Avifaunal Survey of Namanga Hills Forest Reserve, South-western Kenya

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Summary

The study was carried out at two sites in the southern end of Namanga hills forest reserve on an intact, undisturbed and slightly disturbed forest sections on either side of Namanga River. The sites were further sub-divided into forest glade and forest interior. This eleven-day survey recorded 55 bird species from 24 families compared to 47 and 30 species recorded during 1986 and 2002 studies respectively. The survey recorded a total of 20 new species for the forest, thus bringing the species list to 86 from 34 families. Birds recorded included 7 forest-specialists (FF), 20 forest-dependents (F), 10 forest-generalist (f) and 18 non-forest bird species. Mist netting data showed that the intact, undisturbed forest patch, area A, had a higher number of species and individuals than the slightly disturbed patch, area B. However, forest patch B had higher diversity and equability indices, 1.91 and 0.98 respectively compared to patch A with 1.85 and 0.89 respectively; meaning that forest patch B has a higher number of species with all the species there tending to be equally common. A similarity test, to measure the degree to which the species and their relative abundances are shared between different bird communities, revealed poor similarity between patch A and B with an index of 0.4. The mean vegetation density of patch B was higher, 12.2 ± 7.6 (n=30) than that of patch A, 9.9 ± 9.3 (n=40) but the vegetation density did not differ significantly between the two forest patches (t-test, p= 0.25, p-Levene=0.08>0.05). However, canopy cover of the two patches differed significantly (t-test, p= 0.015, p-Levene=0.04<0.05) with that of patch B having a higher mean of 90.3 ± 11.7 against that of patch A, 85.1 ± 17.3 (n=40). Further, the forest glades attracted most of the species and bird individuals with only one individual bird caught in the forest interior. 7 individuals were recorded as breeding; 3 individuals with a brood patch score of 1; 2 with a score of 2; and 2 with a score of 3. 11 species were found to be common, 19 frequent and 6 uncommon. The site records 15 (22.4%) of Kenya's 67 Afrotropical highlands biome species found in the Kenya's Important Bird Areas and none of the globally-threatened species. Pillarwood *Cassipourea molasana* was recorded as being illegally extracted for building poles with 88.1% (n=59) of the sampled cut trees belonging to this species. However, this species has coppicing ability where 57.7% (n=52) of the cut stems had sprouts.

Background and Description of Study Area

Namanga Hills Forest Reserve (S 02° 30'58.9", E 36 ° 47'13.6"), also known as Ol Doinyo Orok, is located within Olkejuado County Council north of the border town (Kenya and Tanzania) of Namanga in the southern part of Kajiado District of the Rift Valley Province in Kenya (see figure 1). It extends 15-17km from north to south and 10km east to west covering an approximate area of 11,860.7 ha (Sanya 2002). However, not all of this area is natural forest. Bennun *et al* (1986) gives a description of its geology and vegetation types. The hill rises above the extensive plains of Amboseli basin to a height ranging from 2,548 - 2,760m above sea level (Bennun *et al*, 1986 and Williams, 1981). The forest was gazetted through a legal notice in August 1979 as a natural forest reserve (Matiru, 1999). This puts it under the direct management of the then Forest Department, now Kenya Forest Service. As an 'island', the forest is separated by 22km from Mt. Longido Forest, and 65km from Mount Kilimanjaro Forest, both in Tanzania (Bennun *et al*, 1986). On the Kenyan side, it is about 124km and 200km from the series of Chyulu and Taita Hills Forests respectively. Predominantly surrounded by a savannah ecosystem, this isolation might have led to formation of metapopulations, resulting from lack of genes flow between populations. The effect of potential isolation is yet to be studied on the forest's bird populations.

The forest is largely intact from observations at the study area that concentrated on the southern end on both sides of Namanga River from 16 to 26 January 2006. This eleven-day study was the third and the longest ornithological survey since a four-day visit by Bennun *et al* (1986) and a 2001 two-day visit by Kariuki *et al* (Unpubl.). According to the Kajiado District Development Plan of 2002-08, the few forest resources available in the district are not for any economic exploitation, but more for necessary environmental management and are all therefore mainly protected catchment areas serving a conservation function (GoK 2007). There is hardly any commercial exploitation apart from local supply of firewood and extraction of construction poles. The study site is one of the few wild places in Kenya that are still in their pristine condition despite a slow selective harvesting of poles for domestic house construction whose extent and effects are not known. This forest is for the most part largely unexplored zoologically (Williams, 1981) and has been neglected by naturalists and scientists alike perhaps due to the precipitous slopes and high presence of Buffalos *Syncerus caffer* (Bennun *et al*, 1986), and the dense undergrowth in some parts making it difficult to penetrate. Water also seems to be a limiting factor as one can only camp in the river valleys making it difficult to work in extensive areas. The said gaps in data on the forest triggered our desire and interest to face these challenges and contribute to the knowledge on birds of this biodiversity refuge.

The globally-threatened and range-restricted Abbott's Starling *Cinnyricinclus femoralis,* is thought to use Chyulu Hills Forests as a stop-over on its way to Mt. Kilimanjaro Forest from the central Kenya highland forests of Mt. Kenya, Kikuyu Escarpment and the Aberdares (Bennun & Njoroge, 2001), a distance of approximately 350 kilometers. The forest habitat structure and conditions at the reserve may attract this species too and it could be using it as a corridor/stop-over to Mt. Kilimanjaro (Kariuki *pers. comm*.).

Entirely, there are a number of taxa and general ecology studies, including relationships between life forms, which need to be carried out in order to document and understand the forest ecology, a strong basis for conservation actions.

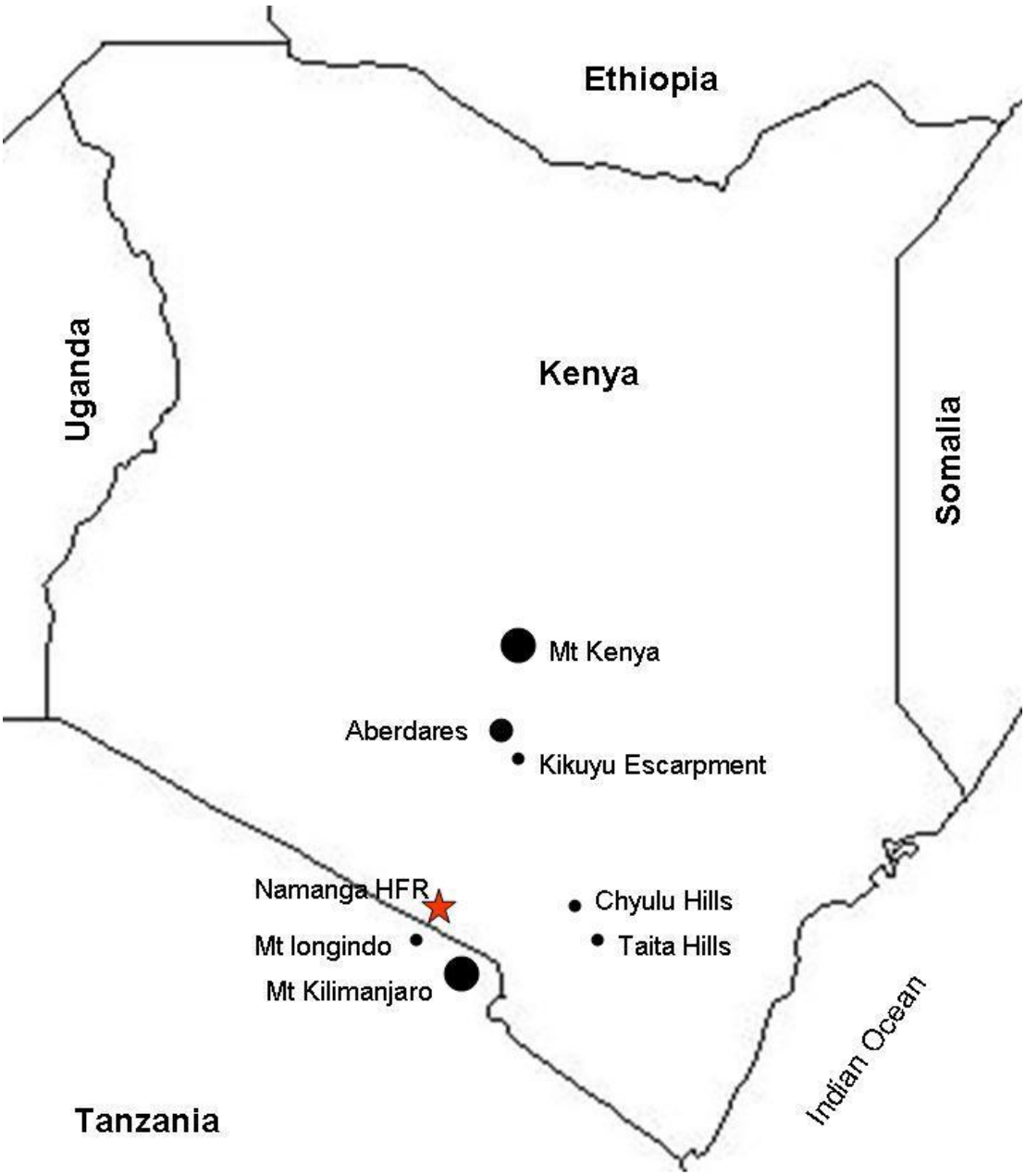

Figure 1: Sketch map of Kenya showing the general location of Namanga Hills Forest Reserve (Namanga HFR) in relation to other major forests in Kenya and Tanzania. Blank map adapted from http://z.about.com/d/geography/1/0/e/J/kenya.jpg.

Objectives

The overall aim of the expedition was to conduct a comprehensive bird survey of the little-known Namanga Hills Forest Reserve as part of documenting the forest's biodiversity and its conservation status. The following were the specific objectives:

i. Assess conservation status of the forest in terms of threats using birds (esp. forest-dependent species - FF) as indicators.
ii. Determine presence or absence of Red Data List Species as well as biome indicator species.
iii. Supplement results of the 1986 and 2001 expeditions, adding to the site's bird checklist, thus broadening our knowledge on the forest's avifauna diversity.
iv. Identify further research areas on the forest's birds and biodiversity.

Survey Materials and Methods

a) Mist Netting

Mist nets were set up at two sites in the southern part of the forest reserve. These sites were undisturbed, intact forest (area A) on the western part of Namanga River and slightly disturbed patch on the eastern side (area B) of the river. The sites were further sub-divided into forest interior and forest glade. 54m and 48m long nets ran through the forest interior and forest glade respectively. Nets were open for 10hrs 20 minutes at each study site between 0730 - 1130hrs in three mornings. All captured birds were carefully extracted and carried in cotton cloth bird bags to a temporary ringing station where they were identified using Zimmermann *et al* (1996) before being marked with numbered metal rings. Birds were then aged and sexed (where possible), and morphological measurements taken (wing length, tarsus length, weight), condition of feathers and body moult scored as well as breeding status checked (presence of a brood patch) before being released back to the wild. Data was recorded in a field ringing data book.

b) Timed Species Counts (TSCs)

This method involves essentially repeated species lists, on which each species was recorded the first time it was positively identified by either sight or sound (Bennun & Howel, 2000 and Sutherland, 1996). Fourteen (14) one-hour long TSCs were conducted within an approximate 845m radius from our base camp along Namanga River. The survey transects were selected randomly going to different directions. Birds observed were recorded in bands of ten minutes with those in the first ten minutes attaining a score of six points while those in the last ten minutes (51-60 mins) attained a score of one point. An average score for all species observed was calculated and species arranged from the highest to least score. A team of three used an 8 x 42 pair of binoculars each for the counts and a Zimmermann *et al* (1996) bird guide for bird identification. One of the team members recorded data on pre-designed datasheets rotationally.

c) Opportunistic Observations

The field team constantly carried a pair of 8 x 42 binoculars during the fieldwork days and recorded any species seen or heard, and positively identified using Zimmermann *et al* (1996) guide book. Because of the high density of trees and closed canopy, some birds were identified using calls. Forest glades, along the river and on vantage rock outcrops as well as swamps were used as observation points. Observations were also made from target areas such as fruiting and flowering trees. All sightings were recorded on a daily basis on pre-designed datasheets.

d) Vegetation Sampling

Two 1.5 km long, vegetation sampling transects were selected each on either side of the river through the mist netting sites. Ten (10) sampling points were placed at 150m intervals done by pacing by the same person each time. The paces had been standardized to one metre. Each sampling point (plot) measured 10x10m square. The following variables were recorded in each plot: visibility i.e. number of squares visible on a checkered board through both diagonals. This data was used to measure vegetation density; percentage canopy cover at each corner of the 10x10m square plot; number of cut and the number of live stems of diameters at breast height (dbh) of various intervals i.e. dbh <10cm, 10-20cm, 20-60cm and >60cm; number of cut shrubs and number of seedling/saplings in the left most-corner of the plot. A further sampling of logged trees was conducted on the slightly disturbed forest in an estimated 50x70m area where diameters of cut stems at the point of cutting were measured using a pair of plastic dial calipers. Opportunistically, all signs of exploitation of the area resources e.g. fuel wood collection; charcoal burning etc were noted whenever encountered.

Results and Discussions

a) Species Discovery Curve

A species discovery curve developed from the bird survey data from 14 TSCs is shown in figure 1 below. The rate of recording of new species was high at the beginning of field activities. This however decreased with time as new species discovered became fewer and fewer. This is because majority of the species seen in the forest were already recorded, leading to a position of near-plateau of the curve.

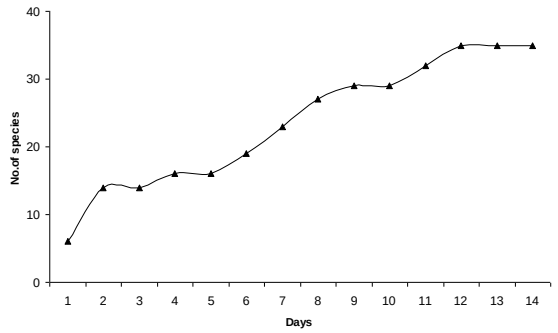

Figure 1: Species discovery curve showing cumulative total of the number of species seen during a two-week field study in Namanga hills forest reserve, Kenya in January 2007. The site included mainly forest interior, forest glades and edges.

35 species were recorded during the 14 TSCs. A species list was developed for the forest site (see appendix 1). Of the species recorded, 5 were classified as uncommon with only one individual of each species recorded (see appendix 2). These included Diederic Cuckoo *Chrysococcyx caprius*, Narina's Trogon *Apaloderma narina*, Eastern Double-collared Sunbird *Nectarinia mediocris*, Oriole Finch *Linurgus olivaceus*, Steppe Eagle *Aquila nipalensis* and Common Buzzard *Buteo buteo*. 19 species were classified as frequent and 11 as common with none of the species recorded as abundant (see appendix 2).

A species discovery curve is meant to give an indication of the optimum length of time to spend at a site so that a majority of species in that site would have been recorded (Bibby *et al* 1998). It also gives a comparative analysis of species richness at different sites. The curve is an important indication particularly to measure one's survey effort at a site against possibilities of having combed the entire site exhaustively for the last but important species for the list. After two weeks of survey effort, the curve was tending to a plateau. However, an additional species is probable with more time. This is more so considering the observation of the uncommon species like the Diederic Cuckoo and Narina's Trogon, which were recorded during the last days of the fieldwork.

It should be noted however that this method favours highly vocal species such as Tropical Boubou *Laniarius aethiopicus* and Black-backed Puffback *Dryoscopus cubla* that are better identified from their calls than sight unlike the shy and less vocal species like Olive Pigeon *Columba arquatrix*. The very

vocal species were heard on a daily basis and regularly throughout the days in most parts of the forest studied.

b) Mist netting data

A total of 28 unmarked individual birds of 10 species were captured in 102m long mist nets divided between the forest interior and the forest glade at 54m and 48m respectively. Whereas the mist netting effort for the two sites under the survey were almost the same, only one individual, the Yellow-whiskered Greenbul *Andropadus latirostris*, a forest generalist, was caught in the forest interior, FN, in both study sites. Another individual of the same species was also caught in the forest glade. All other 27 individuals of 10 species were captured in the forest glade, GN. 4 species of these were forest specialists, 4 forest generalists and 2 forest visitors.

Figure 2 gives a summary of total individuals ringed as new, recaptures and total species for both study sites i.e. forest patches A and B. Figure 3 gives total new captures and recaptures for the period of study.

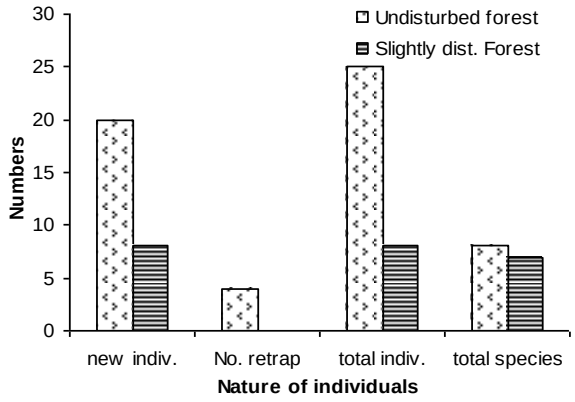

Figure 2: number of new and recaptured bird individuals and the total number of individuals and species captured per site during a survey in Namanga hill forest in January 2007.

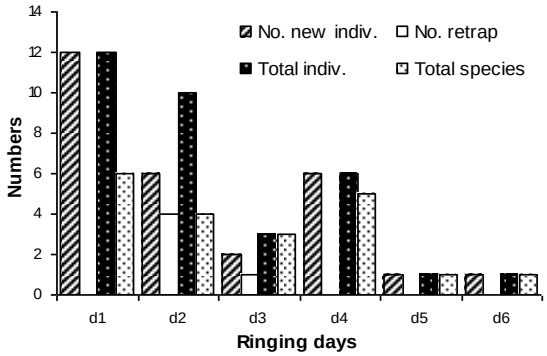

Figure 3: daily number of birds ringed during a two week bird Survey in Namanga hills forest, Kenya in January 2007

The absence of birds captured in mist nets in the forest interior is rather surprising but not unexpected. Namanga hills forest, despite having some level of disturbance, is more or less an intact forest most, or perhaps all of which consist of indigenous trees. However, perhaps due to the shading effect by the 15+m long emergent trees, the forest understorey and floor lacks any vegetation. Bird activities are therefore likely to be restricted to the forest canopy where mist net could not cover.

Forest glades on the other hand comprises of a dense thicket of vegetation (herbs, climbers, thick bush) and indigenous tree seedlings at various stages of regeneration. Depending on the size of the glade and the canopy of the adjacent forest edge, the glades allow much sun to penetrate hence keeping the micro-environment warm and full of activity, which sharply contrast the cold forest interior. This phenomenon in the glades could promote the presence of a lot of food for the birds and provide a favourable niche in a manner enough not to restrict them to their forest dependence categories (FF, F, and f).

It is also likely that birds consider other factors for their forest dependence apart from food; hence their presence in forest glades rather than forest interior cannot conclusively be explained in a single short survey and season. This therefore calls for further studies to establish the interplay of factors important for the choice of forest habitat for different reasons.

Our low catch could be attributed to the fact that our survey followed heavy but unusual rains across the country experienced between September and December 2006.

This meant food resources were abundant and birds did not therefore require moving a lot in search of food. This argument is further supported by recapture of same individuals in the same nets and location. The distance between the ringing sites was 665 metres separated by a river valley. Birds ringed in the forest patch A were never captured in forest patch B.. This suggests that there were not much local movements, at least during this time, although long-term studies are required to confirm this.

The primary objective of trapping birds is to determine their species or sub-species, age and sex composition, and to ring them for the study of local movements, migration, mortality, longevity and fluctuation in population size (Davis, 1981). The forest showed a low diversity of birds in terms of both diversity and abundance.

c) Species richness and diversity

During the eleven-day survey, 55 species of birds were recorded from 24 families. This brings the list total for Namanga hills forest reserve to 86 species from 34 families after merging this list with that of Bennun *et al* (1986) and Kariuki *et al* (Unpubl.) 2001 expeditions, which recorded 47 and 34 species respectively. This survey recorded 20 new species for the site. Among the 55 species were 5 Palearctic migrants, 1 Afro-tropical migrant and the rest were residents. 7 (13%) forest-specialists, 20 (36%) forest generalists, and 10 (18%) forest visitors, classified following Bennun *et al* (1996) were observed, figure 4 below. The rest 28 (33%) are considered as non-forest dependent species. Detailed account of all birds observed during the three surveys (1986, 2001 and 2007) is shown in appendix I.

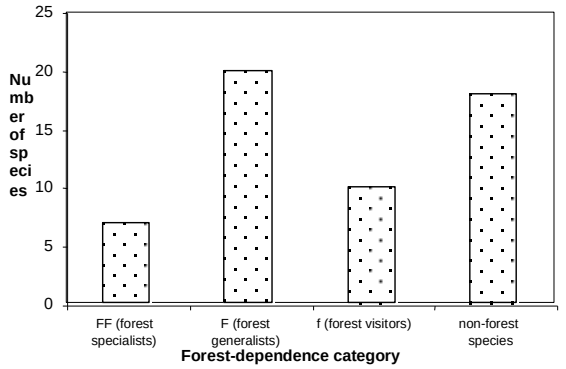

Figure 4: Bird species and their forest-dependence category observed during a two week survey in Namanga hills forest reserve in January 2007.

The classification by Bennun *et al* (1996) allows assessment of a site's importance according to the proportions of each category. Forest-specialists are the true forest birds that require an intact, undisturbed primary forest although they are occasionally found in secondary forest. Their numbers are an initial measure of a forest's relative conservation importance (Bennun *et al* 1996). The total list of 86 species for the forest from the three surveys has 12 of these species, and this number is bound to increase with additional surveys. Observing shifts in each category especially the FF and F species can monitor changes in forest structure. Though birds are arguably one of the best environmental indicators, potential of other taxa needs to be studied so that key species are identified that can be used for monitoring changes in forest structure.

Namanga hills forest reserve has been poorly explored not only ornithologically but also zoologically. This is clear from the number of new species (20) recorded from this short survey. The species list, of course, is not complete; more surveys at different times of the year and at different altitudes and locations within the forest reserve, would undoubtedly add more species. Its avifauna needs be compared to the nearby Mts Longindo and Kilimanjaro forests as well as the central Kenya highland forests, Chyulu and Taita hills forests. The presence of species such as Hartlaub's Turaco *Tauraco hartlaubi*, a regional endemic species, and a forest specialist, indicates suitability of the forest for many other species that require an intact forest habitat. The site records 15 (22.4%) of Kenya's 67 Afrotropical Highlands biome bird species found in Kenya's Important Bird Areas (Bennun & Njoroge, 2001) but none of the globally-threatened species.

Future work should also focus on comparing species in the forest with those listed for the atlas square by Lewis & Pomeroy (1989). Further research work could also study the functions and roles of seed dispersers (frugivores) in the distribution and abundance of certain tree species and in

forest regeneration potential. A detailed analysis of feeding guilds is also important in order to understand interactions between birds, forest and other wildlife in the forest ecosystem.

d) Breeding and Moulting

There were few cases of the 28 captured birds that showed signs of breeding as well as from observations. The birds were assessed for the presence or absence of a brood or incubation patch and assigned a score of 0 to 3 where 0 is the lowest score (brood patch absence) and 3 the highest score. Each of the following species had a score of 1: African Hill Babbler, *Pseudoalcippe abyssinica*, Stripe-cheeked Greenbul, *Andropadus milanjensis* and Yellow-breasted Apalis, *Apalis flavida*. Two individuals, Grey-backed Camaroptera *Camaroptera brachyura* and an African Hill Babbler had a score of 2, while an Olive Sunbird, *Nectarinia olivacea* and a White-starred Robin *Pogonocichla stellata* each had a score of 3. There was only one incidence of an African Dusky Flycatcher *Muscicapa adusta* observed feeding a juvenile that was constantly begging for food. All captured individuals were aged as adults except a Yellow-whiskered Greenbul and a White-starred Robin that were aged as sub-adults. Although the study coincided with the dry season, the rains experienced a few months prior to the study might have caused these birds to breed.

Captured birds were also assessed for their feathers moult condition. An analysis of the primary feathers moult score showed that only 6 individuals were in active moult and none of those that were moulting had a brood patch. Their scores (maximum 50 i.e. complete moult) were as follows: Olive Sunbird (10), Yellow-whiskered Greenbul (35, 41), White-starred Robin (39, 43) and Montane White-eye *Zosterops poliogaster* (45). Majority of other birds had just completed moulting (had fresh or very slightly worn primary feathers).

e) Vegetation data

The means of the two forest patches A and B, studied are shown in table 1.

Table 1: means of vegetation density and canopy cover of two forest patches of Namanga hill forest reserve, Kenya during a two-week survey conducted in January 2007.

VdUF = Vegetation density of intact, undistrubed forest patch, VdSF = Vegetation density of slightly disturbed forest patch, CcUF = canopy cover of intact, undisturbed forest patch, CcSF= canopy cover of slightly disturbed forest patch

	N	Mean	Minimum	Maximum	Sd
VdUF	40	9.9	0	25.0	9.3
VdSF	30	12.2	0	25.0	7.6
CcUF	40	85.1	20.0	100	17.3
CcSF	40	90.3	50.0	100	11.7

The mean vegetation density of patch B (VdSF) was higher than that of patch A (VdUF), table 1. Vegetation density did not differ significantly between patch A and B (t-test, p= 0.25, p-Levene=0.08>0.05). This means that the vegetation density was not affected by forest disturbance, perhaps because vegetation cut does not alter much the vegetation at ground level.

Interestingly, the mean of the canopy cover of patch B was also higher than that of patch A, table 1. Canopy cover for the two forest patches differed significantly (t-test, p= 0.015, p-Levene=0.04<0.05). This can be explained by the fact that trees cut in forest patch B were not canopy trees but understorey trees with a mean diameter of 60.80mm (6.08cm) (n=59, range=2.85 - 10.28cm). This diameter was taken at the point the tree was cut at a mean height of

62.43cm from the ground, a small diameter for a canopy tree. Cut trees were generally young trees whose purpose was for house *manyatta* construction for the *maasai* community (Wamiti *et al* 2007, Pers. interviews of elders cutting poles). The forest patch disturbance might therefore have had no impact on the canopy and the significance of the difference between the two canopies might have been because, naturally, the intact forest has more open canopy than the slightly disturbed forest patch.

Analyses of bird communities in the two forest patches revealed that forest patch A had more bird species but which were unequal in abundance, table 2.

Table 2: diversity and equability indices of two forest patches of Namanga hill forest reserve, Kenya during a two-week survey in January 2007.

	Total catch			
Forest Patch	**Diversity**	**Equability**	**No. of bird individuals**	**No. of species**
Intact & undisturbed area, A	1.85	0.89	20	8
Slightly disturbed area, B	1.91	0.98	8	7

Forest patch B had higher diversity and equability indices, table 2. This means that the site has a higher number of species with all the species there tending to be equally common (with an index of 0.98) compared to patch A. On the overall, although both patches have almost the same diversity and equability indices, patch A has lower indices, reflecting the fact that the patch is uniform with high number of individuals of some species compared to other species. Patch B on the other hand is a community where all species are almost equally abundant, perhaps suggesting some degree of heterogeneity in the habitat that attracts a variety of species despite some level of disturbance. It is likely also that, though insignificant, the removal of understorey trees in patch B might have encouraged the growth of shrubs and herb layer plant which attracts food items utilized by birds compared to patch A, which discourage undergrowth of such plants. However, the fact that patch A has high species richness and high number of bird individual is indisputable and suggest that the change occurring in patch B due to stem cutting is signaling a change in its initial stages, and which need to be monitored over time.

Although it incorporates both species richness and evenness in to a single value, Shannon index is a biased estimator. This is because the total number of species in the community will most likely be greater than the number of species observed in a sample (Ludwig and Reynolds 1988).

A similarity test for the birds of the two forest patches, to measure the degree to which the species and their relative abundances are shared between different bird communities, revealed poor similarity between patches A and B with an index of 0.4, table 3. This further reveals the fact that the two forest patches are different in the way birds derive their niche from them.

Table 3: results of similarity index of bird communities in two forest patches of Namanga hill forest reserve, Kenya during a two-week survey in January 2007.

Forest type	**Abundance of species**	**2 (Σ minimum abundance in A & B)**	**Similarity index**
Intact & undisturbed area, A	20	10	0.36
Slightly disturbed area, B	8		

Trees cut from the forest were mainly Pillarwood *Cassipourea molasana,* which comprised 88.1% (n=59). Other unidentified tree species comprised 10.2%, while Peacock Flower *Albizia gummifera* comprised a mere 1.7%. The mean ideal diameter for the sampled cut stems was 60.80mm (6.08cm) (n = 59, range =2.8 – 10.3cm). Pillarwood is a hardwood, tall, evergreen emergent tree species of high density and is the dominant tree species in the forest. It is an indigenous tree species in the family Rhizophoraceae (Mangroves) that grow with a pillar-like trunk, 10 to 40m in height (Noad & Birne, 1989). It grows straight with very few and small branches thus making it a high quality tree species for construction work. The activity appears to be regular as there were freshly cut stems and stem branches observed.

57.7% (n=52), 83.3% (n=6) and 100% (n=1) of the Pillarwood, other unidentified species and Peacock Flower respectively logged were sprouting, an important factor for regeneration of the species and the rejuvenation of the forest. Chances of stump survival seem to be influenced by the scale of damage done during cutting. This factor (coppicing ability of the stump) has a significant effect on the future of the forest and the sustainability of the selective pole harvesting as a way of community derivation of benefits from forest in general and in Namanga hill forest reserve in particular, considering that the forest has retained some relative pristinity. Further studies that work out simple workable models of sustainable selective pole harvesting could be important in evaluating community utilization of the forests as part of the ongoing Kenyan Government efforts to have adjacent communities derive benefits from forests and other natural resources visa vis its effect on birds and biodiversity.

f) Forest Biodiversity: Status & Conservation

Namanga hills forest reserve holds biodiversity that is yet to be understood well to science. There is therefore need for assessment of variety of life in the forest. Assessing biodiversity, or an inventory, is important in that resources for conservation are always limited, and to maximize the benefits of actions, priorities must be set (Sutherland, 2000). These priorities depend on carrying out inventories and making the results available to authorities and decision makers responsible for implementing conservation actions. Although biodiversity inventories are expensive, they are key to any conservation endeavour. Species of conservation concern in all major taxonomic groups need to be understood.

Given its current status, the forest appears to be intact with only little disturbance and hence still holding important biodiversity over the years. During this survey, high diversity of life such as invertebrates e.g. butterflies, spiders, dragonflies (in the swamps and along the river); amphibians and reptiles; several varieties of orchids and ferns, as well as other lower and higher plants was noted. The recent confirmation of beacons and revision of the reserve's boundary by the Kenya Forest Service is therefore a splendid step towards its protection.

The human population of the boarder town of Namanga is also bound to grow rapidly especially following the recent installation of electricity and ongoing plans to resurface the busy Nairobi-Namanga-Arusha highway. This may attract a market for poles and other forest products such as charcoal. It therefore suffices to take quick action in the regulation and control of forest access and utilization. However, activities that encourage community ownership such as non-commercial extraction of medicinal plants, dry season livestock grazing and watering, and certain level of communal benefits to be derived from there could be allowed to continue under control.

Despite the steep slopes and loose topsoil, there is no serious soil erosion going on as seen in the crystal-clear water of Namanga River. The closed canopy and interlocking sub-surface roots, dense herbs and shrub cover in the glades as well as the litter layer seems to keep surface water in control giving it a chance to percolate. The topsoils are therefore cushioned and remain intact except in animal (mainly Buffalo) trails.

Hence the only possible source of soil and vegetation destabilization though their impact is further reduced by the fact that they seem to make trails across the slope as opposed to up-down. However, the animals greatly enrich the soil with their dung.

The fallen trees further provide surface water control in addition to opening up opportunity for the shade tolerant seedlings and saplings to grow and as they decompose, their nutrients are released back the system.

Recommendations

From our study, we would like to make the following recommendations and observations:

1. Increased ground patrols in the forest by Kenya Forest Service with an input from the local Kenya Wildlife Service office (Amboseli National Park) to control the illegal selective logging and other human activities.

2. Formation of community 'watchdog' groups surrounding the forest for its protection by themselves, and make an understanding of the value of the forest as a life support system e.g. water supply and dry season grazing.

3. Intensive biodiversity inventory surveys in all taxa: fish, invertebrates, fungi, wetlands, mammals, soils/geology, and more work on birds to cover the entire forest.

4. Study on spatial movement (through telemetry/satellite tagging) of Abbott's Starling *Cinnyricinclus femoralis* in the central Kenya highland forests to understand timing, duration and routes followed during movements to and from Mt. Kilimanjaro. This would study the possibility of their use or pass over through Namanga hills forest reserve.

5. Survey on socio-economics to assess the level of reliance on the forest by local communities, and potentials of exploiting the forest as a tourist destination within the Amboseli basin circuit.

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Appendix 1: Annotated list of birds recorded during 1986, 2001 and 2007 surveys at Namanga Hills Forest Reserve.

KEY: OS-c: species number from OS-C (1986); **Cat.:** forest-dependence category: FF – forest-specialist; F – forest generalist; f – forest visitors; **1986:** recorded by Bennun *et al* expedition (); **2001:** recorded by Chege *et al* (unpublished data); 2**007:** recorded by Wamiti *et al* expedition; **Scarcity:** B: rarities with fewer than 50 records in Kenya as of 1986; X: rarities required by OS-c for publication; **Status:** PM: Palearctic migrant, am: Afrotropical migrant occurring along resident or non-migratory individuals.

Family	OS-c #	Species Common Name	Species Scientific Name	For Cat.	Scar-city	Sta-tus	1986	2001	2007
Scopidae	**Hamerkop**								
	52	Hamerkop	*Scopus umbretta*					†	
Ciconiidae	**Storks**								
	54	Black Stork	*Ciconia nigra*		X	PM	†		
Anatidae	**Ducks & Geese**								
	79	African Black Duck	*Anas sparsa*				†		
Accipitridae	**Vultures, Eagles, Hawks, Kites & Allies**								
	125	African Goshawk	*Accipiter tachiro*	F				†	
	133	Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	F	B		†		
	138	Common Buzzard	*Buteo buteo*			PM			†
	139	Mountain Buzzard	*Buteo oreophilus*	FF			†		
	142	Augur Buzzard	*Buteo augur*						†
	147	Tawny Eagle	*Aquila rapax*				†	†	
	148	Steppe Eagle	*Aquila nipalensis*			PM			†
	152	African Hawk Eagle	*Hieraaetus spilogaster*						†
Phasianidae	**Quails & Francolins**								
	190	Crested Francolin	*Francolinus sephaena*						†
Columbidae	**Pigeons & Doves**								
	357	Tambourine Dove	*Turtur tympanistria*	F			†		†
	364	Eastern Bronze-naped Pigeon	*Columba delegorguei*	FF			†		
	365	Olive Pigeon	*Columba arquatrix*	FF			†		†
	369	Lemon Dove	*Aplopelia larvata*	FF			†	†	†
	371	African Mourning Dove	*Streptopelia decipiens*					†	
	377	Laughing Dove	*Streptopelia senegalensis*						†
Musophagidae	**Turacos**								
	398	Hartlaub's Turaco	*Tauraco hartlaubi*	FF			†	†	†
	401	White-bellied Go-away-bird	*Corythaixoides leucogaster*						†
Cuculidae	**Cuckoos & Coucals**								
	408	Black Cuckoo	*Cuculus clamosus*	f	X	am	†		
	409	Red-chested Cuckoo	*Cuculus solitarius*	F			†		†
	410	Eurasian Cuckoo	*Cuculus canorus*		X	PM			†
	417	African Emerald Cuckoo	*Chrysococcyx cupreus*	F					†
	420	Diederik Cuckoo	*Chrysococcyx caprius*						†

Strigidae	**Typical Owls**							
	444	African Wood Owl	*Ciccaba woodfordii*	F		†	†	
Caprimulgidae	**Nightjars**							
	449	Montane Nightjar	*Caprimulqus poliocephalus*	F		†	†	
Apodidae	**Swifts**							
	475	Mottled Swift	*Apus aequatorialis*				†	
	479	Little Swift	*Apus affinis*				†	†
Trogonidae	**Trogons**							
	484	Narina's Trogon	*Apaloderma narina*	F			†	†
Meropidae	**Bee-eaters**							
	511	White-fronted Bee-eater	*Merops bullockoides*				†	
	514	Cinnamon-chested Bee-eater	*Merops oreobates*	F				†
Bucerotidae	**Hornbills**							
	540	Von Der Decken's Hornbill	*Tockus deckeni*				†	
	549	Silvery-cheeked Hornbill	*Bycanistes brevis*	F		†	†	†
Capitonidae	**Barbets & Tinkerbirds**							
	563	Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*	F			†	
	564	Red-fronted Tinkerbird	*Pogoniulus pusillus*				†	
Hirundinidae	**Swallows & Martins**							
	663	Red-rumped Swallow	*Hirundo daurica*					†
	668	Rock Martin	*Hirundo fuligula*			†		†
	670	White-headed Saw-wing	*Psalidoprocne albiceps*	f		†		†
	672	Black Saw-wing	*Psalidoprocne holomelas*	f		†		†
Motacillidae	**Wagtails, Pipits & Longclaws**							
	673	African Pied Wagtail	*Motacilla aguimp*			†	†	†
	676	Mountain Wagtail	*Motacilla clara*	F		†		
Pycnonotidae	**Bulbuls**							
	702	Yellow-whiskered Greenbul	*Andropadus latirostris*	F		†	†	†
	707	Stripe-cheeked Greenbul	*Andropadus milanjensis*	FF		†	†	†
	713	Cabanis' Greenbul	*Phyllastrephus cabanisi*	FF		†		†
	729	Common Bulbul	*Pycnonotus barbatus*	f			†	†
Timaliidae	**Babblers, Chatterers & Illadopses**							
	737	African Hill Babbler	*Pseudoalcippe abyssinica*	FF			†	†
	752	Pale-breasted Illadopsis	*Illadopsis rufipennis*	FF	X	†		
Turdidae	**Thrushes, Chats & Relatives**							
	756	White-starred Forest Robin	*Pogonocichla stellata*	F		†	†	†
	771	Rüppell's Robin-Chat	*Cossypha semirufa*	F		†	†	†
	794	Common Stonechat	*Saxicola torquata*					†
	816	Olive Thrush	*Turdus olivaceus*	F		†	†	†
	825	Orange Ground Thrush	*Zoothera gurneyi*	FF			†	

Muscicapidae	**Old World Flycatchers**								
	831	African Dusky Flycatcher	*Muscicapa adusta*	F			†		†
	840	White-eyed Slaty Flycatcher	*Melaenornis fischeri*	F			†		†
Sylviidae	**Old World Warblers**								
	869	Garden Warbler	*Sylvia borin*	f		PM	†		
	870	Blackcap	*Sylvia atricapilla*	F		PM	†		†
	873	Willow Warbler	*Phylloscopus trochilus*	f		PM	†		1
	884	Cinnamon Bracken Warbler	*Bradypterus cinnamomeus*	F				†	
	933	Grey-backed Camaroptera	*Camaroptera brachyura*	f			†	†	†
	936	Yellow-breasted Apalis	*Apalis flavida*	f					†
	978	Banded Parisoma	*Parisoma boehmi*						†
Zosteropidae	**White-eyes**								
	982	Montane White-eye	*Zosterops poliogaster*	F			†		†
Monarchidae	**Monarch Flycatchers**								
	1007	African Paradise Flycatcher	*Terpsiphone viridis*	f		am	†		†
Platysteiridae	**Batises, Wattle-eyes & Relatives**								
	1013	Chin-spot Batis	*Batis molitor*						†
Malaconotidae	**Bush-Shrikes**								
	1046	Brubru	*Nilaus afer*						†
	1059	Grey-headed Bush-Shrike	*Malaconotus blanchoti*						
	1064	Tropical Boubou	*Laniarius aethiopicus*	f			†	†	†
	1072	Black-backed Puffback	*Dryoscopus cubla*	F			†		†
Dicruridae	**Drongos**								
	1082	Common Drongo	*Dicrurus adsimilis*				†		
Oriolidae	**Orioles**								
	1087	Black-headed Oriole	*Oriolus larvatus*	f				†	
Corvidae	**Crows & Allies**								
	1096	White-naped Raven	*Corvus albicollis*				†		
Sturnidae	**Starlings & Oxpeckers**								
	1118	Superb Starling	*Lamprotornis superbus*					†	
	1123	Sharpe's Starling	*Cinnyricinclus sharpii*	FF	X		†		
Nectariniidae	**Sunbirds**								
	1140	Collared Sunbird	*Anthreptes collaris*	F			†		†
	1143	Olive Sunbird	*Nectarinia olivacea*	FF			†	†	†
	1149	Amethyst Sunbird	*Nectarinia amethystina*	f				†	†
	1152	Variable Sunbird	*Nectarinia venusta*	F			†		†
	1161	Eastern Double-collared Sunbird	*Nectarinia mediocris*	F					†
Ploceidae	**Weavers & Relatives**								
	1197	White-browed Sparrow-Weaver	*Plocepasser mahali*					†	
	1205	Baglafecht Weaver	*Ploceus baglafect*	f			†		†
	1210	Spectacled Weaver	*Ploceus ocularis*	f			†		

Estrildidae	**Waxbills**						
	1279	Abyssinian Crimson-wing	*Cryptospiza salvadorii*	F	†	†	
	1311	Purple Grenadier	*Uraeginthus ianthinogaster*				†
Fringillidae	**Seedeaters, Canaries & Relatives**						
	1346	Yellow-rumped Seedeater	*Serinus reichenowi*				†
	1349	Oriole Finch	*Linurgus olivaceus*	F	†		†
				Total	**47**	**34**	**55**

Appendix 2: List of species encountered in 14 timed species counts during a two-week bird survey of Namanga hills, forest, Kenya in January 2007. Their abundances are shown from the most to the least abundant.

No.	OSc#	Species Name	Total No. of individual	Number of individuals per 10 hrs	Relative abundance
1	756	White-starred Robin	33	23.57	Common
2	933	Grey-backed Camaroptera	28	20	Common
3	771	Ruppell's Robin-Chat	27	19.29	Common
4	1064	Tropical Boubou	26	18.57	Common
5	1143	Olive Sunbird	23	16.43	Common
6	409	Red-chested Cuckoo	22	15.71	Common
7	737	African Hill Babbler	20	14.29	Common
8	417	African Emerald Cuckoo	17	12.14	Common
9	398	Hartlaub's Turaco	17	12.14	Common
10	1072	Black-backed Puffback	16	11.43	Common
11	831	African Dusky Flycatcher	15	10.71	Common
12	1140	Collared Sunbird	14	10	Frequent
13	369	Lemon Dove	13	9.29	Frequent
14	707	Stripe-cheeked Greenbul	10	7.14	Frequent
15	549	Silver-cheeked Hornbill	7	5	Frequent
16	713	Cabanis's Greenbul	7	5	Frequent
17	982	Montane White-eye	7	5	Frequent
18	676	Mountain Wagtail	6	4.29	Frequent
19	840	White-eyed Slaty Flycatcher	5	3.57	Frequent
20	670	White-headed Saw-wing	5	3.57	Frequent
21	479	Little Swift	5	3.57	Frequent
22	1007	African Paradise Flycatcher	4	2.86	Frequent
23	514	Cinnamon-chested Bee-eater	4	2.86	Frequent
24	936	Yellow-breasted Apalis	4	2.86	Frequent
25	357	Tambourine Dove	3	2.14	Frequent
26	1152	Variable Sunbird	3	2.14	Frequent
27	1161	Eastern Double-collared Sunbird	3	2.14	Frequent
28	816	Olive Thrush	2	1.43	Frequent
29	702	Yellow-whiskered Greenbul	2	1.43	Frequent
30	410	Eurasian common Cuckoo	2	1.43	Frequent
31	420	Diederic Cuckoo	1	0.71	Uncommon
32	1349	Oriole Finch	1	0.71	Uncommon
33	148	Steppe Eagle	1	0.71	Uncommon
34	138	Common Buzzard	1	0.71	Uncommon
35	484	Narina's Trogon	1	0.71	Uncommon