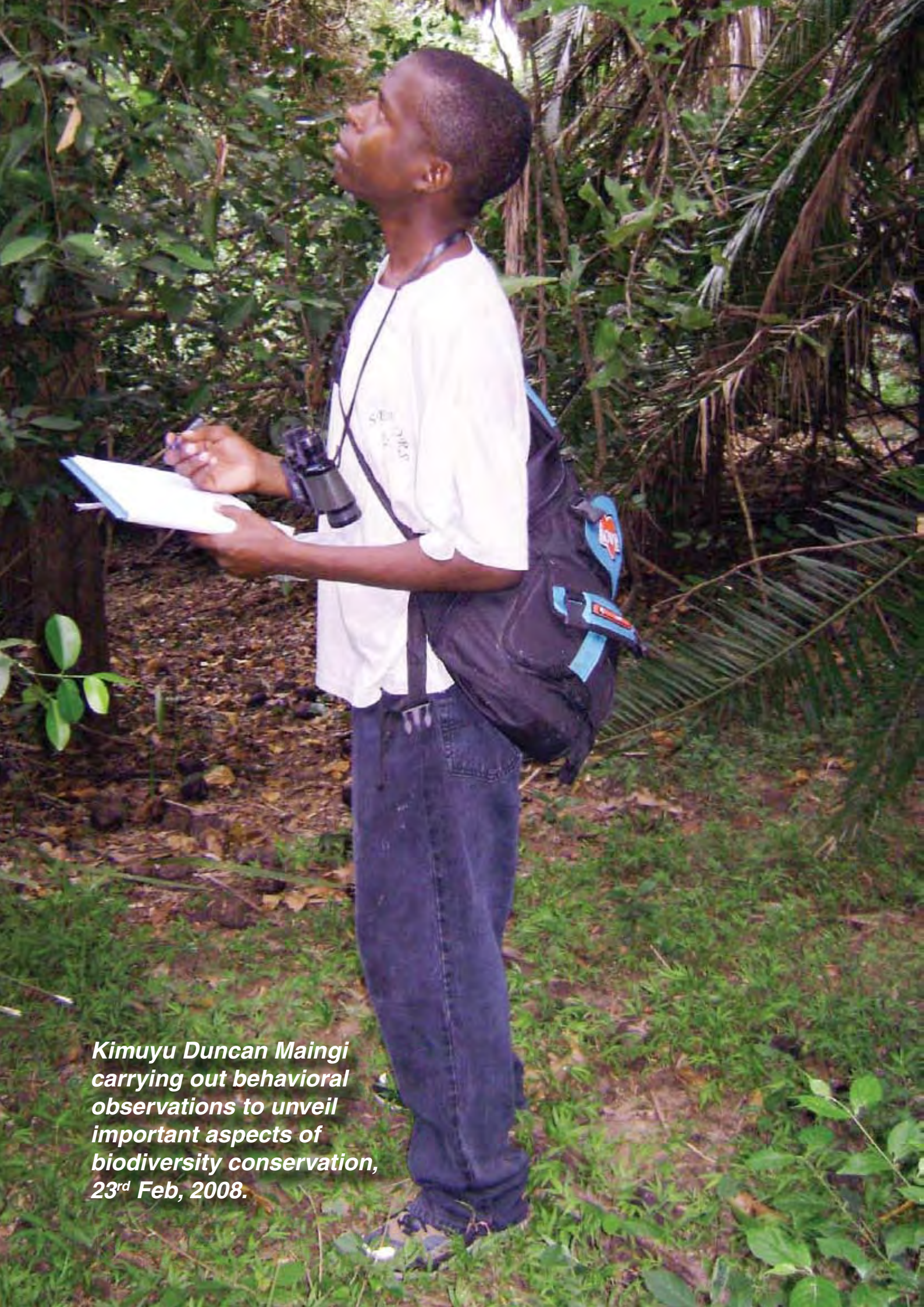
Figure 4: Seeds extracted from a single dung pile

Figure 5: Activities of dung beetles

Figure 6: Seeds germinating from a dung pile

Conclusion

Mangabeys feed on a wide array of fruit species and handle seeds in a variety of ways. They act primarily as seed dispersers but they also predate on some seeds (such as *Acacia robusta, Hyphaene compressa* and *Rinorea elliptica)* depending on developmental stage in which they are handled. Six out of the ten top most tree species in mangabeys diet were confirmed to germinate from fecal clamps. Considering the six species are all canopy trees with the potential to improve forest connectivity and regeneration, the contribution of mangabeys to forest dynamics and distribution of plants cannot be understated. Future studies should examinne how secondary dispersers and seed predators influence germination potential of seeds already dispersed by mangabeys. Focus should also shift to recruitment rates of seedlings.



Kimuyu Duncan Maingi carrying out behavioral observations to unveil important aspects of biodiversity conservation, 23rd Feb, 2008.

Conservation of coastal forest birds in Kenya: a survey of Gongoni forest reserve

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Introduction

The loss of tropical coastal forests in Kenya has been dramatic, and over the past couple of decades the country has experienced intense reduction of forest cover. Today, less than 2% of the total land in Kenya is covered by forests, an area that is below the internationally recommended minimum forest cover of 10%. Burgess *et al.* (2003) estimate that today, the coastal forests in Kenya have decreased in area from over 50,000 km^2 in the early 1900s to about 650 km^2.

Gongoni Forest Reserve lies on the south coast of Kenya in Kwale District. It is a moist semi-deciduous forest rising to an altitude of 40 m above the sea level, and covering an area of 824 ha. The area receives an average annual rainfall of 1300mm. The forest is a mosaic of tree stands with evidence of selective logging. The reserve is listed as a Key Biodiversity Area (KBA) that is important for the conservation of biodiversity in Africa.

No follow up surveys have been conducted to ascertain the presence and status of avian diversity of conservation importance in Gongoni since the quick survey conducted by Waiyaki (2005) to give a rough inventory of birds of the site. This study attempted to assess the conservation status of bird communities in Gongoni forest. Specifically the study examined the relative abundance and richness of bird fauna, and assessed the current habitat condition of the forest. The study revealed that Gongoni holds species characteristic of the East Africa Coast biome, including two globally threatened species and species that the East Africa region has responsibility to conserve (Bennun and Njoroge, 1996). This paper presents the initial results of a detailed avian survey conducted from November 2007 to February 2008.

Methods

Bird surveys

Bird surveys were conducted by line transects and timed species counts. A total of ten transects measuring 1000m were established to represent the major habitat and vegetation types. Line transects were established following the protocols recommended by Pomeroy (1992). Birds were recorded by sight and hearing in each of the

Abandoned firewood (left) and abandoned timber (right).


Evidence of fire (left) and breeding record for Crested Guineafowl (right)

established transects, as described by Bibby *et al* (1992). Data were collected by walking slowly along transects in the mornings and evenings when most birds were quite active. All birds seen or heard on either sides of the transect lines were identified and their numbers counted. Timed species counts followed the protocols recommended by Bennun and Waiyaki (1993). 27 timed species counts were randomly conducted in the forest. The counts were conducted in the evenings and in the mornings. Each timed species count lasted 40 minutes. Data were collected by walking slowly and quietly along a path in each habitat section following different directions and bird records were scored according to the first time the species was seen or heard.

Pairs of binoculars and a field guide were used to aid in identification during the counts. Digital photos were also taken for easy visualization.

Vegetation sampling

Birding transects were used for vegetation assessment. The point centered quarter (PCQ) method was used to collect habitat variables. Ten PCQ sample points were located at intervals of 100m along each transect. At each point, data were collected in four quadrants measuring 5 by 5 m around each point. In each quarter, the shortest distance of the nearest tree, sapling and shrub were recorded from the sample point. The PCQ data were used to calculate tree, sapling and shrub densities. Other vegetation variables measured in the quarters included canopy cover and canopy height.

Preliminary results

A total of 140 species belonging to 50 bird families were recorded during the survey. This number includes all the species encountered irrespective of the method of detection. They comprised 57 species categorized as forest dependent birds (i.e. bird species characteristic of the forest interior, and birds that are regularly found on forest edge, gaps and strips). The rest were birds that are less dependent on forests and include forest visitors, wetland dependent species and species characteristic of savanna or woodland habitats. The five most dominant bird families were Accipitridae (Eagles, Hawks, etc),


Some sections of open vegetation and grassland habitat in Gongoni forest

Turdidae (Thrushes and relatives), Capitonidae (Barbets and Tinkerbirds), Ploceidae (Weavers and relatives) and Pycnonotidae (Bulbuls).

The top five most abundant bird species in relation to the total species in transect counts were Olive Sunbird (11%), Green Barbet (11%), Collared Sunbird (7%), Fischer's Greenbul (6%) and Black-bellied Starling (5%). The five most common species recorded by timed species counts were Collared Sunbird, Olive Sunbird, Common Bulbul, Black-bellied Starling and Crowned Hornbill following in that order.

Two IUCN Red List species, i.e. species of global conservation concern were recorded. These were Fischer's Turaco *Turaco fischeri* (Near threatened) and Southern-banded Snake Eagle *Circaetus fasciolatus* (Near threatened). In addition, it was revealed (by the two field assistants who had a vast knowledge of local birds) that the globally threatened Spotted Ground Thrush *Zoothera guttata* has been previously recorded here during its non-breeding season between April and August. 14 species recorded represent regionally threatened species, out of which five are regionally Vulnerable and two are regionally near threatened, while seven are regional responsibility species.

The major conservation challenge facing Gongoni forest and its biodiversity is the constant drawing of forest resources by the local inhabitants. The forest faces threats emanating from selective logging targeting mature timber trees. Other forms of disturbance that were noted during the survey include tree debarking (for rope making and local use as shampoo for bathing) and forest fires.

Conclusions

Gongoni forest is rich in avian diversity. On the basis of the presence of the globally threatened and East Africa coast biome species, and owing to the comparatively large area of Gongoni forest, the site should qualify as an important bird area (IBA) or at least a potential IBA awaiting additional survey to provide more information on the presence of other species of conservation importance. There is a need to conduct additional surveys in the site to confirm the presence or absence of Spotted Ground Thrush especially between April and August when it winters in the coastal forests of East Africa.

Section of a forest wetland in Gongoni forest

The Impact of Joint Forest Management Institutions: Evidence from New Dabaga Ulongambi Forest Reserve, Iringa Tanzania

Simon Deus Lugandu,
RTP Tanzania,

Introduction

Scholarship on resource use and management has emphasized the key role of institutions. Tanzania's Forest Policy of 1998 also recognizes that institutions are crucial in the management and sustainability of natural resources. Institutionalists interested in resource governance indicate that forest condition is the function of a large number of factors including institutional variables - those related to existence, representation of users, and enforcement of rules and relationship with external authorities. The government of Tanzania introduced Joint Forest Management (JFM) as an institutional arrangement for the management of forest reserves in Tanzania, the aim being to improve the condition of forest reserves and the livelihoods of adjacent communities. This paper highlights the conditions which determine the strength or robustness of JFM institutions for sustainable forest resources management, and is based on findings from the study that I conducted in six villages which are implementing JFM in the New Dabaga Ulongambi Forest Reserve (NDUFR) in Kilolo district, Iringa Tanzania. The aim is to contribute knowledge about JFM institutions, how they work and impact on the forest resource conditions and forest adjacent communities.

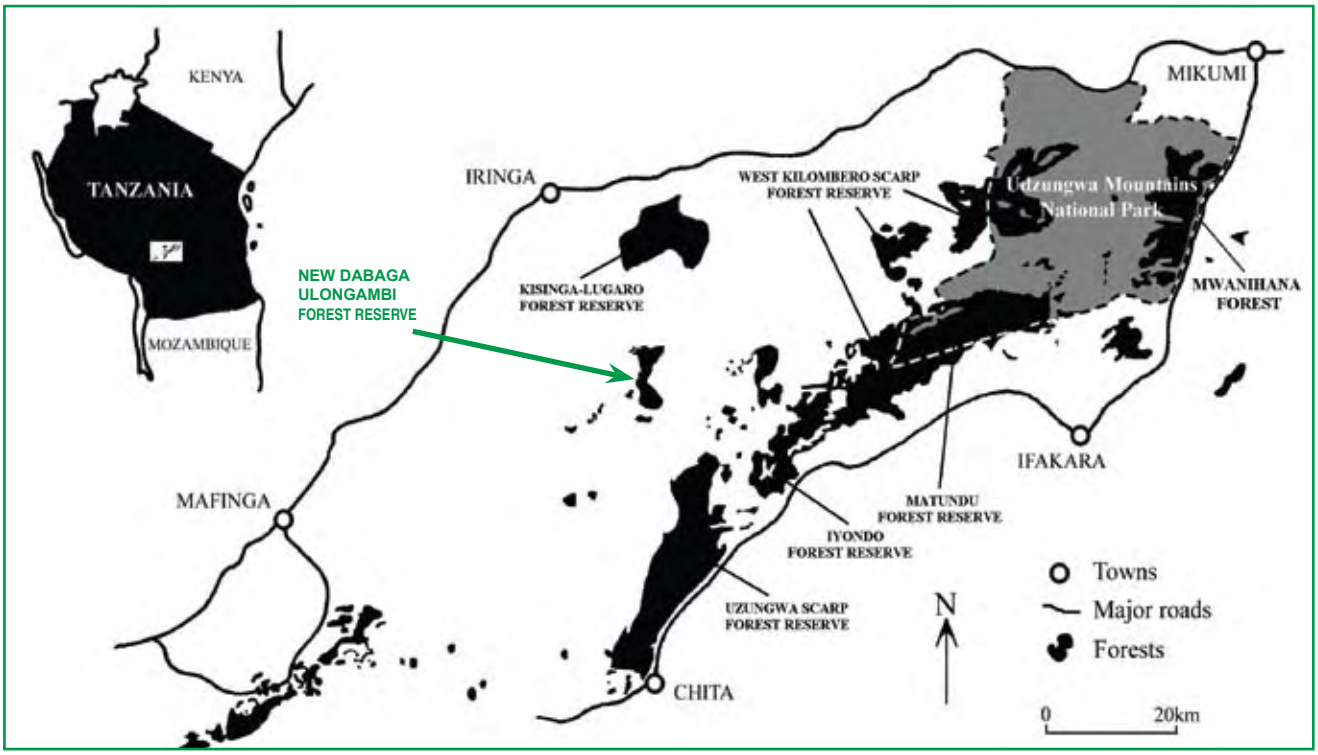


Figure 1: Location of the study area

Definition of Institutions

There are more than a few definitions of the term institutions as applied in different contexts. In this paper's context the definition of institutions is drawn from a number of scholars. Some define institutions as sets of working rules that are used to determine who is eligible to make decisions in some areas, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided and what pay offs will be assigned to individuals dependent on their actions. While others equate institutions to decision making arrangements by a group of individuals involved in the design, implementation and enforcement of rules to ensure proper use of the resources, others define institutions as a set of formal and informal rules that shape interaction of humans with others and nature.

Strength of JFM Institutions in New Dabaga Ulongambi

Preliminary results of analysis of satellite images and aerial photographs for New Dabaga Ulongambi Forest Reserve (NDUFR), as presented in Table 1, indicate that NDUFR is recovering from degradation since the introduction of Joint Forest Management showing that JFM institutions are robust in reducing the impact of negative human activities towards the forest reserve.

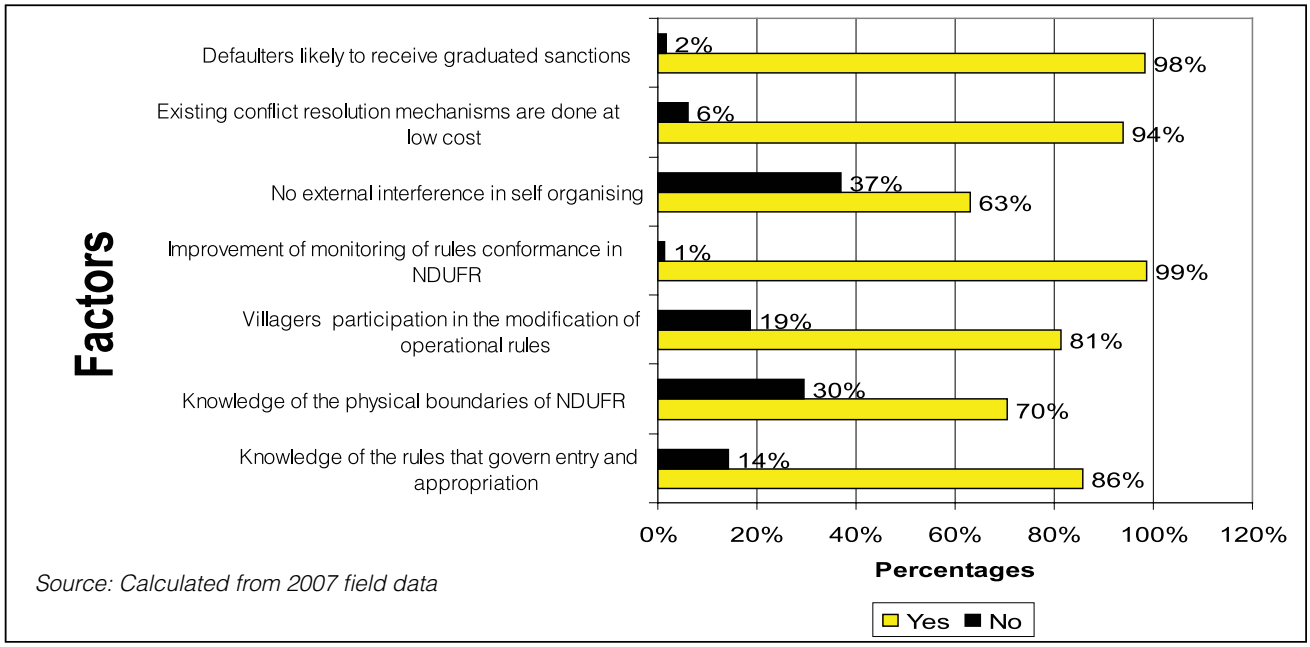
Table 1: Vegetation type and changes of NDUFR for 2000 and 2006

Vegetation Types	Year	
	2000	2006
	Ha (%)	Ha (%)
Bushed Grassland	0 (0)	0 (0)
Bushland with Scattered Cultivation	292.6 (7.8)	41.2 (1.1)
Dense Bushland	1008.6 (29.3)	1459.9 (38.9)
Grassland with Scattered Cropland	0 (0)	0(0)
Open Grassland	27.1 (0.7)	0 (0)
Mixed Cropland	158.4 (4.2)	97.6 (2.6)
Natural Forest	2120.8 (56.6)	2120.8 (56.6)
Wooded Grassland	112 (0.6)	0 (0)
Open Grassland Seasonally Inundated	28.9 (0.8)	28.9 (0.8)
Total	**3,748.4 (100)**	**3748.4 (100)**

Source: Survey data, 2007

Study findings from the 162 interviewed households show that JFM is a stronger arrangement for sustainable management of NDUFR as compared to government management arrangement, as summarised in Chart 1.

Chart 1: Factors that determine the strength of JFM in the sustainable management of NDUFR



Source: Calculated from 2007 field data

Awareness of the rules that govern entry and appropriation of resources

Study findings indicate that 86 % of respondent households know the rules that govern entry and appropriation of resources in NDUFR. This is due to the number of trainings through seminars, meetings and information materials provided through JFM. This awareness of the rules suggests that it is easier for many community members to identify anyone who does not have the right to withdraw resources from the forest reserve and hence be able to take action against them. Since the boundaries of the resource system as well as the individuals or households with rights to harvest resource units are known it helps to avoid and address the problem of free riding.

Awareness of the physical boundaries of NDUFR

Awareness by community members of the physical boundaries of NDUFR has a positive influence on the strength of JFM for the management of NDUFR. It was found out that 70% of the households interviewed have a better understanding of the actual NDUFR boundaries as compared to before the introduction of JFM. A small proportion of the population (30%) does not know the actual forest boundaries. It is easy for people to trespass and withdraw resources from the forest if someone does not know where the forest boundary ends. The boundaries of NDUFR can be identified clearly by the trees planted along the boundaries, beacons, the road separating the forest from other land uses and the fire lines cleared in parts of the forest reserve.

Legitimacy and fairness of rules on distribution of benefits and costs

When asked about whether they consider the appropriation rules to be fair and legitimate 98% of households consider the rules to be fair and legitimate. The explanation for this is that rules related to different goods and services harvesting in NDUFR have been devised and followed. Fair rules are those which keep relatively proportionate relationship between assignment of benefits and costs, otherwise those who contribute time, funds and efforts to sustain a common pool resource (forest in this case) feel bitter about the unfair allocation of benefits to those carrying lesser loads. The whole distribution system can disintegrate if it is not perceived as fair.

Participation of community members in modification of operational rules

Since the introduction of JFM in NDUFR 81 % of households interviewed stated that they are more involved in modification of the operational rules than before the introduction of JFM. The existing rules were prepared through a series of consultative meetings and workshops at local levels in 1999. If most users are not involved in the modification of the rules over time, the information about the benefits and costs is not fully taken into account in any efforts to adapt to new conditions and information over time. If the users start to perceive that they are prevented from making serious changes, they may simply start cheating whenever they have the opportunity and if more join in cheating the enforcement costs become very high and the system collapses.

Monitoring of rules conformance

Survey findings show that 99 percent of respondents acknowledge that monitoring of rules conformance has been practiced more systematically after the introduction of Joint Forest Management. This suggests that the strength of the monitoring institutions such as the Village natural resources committee and the forest guards in the community, has been increased. Without monitoring, many systems do not survive due to attempts by some individuals to cheat in order to gain at the expense of others.

Members of the VNRCs from New Dabaga Ulongambi receive training.

Rules enforcement and sanctions

A large proportion of households (98%) perceived that it is more likely to receive graduated sanctions now than before the Joint Forest Management system was introduced. Each village's forest guards make at least a single patrol every month. At other times members of Village Natural Resources Committees and village governments undertake field visits to inspect the condition of the forest. The Forestry and Beekeeping Divsion, through the catchment forest office, does regular monitoring of the forest reserve thus enforcing the monitoring capability of the local communities. These frequent patrols make appropriation of the resources from NDUFR prohibitive. Procedures of dealing with offenders are defined and implemented through the village bylaws.

Costs of resolving of conflicts resulting from different interpretation of rules

The findings show that 94% of the interviewed households perceive that the existing conflict resolution mechanisms are done at low cost. Through discussions with the Village Natural Resources Committees there has been no recorded conflicts resulting from different interpretations of the rules governing the Forest Reserve. Since the operation of local government is well defined conflicts are resolved through the existing governance structure such as the village government, ward development committees and courts. If disagreements in the interpretation of the rules are not resolved in a low cost and orderly manner, then users lose their willingness to conform to rules.

Rights of community groups and committees to organise without interference

The increase in the right of community groups and committees to organise themselves without interference from higher government authorities is likely to have contributed to making JFM a stronger institution for the management of NDUFR. This means that when the rights of groups to devise their own institutions are recognised by national, regional and local governments, the legitimacy of the rules crafted by users will be less frequently challenged in courts, administrative and legislative settings. Results show that 63% of the households interviewed acknowledged that after the introduction of JFM they have more rights to organise without the interference of the government although there is a notable proportion (37%) who perceive that the government still interferes with the organisation of the people in the villages surrounding NDUFR. Probably the notable proportion of 37 % reflects the FBD influence since it owns the NDUFR.

Conclusion

JFM is a stronger institutional arrangement as compared to direct government intervention arrangement in the management of reserved forest resources since it is participatory in nature and makes use of the local resources. Allocation of benefits and costs is one of the main determinants of willingness of people to participate in management of NDUFR. There is however still some concerns such as poor revenues received from NDUFR resources such that financing of VNRC and guards' activities may be jeopardized. The government is advised to undertake an assessment on how the same can be improved.

Beekeeping and forest conservation: A case study of Arabuko Sokoke forest, Kenya

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University of Pretoria

Introduction

Tropical forests are facing 'extinction' worldwide. This is because of human activities that are geared towards attaining a livelihood or simply put, unsustainable harvesting of timber and non-timber products. In order to combat this, community-driven conservation projects have been undertaken. At Arabuko Sokoke forest, the community is being educated on the usefulness of having the forest conserved. There are various projects undertaken to ensure that the community can draw a livelihood from it without destroying this vital ecosystem. Among the projects involved are bee-keeping ventures within the forest's vicinity. Although some studies worldwide have been carried out on honey quality, pollination services of bees, none has targeted this question: Is honey yield and quality made better by the presence of a forest? This study aims at possibly adding a strong reason why the community living around Arabuko Sokoke forest should conserve it. The specific objectives are: To construct a floral calendar for the Arabuko Sokoke

environs and thus investigate the sources of nectar and pollen for honey bees foraging at the Arabuko Sokoke environs; to assess the quantity and quality of honey collected from beehives at various distances from the forest; to investigate the pollination services rendered by honeybees to mangrove forest.

Preliminary Results

1. Floral calendar studies

71 plant species belonging to 16 orders flowered during this period. 70% of these flowered for 1-2 months and 28% for over two months. *Cocos nucifera, Hermania exapendiculata, Catharanthus roseus, Comellina bengalensis, Carica papaya and Lantana camara* flowered throughout the sampling period. A plant with a flowering period of more than one month is considered important for apiculture. All except one of the crops foraged by bees were flowering for >1 month and are thus important for Apiculture.

`Fg 1: A bee foraging on Aloe sp. flower. Picture by Susan Sande

2. Honey quality and quantity studies

From the preliminary analyses (one more season's data to be done), there are interesting patterns and we may just be able to give the Arabuko Sokoke community one more reason to conserve it. However, from this preliminary data, the moisture content, pH, free acidity, HMF and praline content did not differ significantly among honey collected from various distances away from the forest but all these parameters when judged by international standards indicate that both Arabuko Sokoke Forest and Mida Creek mangrove honey is of very high quality.

3. Mangrove pollination

Aspects of mangrove pollination by bees have been studied. The data has been analysed and is being interpreted in light of past studies in other countries. Mangrove honey is highly priced compared to the honey from the drier part of the Arabuko Sokoke forest. This study sheds light on how to improve the scanty practice of beekeeping for mangrove honey. Ecologically speaking, the pollination aspects can be used in improving mangrove regeneration programmes since they are known to have a high failure rate.

A healthy stand of mangrove at Mida Creek adjacent to the Arabuko Sokoke Forest, Kenya.

Photo by: Susan Sande

Small Mammals of Saadani National Park

How much do we know about species of small mammals that exist in different habitats in Protected Areas?

Christopher A. Sabuni, Sokoine University of Agriculture, Pest Management Centre,

Black and rufous elephant-shrew (Rhynchocyon petersi) in a trap in Saadani. Photo by C. Sabuni.

Squirrel in a live trap in Saadani National Park.

Background

Saadani National Park was gazetted in 2005 and encompasses various habitat types including remnants of coastal forests of which Zaraninge forest is one of the largest coastal forests remaining in Tanzania. According to IUCN categories of Protected Areas, Saadani National Park (SANAPA) falls under category II as "Protected Area managed mainly for ecosystem protection and recreation". However, the creation of protected areas has mostly focused on the protection of charismatic species, primarily, ungulates, primates and carnivores. The small mammals in these habitats remain relatively unknown, perhaps this is because they are cryptic, concealed or 'non majestic'. Funding made by CEPF as support for postgraduate research projects enabled the study of small mammals to be conducted in SANAPA. The study aimed to increase existing knowledge of vertebrate biodiversity in particular of small mammals. The recent discovery of a new species of giant sengi or elephant shrew (genus Rhynchocyon) in the Udzungwa Mountain indicates that further studies are still required to study small mammals in different habitats of Tanzania. Since monitoring and conserving biological diversity commences with the development of a catalogue of species in existence and their geographical distribution, the current study aimed to assess the composition and diversity of small mammals found in the different habitat types of Saadani National Park, with the specific objectives of:

- identifying the species of small mammals and their population characteristics in different habitat types found in SANAPA.
- determining species richness and diversity of small mammals of SANAPA

Collection of small mammals

The study was carried out in four sites:
Zaraninge forest: evergreen forest with a closed canopy;
Kiwandi swamp: dominated by mixed grass woodland and *hyphaene* palms and surrounded by forest;
Mligaji thicket: evergreen thicket mosaic comprised of small patches of evergreen thicket interspersed with *Terminalia* grassland, with riverine forest occurring along Mligaji river. The small thicket patches consist of dense woody vegetation with high species diversity.
Airstrip: bushes with short grasses (Figure 1).

Small mammals were trapped alive using medium Sherman and wire cage traps. Larger species of terrestrial and arboreal small mammals were trapped using wire cages (e.g. elephant shrews, galagos, and squirrels).

Captured individuals were identified at least to genus level and standard taxonomic measurements were taken. Sexually active and non reproductive characteristics for individuals were examined and recorded. Identified animals were fur-clipped and returned and released to the same place where they were trapped. A few individuals were taken as voucher specimens for detailed taxonomic processes and were deposited at SUA Pest Management Centre.

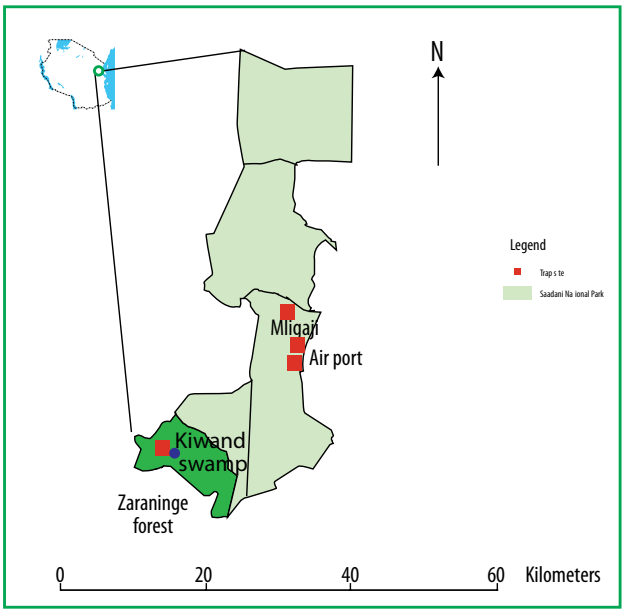

Figure 1: Location of trapping sites of species of small mammals in Saadani National Park

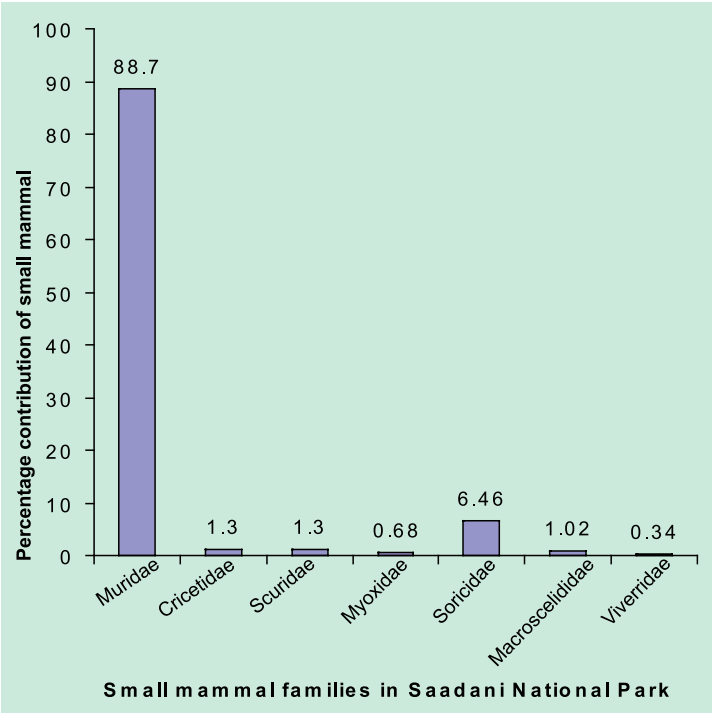

Figure 2: Individual composition of small mammals captured in Saadani National Park

Vegetation at Mligaji

Giant pouched rat trapped from Saadani.

Results

The results of this study found sixteen genera (Acomys, Beamys, Cricetomys, Crocidura, Genetta, Grammomys, Graphiurus, Mus, Lemniscomys, Mastomys, Steatomys, Paraxerus, Petrodromus, Rattus, Rhynchocyon and Tatera) belonging to seven families to exist in Saadani National Park. Most species belong to the muridae family (Fig 2). The population characteristics analysis, which examined age composition, sexual maturation, and reproduction characteristics, were carried out only for muridae for which there was a larger sample size. However, this type of study which is influenced by food availability, cover and rainfall pattern requires a longer period of study. The present results are hoped to increase the species lists of small mammals of Saadani National Park. It also calls for further studies to establish population characteristics of different individuals of small mammals and diversify the study in different habitats in Saadani National Park.

ASSESSMENT OF BIODIVERSITY OF PLANT INHABITING MITES IN EASTERN ARC MOUNTAINS AND ITS ENVIRONS

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Introduction

One of the largest current threats in the Eastern Arc Mountains and East African Coastal Forest Mosaic (EACF) Hotspot comes from the commercial cultivation of vegetables, which are sold in the domestic markets, notably in urban centres like Dar es Salaam, Arusha, Mombasa and Nairobi, and from the growing of cardamom and other spices under forest cover. These activities result in forest clearance and the destruction of forest undergrowth and pollution as a result of excessive use of inorganic agro-chemical inputs (fertilizers and pesticides). However, the livelihoods of many of the people living in the hotspot depend on this vegetable production. Many vegetables are ideal host plants for spider mites. In the Kenyan part of the hotspot (Taita Hills) tomatoes, one of the most commonly grown vegetables in the area, is already under attack from the invasive spider mite *Tetranychus evansi* Baker & Pritchard. Chances are high that this mite is also present in the Usambaras and Ulugurus.

The family Tetranychidae Donnadieu is one of the most important families in the Acari because they can be serious pests of agricultural crops. The "Spider Mites Web" database lists 1,243 mite species that belong to this family. From Africa, 39 genera and 357 species of tetranychid mites have been recorded. Out of these, 219 species have been recorded from South Africa, compared to a range from 1 to 56 species for each of the remaining countries with 10 species reported from Kenya and only 3 from Tanzania. All three species reported from Tanzania (*Mononychellus progresivus* Doreste, *Oligonychus coffeae* (Nietner) and *Oligonychus gossypii* (Zacher)) are well known pests of cultivated plants. By contrast, in South Africa many species have been reported from wild plants. The large discrepancy of tetranychid species recorded in South Africa and other African countries does not reflect the real situation but is caused by lack of interest in this arthropod group in large parts of Africa. Meyer (1987) published the last definitive taxonomic overview of the tetranychid mites of Africa. Surveys in Kenya between September 2005 and April 2007 have already added 13 additional species to the 10 reported in the database (Toroitich 2007, unpublished data).

Quite apart from their agricultural importance, spider mites are a neglected taxon within the biodiversity of the hotspot. Knowledge of the spider mite fauna in cultivated and uncultivated areas of the hotspot would not only contribute to the knowledge of the biodiversity of the hotspot but also help to design environmentally sound control strategies for spider mites attacking vegetables and therefore protect the livelihoods of the people living in the hotspot. This study was designed to assess the species diversity of tetranychid mites in the EACF hotspot and to document the species diversity; identify economically important species and design easy to use protocols for their identification as a pre-requisite to designing appropriate management strategies.

Materials and Methods

Mite collection

Collection of mites was carried out in Tanzania (Usambara and Uluguru Mountains). The sampling concentrated on important vegetable growing areas and covered all the vegetation types and elevations in the chosen environs.

Spider mites from different plants were collected from the stated areas. Mites were collected from within forested areas where possible, forest margins and from fields surrounding the forested areas. The area name and the GPS location of each sampling site was taken as well as the host plant of the mites. The mites were put directly into small vials containing 70% ethanol and transported to the laboratory at *icipe*

In the laboratory, the mites were left in the 70% alcohol for ten days for the purpose of clearing to remove the internal tissues (Craemer *et al.*, 1998). After ten days, the mites preserved in 70% alcohol were mounted in PVA mountant for identification. Identification was carried out under high power magnification of a microscope. The mites were identified up to species level where possible using the shape of the male aedeagus and the position of the duplex setae as the distinguishing characteristics as described by Craemer *et al.* (1998) and Meyer

(1987). Identification of most of the mites collected is still underway and will be presented in a future report.

Preliminary results:

Sampling trips were made to Tanzania in the months of February and March 2008. Mites were collected from two regions in Tanga area namely Kwa Bada location, Muheza district which represents fruit orchard and farmlands in the lowland altitude areas and higher altitude Amani nature reserve and the farms within the forested area, this also represents the East Usambara mountains conservancy area.

The second visit involved visiting the Uluguru mountains area, sampling was done in the higher parts of Mgeta –Nyandira where temperate fruits and vegetables are grown and in the lower and warmer side of Matombo area where citrus fruit orchards are widespread and a little vegetable production is done.

Plate 1: Map of Tanzania showing the exact points where mite collections were done

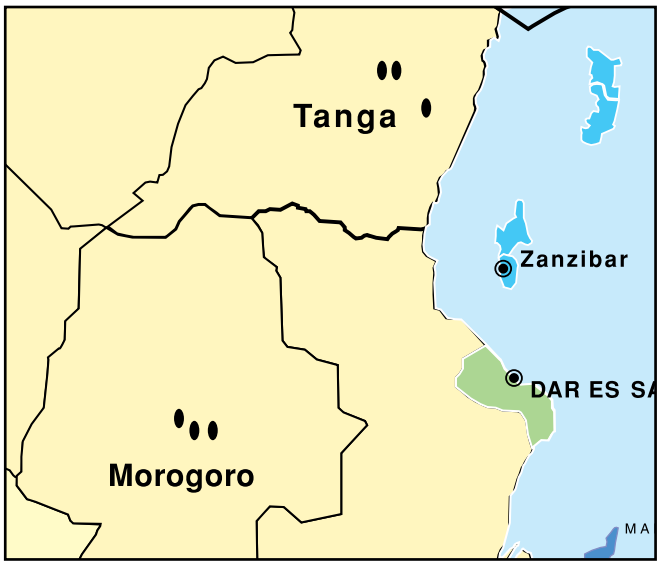

Table 1: Mites collected during preliminary trip to EACF areas in 2007

Place of collection	Mites identified:
Lushoto – Tanzania	1. *Typhlodromus* (Anthoseius) near *transvaalensis* (Nesbitt)
Mazumbai forest – Tanzania	1. (Ascidae) *Lasioseius sp* 2. *Typhlodromus* (Anthoseius) *near crassus* Van der Merwe
Chawea forest – Kenya, Taita	1. *Amblyseius largoensis* 2. *Typhlodromus* (Anthoseius) sp 3. Ascidae, probably *Lasioseius sp*

Table 2: Mite collections during February and March 2008 from Usambara and Uluguru Hotspots

District	Area	GPS	Elevation (metres)	Host	Mites
Muheza	Kwa Bada	S05°19.649”; E038°45.041”	230	Lemon	*Eutetranychus sp.*
Muheza	Kwa Bada	S05°18.848”; E038°47.048”	237	Orange	*Eutetranychus sp.*
Morogoro	Mukuyuni	S06°59.715”; E037°48.687”	390	African eggplant	*Tetranychus evansi*

From the field trips to Tanzania, the invasive mite species *Tetranychus evansi* was collected in an African eggplant farm near the Uluguru mountains of the EACF namely Mukuyuni area but they were not found in Mgeta-Nyandira most probably due to the lower temperature and higher altitudes there.
This pest was not collected in the East Usambaras and its environs where some tomatoes and eggplants were grown in fields around Amani Nature Reserve.
The common citrus mite, *Eutetranychus sp.* was collected in all the citrus fruit orchards visited in East Usambaras - Muheza area although it was present in below-economic threshold levels since the mites damage was not visible and farmers did not complain about any losses caused by this pest. Together with the tetranychids, mites from other families were collected that are yet to be fully identified and th eir identity will be presented in a future report.

Plate 2: A photograph of the red spider mite *Tetranychus evansi* female and male on top under a compound microscope

Plate 3: An African eggplant field in Mukuyuni area in Uluguru mountains environ heavily invested with the invasive mite *Tetranychus evansi*

Plate 4: Healthy eggplant field

Discussion

The findings of the first trip shows that beneficial mite species were collected from the forested areas as opposed to the second table which shows only pest mite species from farmer fields, this shows us that as farming encroaches into the forests, the beneficial mites probably diminish due to use of pesticides and other farming practices therefore allowing the pest species to thrive and with time, reach economically harmful levels. However, it is possible that these beneficial species in the natural habitats can be used in augmentation in biological control strategies.

Avian species richness in three adjacent fragmented coastal forest patches, Mombasa-Kenya

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Introduction

The coastal forests in Kenya and Tanzania were once a continuous ecosystem, which stretched from North of the Somali border with Kenya to the Tanzanian border with Mozambique. However, today they exist as small isolated patches of forest in the midst of rapidly increasing human populations involved in increasing degradation of these sites. Even though the majority of coastal and Eastern Arc Mountain forests in Kenya and Tanzania have benefited from national (legally protected as national parks, forest reserves etc) and international (Important Bird Areas (IBAs), biodiversity hotspot eg Eastern arc mountains and coastal forest of Tanzania and Kenya biodiversity hotspot) recognitions, this has not slowed down the rate of habitat degradation. The majority of sites are little known and recent scientific data is lacking. Changes in the livelihoods of local communities adjacent to the coastal forests indicates that the ongoing extraction of natural products and its overwhelming negative impacts on the survival of biodiversity urgently requires regular updating of conservation interventions with up to date scientific information to respond to emerging challenges of conserving biodiversity. The coastal forests collectively occur within an altitude of 0-500m a.s.l along the coastal strip of Kenya and Tanzania, and are sometimes a few meters or kilometers from each other, but many have been shown to be unique in the type of species they contain which is reflected in the listing of 160 different sites within the Eastern Arc Mountains and coastal forest of Tanzania and Kenya biodiversity hotspot. Additionally, since the majority of coastal forests adjoin or occur close together, the need to increase restoration and connectivity using natural corridors among the fragmented patches throughout the hotspot has gained local and international currency in order to ensure continuous gene flow.

African Goshawk *Accipiter tachiro* a forest generalist bird caught in the net at Kaya Gandini and recorded in timed species count in all other three sites.

Eastern N cator *Nicator gularis* a forest generalist bird caught in the net in all three sites and recorded n TSCs in all other three sites.

Red-tailed Ant Thrush *Neocossyphus rufus* a forest specialist bird caught in the net only at Kaya Gandini and not recorded else where

Goals and objectives

Kaya Gandini (c.150 ha), Kaya Mtswakara (c. 247 ha) and Mwache Forest Reserve (c. 345 ha) are three costal forest patches in Kenya which are approximately 15 km from Mombasa, at *c.* 04°01'S, 39°30'E, and an altitude of 140 – 200 m. The sites are all listed within the Eastern Arc Mountains and coastal forest of Tanzania and Kenya biodiversity hotspot, with Gandini also being listed as an IBA. The fragments are currently adjoined but divided by river valleys (Mwache and Mbome) and by a matrix of human degraded habitat features. Four (Sokoke Pipit *Anthus sokokensis*, Plain–backed Sunbird *Anthreptes reichenowi*, Fischer's Turaco *Tauraco fischeri* and Spotted Ground Thrush *Zoothera guttata fischeri*) globally threatened bird species were recorded in 1999 in Gandini and two (Southern Banded Snake Eagle and Fischer's Turaco) species in Mtswakara. No avian surveys had ever been done in Mwache. It was therefore imperative to increase our scientific knowledge about Mwache. Given the proximity of the patches to one another there was also the likelihood of inter-fragment dispersal of birds in search of resources.

Specific objectives were:

1. Determine the current status of globally threatened bird species.
2. Investigate bird dispersal between the indigenous forest fragments.
3. Recommend the most appropriate conservation strategies for bird species.

Methods and materials

This project was conducted in Kayas; Gandini and Mtswakara and Mwache forests. The sites have Duruma/Kambe sandstone type of soils, two rainfall seasons with long (April-June) and short (July-December) rains averaging 500 mm/year. The vegetation of the three sites is mainly dry deciduous *Cynometra-Terminalia* forest. The survey was done between October 2007-March 2008.

Reconnaissance survey: Three days were spent in each forest familiarising with terrain, habitat types and birds. Bird and vegetation surveys were restricted to the primary habitat sections of the three forest fragments, even though all other habitats were visited for compilation of a comprehensive bird checklist of each study area. Birds were surveyed using Timed Species Counts (TSCs) and banding.

Timed Species Counts: The observer walked quietly for a period of 40 minutes along a particular route at a bird watchers pace, stopping frequently to identify and record all birds seen or heard calling. With a total of 22 TSCs in each forest in a week, it was possible to describe the bird community in each site. Only birds recorded within 0-25m of the recorder were considered for calculating the relative abundance score for each species, with other records being used to compile species list.

Bird ringing/banding: Two net lines of 60m (18m* 2; 12m * 2) and 54m (18m *3) placed at a distance of 60-100m, were established in each ringing site. Each fragment had three ringing sites which were located 200-500m apart from each other. Ringing was done in each forest for four hours (06:00-10:00 hrs) for two consecutive days and twice in each forest (Bennun and Howell, 2002). All captured birds were extracted and fitted with a uniquely numbered aluminium metal ring in one leg and a single colored plastic ring (red-for Gandini, yellow for Mtswakara and Blue for Mwache) to determine species dispersal among the

y y
Mtswakara working as local community guides to protect the two sacred forests from wanton destruction.

p y q y g
Mwache Forest Reserve.

patches. Additional biometric measurements taken were length of head, tarsus, wing, bill, weight and moult scores.

Vegetation: Habitat data was collected around net lines and along routes used in bird surveys. Ten plots each of 10m^2, were marked 10m away from paths and 50m from each other around each ringing site (30 plots) and TSCs (50 plots) routes. Canopy height was estimated in metres as the vegetation above 4 m and canopy cover estimated in %. The gross vegetation was estimated in % within a vertical cylinder of 10m diameter divided in three vegetation levels; low (0-2m), middle (3m-8m) and high (>8m). All live and cut tree stems were counted within a 5m radius from the centre of the plot in categories of 5-10cm Diameter at Breast Height (dbh), 11-20cm, 21-30cm and >31cm. Measures of litter, herb and bare cover were estimated in % within 1m^2 plot placed 1m from the centre of the plot in the northern quarter. To measure the spacing and sizes of canopy trees the closest four trees (>8m tall) were located from the centre of the plot, one in each quadrant of the compass (North, East, West and South) direction. Shrub density was measured at 1m and 2m height, using a chequerboard (50cm by 50cm with 10cm by 10cm red and white squares), at five metres from the centre of the plot directly North and South of the compass bearing. All measurements were taken by the same observer to reduce biases in observations.

Results

A total of 107 bird species were collectively recorded in the three sites, of these 63 birds were in Gandini; Mtswakara and Mwache had 70 and 64 respectively.

Of the 63 species in Gandini, 50 were recorded in the primary habitats of Gandini, while 51 and 31 were respectively recorded in the primary habitats of Mtswakara and Mwache. Two threatened species (Fischer's Turaco and Southern Banded Snake Eagle) were recorded in Gandini and two threatened species (Fischer's Turaco and Plain-backed Sunbird) were recorded in Mstwakara and one threatened species (Plain-backed Sunbird) was recorded in Mwache. Even though two (Sokoke Pipit and Spotted Ground Thrush) threatened species had been previously recorded in Gandini, the continuous habitat disturbance in the fragment might have reduced the pipit populations to low levels making it very scarce. Spotted Ground Thrush was missed in this survey because studies were done between October 2007-March 2008, when the intra-African migrant is not in Kenya (Zimmerman, *et al.*, 1996). However, Gandini seemed to be a potential site for the thrush because of the large quantities of litter in thick undergrowth in the fragment. A total of 59 individuals of 12 species were ringed, but none was observed as having dispersed from one fragment to the other. Gandini was richer in under-storey species, than other fragments despite the fact that out of the 28 vegetation structure variables analyzed, 20 were similar across sites. But Gandini and Mtswakara were more similar in vegetation structure than Mwache which had a different canopy height, canopy cover and density of live trees of dbh 21-30 and >31cm than former two.

Management issues recorded in these coastal forests was rock quarrying which was being undertaken at Mwache forest and expanding at a rate of c. 0.5ha annually. The three sites also exist as 'forest islands'

Degraded areas around Kaya Gandini left bare and eroded with the removal of trees to create farmlands and human settlements

in the middle of increasing human population which has completely converted the surrounding habitats to farmlands and human settlements. People living adjacent to the forests depend on them for firewood. Firewood and poles collection is a serious threat to these forests. The three sites are managed by different authorities. The Kaya forests are sites which were used as hideouts for Mijikendas against external attack by other tribes in the past (before 1900), but became sacred areas for conducting traditional ceremonies after independence (in Kenya 1963). Any exploitation of forest products in the Kayas was controlled by a council of elders through permits provided to interested users and enforced by community guards working in unison with the elders. This system of community management of the Kaya forests was almost collapsing at Gandini and Mtswakara and the local Duruma people living adjacent to these sites were cutting trees inside the sacred grove supposedly the holiest section of the Kayas. This was done with open disregard of the policing roles of the council of elders and community forest guards. Within Mwache, which is managed by Kenya Forest Service, quarrying was the biggest problem, with four different companies operating in the fragment using heavy machinery and chemical explosives which produced thunderous noise probably driving many avian and other species away.

Conclusions

The three forests are still very important sites for avifauna conservation and the differences in species in them still reinforces the uniqueness of sites listed within the Eastern Arc mountains and coastal forests biodiversity hotspot in Kenya and Tanzania for conservation of biodiversity. However, since the forests face enormous conservation challenges innovative proactive interventions are needed to secure the future of existing biodiversity such as opening the Kayas to tourists to enjoy Duruma culture and biodiversity; building the capacity of local communities to address local environmental problems such as soil erosion and loss of trees; all stakeholders to develop a remunerative system for community guards; improve communication among the council of elders, Kenya Forest Service and National Museums of Kenya and provincial administration; ensure environmental impact assessments and audits are done to quarrying projects at Mwache; and conduct additional research to quantify the amount of poles and fuelwood extracted from these forests and determine levels of sustainability.

Pitsawing-selective removal of trees using saws within the three forests by illegal tree poachers

Poles extraction a serious problem leading to degradation of the three forests

Extracted poles are mainly used to construct traditional houses in the surrounding villages

ABUNDANCE AND DIVERSITY OF SMALL MAMMALS IN DISTURBED AND UNDISTURBED FORESTS IN THE ULUGURU MOUNTAINS, TANZANIA

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Timescale: October 2006-July 2007

The Uluguru Mountains in eastern Tanzania harbour rich and unique biological communities. The Mountains contain at least 16 endemic vertebrates and support about 2,000 plant species, 25-30% of which are endemic or near endemic. The degree of endemism in the Ulugurus is exceptional in tropical Africa and the mountains are among the 10 most important tropical forest sites for conservation on the continent. Despite the importance of the biodiversity in the Uluguru ecosystem, the mountain has been affected by a number of disturbances, which include among others, pit sawing (timber harvesting), collection of fuel wood and poles and fire setting for various reasons like hunting and land clearance especially in the former lowland forest areas which have been converted to agricultural land.

The recent disturbances in the Uluguru Mountains are likely to have caused substantial loss of biodiversity. Such loss has been difficult to quantify for all organisms (as is the case in the other Eastern Arc Mountains) because for some fauna there is little baseline information on their diversity and natural history. Small mammals are one of the most poorly known vertebrate fauna in the mountains. Some members in this group are highly sedentary, showing high rates of endemism as well as high variance in species turnover and are thus appropriate indicators for monitoring environmental quality and degradation.

Therefore, in order to contribute to the knowledge of this faunal group, small mammals were trapped in the Uluguru Mountains, in order to assess their abundance and diversity in the disturbed and undisturbed forests with support from CEPF. Trapping was done in four major habitats (with three replicate plots in each habitat) located within the same elevation (1200-1300 m.a.s.l). The habitats included the intact forest (Forest A), slightly disturbed forest (Forest B), cultivated field (shamba) and the fallow land. The distance from one habitat to another was 150 m.

Trapping using various traps is the most common method used to study small mammals and has been successfully used to detect patterns of richness, composition and abundance of small mammal communities along ecological gradients. In the present study, Sherman live traps, metal traps and pitfall traps were used simultaneously. Pitfall traps were intended for capturing mainly the shrews and other smaller mammals. Sherman traps and metal traps were baited with various combinations of fried coconut, peanut butter, dried sardines and

ripe bananas. Caught animals were removed from traps, handled without using anesthesia, weighed to the nearest gram, and identified using mostly the identification keys in Delany (1975) and Kingdon (1974, 1997). They were then marked by toe clipping and released at the points of capture. Wherever specimen identification was difficult in the field the specimen was labeled, preserved and transferred to the University of Dar es Salaam and Pest Management Centre-SUA for further identification. Specimens were preserved in 10% formalin.

Within the study habitats and in each habitat, vegetations were sampled in order to establish habitat characteristics of the study area. Other parameters studied included depth and spatial coverage of dead organic matter as well as number of collected fruits and seeds. The percentage of ground herbaceous cover was also estimated for each habitat. These parameters were subsequently correlated with the occurrence of small mammals.

From a total of 4032 trap nights (*i.e.* 2112 Sherman trap nights and 1920 metal trap nights) and 2112-bucket nights, 449 small mammals, identified to fifteen (15) species, were trapped in all plots and seasons (Figure 1). These included fourteen (14) species of rodents and shrews, which were identified to the genus level only (*Crocidura spp*). Out of 449 small mammals, 215 were caught in the disturbed area and 234 in the forest areas constituting 48% and 52% of all trapped small mammals respectively. Opportunistic recording in the study area, but outside the sample plots, revealed three additional species of small mammal (*i.e.* two *Graphiurus murinus* and one *Dendromus mesomelas)*. The three most common rodent genera encountered in both habitats (disturbed and undisturbed) were Soft-furred rat (*Praomys*, n=90, 20%), African wood mouse (*Hylomyscus*, n=53, 12%) and the Brush-furred mouse (*Lophuromys*, n=121, 27%). These proportions are similar to those documented by other small mammal studies in the Ulugurus and other Eastern Arc Mountains.

Figure 1: Small mammals and their diversity in different habitats in the Uluguru Mountains, Tanzania (2006/2007)

ORDER/Family	Name of species	COMMON NAME	Habitats			
RODENTIA			A	B	C	D
Cricetidae	** *Beamys hindei*	Lesser-Pouched Rat	2	3	0	0
	Dendromus mesomelas	Tree-climbing rat	6	5	2	2
Muridae	*Grammomys dolichurus*	Common thicket rat/ narrow-footed woodland mouse	2	5	0	0
	*SPP GG *(Grammomys sp)*	Common thicket rat	1			
	Praomys delectorum	Soft-furred rat	39	30	10	11
	Lophuromys flavopunctatus	Brush-furred mouse	13	24	34	50
	Hylomyscus deniae	African wood mouse	22	15	3	13
	Mus musculoides		3	2	2	6
Myoxidae/ Muscardinidae	*Graphiurus murinus*	African Common Dormouse	11	5	1	5
`	*SPP XX				1	
	*SPP YY				1	
	*SPP LL				1	1
	*SPP MM		1			
	*SPP KK		1		1	
INSECTIVORA/ Soricidae	*Crocidura spp*	Shrew species	21	24	22	49
	SPECIES DIVERSITY INDEX (H`)		0.82	0.80	0.68	0.65

KEY: **A**= Forest habitat A, **B**= Forest habitat B, **C**= cultivated land (shamba), **D**= fallow land

** Only one individual of the species was known to have been collected in the Uluguru Mountains before the present study

* These rodent species are still under identification to get their names and families.

The relative abundance of small mammals was determined using trap success. In the overall results (dry and wet season), trap success was highest in the fallow land compared to the forest habitats with the lowest trap success recorded in the cultivated land (shamba) (figure 2). Small mammal diversity differed among the habitats and seasons (Figure 2). The habitats in the undisturbed forests (forest A and B) had higher species diversity than the habitats in the disturbed forest (shamba and fallow land) (figure 3).

Habitats	Seasons	
	Dry	Wet
	Number of animals per 100 traps nights (%)	Number of animals per 100 traps nights (%)
Fallow land	25.6	74.2
Cultivated field	49.6	50.4
Forest habitat A	41.5	58.5
Forest habitat B	40	60

Figure 2: Small mammal abundance (trap success) in the U uguru Mountains, Tanzania (2006/2007)

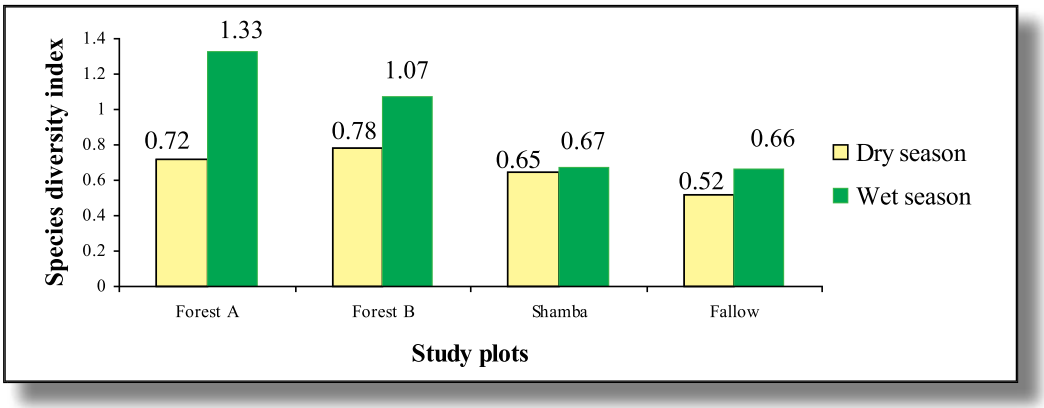

Figure 3: Small mammal species diversity during the dry and wet seasons in the Uluguru Mountains, Tanzania (2006/2007)

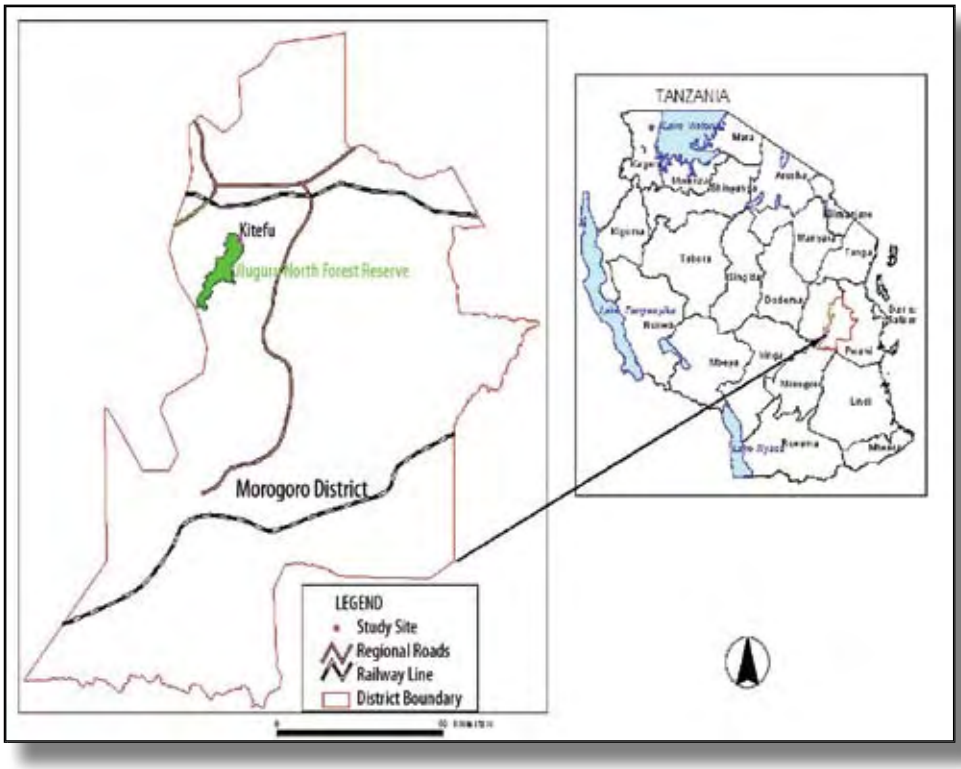

Figure The Map of Tanzania showing the Uluguru North Forest Reserve and the study area (Kitefu).

It is well known that, human interference causing forest disturbances is not a new phenomenon in most African forest ecosystems. In the Uluguru Mountains it has caused a loss of at least 60 % of its forest cover resulting into forest fragments with different levels of disturbances. Such disturbances are likely to have affected species richness, abundance and diversity of small mammals. Richness and diversity of small mammals is influenced by habitat heterogeneity. Habitat heterogeneity (in more complex and stable habitats) creates greater variety of microhabitats (variety of different niches for potential exploitation), which in turn harbours the large number of species.

Only generalist species tolerate disturbances and are found in both disturbed and undisturbed forests (Figure 1). The forest-specialist normally remains strictly in the forests. These are species, which can be of use (as baseline information; e.g. *Beamys hindei*) when assessing the impacts of forest disturbances in the Uluguru Ecosystem. Moreover, even within the generalist group there are some species, which can be used similarly as the specialist species. These are tree-dependant species whose number tends to be more in the forests compared to the disturbed forests. So while species richness might be of equal

Researcher assessing vegetation characteristics in the Uluguru Mountains.

One of the trap sites in the Ulugurus.

magnitude between the disturbed and undisturbed forests, species diversity tends to be higher in the undisturbed forests because of the higher level of species evenness in the undisturbed forests.

The higher abundance of small mammals noted in the fallow land (Figure 2) than in the undisturbed forests should not be misinterpreted to mean that the disturbed forests can as well also sustainably support small mammal species. Agricultural environment is characterised by instability. It is only the times when there is no cultivation that, relatively large area and habitats become available for small mammals to colonize (as was the case in the fallow land). This is also the only time when any competition for food between small mammal species is likely to be minimal. But the period is relatively brief and recultivation takes place sooner than later. When there is cultivation going on small mammals are forced to take refuge at the forest edge; because clearing of the ground cover for cultivation increases predation risks. So, this forest edge competition for food and shelter is likely to be intense and survival rates are rapidly decreased. Cultivation of banana and yams as practiced in the Ulugurus encourages agroforestry whereby indigenous tress such as *Cylicomorpha parviflora, Macaranga kilimandscharica* and *Myrianthus holstii* are left intact. This in turn increases habitat heterogeneity and accompanying diversity of small mammals. Other forms of cultivation are also likely to encourage habitat homogeneity and an accompanying reduction in faunal diversity. So, this study serves to emphasize that, although modified forest habitats are often reported to support a more diverse small mammal community by creating habitat heterogeneity, it is often at the expense of forest-adapted species.

LAND USE DYNAMICS AND IMPACTS ON CONSERVATION OF *Warburgia stuhlmannii* IN DAKATCHA AND MARAFA FORESTS IN MALINDI

Mercy Mwanikah,
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Introduction

Dakatcha Woodlands and Marafa forests have been documented as being part of the Eastern Arc and Coastal Forest Biodiversity Hotspot. These sites have no formal protection status and are highly threatened by anthropogenic factors. A study was carried out in 2007 using LANDSAT images over the past 25 years and baseline data collected to understand impacts of land cover changes on biodiversity. Data was obtained from LANDSAT thematic time series images (1975, 1987, and 2000). IDRISI, GEOVIS and Arc View 3.3 were used to process the raw data and to calculate the percentage change in land use/land cover classes using the arithmetic model builder overlay process. Ecological and social studies were also conducted to establish the global conservation status of *Warburgia stuhlmannii.*

Justification

Most natural habitats face destruction or have been altered to pave way for increasing human development activities. Most of the non-gazetted natural habitats in Kenya are managed and influenced by humans. This is the case for Dakatcha and Marafa sites in Coast Province. The two study sites are facing increased agricultural intensification and expansion, and commercial logging and selective logging. As a result, the tree species, *Warburgia stuhlmannii* is facing fast decline. However, the extent of this threat has not been documented. The study sought to find out the percentage change in forest cover between 1975 and 2000. It also examined the anthropogenic factors contributing to the loss of forest cover, and offers recommendations suggested by the local people as documented during structured interviews. The implications of the research results have been discussed in relation to policy recommendations.

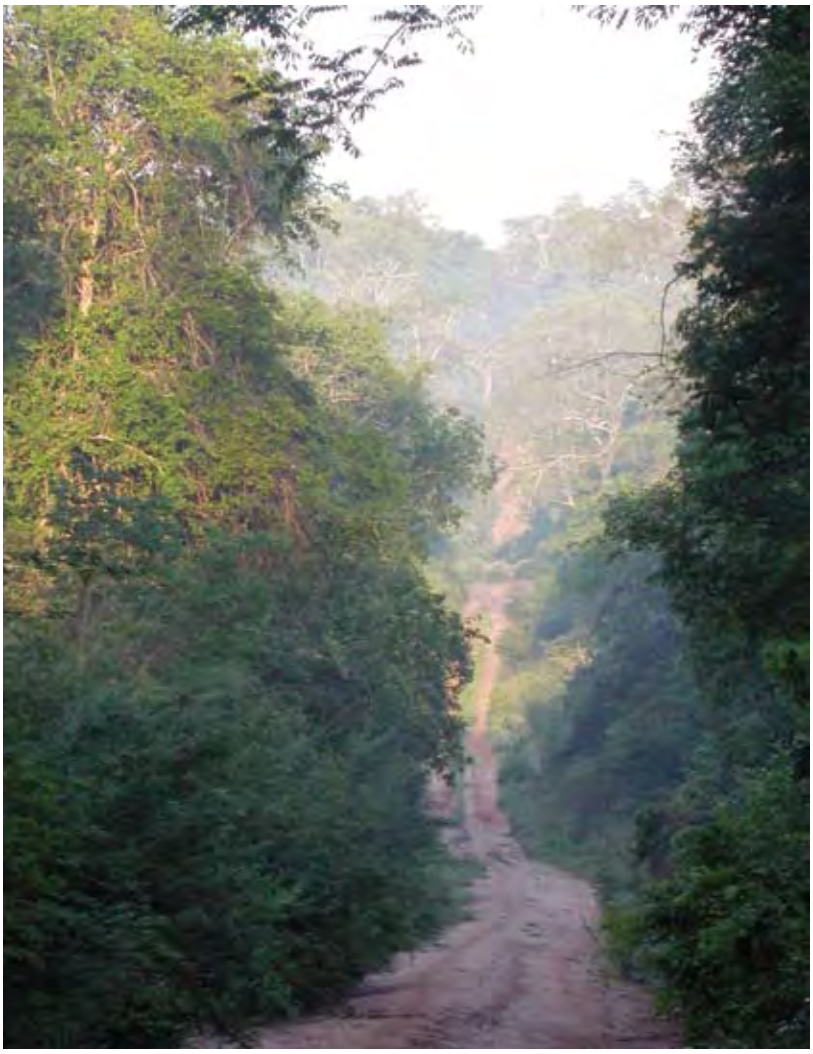


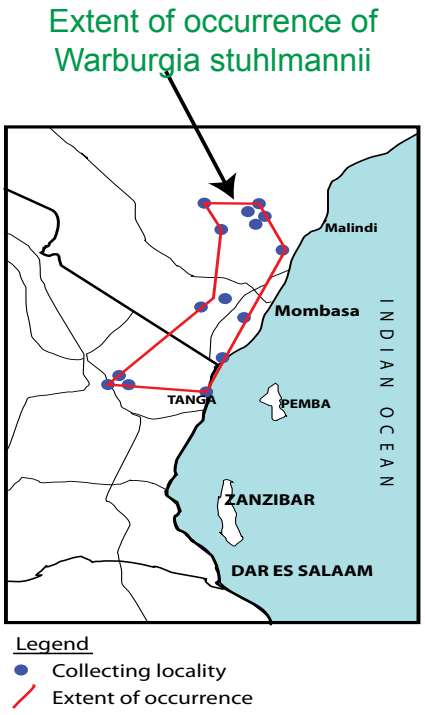
Photo caption: Msumbugwe Forest Reserve is one of the areas where Warburgia stulhmannii has been recorded. A road cuts through the middle of the reserve. Photo by Andrew Perkin

Results

Conservation status assessment

The total number of location records for *Warburgia stulhman*nii in Kenya was fifteen, while in Tanzania there were four. This means that the area of occupancy of *Warburgia stuhlmannii* was 1800 km^2 while its extent of occurrence is 35,387.5 km^2. This is illustrated below. Satellite imagery results for the Kenyan study showed a decrease in the species habitat (dense forest cover) from 82.2% to 34.2%.

The species area of occupancy was found to be less than 2,000 km^2, (IUCN red list criterion B2,). Field observations and calculations employed on satellite area calculations showed that the extent and quality had reduced by more than 50%, and had become fragmented (IUCN red list subcriterion B2a and b (iii)). The species is therefore assessed as Vulnerable (VU B2a, b (iii)) under the IUCN global red list criterion.



Warburgia Stuhlmannii National Museum Herbarium department & field collections

Locality	Y	X	Date	Collector's Name	Number
Lushoto	4 47.5S	38 17.5E	31/3/34	B.Gilchrist	3
Kaembeni	3 30'S	39 50' E	19/3/73	G.W Sangai	95
Vanga	4 38S	39 14E	26/06/1958	D.A Livingstone	95
Gandini	4 06'S	39 21'E	17/2/87	Luke & Robertson	207
Kwale	4 10S	39 10E	19/08/1991	Luke & Robertson	1752
Marafa	3 02S	39 58E	19/08/1991	Luke & Robertson	2491
Pangani river	3 32S	37 34E	28/9/1966	Bradburne	101
Tanga	5 00S	39 00'E	7/2/1967	Brahms	95
Msumbugwe Forest Reserve	5 32 S	38 45E	6/2/1950	M. Gane	AH9922

Field collections July 2007-February 2008

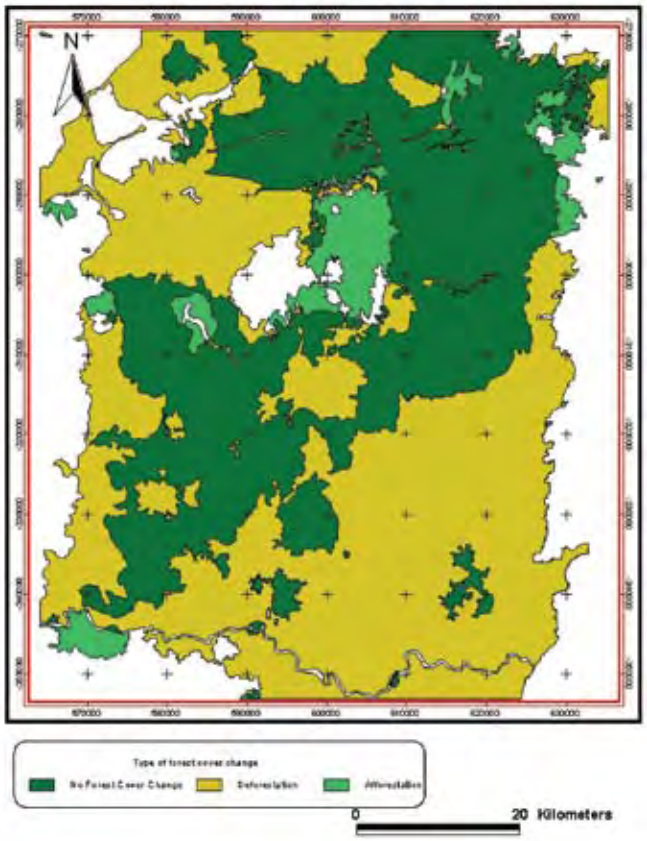
Locality	Y	X
Makumba	S 03.0833	E 39.9833
Wakala	S 03 00	E 039 51.075
Majengo	S 03º 01.07	E 039 º 52.146
Sosoni	S 03 00.74	E 039 49.8
Kanyumbuni	S02 57.847	E039 57.385
Vithunguni	3 02S	39 58E

The species was assessed as VU B1+2c using the 1994 version of the Red listing criteria (Lovett & Clarke, 1996). Revisions to the criteria and application necessitate a reassessment of this species. In Tanzania the species is confined to the Msumbugwe Forest Reserve (44 km^2), where the forest is heavily disturbed by previous logging activities but otherwise free from the pressure of agricultural encroachment which threatens other coastal forests. The Kenyan populations are under threat from habitat loss due to expansion of settlements as found by satellite data and field surveys. This assessment is based on restricted geographic range and habitat fragmentation (Criterion B). This was due to the fact that population data is not yet available. The calculated extent of occurrence (subcriterion B1) (EOO) was 35,387.5km^2, disqualifying the species from any categories. The area of occupancy (subcriterion B2) (AOO) was 1800 km^2, qualifying the species as vulnerable when combined with a severely fragmented population (as shown by land-cover changes in this study), no more than 10 locations; and continuing decline in area of occupancy as shown by the same study.

Pole and firewood collection are still threats within Msumbugwe Forest Reserve. Photo by Andrew Perkin.

W. stuhlmannii is therefore assessed as vulnerable (VU B2a, b (i, iii)). This assessment differs from that of Lovett and Clarke in that the extent of occurrence is greater than the required threshold for threat in the 2001 version of Red List guidelines (IUCN, 2001). This is a useful initial assessment, but, given the restricted occurrence of this species, and its utility to indigenous communities, population monitoring studies ought to be carried out. This will enable assessment by criteria C. D. and E (IUCN, 2001) and enable population recovery strategies to be formulated. The goal of ecological monitoring is to promote policies which will create a human-environment system which allows for long term productivity, for a system of land use which allows a sustained yield (Clarke, 1986). This was significant especially in predicting future implications of contemporary trends for *Warburgia stuhlmannii* and for Dakatcha and Marafa habitats.

Forest cover change between 1975 and 2000 in Marafa division



Discussions

Warburgia stuhlmannii **population study**

W. stuhlmannii populations showed greatest tree size and best condition in woodland and farmland. This suggests that it is a pioneer or early succession tree that will be replaced by other species in an undisturbed succession series. Early succession species are sun-loving and do not establish well under thick cover. Its persistence is therefore probably linked to co-evolution with forest–disrupting agencies such as fire and big mammals such as elephants and buffaloes. The healthy populations observed in settled areas indicate that the species is not destructively harvested.

The effect of harvesting on individual plants varies depending on the type of plant used. Whether recording damage to individual plants or plant populations, it is useful to have a systematic way of measuring individual plants, and field methods for assessing the intensity and frequency of harvest (Cunningham 2001). Where no baseline data was available from permanent plots, it was useful to compare harvesting impacts over a gradient from heavily harvested to unharvested populations at the resource-rich 'frontier' especially in regions where populations of *Warburgia stuhlmannii* species were found to be in high demand like Wakala, Sosoni and Vithunguni. The feedback obtained on the administered structured schedules demonstrated great dependence on this tree for their chest problems. This practice of harvesting for both timber and medicinal purposes contributed to the decline in the species area of occupancy and extent of occurrence.

Forest cover change

This represents the dense natural forests mainly composed of mature trees and other plants growing close together. They were the largest cover types as observed from the land use land cover maps. The forest cover change analyses show general deforestation over the years from 1975-2000. The changes calculated show a decrease of 19.3% (1975-1987); -48.4% (1987-2000) and -58.3% from (1975-2000). The forest cover as demonstrated in the maps dramatically reduced at the south eastern parts of the area, around Wakala, Magarini, Garashi and Marafa towns. This can be attributed possibly to the increase in urbanisation by increasing human population within the region

Recommendations and conclusions

The study clearly shows the need for ecological monitoring in order to promote policies that can create a human-environment system which allows for long term productivity and for a system of land use which can allow a sustained yield. This was significant especially in predicting future implications of contemporary trends for *Warburgia stuhlmannii* and the two study sites in Marafa division. Conservationists need to:

a) Encourage population recovery by protecting areas where the species is found to be common
b) Initiating proper propagation programmes for instance planting of trees
c) A national or regional conservation strategy can be an effective means of reviewing policies, and determining what shifts are required to achieve national objectives in conserving it.

BIRD-HABITAT RELATIONSHIPS IN KENYAN SOUTH COAST FORESTS

Bernard Cheruiyot Soi
Moi University Department of Wildlife Management

Introduction

Background information

The Coastal forests of Kenya lie in an area designated as a biodiversity hotspot. It is considered one of the hotspots most likely to suffer plant and vertebrate extinctions.

Coastal forests, especially those at the southern part of Mombasa (south coast forests) currently exist as patches of differing sizes. They experience different forms and extent of habitat loss. Despite this, they are essential components of the coastal landscape since they support bird species assemblages and ecological processes that differ from those on inland sites. Of particular importance, these forests support a number of unique and highly specialized avian species groups including those listed in the IUCN Red data book as rare, endemic, globally threatened, near threatened and vulnerable (Bennun and Njoroge, 1999). Development and other human activities are the major cause of habitat destruction or habitat degradation. These groups have therefore become a major focus for conservation efforts in Kenyan coastal forests. Thus the Critical Ecosystem Partnership Fund's (CEPF) initiatives have prioritized and invested in conservation and research in these areas. This study on bird-habitat relationships in Kenyan south coast forests was therefore carried out to determine habitat characteristics, species richness, distribution, abundance and habitat use by four avian species viz: *Anthus sokokensis* (Sokoke Pipit), *Anthreptes reichenowi* (Plain-backed sunbird), *Tauraco fischeri* (Fischer's turaco) and *Otus ireneae* (Sokoke Scops-owl). This was done in five south coast forests namely Kaya Waa, Diani, Mrima, Marenje and Dzombo.

Rationale of the study

Anthropogenic activities are increasingly posing conservation problems in Kenya's south coast forests. This has led to constant change in forest structure and quality thus affecting the distribution and persistence of birds. The selected forests have been noted for their suitability for non-breeding populations of a globally threatened species, *Zoothera guttata* (Spotted Ground-thrush). The forests also provide habitats for some of the key threatened, near threatened and restricted range species including *Tauraco fischeri, Anthus sokokensis*, and *Anthreptes reichenowi,* (Bennun and Njoroge, 1999). They also represent a possible habitat for *Otus irenae*. This study was therefore undertaken to confirm the presence of these species, their distribution and abundance and their relationship with the vegetation

structure of these forests.

Forest-dependent bird species have been shown to be detrimentally affected by habitat loss and degradation (Watson *et al*., 2004), rendering some species locally extinct. It is therefore important to determine how individual species are currently affected by habitat change and degradation in order to derive appropriate ecosystem management options.

Objective of the study

The objectives of the study were

i) To determine bird species richness

ii) To determine the distribution, abundance and habitat preference of four selected bird species.

ii) To take measurements of the habitat characteristics of the selected forests.

iii) To assess habitat viability of the five forests in meeting the survival needs of the four selected bird species.

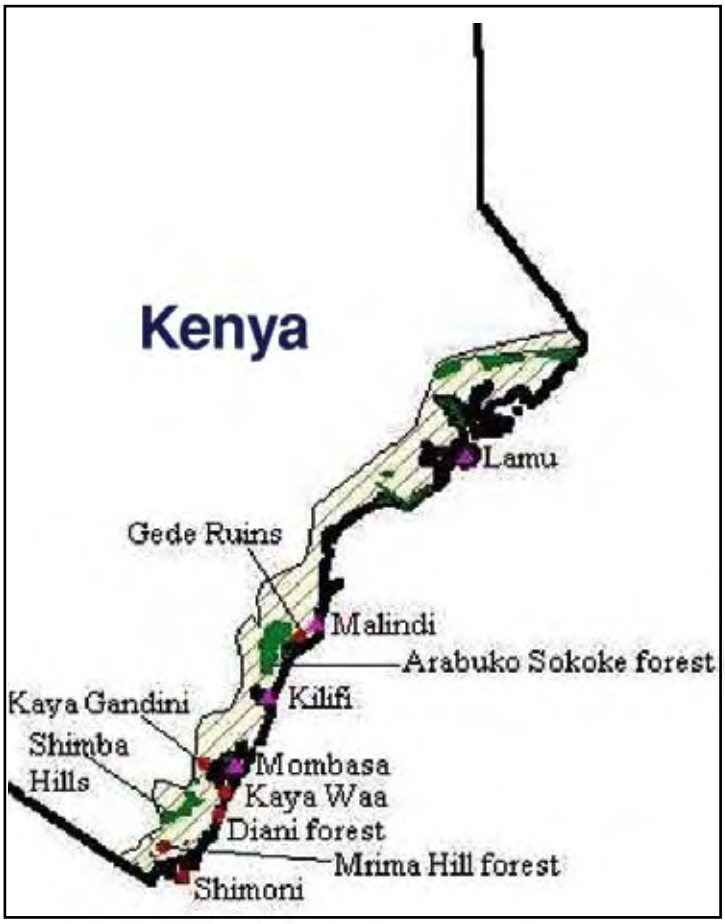
Study methods

Study area and site selection

The study was undertaken in five forest patches of varying sizes in south coastal forest of Kenya namely: Kaya Waa c. 3 ha., Diani c. 80 ha., Mrima 250 ha., Marenje c. 1,480 ha. and Dzombo 295 ha (Figure 1). These sites were selected since they hold or are suspected to hold species of global conservation concern and restricted range species. The forests are also managed differently either as private forests, National Monuments, Forest Reserves, or Nature Reserve or combination of some of these.

Mid and high vegetation at one of the point count station in Marenje

Figure 1: Map of Kenya showing some of the study sites. (Adapted from Ndang'ang'a *et al*. (2004)



Research design

A Point Count method was used in bird data collection. Transects were used to aid in placement of point count stations in each forest. The first transect was randomly positioned by use of a compass, and the rest systematically placed at intervals of 200m. In Kaya Waa and Diani forests, 7 and 15 point count stations were placed respectively. The first point count was placed at 50m from the edge and the rest at 200m intervals along the transect. In Mrima, Marenje and Dzombo forests, 10 transects measuring 850 m long were placed at 200m intervals. Along each of these transects, 5 point counts were placed with the first point count placed at 50 m from the edge and the rest at 200 m intervals. 50 point counts were thus used in each forest. Timed Species Counts were also conducted in all the forests to provide data used in determination of comprehensive species lists.

Bird surveys

Data on both nocturnal and diurnal bird species were collected. Diurnal birds were surveyed between 0600hrs and 1000hrs, and nocturnal ones between 1900hrs and 2300hrs and also between 0330hrs and 0600hrs. Bird species were detected

Expanding sand harvesting at the edge of Kaya Waa

by sight and call and their distances from centre of point count station estimated. Only those species recorded within 50m radius were used in analysis. Surveys were conducted four times for diurnal birds and twice for nocturnal birds in each forest.

Vegetation surveys

The following habitat variables were collected at all point count stations: proportion of foliage cover at heights of 0-1m, 1-3m, 3-5m, 5-8m and >8m; percentage canopy cover, heights of high canopy, sub canopy and low canopy. Also vegetation and litter ground cover including percentage bare ground, grass cover, herbs cover and number of seedlings and saplings were estimated. Percent quantification of evidence of fruiting and flowering in plants were also done. These were collected at all point count stations within the following radii: a 10-m radius, 5m radius sub-plots within the 10m radius, and also at a 0.5 by 0.5m quadrat within the 5m radius sub-plot. Using Point Centred Quarter method, trees and shrub variables were collected (nearest plant distance to centre of the point count, diameter at breast height and their heights). Horizontal vegetation density of low vegetation were estimated at 1m height, using a 50cm by 50cm chequered board painted white and black and viewed at a distance of 10m at all four compass directions from the centre of the point counts.

Results

Distribution of birds of global conservation concern

Tauraco fischeri was recorded in Kaya Waa, Diani, Mrima, Marenje and Dzombo forests while *Anthreptes reichenowi* was recorded in only three of the five forests (Mrima, Marenje and Dzombo). *Anthus sokokensis* and *Otus ireneae* were not recorded in any of the study forests (Table 1).

Abundance of species of concern

Based on the average number of individuals recorded over the four survey periods, a total of 25 individuals of *Tauraco fischeri* were recorded in all the forests considered. One individual in Kaya Waa, 2 individuals in Diani forest, 9 in Mrima forest, 8 in Marenje and 5 individuals in Dzombo forest. A total of 36 individuals of *Anthreptes reichenowi* were recorded where it only occurred in Mrima (15 individuals), Marenje (14 individuals), and Dzombo (8 individuals). An overall summary of the abundance of the species of focus are shown in table 1.

Section of Mrima forest at the background

Table 1. Abundance distribution of species of concern in each forest

Species	KayaWaa	Diani	Mrima	Marenje	Dzombo	Total
TF	1	2	9	8	5	25
AR	0	0	15	14	8	37
AS	0	0	0	0	0	0
OI	0	0	0	0	0	0

TF- *Tauraco fischeri*, ***AR****-Anthreptes reichenowi*, ***AS****-Anthus sokokensis*, ***OI****- Otus ireneae*

Forest structure

Table 2-4, presents the means of the vegetation parameters measured for each forest.

Table 2: % foliage cover at different heights

	Forests				
	Kaya Waa	**Diani**	**Mrima**	**Marenje**	**Dzombo**
Height		**Percentage foliage cover**			
0-1m	39.82	24.1	26.53	34.03	29.03
1-3m	41.96	47.92	37.97	47.43	45.4
3-5m	35.54	24.2	25.25	28.95	33.15
5-8m	37.71	35.83	22.86	31.98	20.45
>8m	19.29	25.08	20.28	33.13	16.1
FHD	1.381	1.342	1.367	1.368	1.348

Table 3: Heights and percentage cover

	Forests				
	KayaWaa	**Diani**	**Mrima**	**Marenje**	**Dzombo**
%CCV	65.71	66.92	51.35	58.66	58.14
HgtHC	12.43	14.83	18.86	22	17.48
HgtSC	7.14	8.47	11.35	13.9	10.5
HgtLC	2.71	3.4	5.57	7	4.74

NB: % CCV- percentage canopy cover; HgtHC-Height of high canopy; HgtSC- Height of sub canopy; HgtLC-Height of low canopy

Table 4: Percentage vegetation ground cover, openness and disturbance

	Forest				
	Kaya Waa	**Diani**	**Mrima**	**Marenje**	**Dzombo**
% flwrs/sds/buds	2.06	3.8	3.9	1.5	3.3
% baregrd	15.06	16.39	16.45	14.55	12.1
% litcover	80.94	73.75	73.35	77.34	80.52
% grscover	0.23	2.29	9.23	6.3	14.28
% hrbscov	3	1.07	3.04	10.6	7.26
% openness (1m)	27.16	23.20	21.36	13.32	17.52
% Disturbance	27.86	14.3	14.9	31.3	25

NB: % flwrs/sds/buds- percent estimate of seeds, flowers and flower buds; % baregrd- percentage bare ground; % litcover-percentage litter cover; % grscover- percentage grass cover; % hrbscv- percentage herbs cover.

Conclusion

The occupancy range of Sokoke Scops owl is probably not extended to South coast forests of Kenya. There is current loss of the globally threatened and restricted-range *Anthus sokokensis* in all the forests surveyed. It is yet unknown the factors that might be responsible for this unfortunate loss of the species where it was earlier recorded. The distribution of *Anthreptes reichenowi* is currently restricted to only larger forests greater than 100 hectares where their abundance is higher than that for *Tauraco fischeri*. This might be due to the failure of the smaller forests to present the forest structure that provides the basic requirement for this species. The abundance of *Tauraco fischeri* is low in the smaller sized forest fragments. The contribution of the state of forest structure, other habitat variables and forest size among other factors are yet to be determined to explain the relative importance of each factor in influencing the abundance and distribution of the four birds studied.

Researcher at one of the sampling point

Concrete wall erected to enclose one of the private forest at Diani

ASSESSMENT OF RARE PLANT SPECIES COMPOSITION AND RESTORATION POTENTIAL THROUGH SEED BANK IN ZARANINGE AND MBWEBWE COASTAL FORESTS, BAGAMOYO DISTRICT, TANZANIA

Nancy Pima

Tanzania Forestry Research Institute (TAFORI)
Lushoto Silvicultural Research Centre (LSRC)

INTRODUCTION

Background Information

Coastal forests are chains of thicket and forest patches scattered along the coastal margins of Eastern Tanzania embedded within savanna woodlands, wetlands, grasslands and in farmlands. Ecological restoration is used as a process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Forest restoration may be achieved through natural regeneration from coppicing, soil seed bank or artificial planting. Restoration though natural seed bank may be relatively cheap and reliable compared to the other methods. Zaraninge and Mbwebwe in coastal Tanzania are under degradation threats from human impacts and may require ecological restoration especially for rare plant species in the future. The knowledge on the abundance of rare and threatened species in Zaraninge and Mbwebwe forests and the potential for their restoration through soil seed bank remains relatively scanty. This study was conducted to assess rare plant species composition and their relation with the soil seed bank as a basis for forest restoration through natural regeneration in Zaraninge and Mbwebwe forests. This assessment forms a baseline for restoration potentials of rare and other plant species from the soil seed bank in Zaraninge and Mbwebwe coastal forests.

METHODOLOGY

Study Sites

Zaraninge and Mbwebwe Coastal Forest are located in Bagamoyo district. Zaraninge forest occupies about 18 000 ha and lies between 6° 04' S - 6° 13' S and 38° 35' E - 38° 42' E with an altitudinal range of 100 m to 300 m. Mbwebwe public forest is adjacent to Zaraninge forest and they differ in their management regimes. The climate is generally oceanic with annual rainfall of 820 mm to 1050 mm and average annual temperature of 20.8°C to 26.5°C

Figure 1 Vegetation of Zaraninge forest

Figure 2a Mbwebwe forest partly disturbed

2b Partly not disturbed

Data Collection

Vegetation sampling

Ecological data was collected through vegetation sampling. The sampling was done in temporary concentric sample plots of 0.07, 0.03, 0.01 ha. Sample plots were established systematically along transect lines that run parallel to each other at a sampling intensity of 0.02% to cover as much variation as possible within the landscape. The distance between plots and transect lines was 100 m and 200 m respectively

At each plot the following were assessed;

- Within 15 m radius, all trees with dbh ≥10 cm were identified and measured
- Within 10m radius, all trees with dbh ≥ 5 <10 cm were identified and measured
- Within 5m radius, all other species not identified in the 10m and 15m radii were identified and recorded.

Soil seed bank sampling

Soil samples were collected from three 0-10cm, 10-20cm, and 20-30cm depth and were randomly taken from three different points in the plot, thoroughly mixed in order to obtain composite samples. Each soil sample was randomly arranged in a germination room and watered twice daily to stimulate natural rainfall conditions. The emerging seedlings were counted, recorded and identified to species and family level. After identification, the seedlings were immediately uprooted and discarded so as to minimize overcrowding.

Data Analysis

Species composition, richness and diversity

The vegetation data was analyzed for species composition, richness and diversity. The species richness was computed as the total number of species. The species Importance Value Index (IVI) was used in computation based on relative basal area, density and frequency. Plant species diversity was computed using Shannon Wiener and Simpson diversity indices. Sorensen's similarity index (SI) was used to test for similarity between species of Zaraninge and Mbwebwe forest for each plot based on species presence/absence.

Soil seed bank

The germinated seeds were segregated by species and density of viable seeds per m^2 computed for each species and by depth. Analysis of Variance (ANOVA) was used to compare the number of viable seeds between soil layers and among growth forms. Seed bank density was calculated using average depth method (Demel, 1996).

RESULTS AND DISCUSSION

Species composition, richness and dominance

A total of 62 and 50 vascular plant species were identified in Zaraninge and Mbwebwe forest belonging to 31 and 28 families respectively. Out of the 62 vascular plant species identified in Zaraninge forest only three species were rare plant species, 35 species common and seven endemic to Zaraninge. Mbwebwe forest shows three rare plant species, 26 common plant species and five species endemic to coastal forest out of 50 vascular plants identified. Six species were the most dominant in Zaraninge forest while Mbwebwe forest had seven dominant species (Fig 1 & 2).

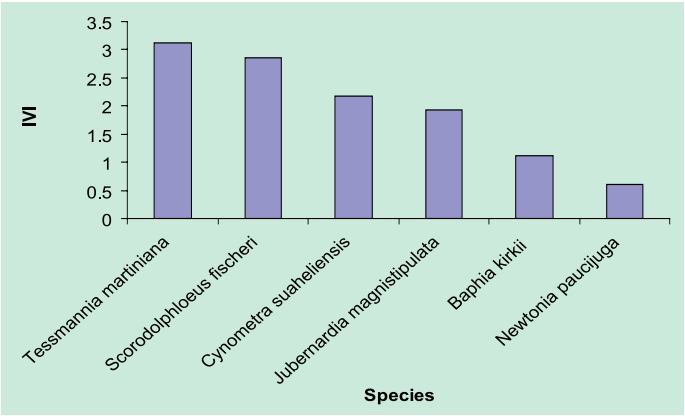


Figure 1 Dominant species in Zaraninge forest with Importance Value Index

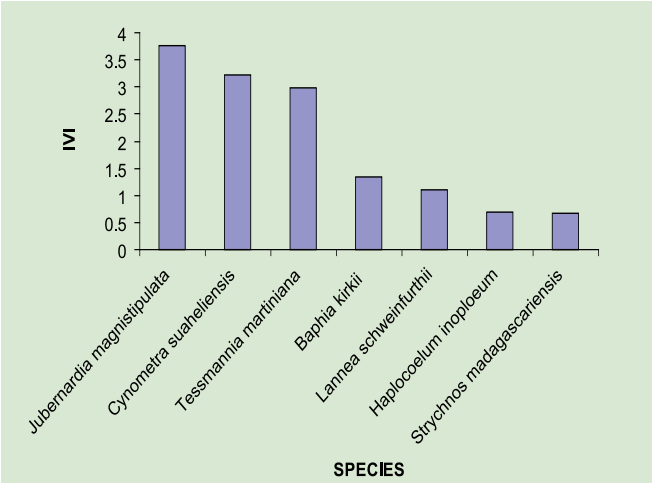


Figure 2 Dominant species in Mbwebwe forest with Importance Value Index

Species diversity and similarity between the two forests in species composition

Zaraninge forest had higher species diversity (Simpson and Shannon Indices of 0.093 and 2.843) than Mbwebwe forest has (Simpson and Shannon Indices of 0.12 and 2.5). This implies that the two forests are relatively similar in diversity though Mbwebwe forest had been disturbed by human activities such as burning of charcoal, fire wood collection and clearing for agriculture. The Sørensen's similarity index (SI) between the two forests was 0.678 implying that the two forests are similar in their species composition.

Diameter Distribution

The diameter distribution in the two forests showed a reverse J shape implying more trees of smaller diameters hence high regeneration potential (Fig 3 and 4).

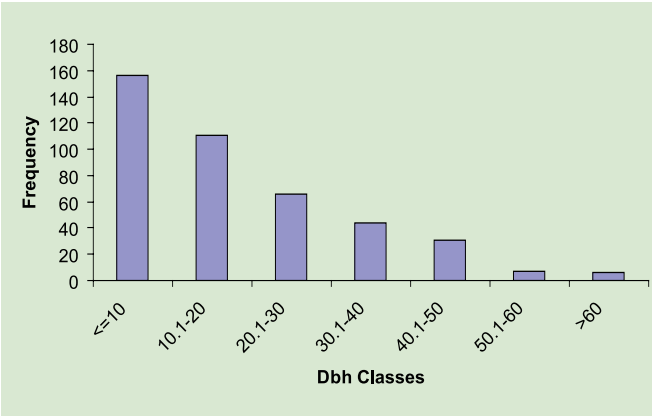


Figure 3 Frequency of species occurrence against Dbh classes in Zaraninge.

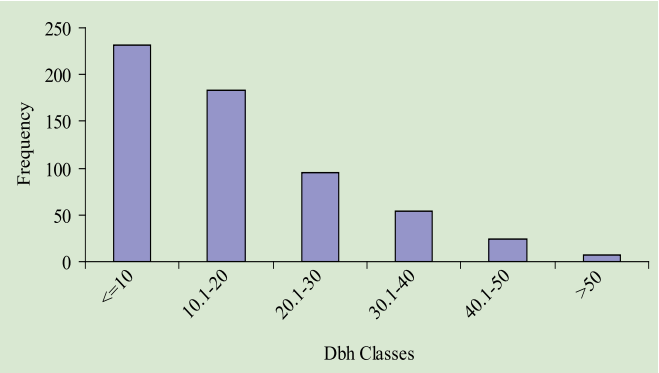


Figure 4 Frequency of species occurrence against Dbh classes in Mbwebwe.

Soil seed bank

Seed bank density

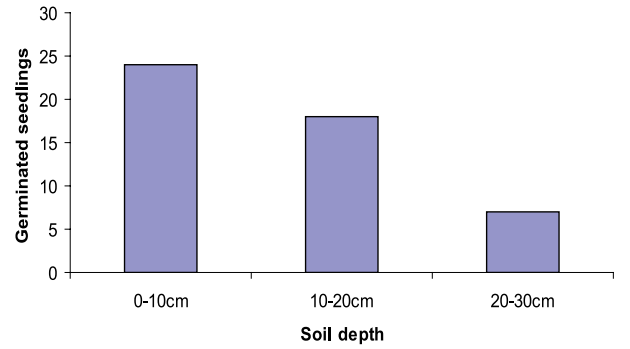
The average soil seed density was 2782 seeds/m^2 in Zaraninge forest and 1170 seeds/m^2 in Mbwebwe forest. The seed bank density for rare plant species were 103.33seeds/m^2 and 51.67seeds/m^2 for Zaraninge and Mbwebwe forest respectively. The result shows that, Zaraninge had higher seed density compared to Mbwebwe forest which may be due to differences in disturbances, mechanisms of seed dispersal, seed predation and soil faunas in the two forests. Zaraninge forest was relatively less disturbed and thus possible intactness of the soil seed bank. Soil fauna are known to play an important role in seed predation in the soil and seeds may be eaten or damaged or moved by soil fauna.

Seedling emergence in the seed bank

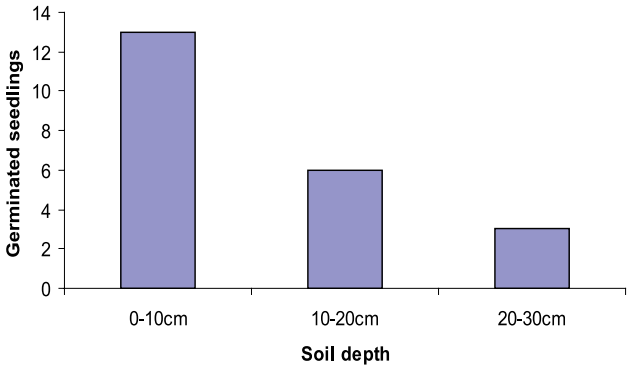
A total of 71 seedlings emerged representing 17 species and 10 families from all samples of the two forests. Of these, 49 and 22 seedlings emerged in Zaraninge and Mbwebwe forests respectively; one species (5%) was identified to be a rare plant species from each forest (*Monanthotaris trichocarpa*). Out of 49 germinants from Zaraninge forest, three were trees, 14 herbs, seven shrubs, nine climbers and 15 graminoids. On the other hand Mbwebwe forest had one tree, three climbers, six herbs and 12 graminoids. Dominance of annual grasses and herbs with limited number of woody species in many seed bank studies has been reported to be due to their ability of allocation of seed production, their short life span and seed variability. The soil seed bank may be a major repository of rare plant species and restoration of rare plant species through natural regeneration may be possible. Species composition of buried seeds in the soil suggests that the seed bank may be important for the restoration of woody plant species richness.

Depth distribution of seeds in the soil

The seed banks identified in this study exhibited variations in seed distribution in the soil. In both forests, seed abundance declined with soil depth with most seeds germinating from the 0-10cm-soil depth (Figure 5a & b). Higher seedlings germination in the upper soil layer has also been reported by other researchers.



a) Zaraninge forest



b) Mbwebwe forest

Figure 5 Number of seeds germinating from soil sampled from Zaraninge and Mbwebwe forests.

In both forests, there were significant differences in seed distribution with depth ($p = 0.001$). The variation in seedlings germination according to soil layer may largely depend on disturbance regime, soil fauna, seed dispersers and predation. The density and distribution of buried seeds in the soil depends on frequency and intensity of disturbance, disperser, predation and pathogens and micro site conditions affecting dormancy and germination.

Analysis of variance indicated that distribution of seeds in the soil did not differ significantly between forests, but differed significantly between depth layers. The decline in the number of seeds in the soil with depth has very strong implication in the ecology of soil seed bank, for it is an indication that most seeds in the soil seed banks are confined to the superficial soil layers. Forest floor is the most vulnerable area since it is where burning, grazing and predation take place.

Relationship between seed bank and standing vegetation

There is scanty relationship between species composition of standing vegetation and composition of seed banks in all forests based on the number of germinated seeds. Other researchers have observed lack of correspondence between soil seed bank and above ground vegetation in many plant communities.

The study revealed that, seed bank density varied between different plant types. Perennial plants were most abundant in the vegetation, while annual plants were most abundant in the seed bank. This may imply that the seed bank of the study site will be a good source of future annual vegetation, but not of perennial vegetation. There are several factors known to influence the relationship between seed bank and above ground vegetation. These include, loss of seeds from parent plants caused by deep burial, death from genetically controlled physiological responses to environmental factors (Simpson *et al.*, 1989) and extreme events such as drought conditions (Bakker *et al.*, 1996) and heavy predation of seeds (Lyaruu, 1996). However in this study, low correspondence might be due to heavy and partial disturbance in case of Mbwebwe forest and in pristine area like Zaraninge forest, transient seed might be missed in the soil samples or they might have been absent because of dominant forest trees which often do not have soil stored seed banks. Succession might have reached a climax where no rapid changes take place. Low similarity may also indicate a small input of new seeds to the soil. Other reason might be seed size, redistribution and predation and ability to form long-lived seed bank.

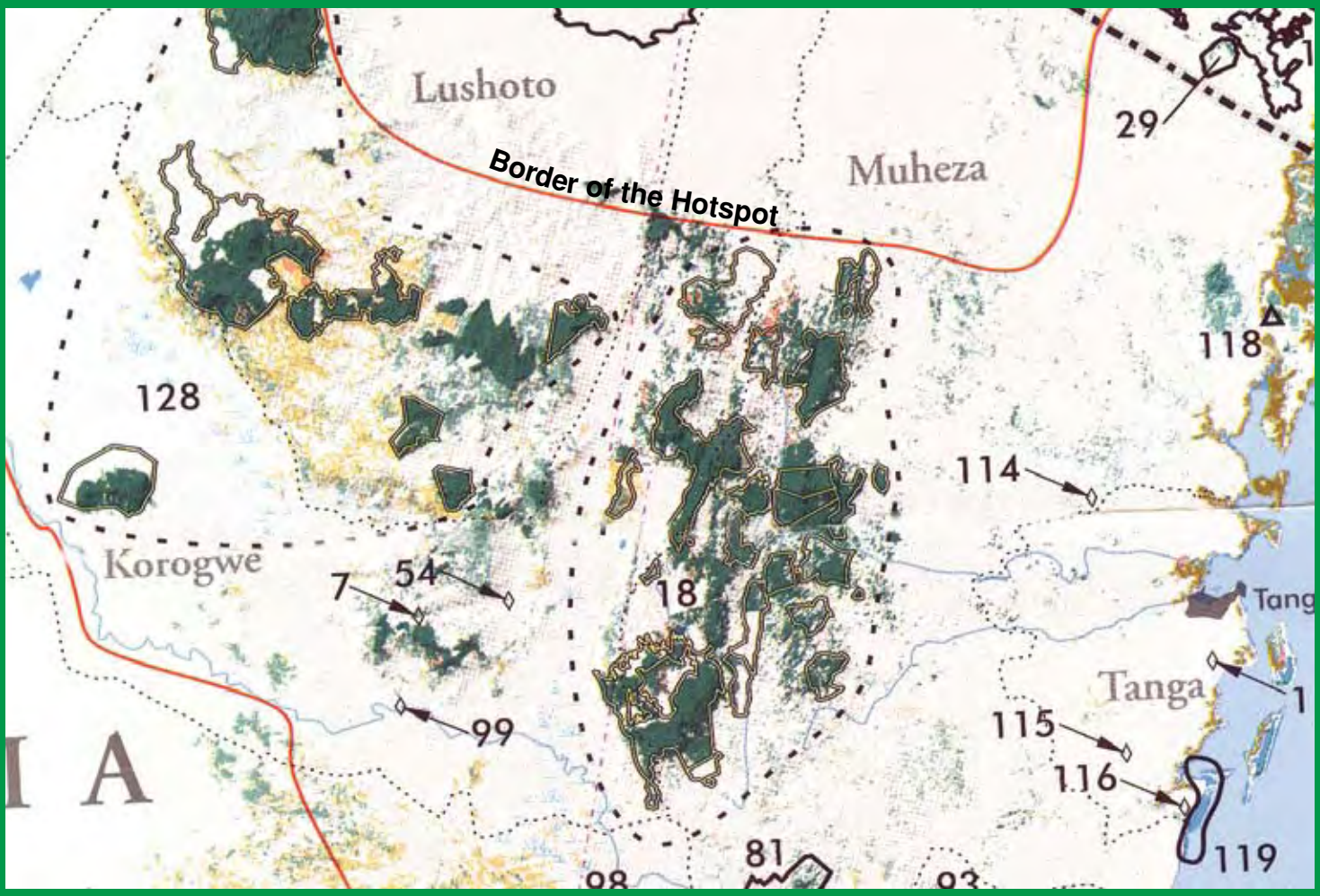
CONCLUSION AND RECOMMENDATION

It is concluded that forest restoration through natural soil seed bank in the coastal forests may greatly depend on seed bank at the surface soil horizons. The soil seed bank may as well be a major repository of rare plant species. The study suggests a longer germination trial in order to capture the full soil seed bank potential especially for rare plants.

First recorded sighting of the ornate shovel snout snake in 80 years

For the first time in 80 years, a researcher has recorded the presence of the Ornate shovel snout snake in the Uluguru Mountains. The snake was first recorded by a scientist in 1926. Subsequent surveys failed to relocate it until Elikana Kalumanga of the University of Dar es Salaam succeeded in collecting seven. With support from CEPF, Elikana was conducting small mammal surveys when he made his discovery. The snake is critically endangered and is only found in a small area of moist tropical forest in the Uluguru Mountains of Tanzania. The plight of the ornate shovel snout snake highlights the need for protecting Eastern Arc Mountain Forests.

CEPF produce deforestation map for the Hotspot



CEPF have recently published a map of the Eastern Arc Mountains and Coastal Forests of Kenya and Tanzania showing precisely where deforestation has occurred between 1990 and 2000. The map shows how widespread deforestation was during the 1990s and how great the need has been for conservation investment in order to arrest further forest loss. The map is based on analyses of forest change carried out by the Centre for Applied Biodiversity Science, Sokoine University of Agriculture and the University of Helsinki (Taita Hills analysis only). A limited number of copies of the map are available from members of the CEPF Coordination Unit. Above is a section of the map showing deforestation in the East and West Usambara Mountains where 3.2 % and 7.8 % of the forest was lost respectively during the 1990s. Deforestation is shown in red.

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This special edition of the Arc Journal is part of TFCG's commitment to ensure that stakeholders are aware of the CEPF process, goals and achievements and are sharing experiences. For more information about CEPF, please visit www.cepf.net

CRITICAL ECOSYSTEM PARTNERSHIP FUND

About the Tanzania Forest Conservation Group
Established in 1985, the Tanzania Forest Conservation Group is a Tanzanian non-governmental organisation promoting the conservation of Tanzania's high biodiversity forests.

TFCG's Vision
We envisage a world in which Tanzanians and the rest of humanity are enjoying the diverse benefits from well conserved, high biodiversity forests.

TFCG's Mission
The mission of TFCG is to conserve and restore the biodiversity of globally important forests in Tanzania for the benefit of the present and future generations. We will achieve this through capacity building, advocacy, research, community development and protected area management, in ways that are sustainable and foster participation, co-operation and partnership.

TFCG supports field based projects promoting participatory forest management, environmental education, community development, advocacy and research in the Eastern Arc Mountain and Coastal forests. TFCG also supports a community forest conservation network that facilitates linkages between communities involved in participatory forest management. To find out more about TFCG please visit our website www.tfcg.org

Inside this edition of the Arc Journal

The Arc Journal:
Newsletter of the Tanzania Forest Conservation Group
Editor: Nike Doggart
Founding Editor: Carter Coleman
This edition was supported by the Critical Ecosystem Partnership Fund
The Arc Journal welcomes articles on forest conservation and biodiversity in Tanzania. If you would like to contribute, please send your article to the Editor by e-mail at tfcg@tfcg.or.tz with high resolution digital photos and maps.