

***BIRD SURVEY EXPEDITION IN DZOMBO HILL FOREST, KWALE
DISTRICT-KENYA***



2014

Report By

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Executive Summary

Dzombo Hill Forest (04°26'S and 39°12'E) found in Malamba Sub-Location, Dzombo location, Lunga Lunga Division, Msambweni District in Kwale County, is an igneous intrusion into Triassic sandstones of the surrounding coastal plain. It covers an area of 295ha with an altitude range of 100 - 470 m above sea level. Dzombo hill forest is a forest of conservation Importance listed as an Important bird area (IBA 10) that is surrounded by small-scale farming activities. The main crop grown in the farms neighboring the forest is Maize.

This study sought to assess and document the bird species composition i.e. species abundance and richness, conservation status of the bird species found in this forest as well as confirm the presence or absence of the four bird species of conservation concern that were suspected to occur in this forest i.e. Sokoke Pipit, Plain-backed Sunbird, Fischer's Turaco, and African Crowned Eagle and any other bird species of conservation interest while assessing the current and potential threats to the forest.

Avifaunal data was collected using timed species count, point counts, mist netting and ad hoc observations. This was done during December 2013. Sampling effort was mainly concentrated in the forest but we also sampled the forest edge and the farmlands around the forest. The forest structure was also described using a 50 x 50 metres quadrant where the number of seedlings, saplings, poles and sawlongs were recorded to assess the generational potential of the forest as well as describe the threat status of the forest.

A total of 118 bird species were recorded. Of the species recorded only 10 were forest specialists, 25 were forest generalists and a further 31 were forest visitors. Four species Martial Eagle (NT), Crowned Eagle (EN), Fischer's Turaco (NT) and Plain-backed Sunbird recorded in

the forest or in the surrounding shrubland are species of conservation importance. A total of 11 afro-tropical migrants and 8 Palearctic migrants were also recorded in and around the forest.

Illegal logging of large trees and grazing was identified as the major threat to the forest. There was also the presence of snares in the forest to trap mammals especially the forest hog evidenced by the burrows observed in the forest. Other suspected mammals include rodents such as the porcupine. This practice is cruel to the animal and extremely dangerous for other forest users.

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Acronyms:

NT - Near Threatened

VU - Vulnerable

EN - Endangered

a.s.l - Above sea level

MEA - Millennium Ecosystem Assessment

Introduction

Coastal forests are the forests of the coastal strip of East Africa and they are composed of the forests of the mountain systems and the lowland forest patches of mangrove forests of the salt-water coasts. The coastal forests of Kenya cover four districts: Lamu to the North, Malindi and Kilifi in the middle and Kwale in the south including Mombasa City. Kenya's coastal forests are of critical importance to the country: they are part of the country's tourism industry, one of leading foreign exchange earner; they are important water catchment areas for the rivers and streams on which the local people in the coastal areas depend; and they are centers of endemism for a wide variety of globally threatened fauna and flora.

Forest and biodiversity surveys measure threats to the forests health overtime and increase public awareness of the importance and status of a healthy forest ecosystem. As global demands for food continues to grow, producing it in environmentally friendly ways becomes even more necessary. One of the greatest challenges of this century will be achieving food security, securing human livelihoods and conserving biodiversity in increasingly human-dominated landscapes. (MEA, 2005). Birds as good indicators of forest health can be used to assess the extent of the forest disturbance. As such, Dzombo Hill Forest is increasingly under threat from agricultural encroachment, unsustainable timber and pole extraction, bark stripping of trees for binding materials and firewood collection (Bennun & Njoroge, 1999). This is an evident threat to the habitat of the rich avifauna of Dzombo, which includes 35 forest- dependent species among them four bird species of conservation concern i.e. Sokoke Pipit (EN), Plain-backed Sunbird (NT), Fischer's Turaco (NT) and African Crowned Eagle (NT) (Birdlife International, 2013). No avian surveys have been done in Dzombo hill forest since the Important Bird Areas (IBA) directory was produced in 1999 until we carried out our survey in December 2013.

Aims and Objectives

The overall aim of the expedition was to conduct a comprehensive bird survey of Dzombo Hill Forest, its surrounding areas, as well as documenting the threats to this forest's avifauna and assessing its conservation status.

The specific objectives of this research were to:

- Assess and document the birds species composition i.e. species richness and species abundance, within and around Dzombo hill forest.
- Assess the conservation status of the bird species of Dzombo hill forest and surrounding areas.
- Determine the presence or absence and status of the four bird species of conservation concern; Sokoke Pipit, Plain-backed Sunbird, Fischer's Turaco, African Crowned Eagle recorded in Dzombo hill forest (Bennun & Njoroge, 1999) and any other bird species of conservation interest (endemics, IUCN red data List species, biome species, regionally threatened species etc)
- Assess the current and potential threats of Dzombo hill forest and propose future conservation action.

Study area

Dzombo hill forest found in Malamba Sub – Location, Dzombo Location, Lunga Lunga Division, Msambweni District in Kwale County, is an igneous intrusion into Triassic sandstones of the surrounding coastal plain (Bennun & Njoroge, 1999). It lies between 04°26'S and 39°12'E longitude and latitude respectively with an altitude of 100 – 470 m a.s.l. The hill rises abruptly to around 470m, with a lower summit at 400m to the west. The rainfall is 900 – 1,100mm per year with considerable additional mist and dew on the upper slopes. Dzombo Hill forest is covered by undifferentiated coastal mixed forest vegetation types and is wettest on the south-eastern slopes. To the north, the forest grades into drier woodland and scrub (Bennun & Njoroge, 1999).

Dzombo Hill forest was gazetted as a forest reserve in 1941 and Kaya Dzombo a national monument found within the forest reserve in 1992. The forest is considered sacred by the local community with the grave of a Digo ruler that is found near the summit, which affords it some protection. The forest is increasingly under threat from agricultural encroachment, unsustainable timber and pole extraction, bark stripping of trees for binding materials and firewood collection (Bennun & Njoroge, 1999). This is an evident threat to the habitat of the rich avifauna of Dzombo, which includes 35 forest- dependent species among them four bird species of conservation concern i.e. Sokoke Pipit (EN), Plain-backed Sunbird (NT), Fischer's Turaco (NT) and African Crowned Eagle (NT) (Birdlife International, 2013). No avian surveys have been done in Dzombo hill forest since the Important Bird Areas (IBA) directory was produced in 1999..

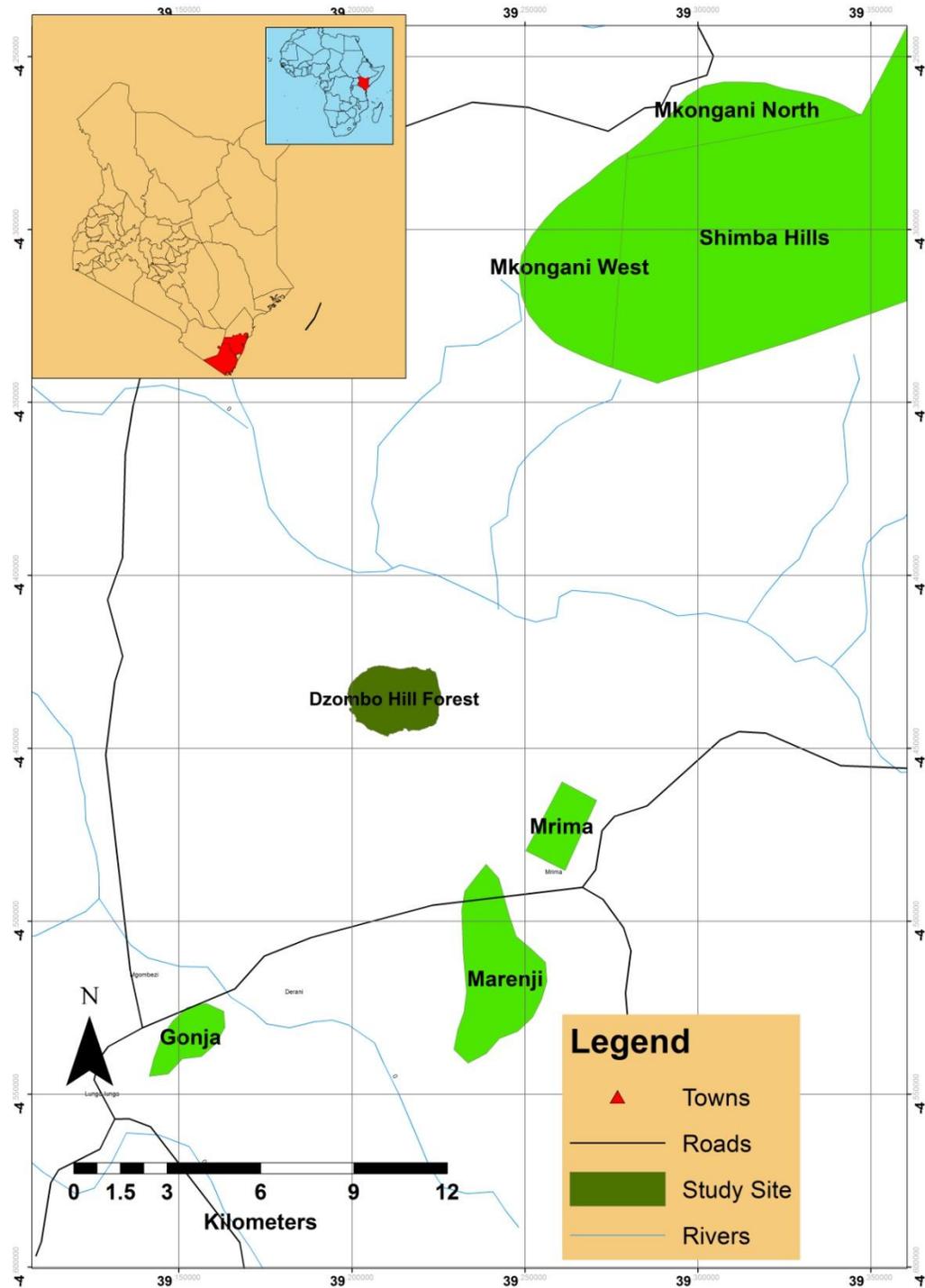


Figure 1: Map showing the location of Dzombo Hill Forest in Kwale County, South Coast Kenya

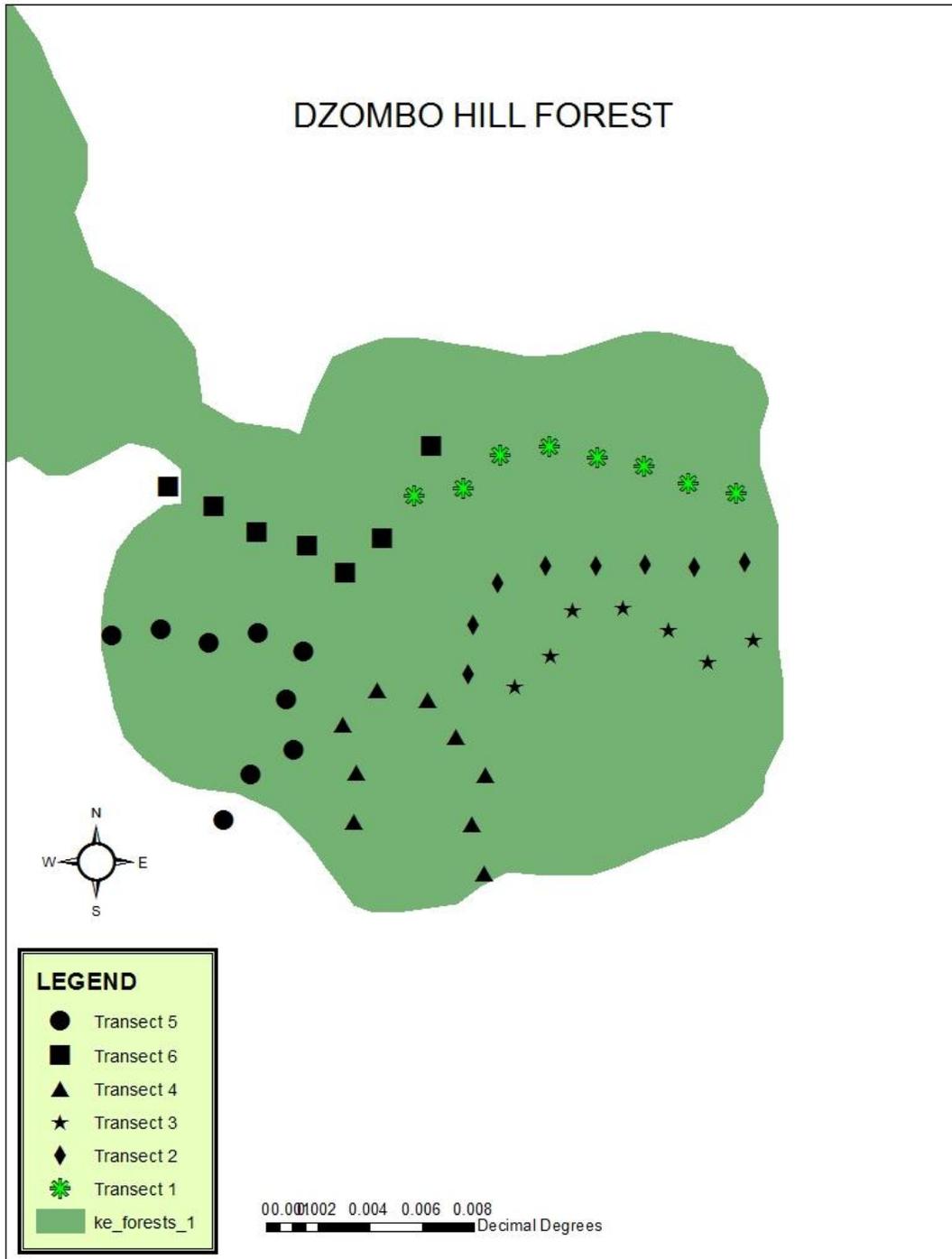


Figure 2.0 Map of Dzombo Hill forest showing how the transects were laid in the forest

Materials and Methods

Reconnaissance

Permission to access the forest for research was sought from the Kenya forest Service and the National Museums of Kenya before the project commenced. There was no risk that this permission would not be granted given that part of the forest (the National Monument) is managed by the National Museums of Kenya. Day one was spent meeting the local community leaders and notifying them about the research and what we intended to do around the forest. We also used this time to familiarize ourselves with the terrain, vegetation, habitat types, identifying net lines, different foot paths and birds. The level of human disturbance was also assessed during this period.

Timed species count

The Timed species-counts (TSCs) method is ideal for building complete species lists quickly and establishing the relative abundance of canopy and mid-level bird species (*Bennun 2002*). TSC's also offers the freedom to investigate any microhabitats that may occur within the forest and surrounding areas. We carried out ten 40-minute TSCs every day within Dzombo hill forest and surrounding areas. Each TSC was separated by at least 100 m or 10 min walk from the next. The TSC method involved essentially repeated species lists, on which each species was recorded the first time it was positively identified by either sight or sound (*Freeman et al, 2004*). For each count, species were scored according to when they were first recorded to give a 'commonness index' (4 if in the first ten minutes, 3 if in the next ten minutes and so on).A stop watch was used to keep time. During the species counts, pairs of binoculars (10 X 50), field guides and previous experience of the birds' calls were used to aid in identification.

Mist-netting

Mist-nets were used to sample understory species and other skulking species. 3 standard mist nets i.e. 18m, 12m and 9m mist-nets were laid in the forested area along small paths and trails as far as possible to avoid habitat destruction. Mist netting sessions were ran daily from dawn to 1000hrs during the morning and from 1600hrs to 1830hrs in the evenings. Mist nets were shifted to new locations after every two days. All birds species caught were identified, aged, sexed, ringed and other biometric measurements taken and also scored the molting so as to be used for any future bird species research. For identification we used (*Zimmerman et al, 1996*), (*Stevenson & Fanshawe, 2002*) and *Identification and Ageing of Palearctic Migrants in Ngulia* (by David Pearson, 2nd Edition November 1997). All bird species caught were photographed.

Point counts and vegetation surveys

Fixed width point counts (with distance sampling) are not as comprehensive as TSCs in building species lists but are ideal for future monitoring purposes and for making comparisons with habitat variables around each point. We systematically set up 10 point counts along permanent transects, set at least 200m from the next, as shown in figure 2.0. Transects were 2 km long and were run in an east-west direction. Along each transect, point counts were conducted at intervals of 200 m and each point permanently marked with a GPS for consistent future monitoring of the birds species. At every point observers waited for 1 minute (settling-in period) before counting all the birds seen or heard within a 25m radius for the next 9 minutes. At each point count station the following vegetation variables were measured: visibility i.e. number of squares visible on a checkered board from 10 m, percentage canopy cover at each corner of a 10x10m square plot; number of cut stems 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 saplings in a 1m x 1m plot.

Opportunistic observation

Opportunistic observations were made during other activities in the forest to help build up the species checklist. We also recorded species heard in the song repertoire of any robin species as probable present species that are found in the forest. In addition, all signs human or animal disturbance resources e.g. fuel wood collection; charcoal burning, grazing etc were recorded whenever encountered.

Results

Total number of species and species cumulative curve

Overall, 118 bird species were recorded over the 10-day survey period in Dzombo Hill Forest and its environs. The highest number of species recorded using the TSC method was 69 species; while 48 species were recorded using the Point count method while 14 species were caught in mist nets. We wanted to predict the number of probable species that can be found in the forest; however, more days and timed species counts are needed in order to have some substantial amount of data to predict the number of probable species that the forest has as shown in figure 2.0.

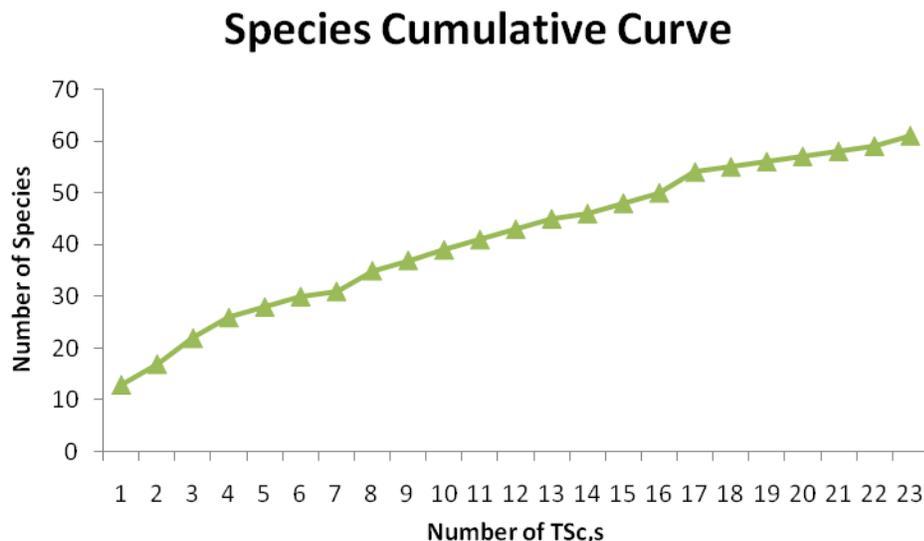


Figure 3.0. *Species Cumulative curve for the transects that were carried out inside the forest*

Species of interest

Threatened Species

Four species listed as globally threatened in the IUCN list of threatened species were recorded in Dzombo Hill Forest and its surrounding areas. Martial Eagle (VU) was recorded several times in TSCs and Point counts in the forests while the Crowned Eagle (EN) was recorded on one occasion overflying the forest. The Fischer's Turaco (NT) and Plain-backed Sunbird (NT) were also recorded as shown in table 1.0.

Table 1: *Threatened species observed during the Dzombo forest survey*

Common name	Scientific name	IUCN Status
Martial Eagle	<i>Polemaetus bellicosus</i>	VU
Crowned Eagle	<i>Stephanoaetus coronatus</i>	EN
Fischer's Turaco	<i>Tauraco fischeri</i>	NT
Plain-backed Sunbird	<i>Anthreptes reichenowi</i>	NT

Biome species

Biome-characteristic species were also observed during the survey, with a larger portion of the total being from the East African Coastal Biome (7 species) and a few from Somali-Maasai Biome (3 species) as shown on the table 2.0 below.

Table 2: *Biome species recorded during the Dzombo forest bird survey*

Common name	Scientific name	Biome Species
African Citril	<i>Crithagra citrinelloides hyposticus</i>	Afrotropical Highlands East African Coastal forest
Green Tinkerbird	<i>Pogoniulus simplex</i>	EBA East African Coastal forest
Brown-headed Parrot	<i>Poicephalus cryptoxanthus</i>	EBA East African Coastal forest
Fischer's Turaco	<i>Tauraco fischeri</i>	EBA East African Coastal forest
Mombasa Woodpecker	<i>Campethera mombassica</i>	EBA East African Coastal forest
Little Yellow Flycatcher	<i>Erythrocercus holochlorus</i>	EBA East African Coastal forest
Fischer's Greenbul	<i>Phyllastrephus fischeri</i>	EBA East African Coastal forest
Black-bellied Starling	<i>Lamprotornis corruscus</i>	EBA
Long-tailed Fiscal	<i>Lanius cabanisi</i>	Somali-Masai
African Grey Flycatcher	<i>Bradornis microrhynchus</i>	Somali-Masai
Golden Palm Weaver	<i>Ploceus bojeri</i>	Somali-Masai

Migrant species

In this survey, a considerable number of migrant species were observed. A total of 19 migrants were recorded. Of these, 9 were afro-tropical migrants, 8 were palaeartic migrants. In addition, 2 species i.e. the Broad-billed Roller and the Black kite have resident populations and migrant population. In line with this, the Broad-billed roller has a population that can be said to be afro-tropical and another being a migratory group from malagasay. The Black kite and the other 18 species, migratory status is shown in table 3.0 below

Table 3: *Migrant species recorded during the Dzombo Forest bird survey (PM= palaeartic migrant, AM= Afro-tropic Migrant, mm=Malagasay Migrant).*

Common name	Scientific name	Status
Wahlberg's Eagle	<i>Aquila wahlbergi</i>	am
	<i>Chrysococcyx</i>	
Diederik Cuckoo	<i>caprius</i>	am
Lilac-breasted Roller	<i>Coracias caudatus</i>	am
	<i>Halcyon</i>	
Grey-headed Kingfisher	<i>leucocephala</i>	am
White-throated Bee-eater	<i>Merops albicollis</i>	AM
Silvery-cheeked Hornbill	<i>Bycanistes brevis</i>	am
African Golden Oriole	<i>Oriolus auratus</i>	AM
African Paradise Flycatcher	<i>Terpsiphone viridis</i>	am
Red-capped Robin Chat	<i>Cossypha natalensis</i>	am
	<i>Eurystomus</i>	
Broad-billed Roller	<i>glaucurus</i>	am, mm
Black Kite	<i>Milvus migrans</i>	am, pm
Steppe Eagle	<i>Aquila nepalensis</i>	PM
Eurasian Bee-eater	<i>Merops apiaster</i>	PM
Isabelline Shrike	<i>Lanius isabellinus</i>	PM
Eurasian Golden Oriole	<i>Oriolus oriolus</i>	PM
Barn Swallow	<i>Hirundo rustica</i>	PM
Thrush Nightingale	<i>Luscinia luscinia</i>	PM
Spotted Flycatcher	<i>Muscicapa striata</i>	PM
Common Buzzard	<i>Buteo buteo</i>	PM,

Forest Dependency

We explored forest dependency by classifying bird species as forest specialist (FF), forest generalist (F), forest visitors (f) or non-forest (non-f) species following Bennun *et al.* (1996). FF species are forest specialists and are characteristic of undisturbed forest and F species are forest generalists and may occur in undisturbed forests but also regularly recorded in forest strips,

edges and gaps. These two groups require forests for breeding and are very much dependent on forests. The f species are forest visitors, which are often recorded in the forest but are always more common in non-forest habitats. Only 10 (12%) species recorded were forest specialists, 25 were forest generalists and a further 31 were forest visitors as shown in figure 2 below.

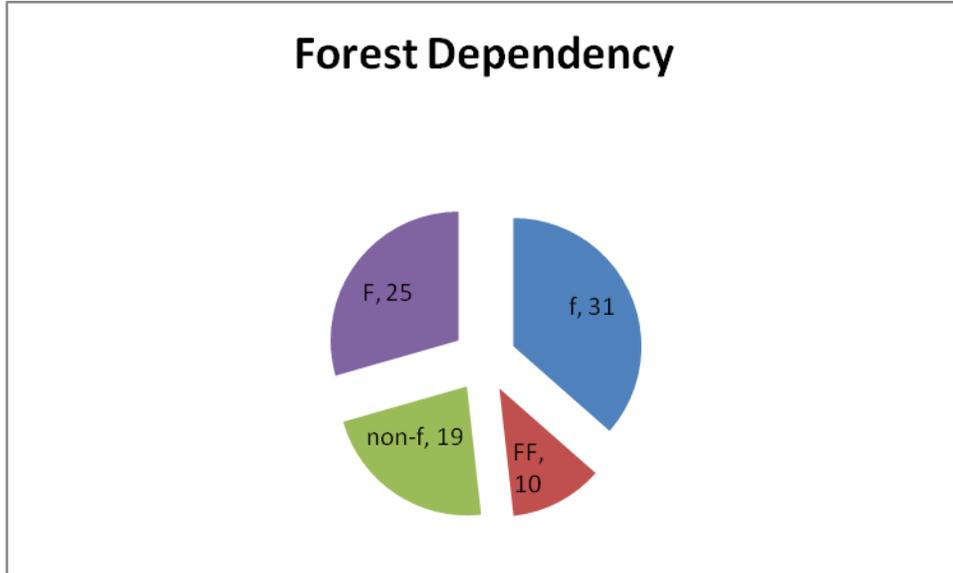


Figure 4.0 Proportions of Forest specialists (FF), forest generalists (F), forest visitors (f) and non-forest species recorded in and around Dzombo Hill forest

Forest birds using the farmland

118 species were recorded in both the forest and the surrounding farmland. Only 7 forest dependent bird species (FF and F) were recorded using the surrounding farmland as shown in table 5.0 below

Table 4.0 ***Birds species and their forest dependency categories recorded in the surrounding farmland of Dzombo forest***

Common Name	Species Name	Dependency
African Goshawk	<i>Accipiter tachiro</i>	F
African Green Pigeon	<i>Treron calvus</i>	F
Black-backed Puffback	<i>Dryoscopus cubla</i>	F
Black-bellied Starling	<i>Lamprotornis corruscus</i>	F
	<i>Poicephalus</i>	
Brown-headed Parrot	<i>cryptoxanthus</i>	F
Kenrick's Starling	<i>Poeoptera kenricki</i>	FF
Tambourine Dove	<i>Turtur tympanistria</i>	F

Feeding guild composition

The distribution of species is based on differences in diet, resulting in carnivores (raptors), nectarivores (nectar feeders), frugivores (fruit-eaters), granivores (seed and grain feeders), mulluscivores (mollusks feeders) and insectivores (insect eaters). In our survey, insectivores had the largest percentage 47% compared to the rest of the feeding guilds as shown in figure 3.0..

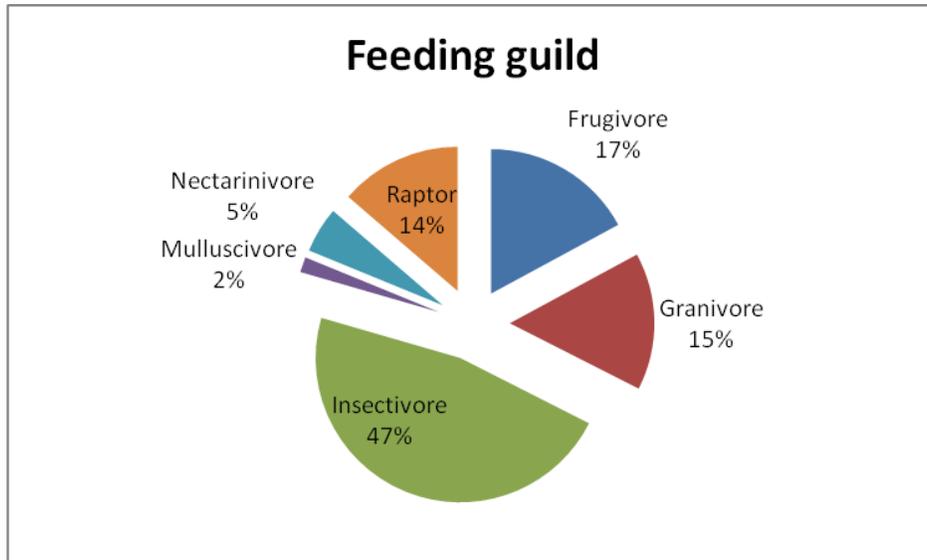


Figure 5.0 *The distribution of species based on differences in diet recorded in Dzombo Hill forest*

Forest structure and threats

The forest has fairly young trees which are as a result of reforestation. As shown in figure 6.0 there are more trees with a DBH between 5-20. If this trend continues, the future of the forest looks good as the number of saplings is also fairly good showing the forest regeneration rate seems to be good (10.3 ± 2.69 saplings per 50 by 50 m plot) as shown in figure 7.0.

The forest is faced by a myriad of threats among them being logging. As shown in figure 6.0 below, the number of saw logs with a DBH of more than 40 cm in diameter is very few (0.95 ± 0.29) i.e. at least one tree or none in a 0.617763454 acre plot (50m by 50m plot). Though the regeneration rate is good, the rate at which larger trees are being cut inside the forest is very high (27.08 ± 5.08) as compared to forest edge (1.77 ± 0.46) where you would expect the opposite as shown in figure 7.0.

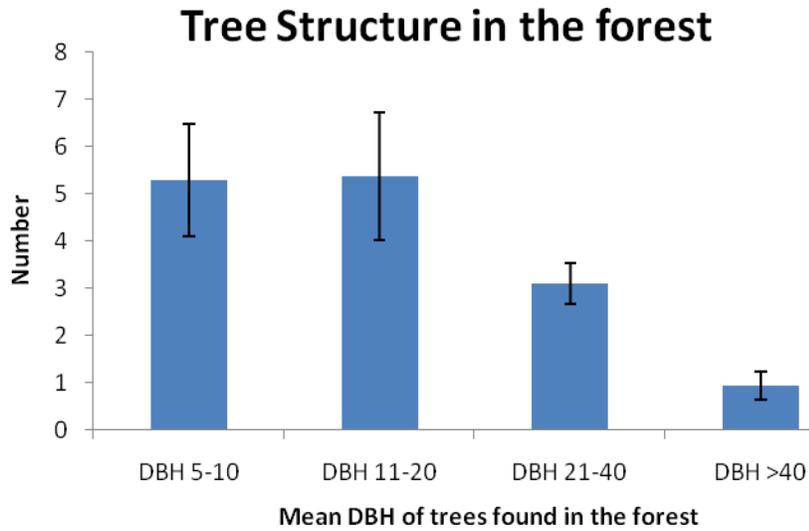


Figure 6.0 Tree structure in Dzombo Hill Forest

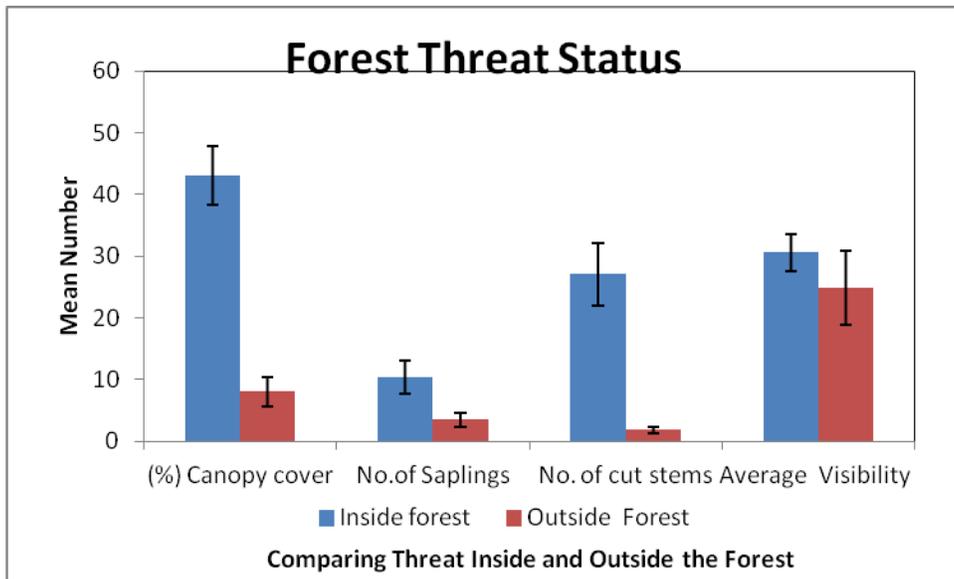


Figure 7.0 Comparing threats inside and outside Dzombo Hill Forest.

Discussion

Species composition

Though we expected to record a higher number of species, the number of bird species recorded in this forest is relatively low to that found in Shimba Hills which is located more or less with the same locality. This is attributable to the fact that in temperate and tropical forests, replacement of natural habitats by monoculture tree plantations is a common practice that results in the simplification of vegetation structure and composition. As is evidenced by the threats that the forest faces, ranging from the persecution of birds to illegal logging to debarking of trees (Bennun and Njoroge 1999), these together with natural deaths and population controls by their prey has contributed to the low species numbers. The regular distribution of trees in plantations and the loss of structural components of old-growth forests (such as old living trees, logs and snags) reduce richness and change the composition of bird communities. (Zurita *et al*, 2006).

The neighbouring farmlands provide a different habitat for birds that visit the farmlands and seek refuge in the forest as was the case with the Martial Eagle (*Polemaetus bellicosus*) whose conservation status is listed as vulnerable, was observed soaring in the farmlands. With increased awareness creation on the ecosystem services that this bird and other birds of prey provide their conservation in and around this forest could be improved. Most of the community members living around the forest view birds of prey as their number one enemy as they feed on their chicken and young goats.

Forest specialists are indicative of undisturbed forests (Bennun and Howell, 2002) and it can thus be assumed that Dzombo Forest with the low number of forest specialists compared to the other forest categories (forest generalists and visitors) suggest that the forest is heavily disturbed. Photographs taken inside the forest clearly show that the forest is disturbed. Forest specialists are usually confined to a less disturbed forest for their survival and are the best indicators of an undisturbed forest habitat.

Species of interest (Threatened Species, Biome species, Migrant species) and threats to the forest

The coastal forests are the remains of a once widespread forest cover along the East African coastal strip. (Burgess *et al*. 2000) Dzombo forest being one of the coastal forests is mapped as a moist savannah complex, as the forest has largely gone, leaving a little over 250 patches of forest. Four species listed as globally threatened in the IUCN list of threatened species were recorded in Dzombo Hill Forest or surrounding areas. Martial Eagle (Vu), Crowned Eagle (En), Fischer's Turaco (NT) and Plain-backed Sunbird (NT). The martial eagle was observed soaring above farmlands maybe foraging for food, considering the forest is very much disturbed.

The East African Coastal Forest Biome was well represented although 3 Somali-Maasai Biome species -Long-tailed Fiscal (LC), African- Grey Flycatcher (LC) and Golden Palm Weaver (LC) were recorded. Another interesting observation was that of the African Citril (*Serinus citrinelloides hyposticus*), which is a species in the Afrotropical highlands biome. This species may have extended its range from Chyulu hills which is the nearest distribution range (Zimmerman *et al*, 1996) to Dzombo hill forest.

Conservation Issues and Recommendations

There is a myriad of threats mainly related to human activities and need to be addressed in conserving Dzombo Hill Forest. One of the biggest challenge is poaching (wildlife and trees) as shown by the images below of snares, tree logging and encroachment of the forest for farming. Foot paths were also observed in the forest and this shows that there's uncontrollable movement inside the forest. Another problem facing this forest is the introduction of exotic and invasive species which was evident by the presence of Eucalyptus sp. and *Lantana camara* respectively. Community members were also observed to be farming close to the forest and their cattle grazing inside the forest without the supervision of a herdsman.

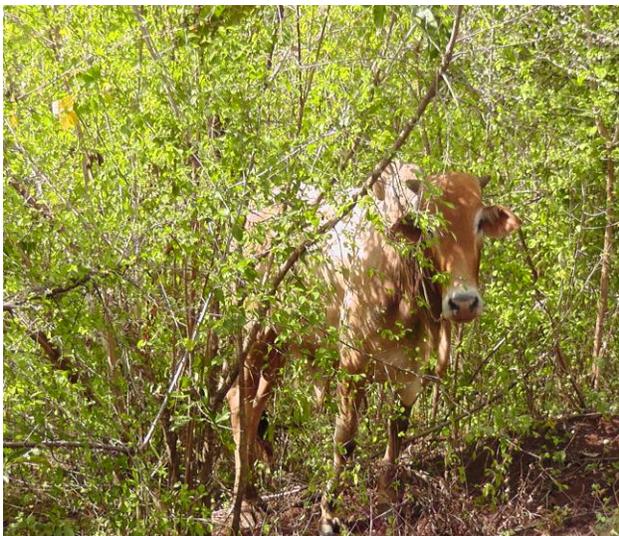
As a way forward, there's need for environmental education for the local community leaving around the forest especially on sustainable usage of the forest resources. The forest can also be fenced leaving a few exits and entrances and this can help the few forest guards manning the forest curb poaching and encroachment and in return reduce the human-wildlife conflict. Community members can also be charged a small fee to enable them to collect household firewood sustainably. The local community should also be trained on sustainable agriculture and also on the reforestation of the forest using indigenous trees. Sustainable agriculture will help the local community spare some of their lands for cattle grazing. Training the local guides employed by MRIMADZO would ensure that the information is disseminated to most individuals hence extending the conservation focus outside the forest.

Dzombo Hill forest remains an important area for conservation of coastal forest characteristic avifauna and therefore there's need for increased effort on protecting it. This is because of the presence of important species of conservation concern.

Dzombo Expedition in pictures



One of the team members (l) and a local guide (r) during the expedition in the forest



*Uncontrolled cattle grazing inside the forest
(l)*



Illegal snare traps in the forest (r)



Remnants of charcoal burning (l)



Tree splitting in Dzombo forest (r).



Tree splitting (l)



Farmlands so close to the forest edge (encroachment) (r)



Brown-hooded kingfisher



Common Bulbul



Peters's Twinspot (Red-throated Twinspot)



Issuing of books on common birds to the head teacher of the Local school

References

- Anthony Githitho**, (2008). *The Sacred Mijikenda kaya forests of coastal Kenya and Biodiversity conservation*.
- Bennun, L. A and Njoroge, P.** (1999). *Important Bird areas of Kenya*. Nairobi: Nature Kenya. pp 318
- Bibby, C. J. and Marsden, S** (1998). *Expedition Field techniques: Birds Surveys*. London: Royal Geographic Society. pp 134.
- BirdLife International (2013)** Species factsheet: Downloaded from <http://www.birdlife.org> on 11/06/2013.
- Burgess, N., Butynski, T., Gordon, I., Sumbi, P., Like, Q. and Watkin, J** (2003). *East Arc Mountains and coastal forests of Tanzania and Kenya Biodiversity Hotspots*. Washington DC. USA: Conservation International. pp 238.
- Burgess, N.D. and Clarke, G.P.** (2000). *Coastal forests of eastern Africa*. 456 pp.
- David Pearson**, (1997). *Identification and Ageing of Palearctic Migrants in Ngulia*, 2nd Edition November.
- Freeman, S., Pomeroy, D. E. & Tushabe H.**, (2004). *On the use of Timed Species Counts to estimate avian abundance indices in species-rich communities*
- Furness RW and JJD Greenwood**, (1993). *Birds as monitors of environmental change*. pp 356
- Millennium Ecosystem Assessment**, (2005) *Ecosystems and human well-being Vol.5*. Washington, D.C: Island Press
- Stevenson T. & Fanshawe J.** (2002) *Field Guide to the Birds of East Africa – Kenya, Tanzania, Uganda, Rwanda and Burundi*. Christopher Helm London
- Zimmerman, D. A., Turner, D.A. and Pearson D, J.** (1996). *Birds of Kenya and Northern Tanzania. Halfway House: Russel Friedman Books*. pp 575
- Zurita, G. A., Rey, N., Varela, D.M., Villagra, M. and Bellocq M, I.** (2006). Conversion of the Atlantic Forest into native and exotic tree plantations: *Effects on bird communities from the local and regional perspectives*. *Forest Ecology and Management* .Volume 235, Issues 1-3, pp 164-173

Appendices

Appendix 1: List of bird species recorded in Dzombo Hill Forest and surrounding farmland during the survey (Status: am-afrotropical migrant; pm-palaeartic migrant; mm-malagasy migrant; EN-Endangered; VU-Vulnerable; NT-Near-threatened, Forest dependency: FF-forest specialist; F- forest generalist; f- forest visitor; non-f – non-forest species)

Common name	Scientific name	Forest Dependency	Status	Feeding guild
Numididae: guineafowl				
Crested Guineafowl	<i>Guttera pucherani</i>	F		Granivore
Podicipedidae: grebes				
Little Grebe	<i>Tachybaptus ruficollis</i>	non-f		Insectivore
Ciconiidae: storks				
Woolly-necked Stork	<i>Ciconia episcopus</i>	non-f		Mulluscivore
Ardeidae: herons, egrets and bitterns				
Black-headed Heron	<i>Ardea melanocephala</i>	non-f		Insectivore
Scopidae: Hamerkop				
Hamerkop	<i>Scopus umbretta</i>	non-f		Insectivore
Accipitridae: diurnal birds of prey other than falcons				
Black Kite	<i>Milvus migrans</i>	non-f	am, pm	Raptor
Palm-nut Vulture	<i>Gypohierax angolensis</i>	non-f		Raptor
Brown Snake Eagle	<i>Circaetus cinereus</i>	non-f		Raptor
African Harrier Hawk	<i>Polyboroides typus</i>	f		Raptor
Gabar Goshawk	<i>Micronisus gabar</i>	F		Raptor
African Goshawk	<i>Accipiter tachiro</i>	F		Raptor
Great Sparrowhawk	<i>Accipiter melanoleucus</i>	F		Raptor
Lizard Buzzard	<i>Kaupifalco monogrammicus</i>	f		Raptor
Common Buzzard	<i>Buteo buteo</i>	non-f	PM,	Raptor
Steppe Eagle	<i>Aquila nepalensis</i>	non-f	PM	Raptor
Wahlberg's Eagle	<i>Aquila wahlbergi</i>	non-f	am	Raptor
African Hawk Eagle	<i>Aquila spilogaster</i>	F		Raptor
Martial Eagle	<i>Polemaetus bellicosus</i>	non-f	VU	Raptor

Long-crested Eagle	<i>Lophaetus occipitalis</i>	f		Raptor
Crowned Eagle	<i>Stephanoaetus coronatus</i>	non-f	EN	Raptor
Rallidae: rails and relatives				
Black Crake	<i>Amaurornis flavirostra</i>	non-f		Molluscivore
Columbidae: pigeons and doves				
Red-eyed Dove	<i>Streptopelia semitorquata</i>	f		Frugivore
Ring-necked Dove	<i>Streptopelia capicola</i>	f		Frugivore
Emerald-spotted Wood Dove	<i>Turtur chalcospilos</i>	f		Frugivore
Tambourine Dove	<i>Turtur tympanistria</i>	F		Frugivore
African Green Pigeon	<i>Treron calvus</i>	F		Frugivore
Psittacidae: lovebirds and parrots				
Brown-headed Parrot	<i>Poicephalus cryptoxanthus</i>	F		Granivore
Musophagidae: turacos				
Fischer's Turaco	<i>Tauraco fischeri</i>	F	NT	Frugivore
Cuculidae: cuckoos and coucals				
Thick-billed Cuckoo	<i>Pachycoccyx audeberti</i>	f		Insectivore
Diederik Cuckoo	<i>Chrysococcyx caprius</i>	non-f	am	Insectivore
White-browed Coucal	<i>Centropus superciliosus</i>	non-f		Insectivore
Strigidae: typical owls				
Spotted Eagle Owl	<i>Bubo africanus</i>	non-f		Raptor
Apodidae: swifts				
Böhm's Spinetail	<i>Neafrapus boehmi</i>	F		Insectivore
Mottled Spinetail	<i>Telecanthura ussheri</i>	F		Insectivore
African Palm Swift	<i>Cypsiurus parvus</i>	non-f		Insectivore
Mottled Swift	<i>Tachymarptis aequatorialis</i>	non-f		Insectivore
Coliidae: mousebirds				
Speckled Mousebird	<i>Colius striatus</i>	non-f		Frugivore
Coraciidae: rollers				
Lilac-breasted Roller	<i>Coracias caudatus</i>	non-f	am	Insectivore
Broad-billed Roller	<i>Eurystomus glaucurus</i>	f	am,	Insectivore

			mm	
Alcedinidae: kingfishers				
Grey-headed Kingfisher	<i>Halcyon leucocephala</i>	f	am	Insectivore
Brown-hooded Kingfisher	<i>Halcyon albiventris</i>	non-f		Insectivore
Striped Kingfisher	<i>Halcyon chelicuti</i>	non-f		Insectivore
Meropidae: bee-eaters				
White-throated Bee-eater	<i>Merops albicollis</i>	f	AM	Insectivore
Eurasian Bee-eater	<i>Merops apiaster</i>	f	PM	Insectivore
Phoeniculidae: wood-hoopoes				
Green Wood-hoopoe	<i>Pheoniculus purpureus</i>	non-f		Insectivore
Common Scimitarbill	<i>Rhinopomastus cyanomelas</i>	non-f		Insectivore
Bucerotidae: hornbills				
Crowned Hornbill	<i>Tockus alboterminatus</i>	f		Frugivore
Black-and-white Casqued Hornbill	<i>Bycanistes subcylindricus</i>	F		Frugivore
Silvery-cheeked Hornbill	<i>Bycanistes brevis</i>	F	am	Frugivore
Capitonidae: barbets and tinkerbirds				
White-eared Barbet	<i>Stactolaema leucotis</i>	F		Frugivore
Green Barbet	<i>Stactolaema olivacea</i>	FF		Frugivore
Green Tinkerbird	<i>Pogoniulus simplex</i>	FF		Frugivore
Red-fronted Tinkerbird	<i>Pogoniulus pusillus</i>	non-f		Frugivore
Indicatoridae: honeyguides				
Lesser Honeyguide	<i>Indicator minor</i>	f		Insectivore
Scaly-throated Honeyguide	<i>Indicator variegatus</i>	f		Insectivore
Greater Honeyguide	<i>Indicator indicator</i>	f		Insectivore
Picidae: wrynecks and woodpeckers				
Mombasa Woodpecker	<i>Campethera mombassica</i>	F		Insectivore
Platysteiridae: batises, wattle-eyes and relatives				
Forest Batis	<i>Batis mixta</i>	FF		Insectivore
Malaconotidae: helmetshrikes, bushshrikes, tchagras and puffbacks				
Retz's Helmetshrike	<i>Prionops retzii</i>	f		Insectivore

Brown-crowned Tchagra	<i>Tchagra australis</i>	non-f		Insectivore
Black-crowned Tchagra	<i>Tchagra senegalus</i>	non-f		Insectivore
Black-backed Puffback	<i>Dryoscopus cubla</i>	FF		Insectivore
Tropical Boubou	<i>Laniarius aethopicus</i>	f		Insectivore
Laniidae: shrikes				
Isabelline Shrike	<i>Lanius isabellinus</i>	non-f	PM	Insectivore
Long-tailed Fiscal	<i>Lanius cabanisi</i>	non-f		Insectivore
Oriolidae: orioles				
Eurasian Golden Oriole	<i>Oriolus oriolus</i>	f	PM	Insectivore
African Golden Oriole	<i>Oriolus auratus</i>	f	AM	Insectivore
Black-headed Oriole	<i>Oriolus larvatus</i>	f		Insectivore
Dicruridae: drongos				
Common Drongo	<i>Dicrurus adsimilis</i>	non-f		Insectivore
Monarchidae: monarch flycatchers				
Little Yellow Flycatcher	<i>Erythrocerus holochlorus</i>	FF		Insectivore
African Paradise Flycatcher	<i>Terpsiphone viridis</i>	f	am	Insectivore
Hirundinidae: saw-wings, swallows and martins				
Barn Swallow	<i>Hirundo rustica</i>	non-f	PM	Insectivore
Lesser Striped Swallow	<i>Cecropis abyssinica</i>	non-f		Insectivore
Cisticolidae: cisticolas and allies				
Rattling Cisticola	<i>Cisticola chiniana</i>	non-f		Insectivore
Winding Cisticola	<i>Cisticola galactotes</i>	non-f		Insectivore
Tawny-flanked Prinia	<i>Prinia subflava</i>	f		Insectivore
Black-headed Apalis	<i>Apalis melanocephala</i>	FF		Insectivore
Grey-backed Camaroptera	<i>Camaroptera brachyura</i>	f		Insectivore
Pycnonotidae: bulbuls				
Common Bulbul	<i>Pycnonotus barbatus</i>	f		Frugivore
Zanzibar Greenbul	<i>Andropadus importunus</i>	non-f		Frugivore
Yellow-bellied Greenbul	<i>Chlorocichla flaviventris</i>	F		Frugivore
Terrestrial Brownbul	<i>Phyllastrephus terrestris</i>	F		Frugivore
Fischer's Greenbul	<i>Phyllastrephus fischeri</i>	FF		Frugivore
Eastern Nicator	<i>Nicator gularis</i>	F		Frugivore

Sturnidae: starlings and oxpeckers				
Black-bellied Starling	<i>Lamprotornis corruscus</i>	F		Insectivore
Kenrick's Starling	<i>Poeoptera kenricki</i>	FF		Insectivore
Turdidae: thrushes				
African Bare-eyed Thrush	<i>Turdus tephronotus</i>	non-f		Insectivore
Muscicapidae: chats, wheatears and Old World flycatchers				
Thrush Nightingale	<i>Luscinia luscinia</i>	non-f	PM	Insectivore
White-browed Robin Chat	<i>Cossypha heuglini</i>	f		Insectivore
Red-capped Robin Chat	<i>Cossypha natalensis</i>	F	am	Insectivore
Bearded Scrub Robin	<i>Cercotrichas quadrivirgata</i>	f		Insectivore
African Grey Flycatcher	<i>Bradornis microrhynchus</i>	non-f		Insectivore
Spotted Flycatcher	<i>Muscicapa striata</i>	non-f	PM	Insectivore
Ashy Flycatcher	<i>Muscicapa caerulescens</i>	F		Insectivore
African Dusky Flycatcher	<i>Muscicapa adusta</i>	F		Insectivore
Nectariniidae: sunbirds				
Plain-backed Sunbird	<i>Anthreptes reichenowi</i>	FF	NT	Nectarinivore
Collared Sunbird	<i>Hedydipna collaris</i>	F		Nectarinivore
Olive Sunbird	<i>Cyanomitra olivacea</i>	FF		Nectarinivore
Scarlet-chested Sunbird	<i>Chalcomitra senegalensis</i>	non-f		Nectarinivore
Purple-banded Sunbird	<i>Cinnyris bifasciatus</i>	f		Nectarinivore
Variable Sunbird	<i>Cinnyris venustus</i>	f		Nectarinivore
Passeridae: sparrow weavers, Old World sparrows and petronias				
Grey-headed Sparrow	<i>Passer griseus</i>	non-f		Granivore
Ploceidae: weavers, bishops and widowbirds				
Spectacled Weaver	<i>Ploceus ocularis</i>	f		Granivore
Golden Palm Weaver	<i>Ploceus bojeri</i>	non-f		Granivore
Village Weaver	<i>Ploceus cucullatus</i>	non-f		Granivore
Dark-backed Weaver	<i>Ploceus bicolor</i>	F		Granivore
Zanzibar Red Bishop	<i>Euplectes nigroventris</i>	non-f		Granivore
Estrildidae: waxbills				
Crimson-rumped Waxbill	<i>Estrilda rhodopyga</i>	non-f		Granivore

Red-cheeked Cordon-bleu	<i>Uraeginthus bengalus</i>	non-f		Granivore
Peters's Twinspot	<i>Hypargos niveoguttatus</i>	F		Granivore
Bronze Mannikin	<i>Spermestes cucullatus</i>	non-f		Granivore
Black-and-white Mannikin	<i>Spermestes bicolor</i>	f		Granivore
Magpie Mannikin	<i>Spermestes fringilloides</i>	f		Granivore
Motacillidae: wagtails, longclaws and pipits				
African Pied Wagtail	<i>Motacilla aguimp</i>	non-f		Granivore
Yellow-throated Longclaw	<i>Macronyx croceus</i>	non-f		Granivore
Grassland Pipit	<i>Anthus cinnamomeus</i>	non-f		
Fringillidae: canaries, citrils, seedeaters and relatives				
African Citril	<i>Crithagra citrinelloides</i>	f		Granivore
Yellow-fronted Canary	<i>Crithagra mozambica</i>	non-f		Granivore