

CRITICAL ECOSYSTEM PARTNERSHIP FUND



**PROJECT TITTLE: - MAPPING OF THE REMAINING UN-
PROTECTED NATURAL FORESTS AND ASSESSMENT OF
THEIR RESOURCES AND THREATS AS A ROADMAP TO
CONSERVE EASTERN AFROMONTANE BIODIVERSITY
HOTSPOT IN LUDEWA, TANZANIA**

**BIODIVERSITY (BIRDS AND MAMMALS) ASSESSMENT REPORT
FOR SIX UN-PROTECTED FORESTS OF NKOMANG'OMBE,
MAWENGI, MVAVA, MASIMAVALAFU, KIMELEMBE AND IWELA**

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From

FORCONSULT - SUA

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EXECUTIVE SUMMARY

Ludewa is one of the Districts in Njombe Regions which is endowed with abundant natural forests and wildlife. Most of these forests are not protected and therefore no proper framework for its management exists. This study was conducted in six un-protected forests of Nkomang'ombe, Mawengi, Mvava, Masimavalafu, Kimelembe and Iwela. The aim was to determine the abundance and diversity of both birds and mammals. Line transects of different size ranging from 0.5 -2.3 km were established in different stratified habitats of the forest. Visual encounter surveys (VES) method was used for both birds and mammals surveys. Shannon – Wiener Index of Diversity, (H') was used to calculate diversity of species and Mann–Whitney U-test for comparison between the habitats. More birds were recorded in Masimavalafu and relatively less to Mawengi forest. Overall, high diversity of bird species was noted in Iwela and relatively less in Mawengi forest. With exception of Iwela forest where birds are relatively more diverse in riverine than woodland, other forests were different. The difference was significantly noted in Nkomang'ombe and Masimavalafu forests.

Of all the birds recorded, Dappled Mountain-robin (*Arcanator orostruthus*) was the most threatened species categorized as vulnerable species. So far the species are reported to be native in Mt Namuli and Mt Mabu in Mozambique and in the East Usambara Mountains and Udzungwa Mountains in Tanzania. The specie's population is suspected to be declining in line with the fragmentation and degradation of mid-elevation forests within its range. Other near threatened species includes Olive-headed Weaver (*Ploceus olivaceiceps*), Bateleur (*Terathopius ecaudatus*), African Crowned Eagle (*Stephanoaetus coronatus*), Sooty Falcon (*Falco concolor*) and Snake-eagle (*Circaetus Fasciolatus*). Shelley's Sunbird (*Cinnyris shelleyi*) observed in Iwela forest was not yet recognized by IUCN.

Mammals were rarely observed in six surveyed forest. However, one threatened specie namely Leopard (*Panthera pardus*) which is vulnerable were recorded in Masimavalafu forest. Other near threatened Cape Clawless Otter (*Aonyx capensis*) was observed in

Iwela forest. Observation of Leopard (*Panthera pardus*) in Masimavalafu corresponds to relatively number of preys species observed in the forest including Harvey Duiker (*Cephalophus harveyi*), Suni (*Neotragus moschatus*), Common (grey) Duiker (*Sylvicapra grimmia*) and Greater Kudu (*Tragelaphus strepsiceros*).

The study concluded that the surveyed forests are important habitats for birds and mammals. However, the forests could attract more birds and mammals if sufficient measures are taken to manage the area from anthropogenic activities that threaten their life. This calls for more protection and management measures of the surveyed forests through sustainable management framework for conservation of biodiversity and restoration of degraded habitats.

1.0 INTRODUCTION

Ludewa is one of the districts in Njombe region with prominent natural forests, containing high abundance and diversity of both flora and fauna. While Ludewa's forests play a significant role in supporting biodiversity, sustaining livelihoods and climate change mitigation and adaptation, a considerable part of its natural forests fall under Village Land Forests (VLFs) and General Land Forests (GLFs), and therefore not properly protected. This lead to forest disturbance that fuel more threats from uncontrolled anthropogenic activities and therefore urgent management system are needed to restore and protect degraded forests in the district.

Development of effective forest management system (e.g. Participatory Forest Management) requires sufficient knowledge of the remaining unprotected forests. These include biodiversity status to update information from existing baselines. Biodiversity assessment uncovers forest condition, structure, health and quantifies present biodiversity both wildlife and forest for appropriate decision making on management. Measuring forest biodiversity is, however, a time intensive and expensive process (Lawton *et al.*, 1998). A good way to measure it is to use different proxies for biodiversity including indicator species (Lindenmayer *et al.*, 2000). Birds and mammals are among those groups of organisms that are easy to survey with a multispecies approach, since even if they cannot always be seen they can often be heard and or signs may be used as surrogate (Bibby 1999). It is from this perspective that this report focus on wildlife survey as a part of broader biodiversity assessment. The aim was to establish a list of birds and mammals present in the forest and to determine abundance and diversity. Findings from this study will form the basis for specific and general recommendations to proper forest management strategies. Additionally, as there is no such study conducted in the area, findings will serve as baseline information for future studies including monitoring.

Importantly, the findings from this study will feed directly to the long term goal of establishing Village Land Forest Reserves (VLFRs) which will be owned and managed by communities in the framework of Community Based Forest Management (CBFM). With CBFM, control and ownership of forest resources is devolved to the village government/Village Council. CBFM has demonstrated to be appropriate governance strategy in Tanzania to protect and manage profitably and sustainably natural forests while at the same time sustaining rural incomes and local livelihoods.

2.0 METHODOLOGY

2.1 Description of the study area

This study was conducted in six forest of Nkomang'ombe, Mawengi, Mvava, Kimelembe, Masimavalafu and Iwela (Fig 1). The forests are located in Ludewa district, Njombe region within the coordinates of 34° 34' – 34° 58' E and 9° 52' – 10° 16' S. Ludewa district has the area of 8,397.0 km² of which 6,325 km² (75.3%) is the land area and 2,072 km² (24.7%) is water surface (URT, 2014). The surveyed forests covers 16741.408 ha (167.4 km²) equals to about 10% of the total district area.

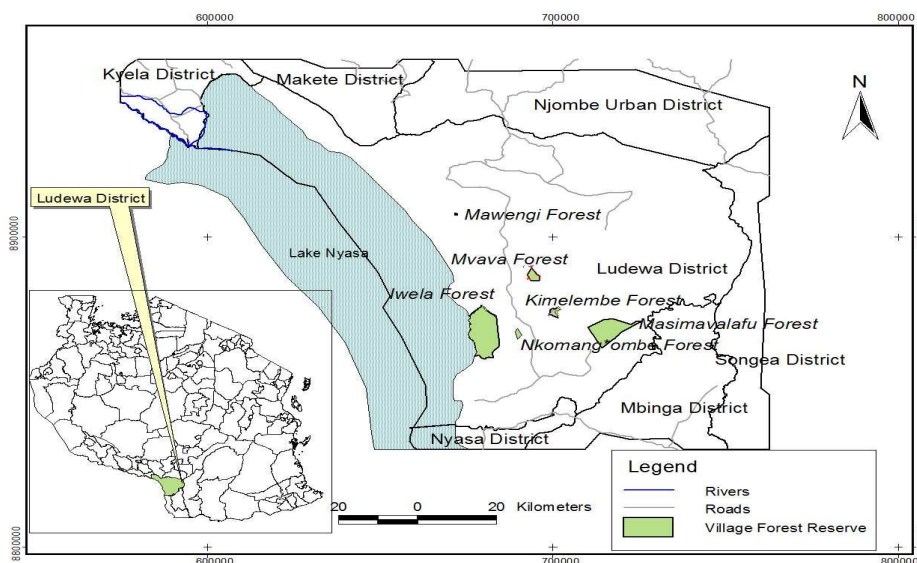


Figure 1: The Map of Ludewa District Showing Study forests

2.2 Sampling Design

The forests were firstly stratified based on the main habitats. A random sampling technique was then used to lay-out transect lines in each identified habitat. A total of 45 transects were established and surveyed in six forests; 9 transects each in Masimavalafu and Iwela forests, 8 transects each in Kimelembe and Komang'ombe forests, 7 transects in Mvava forest and 4 transects in Mawengi forest. The size of transect ranged from 0.5 to 2.3 km depending on vegetation density, terrain morphology and area of the forest. The interval between transects was at least 100m. Transects were pointed on different direction and made as straight as the terrain and vegetation allowed. To ensure fair sampling which represents entire forest, the experience of accompanied local/village member who is fully aware on the forest areas and its boundaries was necessary.

2.3 Data Collection

Visual encounter surveys (VES) method was used for data collection. VES including recording all forms of vertebrate sign is an appealing method because of low cost and few logistical burdens (Heyer *et al.*, 1994, Wemmer *et al.*, 1996). Surveys and counts of diurnal species were done by walking along the line-transect at an average speed of 1km/h. VES were done in specified line transect for both birds and large/medium sized mammals surveys. Line transect proved most efficient method in terms of data collection per unit effort (Yallop *et al.*, 2000).

Two to three transect walks were done each day during morning hours (7:00 am to 10 am), during afternoon hours (1:00pm to 3:00pm) and during evening hours from (04:30 to 6:30pm) respectively. The afternoon transect was meant purposely for mammals surveys only. All birds encountered (both visually and vocally) were recorded. Likewise all mammals encountered during visual surveys were identified by sighting and sign (tracks, dung, digging/borrows). Birds and mammals' species and/or signs were identified in the field based on the researcher's experience and the help of field guides books (Birds of East Africa, and Mammals of East Africa).

In every encounter; time of observation, altitude, habitat, distance (from the start of transect and estimated perpendicular distance from observation), compass direction, and number of observed species were recorded. GPS readings and time for the start and end points of each transect were also recorded. However, there were no width limit on the transects because, while the estimate of distance to visually observed birds were easier, estimate of distance to calls was more difficult, and such estimates would be highly unreliable.

2.4 Data Analysis

Primary data collected from the field were used to prepare a checklist of birds and mammals recorded in the survey and for statistical analysis of abundance and diversity of birds.

2.4.1 Species abundance

The relative abundance of a species was obtained by dividing the abundance of a species by the total abundance of all species combined based on the assumption that the frequently seen the species the more abundant it is (Bibby *et al.*, 1992). In the forests where different habitats were recorded, a relative abundance of bird's species in each habitat was calculated as the ratio of the number of species observed in each habitat and the total number of species recorded in particular habitat (Kangah-Kesse *et al.*, 2007). Relative abundances and diversity between habitats were statistically compared using a Mann–Whitney U-test. The statistical tests were performed using the InStat programme.

2.4.2 Species diversity

Shannon – Wiener Index of Diversity, (H') was used to calculate diversity of species in various habitats

$$H' = -\sum_{i=1}^s (P_i \ln P_i)$$

Where;-

H' = The index of species diversity,

P_i = The proportion of the total sample belonging to the i -th species and

\ln = natural logarithm.

s = Total number of species of the community (number seen and heard)

Species richness was summed as the total number of species encountered.

2.5 Limitation of study

- Due to resource limits (time and fund) it was difficult to conduct small mammals surveys as their techniques for surveys may relatively be resource demanding. Nevertheless, any small mammals encountered during surveys were recorded accordingly.
- Again due to relatively high terrain morphology of Iwela forest, it was difficult to survey some of the forest areas.

3.0 RESULTS

3.1 Birds

3.1.1 Relative abundance of birds

3.1.1.1 Relative abundance of Birds in Komang'ombe forest

A total of 373 individuals belonging to 58 species, 27 families and 11 orders were recorded from Nkomang'ombe forest (Appendix I). Of all the individual birds, 367 (98.4%) were recorded by direct observation (sighting) and 6 (1.6%) by hearing. The birds were recorded in Miombo woodland and riverine habitats. The dominant family was Muscipidae, comprising of 10.3% of the total species, followed by Nectariniidae and ploceidae (8.6%), Cuculidae and Estrildidae each comprising of 6.9% of the total species (Appendix I). Of all birds recorded, 43 species were recorded in Miombo woodland and 20 species in riverine habitat (Table 1).

Table 1: Relative abundance of birds recorded in Komang'ombe Forest

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|-----------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 1. | African Green-pigeon | 1 | 0.4 | 0 | 0.0 | 1 | 0.3 |
| 2. | African Grey Hornbill | 6 | 2.4 | | 0.0 | 6 | 1.6 |
| 3. | African Harrier-hawk | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 4. | African Hill-babbler | 3 | 1.2 | | 0.0 | 3 | 0.8 |
| 5. | African Mourning Dove | | 0.0 | 1 | 0.8 | 1 | 0.3 |
| 6. | African Paradise-flycatcher | | 0.0 | 1 | 0.8 | 1 | 0.3 |
| 7. | African Penduline Tit | 5 | 2.0 | | 0.0 | 5 | 1.3 |
| 8. | African Pied Wagtail | | 0.0 | 4 | 3.4 | 4 | 1.1 |
| 9. | Baglafetch Weaver | | 0.0 | 2 | 1.7 | 2 | 0.5 |
| 10. | Black and white Cuckoo | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 11. | Black Kite | 3 | 1.2 | | 0.0 | 3 | 0.8 |
| 12. | Black-winged Bishop | 3 | 1.2 | | 0.0 | 3 | 0.8 |
| 13. | Bronze Mankin | 7 | 2.8 | 8 | 6.7 | 15 | 4.0 |
| 14. | Brown-crowned Tchagra | 16 | 6.3 | | 0.0 | 16 | 4.3 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|---------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 15. | Capped Wheatear | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 16. | Cardinal Woodpeckers | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 17. | Chestnut Weaver | 3 | 1.2 | | 0.0 | 3 | 0.8 |
| 18. | Collared Sunbird | | 0.0 | 2 | 1.7 | 2 | 0.5 |
| 19. | Croaking Cisticola | | 0.0 | 3 | 2.5 | 3 | 0.8 |
| 20. | Crowned Hornbill | 4 | 1.6 | | 0.0 | 4 | 1.1 |
| 21. | Eurasian Hobby | 8 | 3.1 | 8 | 6.7 | 16 | 4.3 |
| 22. | Eurasian Swift | 2 | 0.8 | 31 | 26.1 | 33 | 8.8 |
| 23. | Familiar Chat | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 24. | Fork-tailed Drongo | 21 | 8.3 | | 0.0 | 21 | 5.6 |
| 25. | Fuelleborn's Black Boubou | 6 | 2.4 | 1 | 0.8 | 7 | 1.9 |
| 26. | Garden Warbler | 8 | 3.1 | | 0.0 | 8 | 2.1 |
| 27. | Grassland Pipit | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 28. | Grey-headed Kingfisher | | 0.0 | 2 | 1.7 | 2 | 0.5 |
| 29. | Helmeted Guineafowl | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 30. | Klaas's Cuckoo | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 31. | Lesser Honeyguide | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 32. | Lesser Kestrel | 4 | 1.6 | 1 | 0.8 | 5 | 1.3 |
| 33. | Loughing Dove | 4 | 1.6 | | 0.0 | 4 | 1.1 |
| 34. | Martial Eagle | 5 | 2.0 | | 0.0 | 5 | 1.3 |
| 35. | Miombo Rock-thrush | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 36. | Namaqua Dove | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 37. | Orange Ground-thrush | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 38. | Pin-tailed Whydah | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 39. | Purple-banded Sunbird | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 40. | Rattling Cisticola | 52 | 20.5 | | 0.0 | 52 | 13.9 |
| 41. | Red-backed Shrike | | 0.0 | 2 | 1.7 | 2 | 0.5 |
| 42. | Red-billed Firefinch | 2 | 0.8 | 2 | 1.7 | 4 | 1.1 |
| 43. | Red -capped Robin-chat | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 44. | Red-chested Cuckoo | 12 | 4.7 | | 0.0 | 12 | 3.2 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|--------------|-------------------------|------------|--------|------------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 45. | Ross's Turaco | | 0.0 | 4 | 3.4 | 4 | 1.1 |
| 46. | Scarlet-chested Sunbird | 1 | 0.4 | 1 | 0.8 | 2 | 0.5 |
| 47. | Shelley's Sunbird | | 0.0 | 1 | 0.8 | 1 | 0.3 |
| 48. | Sooty Falcon | 1 | 0.4 | | 0.0 | 1 | 0.3 |
| 49. | Southern Red Bishop | 13 | 5.1 | | 0.0 | 13 | 3.5 |
| 50. | Spotted Flycatcher | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 51. | Squire-tailed Drongo | 8 | 3.1 | | 0.0 | 8 | 2.1 |
| 52. | Tawny-flanked Prinia | 2 | 0.8 | | 0.0 | 2 | 0.5 |
| 53. | Trumpeter Hornbill | 4 | 1.6 | | 0.0 | 4 | 1.1 |
| 54. | Variable Sunbird | 2 | 0.8 | 8 | 6.7 | 10 | 2.7 |
| 55. | Violet Backed Starling | 3 | 1.2 | | 0.0 | 3 | 0.8 |
| 56. | White-browed Robin-chat | 7 | 2.8 | | 0.0 | 7 | 1.9 |
| 57. | Yellow Bishop | 10 | 3.9 | 13 | 10.9 | 23 | 6.2 |
| 58. | Yellow-vented Bulbul | 2 | 0.8 | 24 | 20.2 | 26 | 7.0 |
| Total | | 254 | | 119 | | 373 | 100.0 |

Key: IND = Number of individuals; RA= Relative abundance; WLD= Woodland; RVRN=Riverine

The relative abundance was noted to differ among species and habitats (Table 1). The most abundant species at Komang'ombe forest was the Rattling Cisticola (*Cisticola chiniana*) (RA =13.9%), followed by the Eurasian Swift (*Apus apus*) (RA = 8.8%), Yellow-vented Bulbul (*Pycnonotus barbatus*) (RA = 7.0%), Yellow Bishop (*Euplectes capensis*) (RA = 6.2%), Fork-tailed Drongo (*Dicrurus adsimilis*), (RA = 5.6%), and Eurasian Hobby (*Falco subbuteo*) and Brown-crowned Tchagra (*Tchagra australis*) that had the same relative abundance of 4.3% (Table 1). These seven species together make up 50.1% of the species recorded.

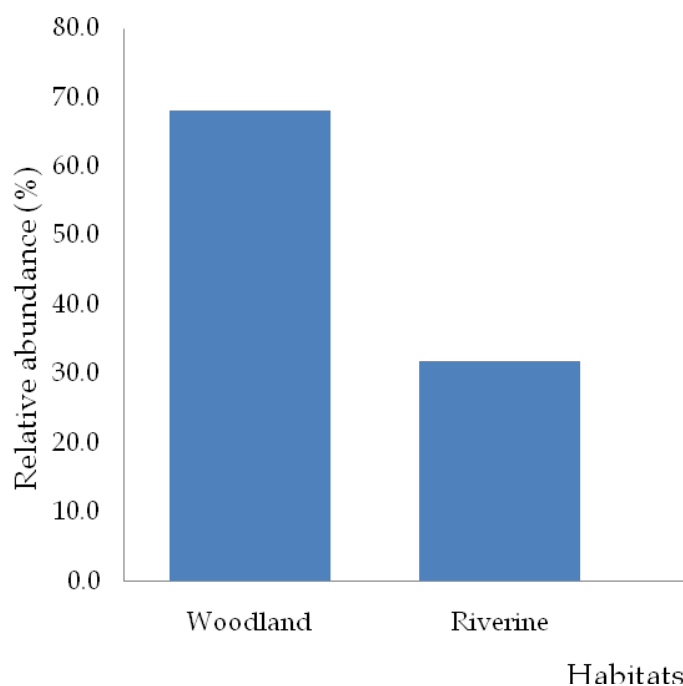


Figure 2: Relative abundance of birds' species by habitats in Komang'ombe forest

Relatively, more abundance of birds were recorded in miombo woodland (68.1%), than riverine habitat (31.9%) (Fig. 2). Rattling Cisticola (*Cisticola chiniana*) was the abundant species in woodland with relative abundance of 20.5%. Likewise, Eurasian Swift (*Apus apus*) was the most abundant species in riverine habitat with relative abundance of 26.1% followed by Yellow-vented Bulbul (*Pycnonotus barbatus*) (20.2%) and Yellow Bishop (*Euplectes capensis*) 10.9%. Other species had less than 10% relative abundance each. Relative species abundance between habitats was tested by Mann-Whitney U test at 5% significance level. Results showed that there was significant different on species abundance between woodland and riverine habitats (Mann-Whitney U test $P = 0.0003$).

3.1.1.2 Relative abundance of Birds in Mawengi forest

A total of 76 birds belonging to 23 species, 15 families and 6 orders were recorded from Mawengi forest. The birds were recorded in Miombo woodland as the main habitat type of the forest. Of all the birds recorded, 72 (94.7%) birds were recorded by direct observation (sighting) and 4 (5.3%) were recorded by hearing. The dominant family was Columbidae, Nectariniidae and Estrildidae each comprising of 13% of the total species (Appendix II).

Table 2: Relative abundance of birds recorded in Mawengi Forest

| No. | Common name | Habitat | |
|--------------|-------------------------|-----------------------|--------------------|
| | | Miombo Woodland | |
| | | Number of individuals | Relative abundance |
| 1. | Amethyst Sunbird | 2 | 2.6 |
| 2. | Black and white Cuckoo | 5 | 6.6 |
| 3. | Blue-spotted Wood-dove | 2 | 2.6 |
| 4. | Bronze Mankin | 7 | 9.2 |
| 5. | Collared Sunbird | 1 | 1.3 |
| 6. | Common Stonechat | 3 | 3.9 |
| 7. | Crimson-rumped Waxbill | 4 | 5.3 |
| 8. | Green-throated Sunbird | 8 | 10.5 |
| 9. | Helmeted Guineafowl | 3 | 3.9 |
| 10. | Hildebrandt's Francolin | 2 | 2.6 |
| 11. | Mountain Wagtail | 3 | 3.9 |
| 12. | Namaqua Dove | 1 | 1.3 |
| 13. | Osprey | 2 | 2.6 |
| 14. | Pale Batis | 3 | 3.9 |
| 15. | Pied Crow | 1 | 1.3 |
| 16. | Pygm Batis | 4 | 5.3 |
| 17. | Rattling Cisticola | 10 | 13.2 |
| 18. | Red-chested Cuckoo | 2 | 2.6 |
| 19. | Red-faced Crombec | 3 | 3.9 |
| 20. | Ring-necked Dove | 1 | 1.3 |
| 21. | Ross's Turaco | 1 | 1.3 |
| 22. | Yellow-billed Waxbill | 4 | 5.3 |
| 23. | Yellow Bishop | 4 | 5.3 |
| TOTAL | | 76 | 100 |

Abundance of birds was noted to differ among species (Table 2). The most abundant species at Mawengi forest was the Rattling Cisticola (*Cisticola chiniana*) (RA =13.2%), followed by the Green-throated Sunbird (*Chalcomitra rubescens*) (RA = 10.5%), Bronze Mankin (*Lonchura cucullata*) (RA = 9.2%), and Black and white Cuckoo (*Oxylophus jacobinus*) (RA = 6.6%) Table 2. These four species together make up 39.5% of the species recorded.

3.1.1.3 Relative abundance of Birds recorded in Mvava forest

Three hundred and twenty three (323) birds belonging to 53 species, 27 families and 9 orders were recorded in Mvava forest. All individual birds were recorded by direct observation (Table 3). About eleven percent (11.3%) of the total species recorded were belonging to the family Columbidae followed by Muscicapidae and Nectariniidae comprising 7.5% each (Appendix III). Majority (67.9%) of all recorded species were belonging to odder Passeriformes.

Table 3: Relative abundance of birds in Mvava Forest

| No. | Common Name | Habitat | |
|-----|------------------------|-----------------------|--------------------|
| | | Miombo Woodland | |
| | | Number Of Individuals | Relative Abundance |
| 1. | African Black Swift | 23 | 7.1 |
| 2. | African Grey Hornbill | 6 | 1.9 |
| 3. | African Mourning Dove | 2 | 0.6 |
| 4. | African Pied Wagtail | 2 | 0.6 |
| 5. | Amethyst Sunbird | 5 | 1.5 |
| 6. | Ashy Flycatcher | 5 | 1.5 |
| 7. | Black and white Cuckoo | 35 | 10.8 |
| 8. | Black-crowned Tchagra | 6 | 1.9 |
| 9. | Black Kite | 1 | 0.3 |
| 10. | Black-shouldered Kite | 2 | 0.6 |
| 11. | Bohm's-spine Tail | 16 | 5.0 |
| 12. | Bronze Mankin | 14 | 4.3 |
| 13. | Brown-crowned Tchagra | 9 | 2.8 |
| 14. | Dappled Mountain-robin | 2 | 0.6 |
| 15. | Dusky Tit | 1 | 0.3 |

| | | | |
|--------------|-------------------------------|------------|------------|
| 16. | Emerald-wood Spotted-dove | 1 | 0.3 |
| 17. | Forest Batis | 14 | 4.3 |
| 18. | Fork-tailed Drongo | 14 | 4.3 |
| 19. | Green-capped Eromela | 3 | 0.9 |
| 20. | Grey-backed Camaroptera | 1 | 0.3 |
| 21. | Hartlaub's Marsh Widowbird | 1 | 0.3 |
| 22. | Hildebrandt's Francolin | 11 | 3.4 |
| 23. | Hill Babbler | 3 | 0.9 |
| 24. | Laughing Dove | 1 | 0.3 |
| 25. | Lead-coloured Flycatcher | 1 | 0.3 |
| 26. | Lesser Honeyguide | 4 | 1.2 |
| 27. | Marsh Warbler | 2 | 0.6 |
| 28. | Miombo Double-colored Sunbird | 3 | 0.9 |
| 29. | Mountain Greenbul | 9 | 2.8 |
| 30. | Namaqua Dove | 1 | 0.3 |
| 31. | Olive-flanked Robin-chat | 1 | 0.3 |
| 32. | Orange Ground-thrush | 1 | 0.3 |
| 33. | Pale Batis | 13 | 4.0 |
| 34. | Pale Flycatcher | 2 | 0.6 |
| 35. | Pin-tailed Drongo | 3 | 0.9 |
| 36. | Rattling Cisticola | 4 | 1.2 |
| 37. | Red-billed Firefinch | 10 | 3.1 |
| 38. | Red-billed Oxpeker | 2 | 0.6 |
| 39. | Red-chested Cuckoo | 3 | 0.9 |
| 40. | Red-eyed Dove | 3 | 0.9 |
| 41. | Red-faced Crimsonwing | 2 | 0.6 |
| 42. | Ring-necked Dove | 5 | 1.5 |
| 43. | Scarlet-chested Sunbird | 19 | 5.9 |
| 44. | Spotted Flycatcher | 2 | 0.6 |
| 45. | Square-tailed Drongo | 11 | 3.4 |
| 46. | Square-tailed Nightjar | 2 | 0.6 |
| 47. | Variable Sunbird | 1 | 0.3 |
| 48. | Village Indigobird | 6 | 1.9 |
| 49. | White-browed Caucal | 4 | 1.2 |
| 50. | Yellow-bellied Greenbul | 1 | 0.3 |
| 51. | Yellow Bishop | 22 | 6.8 |
| 52. | Yellow-fronted Canary | 1 | 0.3 |
| 53. | Yellow-vented Bulbul | 7 | 2.2 |
| Total | | 323 | 100 |

The most abundant species at Mvava forest was the Black and white Cuckoo (*Oxylophus jacobinus*) (RA =10.8%), followed by the African Black Swift (*Apus barbatus*) (RA = 7.1%), Yellow bishop (*Euplectes capensis*) (RA = 6.8%) and Scarlet-chested Sunbird (*Chalcomitra senegalensis*) (RA = 5.9%) Table 3. These four species together make up 30.6% of all the species recorded.

3.1.1.4 Relative abundance of Birds in Mazivamalafu forest

Six hundred and forty nine (649) individuals belonging to 72 species, 34 families and 13 orders were recorded from Masimavalafu forest (Appendix IV). Birds were recorded in Miombo woodland, and riverine as the main habitats in the forest. Of all the individual birds, 585 (90.1%) birds were recorded by direct observation (sighting) and 64 (9.9%) were recorded by hearing. The dominant family was Accipitridae, comprising of 11.1% of the total species, followed by Muscicapidae (8.3%). Estrildidae, Ploceidae and Nectariniidae each comprised of 6.9% of the total species (Appendix IV). Three hundred and sixty two (362) individuals belonging to 58 species were recorded in Miombo woodland and 287 individuals belonging to 42 species in riverine habitat (Table 4).

Table 4: Relative abundance of birds in Mazivamalafu Forest

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|---------------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 1. | African Black-headed Oriole | 11 | 3.0 | 1 | 0.3 | 12 | 1.8 |
| 2. | African Citril | 5 | 1.4 | 2 | 0.7 | 7 | 1.1 |
| 3. | African Crowned Eagle | 2 | 0.6 | 0 | 0.0 | 2 | 0.3 |
| 4. | African Firefinch | 1 | 0.3 | 16 | 5.6 | 17 | 2.6 |
| 5. | African Golden Oriole | 1 | 0.3 | 1 | 0.3 | 2 | 0.3 |
| 6. | African Golden-breasted Bunting | 1 | 0.3 | 9 | 3.1 | 10 | 1.5 |
| 7. | Amythest Sunbird | 22 | 6.1 | 0 | 0.0 | 22 | 3.4 |
| 8. | Arrow-marked Babbler | 23 | 6.4 | 9 | 3.1 | 32 | 4.9 |
| 9. | Bateleur | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|--------------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 10. | Bearded Woodpecker | 4 | 1.1 | 0 | 0.0 | 4 | 0.6 |
| 11. | Black and white Mannkin | 12 | 3.3 | 20 | 7.0 | 32 | 4.9 |
| 12. | Black Cuckoo-shrike | 2 | 0.6 | 1 | 0.3 | 3 | 0.5 |
| 13. | Black-backed Puffback | 9 | 2.5 | 3 | 1.0 | 12 | 1.8 |
| 14. | Black-crowned Tchagra | 7 | 1.9 | 0 | 0.0 | 7 | 1.1 |
| 15. | Black-Shouldered kite | 6 | 1.7 | 0 | 0.0 | 6 | 0.9 |
| 16. | Broad-tailed Paradise-Whydah | 12 | 3.3 | 1 | 0.3 | 13 | 2.0 |
| 17. | Brown-hooded Kingfisher | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 18. | Brown-naked Parrot | 5 | 1.4 | 0 | 0.0 | 5 | 0.8 |
| 19. | Cabanis's Bunting | 8 | 2.2 | 0 | 0.0 | 8 | 1.2 |
| 20. | Cardinal Woodpecker | 3 | 0.8 | 0 | 0.0 | 3 | 0.5 |
| 21. | Chin-spot Batis | 12 | 3.3 | 7 | 2.4 | 19 | 2.9 |
| 22. | Cinnamon-breasted Rock Bunting | 2 | 0.6 | 0 | 0.0 | 2 | 0.3 |
| 23. | Collared Sunbird | 5 | 1.4 | 2 | 0.7 | 7 | 1.1 |
| 24. | Common Bulbul | 13 | 3.6 | 5 | 1.7 | 18 | 2.8 |
| 25. | Common Scimitarbill | 4 | 1.1 | 2 | 0.7 | 6 | 0.9 |
| 26. | Crowned Hornbill | 14 | 3.9 | 3 | 1.0 | 17 | 2.6 |
| 27. | Eastern Chanting-Goshawk | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |
| 28. | Eastern nicator | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |
| 29. | Eastern Saw-wing | 2 | 0.6 | 15 | 5.2 | 17 | 2.6 |
| 30. | Emerald-spotted Wood-Dove | 3 | 0.8 | 1 | 0.3 | 4 | 0.6 |
| 31. | Familiar Chat | 1 | 0.3 | 2 | 0.7 | 3 | 0.5 |
| 32. | Fawn-breasted Waxbil | 1 | 0.3 | 18 | 6.3 | 19 | 2.9 |
| 33. | Fork-tailed Drongo | 14 | 3.9 | 4 | 1.4 | 18 | 2.8 |
| 34. | Fulleborn's Black Boubou | 0 | 0.0 | 2 | 0.7 | 2 | 0.3 |
| 35. | Greater Honeyguide | 3 | 0.8 | 1 | 0.3 | 4 | 0.6 |
| 36. | Grey-headed Kingfisher | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 37. | Hamerkop | 2 | 0.6 | 1 | 0.3 | 3 | 0.5 |
| 38. | Helmeted Guinefowl | 2 | 0.6 | 2 | 0.7 | 4 | 0.6 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|---------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 39. | Little Banded Goshawk | 2 | 0.6 | 0 | 0.0 | 2 | 0.3 |
| 40. | Little Bee-eater | 27 | 7.5 | 3 | 1.0 | 30 | 4.6 |
| 41. | Little Greenbul | 0 | 0.0 | 9 | 3.1 | 9 | 1.4 |
| 42. | Lizard Buzzard | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 43. | Miombo Rock-Thrush | 3 | 0.8 | 0 | 0.0 | 3 | 0.5 |
| 44. | Namaqua Dove | 2 | 0.6 | 0 | 0.0 | 2 | 0.3 |
| 45. | Olive Sunbird | 7 | 1.9 | 3 | 1.0 | 10 | 1.5 |
| 46. | Olived-flanked Robin-chat | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 47. | Olive-headed Weaver | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |
| 48. | Piping Cisticola | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 49. | Purple Granadier | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 50. | Purple-crested Turaco | 7 | 1.9 | 0 | 0.0 | 7 | 1.1 |
| 51. | Rattling Cisticola | 8 | 2.2 | 0 | 0.0 | 8 | 1.2 |
| 52. | Red-caped Robin-Chat | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 53. | Red-collared Widowbird | 0 | 0.0 | 6 | 2.1 | 6 | 0.9 |
| 54. | Red-necked Spurfowl | 3 | 0.8 | 0 | 0.0 | 3 | 0.5 |
| 55. | Retz's Helmet-shrike | 15 | 4.1 | 50 | 17.4 | 65 | 10.0 |
| 56. | Ring-necked Dove | 10 | 2.8 | 0 | 0.0 | 10 | 1.5 |
| 57. | Rufous-bellied Tit | 1 | 0.3 | 0 | 0.0 | 1 | 0.2 |
| 58. | Scarlet-chested Sunbird | 5 | 1.4 | 0 | 0.0 | 5 | 0.8 |
| 59. | Southern Cordon-bleu | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |
| 60. | Southern Red Bishop | 0 | 0.0 | 4 | 1.4 | 4 | 0.6 |
| 61. | Speckled Mousebird | 0 | 0.0 | 4 | 1.4 | 4 | 0.6 |
| 62. | Swallow-tailed Bee-eater | 7 | 1.9 | 0 | 0.0 | 7 | 1.1 |
| 63. | Tawny-flanked Prinia | 16 | 4.4 | 5 | 1.7 | 21 | 3.2 |
| 64. | Tropical Boubou | 7 | 1.9 | 1 | 0.3 | 8 | 1.2 |
| 65. | Trumpeter Hornbill | 13 | 3.6 | 0 | 0.0 | 13 | 2.0 |
| 66. | Variable Sunbird | 0 | 0.0 | 1 | 0.3 | 1 | 0.2 |
| 67. | Village Indigobird | 3 | 0.8 | 0 | 0.0 | 3 | 0.5 |
| 68. | White-browed Robin-Chat | 0 | 0.0 | 4 | 1.4 | 4 | 0.6 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|--------------|--------------------------|------------|--------|------------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 69. | White-browed Scrub-Robin | 5 | 1.4 | 0 | 0.0 | 5 | 0.8 |
| 70. | White-winged Widowbird | 0 | 0.0 | 42 | 14.6 | 42 | 6.5 |
| 71. | Yellow Bishop | 0 | 0.0 | 22 | 7.7 | 22 | 3.4 |
| 72. | Yellow-bellied Greenbul | 2 | 0.6 | 0 | 0.0 | 2 | 0.3 |
| TOTAL | | 362 | | 287 | | 649 | |

Key: IND = Number of individuals; RA= Relative abundance; WLD= Woodland; RVRN=Riverine;

The abundance of birds was noted to differ among species and habitats (Table 4). The most abundant species at Masimavalafu forest was the Retz's Helmet-shrike (*Prionops retzii*) (RA =10%), followed by the White-winged Widowbird (*Euplactes albonotatus*) (RA = 6.5%), Black and white Mannkin (*Lonchura bicolor*) and Arrow-marked Babbler (*Turdoides jardineii*) which had the same relative abundance of 4.9% each. Little Bee-eater (*Merops pusillus*) had the relative abundance of 4.6% (Table 4). These five species together make up 30.9% of all the species recorded.

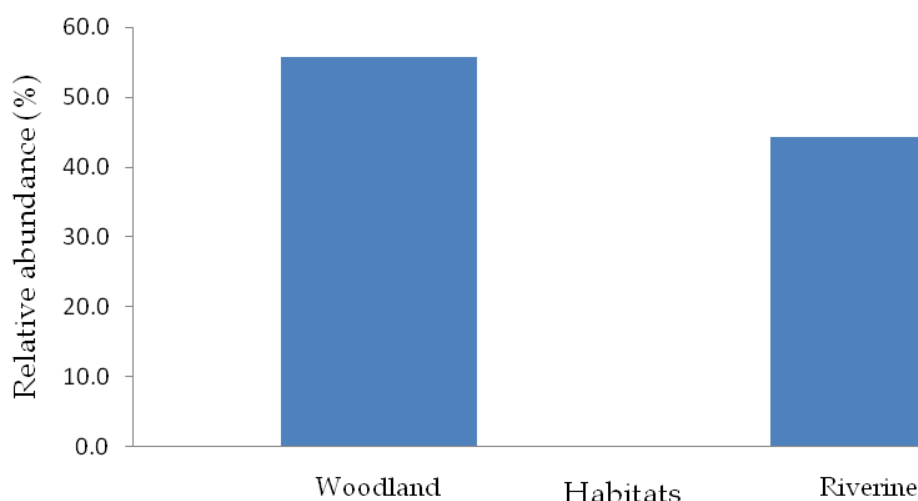


Figure 3: Relative abundance of bird's species by habitats in Masimavalafu forest

About fifty six percent (55.8%) of recorded bird individuals were observed in miombo woodland and 44.2% in riverine (Fig 3). Retz's Helmet-hike (*Pinups retie*) was the dominant species in the woodland with relative abundance of 7.5% followed by Arrow-marked Babbler (*Tortoises jardineii*) (6.4%) and Amythest Sunbird (*Chalcomitra rubescens*) (6.1%). White-winged Widowbird (*Euplactes albonotatus*) was the most abundant bird species in riverine with relative abundance of 14.6% followed by Yellow Bishop (*Euplectes capensis*) (7.7%) and Black and white Mannkin (*Lonchura bicolor*) (7.0%). Other species had less than 7% relative abundance. Difference in relative abundance between habitats was tested by Mann-Whitney U test at 5% significance level. The results showed that there is significant difference between the two habitats (Mann-Whitney U test, $P = 0.009$).

3.1.1.5 Relative abundance of Birds in Kimelembe forest

Two hundred and twenty six (226) individuals representing 50 species from 30 families and 12 orders were recorded from Kimelembe forest (Appendix V). Birds were recorded in Miombo woodland, and riverine as the main habitats. Of all the individuals, 192 (85%) birds were recorded by direct observation (sighting) and 34 (15%) were recorded by hearing. The dominant family was Nectariniidae, comprising of 12% (6 species) of the total species, followed by Pycnonotidae (8%), and Accipitridae, Bucerotidae, Cisticolidae, Malaconotidae and Muscicapidae each comprising of 6% of the total species (Appendix V). One hundred and forty five (145) individuals representing thirty eight (38) species were recorded in Miombo woodland and 81 bird's individuals belonging to 24 species in riverine (Table 5).

Table 5: Relative abundance of birds recorded in Kimelembe Forest

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|-------------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 1. | African Black-headed Oriole | 7 | 4.8 | 1 | 1.2 | 8 | 3.5 |
| 2. | African Citril | 3 | 2.1 | 0 | 0.0 | 3 | 1.3 |
| 3. | African Dusky Flycatcher | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 4. | African Firefinch | 0 | 0.0 | 4 | 4.9 | 4 | 1.8 |
| 5. | African Paradise-flycatcher | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |
| 6. | Amythest Sunbird | 5 | 3.4 | 0 | 0.0 | 5 | 2.2 |
| 7. | Black Cuckoo-shrike | 2 | 1.4 | 0 | 0.0 | 2 | 0.9 |
| 8. | Black-backed Puffback | 2 | 1.4 | 0 | 0.0 | 2 | 0.9 |
| 9. | Black-crowned Tchagra | 1 | 0.7 | 2 | 2.5 | 3 | 1.3 |
| 10. | Black-shouldered Kite | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 11. | Broad-tailed Paradise-Whydah | 3 | 2.1 | 0 | 0.0 | 3 | 1.3 |
| 12. | Brown-necked Parrot | 2 | 1.4 | 0 | 0.0 | 2 | 0.9 |
| 13. | Cardinal Woodpecker | 2 | 1.4 | 0 | 0.0 | 2 | 0.9 |
| 14. | Chin-spot Batis | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 15. | Collared Sunbird | 8 | 5.5 | 3 | 3.7 | 11 | 4.9 |
| 16. | Common Bulbul | 4 | 2.8 | 6 | 7.4 | 10 | 4.4 |
| 17. | Common Scimitarbill | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 18. | Crowned Hornbill | 1 | 0.7 | 9 | 11.1 | 10 | 4.4 |
| 19. | Eastern Nicator | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |
| 20. | Fork-tailed Drongo | 10 | 6.9 | 0 | 0.0 | 10 | 4.4 |
| 21. | Giant Kingfisher | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |
| 22. | Hamerkop | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |
| 23. | Helmeted Guineafowl | 6 | 4.1 | 0 | 0.0 | 6 | 2.7 |
| 24. | Little Greenbul | 0 | 0.0 | 2 | 2.5 | 2 | 0.9 |
| 25. | Miombo Double-collard Sunbird | 2 | 1.4 | 5 | 6.2 | 7 | 3.1 |
| 26. | Mottled Swift | 12 | 8.3 | 0 | 0.0 | 12 | 5.3 |
| 27. | Mountain Wagtail | 0 | 0.0 | 10 | 12.3 | 10 | 4.4 |
| 28. | Narina Trogon | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|--------------|------------------------------|------------|--------|-----------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 29. | Olive Sunbird | 3 | 2.1 | 6 | 7.4 | 9 | 4.0 |
| 30. | Pale-billed Hornbill | 7 | 4.8 | 3 | 3.7 | 10 | 4.4 |
| 31. | Rattling Cisticola | 11 | 7.6 | 0 | 0.0 | 11 | 4.9 |
| 32. | Red-necked Spurfowl | 3 | 2.1 | 0 | 0.0 | 3 | 1.3 |
| 33. | Retz's Helmet-shrike | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 34. | Ring-necked Dove | 0 | 0.0 | 1 | 1.2 | 1 | 0.4 |
| 35. | Scaly-throated Honeyguide | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 36. | Scarlet-chested Sunbird | 1 | 0.7 | 1 | 1.2 | 2 | 0.9 |
| 37. | Shelly's Greenbul | 0 | 0.0 | 6 | 7.4 | 6 | 2.7 |
| 38. | Southern Banded Snake-Eagle | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 39. | Southern Black Flycatcher | 10 | 6.9 | 0 | 0.0 | 10 | 4.4 |
| 40. | Souza's Shrike | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 41. | Tawny-flanked Prinia | 3 | 2.1 | 2 | 2.5 | 5 | 2.2 |
| 42. | Tropical Boubou | 1 | 0.7 | 1 | 1.2 | 2 | 0.9 |
| 43. | Trumpeter Hornbill | 22 | 15.2 | 0 | 0.0 | 22 | 9.7 |
| 44. | Variable Sunbird | 1 | 0.7 | 8 | 9.9 | 9 | 4.0 |
| 45. | White-breasted Cuckoo-Shrike | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 46. | White-Browed Scrub-Robin | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 47. | White-rumped Swift | 1 | 0.7 | 0 | 0.0 | 1 | 0.4 |
| 48. | Whyte's Barbet | 2 | 1.4 | 0 | 0.0 | 2 | 0.9 |
| 49. | Yellow-bellied Greenbul | 0 | 0.0 | 4 | 4.9 | 4 | 1.8 |
| 50. | Yellow-breasted Apalis | 0 | 0.0 | 2 | 2.5 | 2 | 0.9 |
| TOTAL | | 145 | | 81 | | 226 | |

Key: IND = Number of individuals; RA= Relative abundance; WLD= Woodland; RVRN=Riverine

The abundance was noted to differ among species and habitats (Table 4). The most abundant species at Kimelembe forest was the Trumpeter Hornbill (*Bycanistes bucinator*) (RA =9.7%), followed by Mottled Swift (*Apus aequatorialis*) (RA = 5.3%) and Rattling Cisticola (*Cisticola chiniana*) and Collared Sunbird (*Hedydipna collaris*) which had the same relative abundance of 4.9% each (Table 5). Pale-billed Hornbill (*Tockus*

pallidirostris), Crowned Hornbill (*Tockus albeterminatus*), Mountain Wagtail (*Motacilla clara*) Southern Black Flycatcher (*Melaenornis pammelaina*), Common Bulbul (*Pycnonotus barbatus*) and Fork-tailed Drongo (*Dicrurus adsimilis*) had the same relative abundance of 4.4% each. These ten species together make up an abundance of 51.2% of all the species recorded.

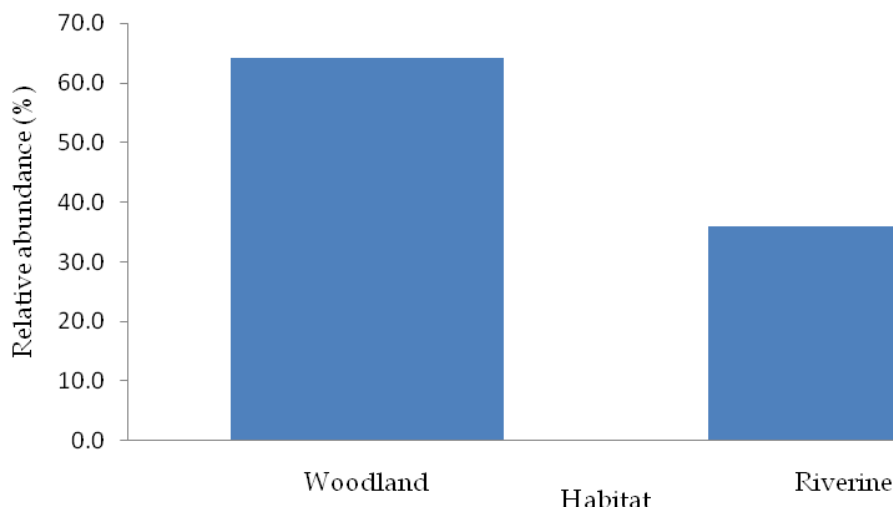


Figure 4: Relative abundance of bird's species by habitats in Kimelembe forest

Relatively, more abundance of bird's species was recorded in miombo woodland (64.2%) than (35.8%) in riverine habitat (Fig 4). Trumpeter Hornbill (*Bycanistes bucinator*) was the abundant bird species in woodland with relative abundance of 15.2% followed by Mottled Swift (*Apus aequatorialis*) (RA = 8.3%), Rattling Cisticola (*Cisticola chiniana*) (RA = 7.6%), and Southern Black Flycatcher (*Melaenornis pammelaina*) and Fork-tailed Drongo (*Dicrurus adsimilis*) which have the same relative abundance of 6.9%.

Mountain Wagtail (*Motacilla clara*) was the most abundant bird species in riverine with relative abundance of 12.3% followed by Crowned Hornbill (*Tockus albeterminatus*), (11.1%) and Variable Sunbird (*Cinnyris venusta*) (9.9%). Others are Common Bulbul (*Pycnonotus barbatus*), Shelly's Greenbul (*Arizelocichla masukuensis*) and Olive Sunbird (*Cyanomitra olivacea*) which had the same relative abundance of 7.4%. Relative

abundance between habitats was tested by Mann-Whitney U test at 5% significance level. The results showed that there is no significant difference between the two habitats (Mann-Whitney U test, $P = 0.193$).

3.1.1.6 Relative abundance of Birds in Iwela forest

A total of 319 individuals belonging to 68 species, 36 families and 12 order were recorded from Iwela forest (Appendix VI). Birds were recorded in Miombo woodland, and riverine as the main habitats in the forest. Of all the individuals birds recorded, 279 (87.5%) birds were recorded by direct observation (sighting) and 40 (12.5%) were recorded by hearing. The dominant family was Nectariniidae, comprising of 8.8% (6 species) of the total species, followed by Accipitridae (7.4%), and Malaconotidae (5.9%). Others families are Bucerotidae, Columbidae, Monarchidae, Motacillidae, Muscicapidae and Pycnonotidae comprising of 4.4% each of the total species recorded (Appendix VI). One hundred and sixty four (164) individuals belonging to 39 species were recorded in Miombo woodland and 155 individuals belonging to 51 species in the riverine habitat (Table 6).

Table 6: Relative abundance of birds recorded in Iwela Forest

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|-----------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 1. | African Black-headed Oriole | 6 | 3.7 | 0 | 0.0 | 6 | 1.9 |
| 2. | African Citril | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 3. | African Crowned Eagle | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 4. | African firefinch | 1 | 0.6 | 6 | 3.9 | 7 | 2.2 |
| 5. | African Fish-eagle | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 6. | African Green-pigeon | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 7. | African Paradise-flycatcher | 2 | 1.2 | 0 | 0.0 | 2 | 0.6 |
| 8. | African Pied Wagtail | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |
| 9. | African Yellow White-eye | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |
| 10. | Amythest Sunbird | 8 | 4.9 | 0 | 0.0 | 8 | 2.5 |
| 11. | Bateleur | 1 | 0.6 | 1 | 0.6 | 2 | 0.6 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|-----|--------------------------------|----------|--------|------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 12. | Black Cuckoo-shrike | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 13. | Black-backed Puffback | 8 | 4.9 | 3 | 1.9 | 11 | 3.4 |
| 14. | Black-chested Snake-Eagle | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 15. | Black-collared Barbet | 2 | 1.2 | 2 | 1.3 | 4 | 1.3 |
| 16. | Black-crowned Tchagra | 2 | 1.2 | 2 | 1.3 | 4 | 1.3 |
| 17. | Black-fronted Bush-shrike | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 18. | Black-throated Wattle-eye | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 19. | Cardinal Woodpecker | 2 | 1.2 | 1 | 0.6 | 3 | 0.9 |
| 20. | Chin-spot Batis | 9 | 5.5 | 1 | 0.6 | 10 | 3.1 |
| 21. | Cinnamon Bracken Warbler | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 22. | Cinnamon-breasted Rock Bunting | 1 | 0.6 | 2 | 1.3 | 3 | 0.9 |
| 23. | Collared Sunbird | 2 | 1.2 | 1 | 0.6 | 3 | 0.9 |
| 24. | Common Bulbul | 6 | 3.7 | 8 | 5.2 | 14 | 4.4 |
| 25. | Crowned Hornbill | 4 | 2.4 | 6 | 3.9 | 10 | 3.1 |
| 26. | Eastern Bearded Scrub-Robin | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |
| 27. | Eastern Paradise-whydah | 0 | 0.0 | 22 | 14.2 | 22 | 6.9 |
| 28. | Emerald-spotted Wood-Dove | 6 | 3.7 | 3 | 1.9 | 9 | 2.8 |
| 29. | Fiery-necked Nightjar | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 30. | Fork-tailed Drongo | 8 | 4.9 | 5 | 3.2 | 13 | 4.1 |
| 31. | Giant Kingfisher | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 32. | Grey-backed Camaroptera | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |
| 33. | Hamerkop | 0 | 0.0 | 7 | 4.5 | 7 | 2.2 |
| 34. | Helmeted Guineafowl | 9 | 5.5 | 1 | 0.6 | 10 | 3.1 |
| 35. | Kurrichane Thrush | 2 | 1.2 | 0 | 0.0 | 2 | 0.6 |
| 36. | Lead-colored Flycatcher | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |
| 37. | Little Bee-eater | 0 | 0.0 | 10 | 6.5 | 10 | 3.1 |
| 38. | Little Greenbul | 1 | 0.6 | 1 | 0.6 | 2 | 0.6 |
| 39. | Livingstone's Turaco | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 40. | Mountain Wagtail | 0 | 0.0 | 8 | 5.2 | 8 | 2.5 |
| 41. | Narina Trogon | 0 | 0.0 | 3 | 1.9 | 3 | 0.9 |

| No. | Common name | Habitats | | | | Total Number of observation (i) | Overall RA (%) |
|--------------|---------------------------|------------|--------|------------|--------|---------------------------------|----------------|
| | | WLD | | RVRN | | | |
| | | IND | RA (%) | IND | RA (%) | | |
| 42. | Olive Sunbird | 0 | 0.0 | 4 | 2.6 | 4 | 1.3 |
| 43. | Olived-flanked Robin-chat | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 44. | Orange Ground-Thrush | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 45. | Pale Batis | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 46. | Pale-billed Hornbill | 12 | 7.3 | 2 | 1.3 | 14 | 4.4 |
| 47. | Peters's Twinspot | 0 | 0.0 | 4 | 2.6 | 4 | 1.3 |
| 48. | Purple-crested Turaco | 2 | 1.2 | 0 | 0.0 | 2 | 0.6 |
| 49. | Red-faced Crombec | 2 | 1.2 | 1 | 0.6 | 3 | 0.9 |
| 50. | Red-headed Weaver | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 51. | Red-necked Spurfowl | 4 | 2.4 | 0 | 0.0 | 4 | 1.3 |
| 52. | Retz's Helmet-shrike | 3 | 1.8 | 0 | 0.0 | 3 | 0.9 |
| 53. | Ring-necked Dove | 2 | 1.2 | 1 | 0.6 | 3 | 0.9 |
| 54. | Rufous-bellied Tit | 4 | 2.4 | 0 | 0.0 | 4 | 1.3 |
| 55. | Shelly's Sunbird | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 56. | Striped Pipit | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 57. | Swallow-tailed Bee-eater | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 58. | Tawny Eagle | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 59. | Tropical Boubou | 18 | 11.0 | 7 | 4.5 | 25 | 7.8 |
| 60. | Trumpeter Hornbill | 11 | 6.7 | 0 | 0.0 | 11 | 3.4 |
| 61. | Variable Sunbird | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 62. | White-bellied Sunbird | 1 | 0.6 | 0 | 0.0 | 1 | 0.3 |
| 63. | White-browed Scrub-Robin | 1 | 0.6 | 1 | 0.6 | 2 | 0.6 |
| 64. | White-tailed Lark | 14 | 8.5 | 0 | 0.0 | 14 | 4.4 |
| 65. | Wire-tailed Swallow | 0 | 0.0 | 1 | 0.6 | 1 | 0.3 |
| 66. | Yellow-bellied Greenbul | 1 | 0.6 | 1 | 0.6 | 2 | 0.6 |
| 67. | Yellow-breasted Apalis | 0 | 0.0 | 2 | 1.3 | 2 | 0.6 |
| 68. | Yellow-fronted Tinkerbird | 3 | 1.8 | 2 | 1.3 | 5 | 1.6 |
| TOTAL | | 164 | | 155 | | 319 | |

Key: IND = Number of individuals; RA= Relative abundance; WLD= Woodland; RVRN=Riverine

The abundance of birds was noted to differ among species and habitats (Table 6). The most abundant bird species at Iwela forest was Tropical Boubou (*Laniarius major*) (RA =7.8%), followed by Eastern Paradise-whydah (*Vidua paradisaea*) (RA = 6.9%) and White-tailed Lark (*Mirafra africanoides*), Common bulbul (*Pycnonotus barbatus*), and Pale-billed Hornbill (*Tockus pallidirostris*) which had the same relative abundance of 4.4% each. Other species and their relative abundance in brackets are Fork-tailed Drongo (*Dicrurus adsimilis*) (4.1%), Trumpeter Hornbill (*Bycanistes bucinator*) (3.4%) and Black-backed Puffback (*Dryoscopus gambensis*) (3.4%). Little Bee-eater (*Merops pusillus*), Chin-spot Batis (*Batis Molitor*), Crowned Hornbill (*Tockus albeterminatus*) and Helmeted Guineafowl (*Numida meleagris*) had the same relative abundance of 3.1% each (Table 6). In total, these twelve species together make up 51.2% of all the species recorded.

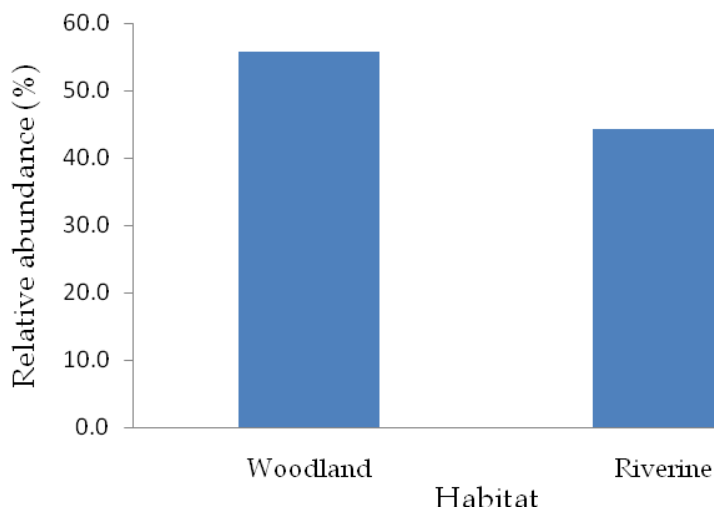


Figure 5: Relative abundance of bird's species by habitats in Iwela forest

Relatively high abundance of birds species were recorded in miombo woodland (51.4%), than 48.6% in riverine (Fig 5). Tropical Boubou (*Laniarius major*) was the abundant bird species in woodland with relative abundance of 11% followed by White-tailed Lark (*Mirafra africanoides*) (8.5%), Pale-billed Hornbill (*Tockus pallidirostris*) (7.3%) and Trumpeter Hornbill (*Bycanistes bucinator*) (6.7%). Likewise, Eastern Paradise-whydah (*Vidua paradisaea*) was the most abundant bird species in riverine with relative

abundance of 14.2% followed by Little Bee-eater (*Merops pusillus*) (6.5%). Common Bulbul (*Pycnonotus barbatus*) and Mountain Wagtail (*Motacilla clara*) had the same relative abundance of 5.2% each. Other species had less than 5% relative abundance. Relative abundance between habitats was tested by Mann-Whitney U test at 5% significance level. The result showed that there was no significant difference between the two habitats (Mann-Whitney U test, $P = 0.128$).

3.1.2 Species diversity of birds

3.1.2.1 Species diversity of Birds in Komang'ombe forest

A total 58 species were recorded during the study period, with relative high species richness in woodland (43) than riverine (20) (Table 7). Shannon's diversity index indicate that woodland habitat had higher species diversity ($H' = 3.28$) compared to riverine habitat ($H' = 2.36$). The overall birds' diversity for all habitats in Komang'ombe forest was 3.43 (Table 7).

Table 7: Birds diversity in Komang'ombe forest

| Parameter | Habitats | | All habitats |
|-----------------------------|----------|----------|--------------|
| | Woodland | Riverine | |
| Number of individuals | 254 | 119 | 373 |
| Proportional by habitat (%) | 68.1 | 31.9 | 100 |
| Species richness | 43 | 20 | 58 |
| Shannon's diversity index | 3.28 | 2.36 | 3.43 |

The species diversity between habitats was tested by Mann-Whitney U test. The result showed a significant different at 95% confidence interval (Mann-Whitney U test, $P=0.0008$).

3.1.2.2 Species diversity of Birds in Mawengi forest

A total 76 birds individuals recorded during the study period were belongs to 23 species. All the species were recorded in Miombo woodland. Shannon's diversity index indicates the overall birds' diversity in Mawengi forest to be 2.92 (Table 8).

Table 8: Birds diversity in Mawengi forest

| Parameter | Habitats |
|-----------------------------|----------|
| | Woodland |
| Number of individuals | 76 |
| Proportional by habitat (%) | 100 |
| Species richness | 23 |
| Shannon's diversity index | 2.92 |

3.1.2.3 Species diversity of Birds in Mvava forest

A total of 53 species were recorded in Mvava forest which is mainly characterized by Miombo woodland. Shannon's diversity index indicates the overall birds' diversity in Mvava forest to be 3.47 (Table 9).

Table 9: Birds diversity in Mvava forest

| Parameter | Habitats |
|-----------------------------|----------|
| | Woodland |
| Number of individuals | 323 |
| Proportional by habitat (%) | 100 |
| Species richness | 53 |
| Shannon's diversity index | 3.47 |

3.1.2.4 Species diversity of Birds in Masimavalafu forest

Table 10 shows a total 72 species were recorded during the study period, with relative high species richness in woodland (58) than riverine (42). The overall birds' diversity in Masimavalafu forest was 3.742 (Table 10). Shannon's diversity index indicate that woodland habitat had higher species diversity ($H' = 3.66$) compared to riverine ($H' = 2.96$).

Table 10: Birds diversity in Masimavalafu forest

| Parameter | Habitats | | All habitats |
|-----------------------------|----------|----------|--------------|
| | Woodland | Riverine | |
| Number of individuals | 362 | 287 | 649 |
| Proportional by habitat (%) | 55.8 | 44.2 | 100 |
| Species richness | 58 | 42 | 72 |
| Shannon's diversity index | 3.66 | 2.96 | 3.742 |

The species diversity between habitats was statistically compared by Mann-Whitney U test at 5% level of significance. The results showed a significant difference between habitats (Mann-Whitney U test, $P = 0.02$).

3.1.2.5 Species diversity of Birds in Kimelembe forest

A total 51 species were recorded during the study period, with relative high species richness in woodland (39) than riverine (24) (Table 11). Shannon's diversity index indicate that woodland habitat had higher species diversity ($H' = 3.16$) compared to riverine ($H' = 2.7$). The overall birds' diversity for all habitats in Kimelembe forest was 3.505 (Table 11).

Table 11: Birds diversity in Kimelembe forest

| Parameter | Habitats | | All habitats |
|-----------------------------|----------|----------|--------------|
| | Woodland | Riverine | |
| Number of individuals | 145 | 81 | 226 |
| Proportional by habitat (%) | 64.2 | 35.8 | 100 |
| Species richness | 39 | 24 | 50 |
| Shannon's diversity index | 3.16 | 2.7 | 3.505 |

Species diversity between habitats was tested by Mann-Whitney U test. The result showed no significant different at 95% confidence interval (Mann-Whitney U test, $P=0.086$).

3.1.2.6 Species diversity of Birds in Iwela forest

Table 12 shows a total 68 species were recorded during the study period, with relative high species richness in riverine (51) than woodland (39). Shannon's diversity index indicate that riverine habitat had higher species diversity ($H' = 3.4$) compared to woodland ($H' = 3.17$). The overall birds' diversity for all habitats in Iwela forest was 3.794 (Table 12).

Table 12: Birds diversity in Iwela forest

| Parameter | Habitats | | All habitats |
|-----------------------------|----------|----------|--------------|
| | Woodland | Riverine | |
| Number of individuals | 164 | 155 | 319 |
| Proportional by habitat (%) | 51.4 | 48.6 | 100 |
| Species richness | 39 | 51 | 68 |
| Shannon's diversity index | 3.17 | 3.4 | 3.794 |

The species diversity between habitats was tested by Mann-Whitney U test. The result shows no significant difference at 95% confidence interval (Mann-Whitney U test, $P=0.062$).

3.1.3 Conservation Status of recorded birds in the surveyed forests

Of all the individual birds recorded in six surveyed forests, one threatened species namely Dappled Mountain-robin (*Arcanator orostruthus*) was recorded as vulnerable species. The species was recorded in Mvava forest. The species inhabits wet montane forest at mid-elevations of mostly 1,300-1,700 m with few observations at 1,200m (Dinesen *et al.*, 2001), preferring closed-canopy areas with a dense growth of wild ginger (Zingiberaceae) and saplings on the ground. So far the species are reported to be native in Mt Namuli and Mt Mabu in Mozambique and in the East Usambara Mountains and Udzungwa Mountains in Tanzania. The species's population is suspected to be declining in line with the fragmentation and degradation of mid-elevation forests within its range (Fjeldså, 1999).

Others are near threatened species; including Sooty Falcon (*Falco concolor*) recorded in Komang'ombe forest and three species of Olive-headed Weaver (*Ploceus olivaceiceps*), Bateleur (*Terathopius ecaudatus*) and African Crowned Eagle (*Stephanoaetus coronatus*) recorded in Masimavalafu forest. Other near threatened species includes Southern Banded Snake-eagle (*Circaetus fasciolatus*) recorded in Kimelembe forest and African Crowned Eagle (*Stephanoaetus coronatus*) which was recorded in Iwela forest. Shelley's sunbird (*Cinnyris shelleyi*) recorded in Iwela forest was not yet recognized by IUCN. Following the IUCN categories, the other recorded birds species in six surveyed forests were categorized as least concerned birds.

3.2 Mammals

3.2.1 Mammals recorded in Komang'ombe, Mawengi and Mvava Forests

Results show that 8 species of mammals were identified in Komang'ombe forest, 7 species in Mvava forest and three species in Mawengi forest. Of all the species, three species in Komang'ombe and Mvava forests and two species in Mawengi forest were directly observed by sighting (Table 13). Presence of other species was recognized by using different signs which were used as a surrogate of a true species. Habitat wise, three different species (Vervet Monkey, Bushpig, and Yellow baboon) were observed in riverine ecosystem in Nkomangombe forest.

Table 13: Recorded Mammals of Komang'ombe, Mawengi and Mvava Forests

| No. | Common Name (Scientific Name) | Families | Mode of observation in respective forests | | | | Conservation Status |
|---|---|-----------------|---|----------|----------|----------|---------------------|
| | | | Nkomang'ombe | | Mawengi | Mvava | |
| | | | WLD | RVRN | | | |
| 1 | Vervet Monkey (<i>Chlorocebus pygerythrus</i>) | Cercopithecidae | S | S | S | S | Least concern |
| 2 | Bushpig (<i>Potamochoerus larvatus</i>) | Suidae | B | B | B | T, B | Least concern |
| 3 | Banded Mongoose (<i>Mungos mungo</i>) | Herpestidae | | | | T | Least concern |
| 4 | Yellow baboon (<i>Papio cynocephalus</i>) | Cercopithecidae | S | S | S | S | Least concern |
| 5 | African hare (<i>Lepus spp</i>) | Leporidae | S | | | S | Least concern |
| 6 | Aardvark (<i>Orycteropus afer</i>) | Orycteropodidae | B | | | B | Least concern |
| 7 | Crested Porcupine (<i>Hystrix africae australis</i>) | Hystricidae | Q | | | D | Least concern |
| 8 | Ground Squirrel (<i>Xerus rutilus</i>) | Sciuridae | D | | | | Least concern |
| 9 | African Civet (<i>Civettictis Civetta</i>) | Viverridae | D | | | | Least concern |
| Total species recorded in habitats | | | 8 | 3 | 3 | 7 | |
| Total species recorded in a forest | | | 8 | | 3 | 7 | |

Key: S=Sighting, B= Burrows, D= Dung, Q=Quills, and T = Trucks
: WLD= Woodland, RVRN=Riverine

3.2.2 Mammals recorded in Masimavalafu, Kimelembe, and Iwela Forests

Table 14 shows that, seventeen species of mammals were identified in Masimavalafu forest, followed by Iwela forest (16 species) and Kimelembe (13 species). Relatively more species were recorded in woodland than riverine forests (Table 14). However, most of species were identified and recorded from surrogate indices than sighting.

Table 14: Recorded Mammals of Masimavalafu, Kimelembe and Iwela Forests

| No. | Common name (Scientific name) | Family | Mode of observation in respective forests and habitats | | | | | | Conservation status |
|-----|---|-----------------|--|------|-----------|------|-------|------|---------------------|
| | | | Masimavalafu | | Kimelembe | | Iwela | | |
| | | | WLD | RVRN | WLD | RVRN | WLD | RVRN | |
| 1. | Harvey Duiker (<i>Cephalophus harveyi</i>) | Bovidae | D | | | | | | Least concern |
| 2. | Suni (<i>Neotragus moschatus</i>) | Bovidae | T | T | | | D | | Least concern |
| 3. | Bushpig (<i>Potamochoerus larvatus</i>) | Suidae | B, D | | | | D | | Least concern |
| 4. | African hare (<i>Lepus spp</i>) | Leporidae | S | D | | | | | Least concern |
| 5. | Banded Mongoose (<i>Mungos mungo</i>) | Herpestidae | | | | | T,S | | Least concern |
| 6. | Slender Mongoose (<i>Herpestes sanguineus</i>) | Herpestidae | D | D | D | | | | Least concern |
| 7. | Crested Porcupine (<i>Hystrix africae australis</i>) | Hystricidae | D, Q | | D | | Q | | Least concern |
| 8. | Leopard (<i>Panthera pardus</i>) | Felidae | S | T | | | | | Vulnerable |
| 9. | Greater cane rat (<i>Thryonomys swinderianus</i>) | Thryonomyidae | D | | | | | | Least concern |
| 10. | Cape Clawless Otter (<i>Aonyx capensis</i>) | Mustelidae | | D,T | | | | T | Near threatened |
| 11. | Tree Squirrel | Sciuridae | S | | | | S | | |
| 12. | Yellow baboon (<i>Papio cynocephalus</i>) | Cercopithecidae | S, D | D | S | D, S | D,S | D | Least concern |
| 13. | African Civet (<i>Civettictis Civetta</i>) | Viverridae | | | D | | | | Least concern |
| 14. | Marsh (Water) Mongoose (<i>Atilax</i>) | Herpestidae | | | | S | | T,D | Least concern |

| | | | | | | | | | |
|---|--|---------------------|-----------|----------|-----------|----------|-----------|----------|---------------|
| | <i>paludinosus</i>) | | | | | | | | |
| 15. | Dwarf Mongoose (<i>Helogale parvula</i>) | Herpestidae | | | | T | | | Least concern |
| 16. | Common (grey) Duiker (<i>Sylvicapra grimmia</i>) | Bovidae | T, D | D | T | T,D | | | Least concern |
| 17. | Vervet Monkey (<i>Chlorocebus pygerythrus</i>) | Cercopithec idae | | | | S | | S | Least concern |
| 18. | Greater Kudu (<i>Tragelaphus strepsiceros</i>) | Bovidae | D | D | | | | S | Least concern |
| 19. | Bushpig (<i>Potamochoerus larvatus</i>) | Suidae | D | | T,B | T, B | D,B | T,D | Least concern |
| 20. | Common genet (<i>Genetta genetta</i>) | Veverridae | | | | D | D, T | D,T | Least concern |
| 21. | Bush Baby (<i>Otolemur spp</i>) | Galagidae | S | | S | S | | | Least concern |
| 22. | White-tailed Mongoose (<i>Ichneumia albicauda</i>) | Herpestidae | | | | | S | | Least concern |
| 23. | Aardvark (<i>Orycteropus afer</i>) | Orycteropo didae | B | | | | B | | Least concern |
| 24. | Ground Squirrel (<i>Xerus rutilus</i>) | Sciuridae | B | | B | | | | Least concern |
| 25. | Black and White Colubus (<i>Colobus Guereza</i>) | Cercopithec idae | | | | | | S | Least concern |
| 26. | Kirki dik-dik (<i>Madoqua kirkii</i>) | Bovidae | | | | | S | | |
| 27. | Bushback (<i>Tragelaphus scriptus</i>) | Bovidae | | | S | | | | |
| Total species recorded in habitats | | | 16 | 8 | 9 | 8 | 11 | 8 | |
| Total species recorded in a forest | | | 17 | | 13 | | 16 | | |

Key: S=Sighting, B= Burrows, D= Dung, Q=Quills, and T = Trucks
: WLD= Woodland, RVRN=Riverine

4.0 DISCUSION

4.1 Birds

4.1.1 Summary of birds abundance in all six surveyed forest and discussion

This section summarizes the abundances of birds from six surveyed forests of Nkomang'ombe, Mawengi, Mvava, Masimavalafu, Kimelembe and Iwela. The section also gives the breaaf discussion of the results. Fig 6 shows that, relatively more birds (643 birds) were recorded in Masimavalafu forests, followed by Nkomang'ombe (373), Mvava (323), Iwela (319), Kimelembe (226) and Mawengi 76 birds. The difference could be attributed by different in forest size, as smaller fragments are known to contain fewer species than larger-sized fragments (Newmark 1991). The other reason could be due to variation of sampling effort as the numbers of days spent in the field were relativey few.

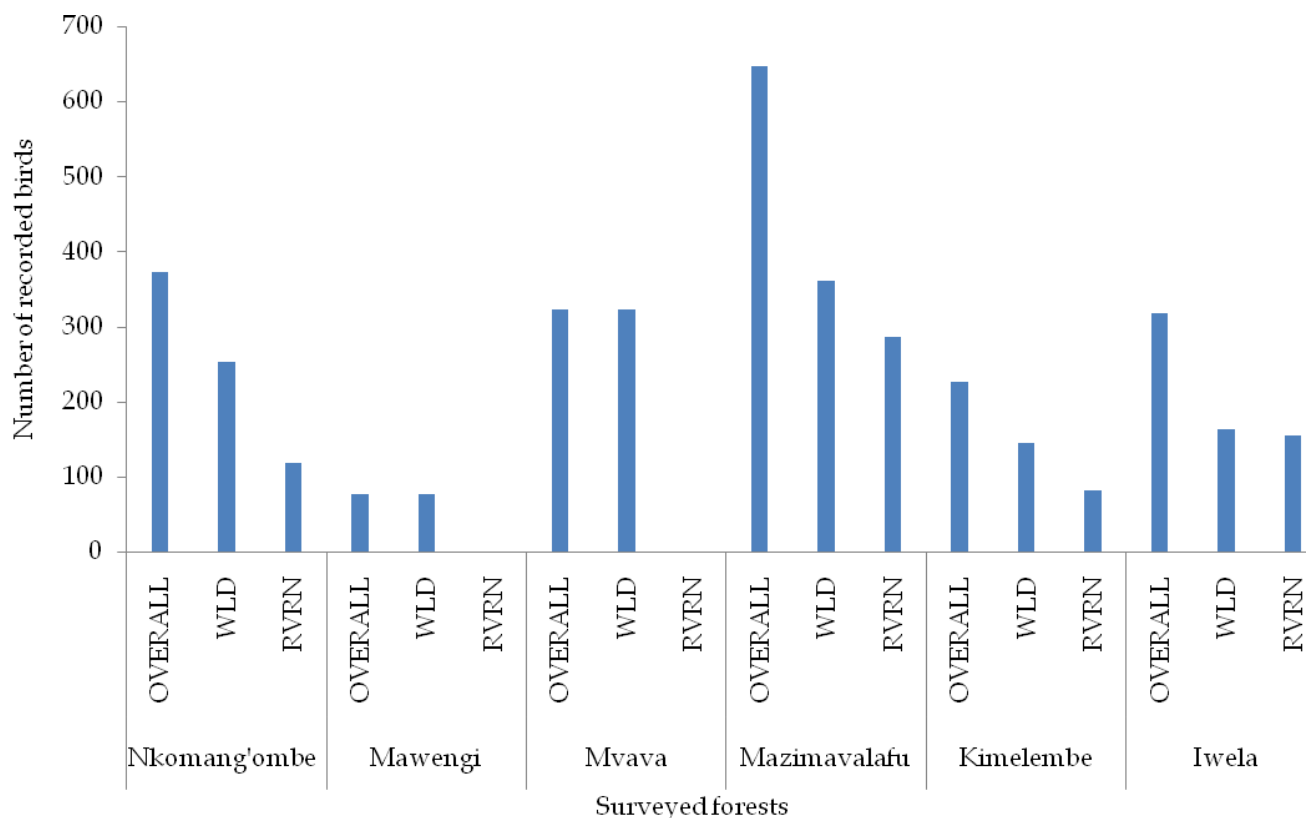


Figure 6: Summary of bird's abundance in six surveyed forests

Abundance of birds was also noted to vary between habitats. While Mawengi and Mvava forest were noted to be covered entirely by Miombo woodlands only, other forests were noted to comprise of relatively small riverine habitats. However, in all surveyed forests, relatively more birds were recorded in woodlands than riverine. Relative abundance from respective forests revealed that, 68.1% of the recorded birds in Nkomang'ombe were recorded in Miombo woodland and 31.9% in riverine. Likewise to Kimelembe forest, 64.2% were recorded in Woodland and 35.8% in riverine. In Masimavalafu forest 55.8% were recorded in woodland and 44.2% in riverine while in Iwela forest, 51.4% of the recorded birds were identified in woodland and 48.6% in riverine. Relative abundance between habitats was noted to be significantly difference in Komang'ombe and Masimavalafu forests at 0.05 statistical level. Higher number of birds in woodland habitat may be attributed by having greater resources such as food and nesting sites resulting to its ability to support more birds (Lameed, 2011). Renwick *et al.* (2012) also pointed out that bird abundance and varieties rise with increase in food availability. The higher abundance of birds in woodland habitat could also be due to the composition of the vegetation that forms the main element of their habitat (Salah, and Idris, 2013). Moreover, more birds recorded in miombo woodlands may also be due to its relatively big size than riverine habitats which were noted to be small. On the other hand, relatively less number of birds recorded in riverine could be attributed by the destruction of the habitats, mainly through grazing activities and cultivation along the river. River ecosystems were observed to be greatly overgrazed by cattle which use the areas around the river as feeding and watering areas. Likewise, vegetation were noted to be cleared for cultivation, thus interferes nesting, feeding, and breeding sites for birds. Nevertheless, variation of bird's composition between forests may be associated by different level of disturbance. For example, riverine habitats in Nkomang'ombe forest were noted to be relatively highly encroached by farming activities. Probably this could be the reason of relatively less bird's abundance in riverine habitat in Nkomang'ombe forest compare to other riverine habitats of the other forests.

Evaluation of bird communities may also be used as an indicator of the quality and conservation interest of the habitats (Spellerber, 1992). For example, higher relative abundance of savanna bird, Rattling Cisticola (*Cisticola chiniana*) observed in Nkomang'ombe and Mawengi forest suggests transformation of forest vegetation into savanna. On the other hand relatively high composition of forest specialist birds namely Retz's Helmet-shrike (*Prionops retzii*) and Trumpeter Hornbill (*Bycanistes bucinator*) observed in Masimavalafu and Kimelembe forests respectively implies relatively health forest condition despite its fragmentation. This suggests that the remaining forest is worthy of careful conservation and management measures to guarantee its long term survival (Chacha *et al.*, 2013).

4.1.2 Summary of birds diversity in all six surveyed forest and discussion

This section summarizes the diversity of birds from six surveyed forests of Nkomang'ombe, Mawengi, Mvava, Masimavalafu, Kimelembe and Iwela. The section also gives the brief discussion of the results. Fig 7 shows that, relatively more bird's diversity (3.794) was noted in Iwela forests, followed by Masimavalafu (3.742), Kimelembe (3.505), Mvava (3.47), Nkomang'ombe (3.43) and Mawengi 2.92.

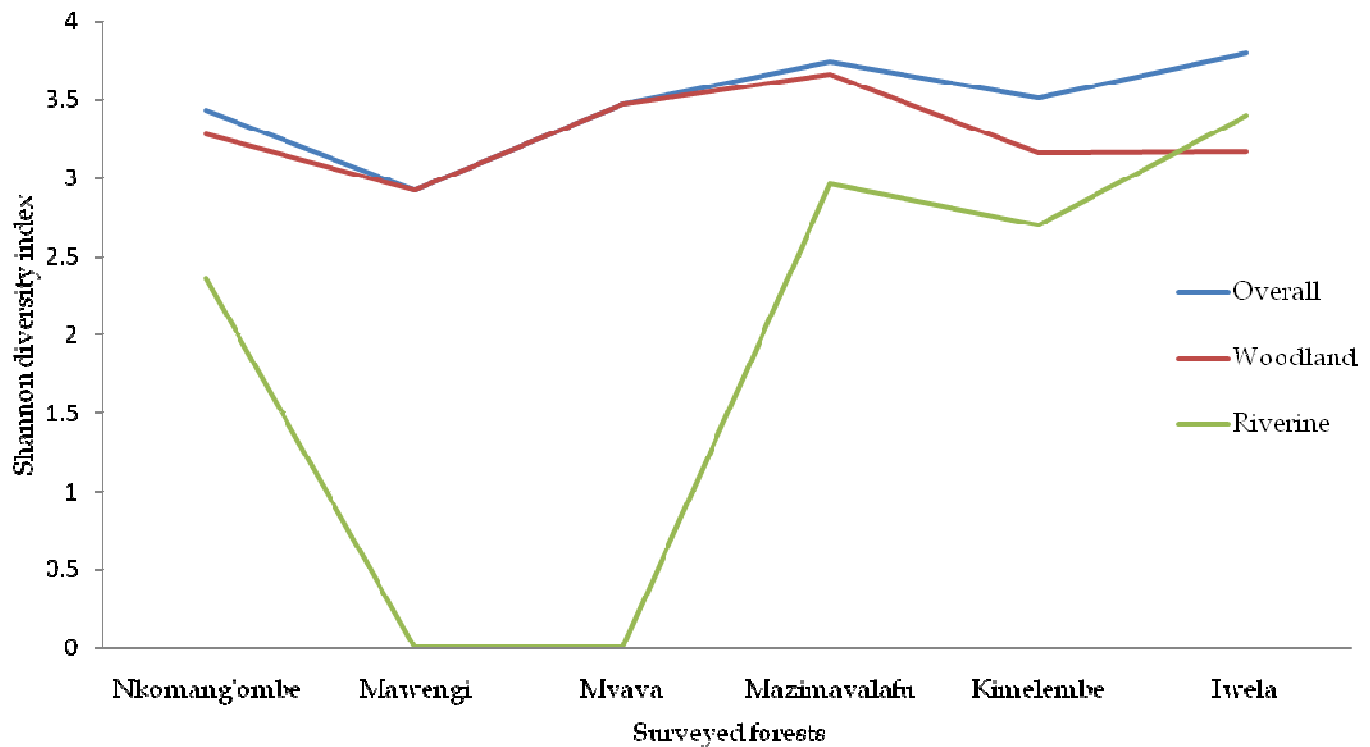


Figure 7: Summary of bird's species diversity in six surveyed forests

Within the forest, diversity was noted to vary between habitats. With exception of Mawengi and Mvava forests which are entirely covered by miombo woodland, other forests were covered by mainly miombo woodland and riverine habitats. Habitat wise species diversity from Nkomang'ombe forest revealed that, woodland habitats were covered by relatively high diversity of birds ($H'=3.28$), than riverine habitats ($H'=2.36$). Likewise, to Masimavalafu, high species diversity were recorded in woodlands ($H'=3.66$) than in riverine ($H'=2.96$) and to Kimelembe forest, less species diversity were recorded in riverine ($H'=2.7$) than woodland ($H'=3.16$). However, bird's diversity between habitats was noted to be statistically difference in Komang'ombe and Masimavalafu forests only. Relatively high diversity in woodland may be attributed by diverse vegetation structure as microhabitats which favored varieties of bird species. Likewise, it was observed that livestock grazing, logging and farming were the main activities undertaken in the forests and specifically along the riverine ecosystem; this might be the reasons of low bird species diversity in riverine. On the other hand species

diversity of birds were reported to be high in riverine habitat ($H'=3.4$) than woodland ($H'=3.17$) in Iwela forest. These may be attributed by relatively less disturbance/threats along the lake shores.

4.2 Mammals

Mammals were rarely observed during the survey. According to Buckland *et al.* (2001), it is difficult to generate robust and informative estimates if species are rarely observed. Likewise, Glyn (2002) suggests that a minimum of 40 sightings is needed for statistical analyses of the data obtained from a transect method. It is from these scientific arguments that data were analyzed descriptively and presented in tables and figures. However, a checklist of mammals was established from identified mammals through signs or live individuals encountered in the study forests. Relatively, more species richness were recorded in Masimavalafu forest (17), followed by Iwela (15), Kimelembe (12), Nkomang'ombe (8), Mvava (7) and Mawengi (3). The variation in species richness may be attributed by different level of disturbance including livestock grazing, logging and farming which are taking place inside the forest. The study findings revealed that mammal species which are not normally hunted for a pot such as Mongoose, Squirrel, Vervet Monkey, Yellow baboon and Black and White Colubus, were directly observed in the area.

Accordingly, Bushpig and Yellow baboon were commonly observed in all the surveyed forest. Their presence in the forest could be attributed by their opportunistic eating habits. According to Johnson *et al.* (2015), Baboons are able to fill a tremendous number of different ecological niches, including places considered adverse to other animals. It is the same behavioral adaptations that make themselves successful but also considered as pests by humans in many areas including raiding on farmers' crops. On the other hand Bushpig have commonly located in areas given over to subsistence farming or to agricultural crops such as sugar cane, maize, peanuts and beans, and may become a serious problem in such areas (Seydack, 2013).

Following the IUCN red list categories, one threatened (vulnerable) species namely Leopard (*Panthera pardus*) was recorded in both habitats (woodlands and riverine) in Masimavalafu forest. The distribution of Leopards in East Africa has been reduced considerably in particular in Somalia, Kenya, Ethiopia and central Tanzania (Ripple *et al.*, 2014). In Tanzania, Leopards are found throughout the Serengeti-Ngorogoro Crater system and to the south and west. Though Leopards are highly adaptable and widely distributed, can persist in areas where other large carnivores have been extirpated. One main factor for Leopard declines in Africa is related to prey declines. Leopard population density across Africa is known to track the biomass of their principle prey species, medium and large-sized wild herbivores (Marker and Dickman 2005, Hayward *et al.* 2006). However, observation of Leopard (*Panthera pardus*) in Masimavalafu corresponds to relatively number of preys species observed in the forest including Harvey Duiker (*Cephalophus harveyi*), Suni (*Neotragus moschatus*), Common (grey) Duiker (*Sylvicapra grimmia*) and Greater Kudu (*Tragelaphus strepsiceros*). This implies that forest management strategies should be directed towards conservation for enhancement of preys so as to increase the number of Leopards and other predators.

In all the surveyed forest, Cape Clawless Otter (*Aonyx capensis*) was the only near threatened species observed. The species was recorded in riverine ecosystem at Iwela forest. Other recorded mammals are categorized by IUCN as Least concern.

Not only birds but mammals species may also suggest the health condition of the forest. Presence of Harvey Duiker (*Cephalophus harveyi*) at Masimavalafu suggests a relatively health forest. Harvey Duiker (*Cephalophus harveyi*) is predominantly distributed in reserved forestlands which are effectively protected against habitat destruction and illegal hunting (Kingdon and Rovero, 2013).

5.0 Conclusion and Recommendation

5.1 Conclusion

The study concluded that six surveyed forests are very important to the bird communities. Our findings have revealed that relatively high abundances of birds were observed in Masimavalafu forest followed by Nkomang'ombe, Mvava, Iwela, Kimelembe and lastly Mawengi forest. However, Iwela forest was observed to harbor enormous diversity of birds than Masimavalafu forest. Kimelembe forest was the third ranked forest to harbor enormous diversity of birds followed by Mvava, Nkomang'ombe and Mawengi forest. Relatively high species richness was recorded in Masimavalafu forest followed by Iwela, Nkomang'ombe, Mvava, Kimelembe and Mawengi forests. Accordingly, there was greater variation in species abundance between woodland and riverine habitats. With exception of Iwela forest, woodland contributed much in terms of species abundance than riverine habitat. Variation in species abundances, diversity and richness may be attributed by different level of anthropogenic activities observed within and between the forests.

While majority of recorded bird species fallen in the least concerned category, one bird species called Dappled Mountain-robin (*Arcanator orostruthus*) that was recorded in Mvava forest fallen in the vulnerable category. Other three species namely Olive-headed Weaver (*Ploceus olivaceiceps*), Bateleur (*Terathopius ecaudatus*) and African Crowned Eagle (*Stephanoaetus coronatus*) were recorded as near threatened species in Masimavalafu forest. Likewise, Sooty Falcon (*Falco concolor*) and Snake-eagle (*Circaetus fasciolatus*) were observed as near threatened species in Komang'ombe and Kimelembe forests respectively. Shelley's Sunbird (*Cinnyris shelleyi*) observed in Iwela forest was not yet recognized by IUCN.

Mammals were rarely observed during the survey. Most of species were identified and recorded from surrogate indices than sighting. Relatively, more species were recorded in Masimavalafu forest (17), followed by Iwela (15), Kimelembe (12), Nkomang'ombe

(8), Mvava (7) and Mawengi (3). The variation in species richness may be attributed to different level of disturbance including livestock grazing, logging, farming and hunting which are taking place inside the forest. Cape Clawless Otter (*Aonyx capensis*) and Leopard (*Panthera pardus*) were categorized as near threatened and vulnerable species respectively. Observation of Leopard (*Panthera pardus*) in Masimavalafu corresponds to relatively number of preys species observed in the forest. Likewise, presence of Harvey Duiker (*Cephalophus harveyi*) at Masimavalafu suggests a relatively health forest since the species are commonly distributed in relatively less threatened forest.

The forests could attract more birds and mammals if sufficient measures are taken to manage the area from anthropogenic activities that threaten the life of avifauna and mammals. Habitat destruction could have a net negative effect on the population of birds and mammals. Thus, if the size and quality of forests habitat is substantially reduced, populations of dependent birds and mammals in the area also can be expected to decrease.

5.2 Recommendation

Based on conclusion and given empirical findings, the study recommends the following:

- (i) Protection and management measures of the surveyed forests through sustainable management framework are recommended for conservation of biodiversity and restoration of degraded habitats.
- (ii) Further studies to cover nocturnal birds and mammals, small mammals, reptiles and amphibians to generate a comprehensive list of vertebrate in the surveyed forests are recommended.
- (iii) Public awareness on importance of conserving forests should be emphasized as soft measures to combat harmful anthropogenic activities.

APPENDICES

Appendix I: Abundance and Diversity indices of Birds recorded in Komang'ombe forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index ($H' = -\sum (P_i \ln P_i)$) |
|-----|-----------------------------|---------------------------------|---------------|-----------------|---------------------------|-------------------------|--|
| 1. | African Green-pigeon | <i>Treron calva</i> | Columbidae | Columbiformes | 1 | 0.0027 | 0.0159 |
| 2. | African Grey Hornbill | <i>Tockus nasutus</i> | Bucerotidae | Bucerotiformes | 6 | 0.0161 | 0.0664 |
| 3. | African Harrier-hawk | <i>Polyboroides typus</i> | Accipitridae | Accipitriformes | 2 | 0.0054 | 0.0280 |
| 4. | African Hill-babbler | <i>Pseudoalcippe abyssinica</i> | Sylviidae | Passeriformes | 3 | 0.0080 | 0.0388 |
| 5. | African Mourning Dove | <i>Streptopelia decipiens</i> | Columbidae | Columbiformes | 1 | 0.0027 | 0.0159 |
| 6. | African Paradise-flycatcher | <i>Terpsiphone viridis</i> | Monarchidae | Passeriformes | 1 | 0.0027 | 0.0159 |
| 7. | African Penduline Tit | <i>Anthoscopus caroli</i> | Remizidae | Passeriformes | 5 | 0.0134 | 0.0578 |
| 8. | African Pied Wagtail | <i>Motacilla aguimp</i> | Motacillidae | Passeriformes | 4 | 0.0107 | 0.0486 |
| 9. | Baglafetch Weaver | <i>Ploceus baglafecht</i> | Ploceidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 10. | Black and white Cuckoo | <i>Clamator jacobinus</i> | Cuculidae | Cuculiformes | 1 | 0.0027 | 0.0159 |
| 11. | Black Kite | <i>Milvus migrans</i> | Accipitridae | Accipitriformes | 3 | 0.0080 | 0.0388 |
| 12. | Black-winged Bishop | <i>Euplectes hordeaceus</i> | Ploceidae | Passeriformes | 3 | 0.0080 | 0.0388 |
| 13. | Bronze Mankin | <i>Lonchura cucullata</i> | Estrildidae | Passeriformes | 15 | 0.0402 | 0.1292 |
| 14. | Brown-crowned Tchagra | <i>Tchagra australis</i> | Malaconotidae | Passeriformes | 16 | 0.0429 | 0.1351 |
| 15. | Capped Wheatear | <i>Oenanthe pileata</i> | Muscicapidae | Passeriformes | 1 | 0.0027 | 0.0159 |
| 16. | Cardinal Woodpeckers | <i>Dendropicos fuscescens</i> | Picidae | Piciformes | 1 | 0.0027 | 0.0159 |
| 17. | Chestnut Weaver | <i>Ploceus rubiginosus</i> | Ploceidae | Passeriformes | 3 | 0.0080 | 0.0388 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index ($H' = -\sum (P_i \ln P_i)$) |
|-----|---------------------------|--------------------------------|---------------|-----------------|---------------------------|-------------------------|--|
| 18. | Collered Sunbird | <i>Hedydipna collaris</i> | Nectariniidae | Musophagiformes | 2 | 0.0054 | 0.0280 |
| 19. | Croaking Cisticola | <i>Cisticola natalensis</i> | Cisticolidae | Passeriformes | 3 | 0.0080 | 0.0388 |
| 20. | Crowned Hornbill | <i>Tockus alboterminatus</i> | Bucerotidae | Bucerotiformes | 4 | 0.0107 | 0.0486 |
| 21. | Eurasian Hobby | <i>Falco subbuteo</i> | Falconidae | Falconiformes | 16 | 0.0429 | 0.1351 |
| 22. | Eurasian Swift | <i>Apus apus</i> | Apodidae | Apodiformes | 33 | 0.0885 | 0.2146 |
| 23. | Familiar Chat | <i>Cercomela familiaris</i> | Muscicapidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 24. | Fork-tailed Drongo | <i>Dicrurus adsimilis</i> | Dicruridae | Passeriformes | 21 | 0.0563 | 0.1620 |
| 25. | Fuelleborn's Black Boubou | <i>Laniarius fuelleborni</i> | Malaconotidae | Passeriformes | 7 | 0.0188 | 0.0746 |
| 26. | Garden Warbler | <i>Sylvia borin</i> | Sylviidae | Passeriformes | 8 | 0.0214 | 0.0824 |
| 27. | Grassland Pipit | <i>Anthus cinnamomeus</i> | Motacillidae | Passeriformes | 1 | 0.0027 | 0.0159 |
| 28. | Grey-headed Kingfisher | <i>Halcyon leucocephala</i> | Halcyonidae | Coraciiformes | 2 | 0.0054 | 0.0280 |
| 29. | Helmeted Guineafowl | <i>Numida meleagris</i> | Numididae | Galliformes | 2 | 0.0054 | 0.0280 |
| 30. | Klaas's Cuckoo | <i>Chrysococcyx klaas</i> | Cuculidae | Cuculiformes | 2 | 0.0054 | 0.0280 |
| 31. | Lesser Honeyguide | <i>Indicator minor</i> | Indicatoridae | Piciformes | 2 | 0.0054 | 0.0280 |
| 32. | Lesser Kestrel | <i>Falco naumanni</i> | Falconidae | Falconiformes | 5 | 0.0134 | 0.0578 |
| 33. | Loughing Dove | <i>Spilopelia senegalensis</i> | Columbidae | Columbiformes | 4 | 0.0107 | 0.0486 |
| 34. | Martial Eagle | <i>Polemaetus bellicosus</i> | Accipitridae | Accipitriformes | 5 | 0.0134 | 0.0578 |
| 35. | Miombo Rock-thrush | <i>Monticola angolensis</i> | Muscicapidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 36. | Namaqua Dove | <i>Oena capensis</i> | Cuculidae | Cuculiformes | 1 | 0.0027 | 0.0159 |
| 37. | Orange Ground-thrush | <i>Geokichla gurneyi</i> | Turdidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 38. | Pin-tailed Whydah | <i>Vidua macroura</i> | Viduidae | Passeriformes | 2 | 0.0054 | 0.0280 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index ($H' = -\sum (P_i \ln P_i)$) |
|--------------|-------------------------|-----------------------------------|---------------|-----------------|---------------------------|-------------------------|--|
| 39. | Purple-banded Sunbird | <i>Cinnyris bifasciatus</i> | Nectariniidae | Musophagiformes | 2 | 0.0054 | 0.0280 |
| 40. | Rattling Cisticola | <i>Cisticola chiniana</i> | Cisticolidae | Passeriformes | 52 | 0.1394 | 0.2747 |
| 41. | Red-backed Shrike | <i>Lanius collurio</i> | Laniidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 42. | Red-billed Firefinch | <i>Lagonosticta senegala</i> | Estrildidae | Passeriformes | 4 | 0.0107 | 0.0486 |
| 43. | Red -capped Robin-chat | <i>Cossypha natalensis</i> | Muscicapidae | Passeriformes | 1 | 0.0027 | 0.0159 |
| 44. | Red-chested Cuckoo | <i>Cuculus solitarius</i> | Cuculidae | Cuculiformes | 12 | 0.0322 | 0.1106 |
| 45. | Ross's Turaco | <i>Musophaga rossae</i> | Musophagidae | Musophagiformes | 4 | 0.0107 | 0.0486 |
| 46. | Scarlet-chested Sunbird | <i>Chalcomitra senegalensis</i> | Nectariniidae | Musophagiformes | 2 | 0.0054 | 0.0280 |
| 47. | Shelley's Sunbird | <i>Cinnyris shelleyi</i> | Nectariniidae | Passeriformes | 1 | 0.0027 | 0.0159 |
| 48. | Sooty Falcon | <i>Falco concolor</i> | Falconidae | Falconiformes | 1 | 0.0027 | 0.0159 |
| 49. | Southern Red Bishop | <i>Euplectes orix</i> | Ploceidae | Passeriformes | 13 | 0.0349 | 0.1170 |
| 50. | Spotted Flycatcher | <i>Muscicapa striata</i> | Muscicapidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 51. | Squire-tailed Drongo | <i>Dicrurus ludwigii</i> | Dicruridae | Passeriformes | 8 | 0.0214 | 0.0824 |
| 52. | Tawny-flanked Prinia | <i>Prinia subflava</i> | Cisticolidae | Passeriformes | 2 | 0.0054 | 0.0280 |
| 53. | Trumpeter Hornbill | <i>Bycanistes bucinator</i> | Bucerotidae | Bucerotiformes | 4 | 0.0107 | 0.0486 |
| 54. | Variable Sunbird | <i>Cinnyris venustus</i> | Nectariniidae | Passeriformes | 10 | 0.0268 | 0.0970 |
| 55. | Violet Backed Starling | <i>Cinnyricinclus leucogaster</i> | Sturnidae | Passeriformes | 3 | 0.0080 | 0.0388 |
| 56. | White-browed Robin-chat | <i>Cossypha heuglini</i> | Muscicapidae | Passeriformes | 7 | 0.0188 | 0.0746 |
| 57. | Yellow Bishop | <i>Euplectes capensis</i> | Ploceidae | Passeriformes | 23 | 0.0617 | 0.1718 |
| 58. | Yellow-vented Bulbul | <i>Pycnonotus barbatus</i> | Pycnonotidae | Passeriformes | 26 | 0.0697 | 0.1857 |
| TOTAL | | | | | 373 | | 3.4342 |

Appendix II: Abundance and Diversity indices of Birds recorded in Mawengi forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|-------------------------|---------------------------------|----------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 1. | Amethyst Sunbird | <i>Chalcomitra amethystina</i> | Nectariniidae | Passeriformes | 2 | 0.0263 | 0.10 |
| 2. | Black and white Cuckoo | <i>Oxylophus jacobinus</i> | Cuculidae | Cuculiformes | 5 | 0.0658 | 0.18 |
| 3. | Blue-spotted Wood-dove | <i>Turtur afer</i> | Columbidae | Columbiformes | 2 | 0.0263 | 0.10 |
| 4. | Bronze Mankin | <i>Lonchura cucullata</i> | Estrildidae | Passeriformes | 7 | 0.0921 | 0.22 |
| 5. | Collared Sunbird | <i>Hedydipna collaris</i> | Nectariniidae | Passeriformes | 1 | 0.0132 | 0.06 |
| 6. | Common Stonechat | <i>Saxicola torquata</i> | Muscicapidae | Passeriformes | 3 | 0.0395 | 0.13 |
| 7. | Crimson-rumped Waxbill | <i>Estrilda rhodopyga</i> | Estrildidae | Passeriformes | 4 | 0.0526 | 0.15 |
| 8. | Green-throated Sunbird | <i>Chalcomitra rubescens</i> | Nectariniidae | Passeriformes | 8 | 0.1053 | 0.24 |
| 9. | Helmeted Guineafowl | <i>Numida meleagris</i> | Numididae | Galliformes | 3 | 0.0395 | 0.13 |
| 10. | Hildebrandt's Francolin | <i>Francolinus hildebrandti</i> | Phasianidae | Galliformes | 2 | 0.0263 | 0.10 |
| 11. | Mountain Wagtail | <i>Motacilla clara</i> | Motacillidae | Passeriformes | 3 | 0.0395 | 0.13 |
| 12. | Namaqua Dove | <i>Oena capensis</i> | Columbidae | Columbiformes | 1 | 0.0132 | 0.06 |
| 13. | Osprey | <i>Pandion haliaetus</i> | Pandionidae | Accipitriformes | 2 | 0.0263 | 0.10 |
| 14. | Pale Batis | <i>Batis soror</i> | Platysteiridae | Passeriformes | 3 | 0.0395 | 0.13 |
| 15. | Pied Crow | <i>Corvus capensis</i> | Corvidae | Passeriformes | 1 | 0.0132 | 0.06 |
| 16. | Pygm Batis | <i>Batis perkeo</i> | Platysteiridae | Passeriformes | 4 | 0.0526 | 0.15 |
| 17. | Rattling Cisticola | <i>Cisticola chiniana</i> | Cisticolidae | Passeriformes | 10 | 0.1316 | 0.27 |
| 18. | Red-chested Cuckoo | <i>Cuculus solitarius</i> | Cuculidae | Cuculiformes | 2 | 0.0263 | 0.10 |
| 19. | Red-faced Crombec | <i>Sylvietta whytii</i> | Macrosphenidae | Passeriformes | 3 | 0.0395 | 0.13 |
| 20. | Ring-necked Dove | <i>Streptopelia capicola</i> | Columbidae | Columbiformes | 1 | 0.0132 | 0.06 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|--------------|-----------------------|---------------------------|--------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 21. | Ross's Turaco | <i>Musophaga rossae</i> | Musophagidae | Musophagiformes | 1 | 0.0132 | 0.06 |
| 22. | Yellow-billed Waxbill | <i>Estrilda astrild</i> | Estrildidae | Passeriformes | 4 | 0.0526 | 0.15 |
| 23. | Yellow Bishop | <i>Euplectes capensis</i> | Ploceidae | Passeriformes | 4 | 0.0526 | 0.15 |
| TOTAL | | | | | 76 | | 2.92 |

Appendix III: Abundance and Diversity indices of Birds recorded in Mvava forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|---------------------------|--------------------------------|----------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 1. | African Black Swift | <i>Apus barbatus</i> | Apodidae | Apodiformes | 23 | 0.0712 | 0.19 |
| 2. | African Grey Hornbill | <i>Tockus nasutus</i> | Bucerotidae | Bucerotiformes | 6 | 0.0186 | 0.07 |
| 3. | African Mourning Dove | <i>Streptopelia decipiens</i> | Columbidae | Columbiformes | 2 | 0.0062 | 0.03 |
| 4. | African Pied Wagtail | <i>Motacilla aguimp</i> | Motacillidae | Passeriformes | 2 | 0.0062 | 0.03 |
| 5. | Amethyst Sunbird | <i>Chalcomitra amethystina</i> | Nectariniidae | Passeriformes | 5 | 0.0155 | 0.06 |
| 6. | Ashy Flycatcher | <i>Muscicapa caerulescens</i> | Muscicapidae | Passeriformes | 5 | 0.0155 | 0.06 |
| 7. | Black and white Cuckoo | <i>Clamator jacobinus</i> | Cuculidae | Cuculiformes | 35 | 0.1084 | 0.24 |
| 8. | Black-crowned Tchagra | <i>Tchagra senegala</i> | Malaconotidae | Passeriformes | 6 | 0.0186 | 0.07 |
| 9. | Black Kite | <i>Milvus migrans</i> | Accipitridae | Accipitriformes | 1 | 0.0031 | 0.02 |
| 10. | Black-shouldered Kite | <i>Elanus axillaris</i> | Apodidae | Accipitriformes | 2 | 0.0062 | 0.03 |
| 11. | Bohm's-spine Tail | <i>Neafrapus boehmi</i> | Apodidae | Apodiformes | 16 | 0.0495 | 0.15 |
| 12. | Bronze Mankin | <i>Lonchura cucullata</i> | Estrildidae | Passeriformes | 14 | 0.0433 | 0.14 |
| 13. | Brown-crowned Tchagra | <i>Tchagra australis</i> | Malaconotidae | Passeriformes | 9 | 0.0279 | 0.10 |
| 14. | Dappled Mountain-robin | <i>Arcanator orostruthus</i> | Arcanatoridae | Passeriformes | 2 | 0.0062 | 0.03 |
| 15. | Dusky Tit | <i>Melaniparus funereus</i> | Paridae | Passeriformes | 1 | 0.0031 | 0.02 |
| 16. | Emerald-wood Spotted-dove | <i>Turtur chalcospilos</i> | Columbidae | Columbiformes | 1 | 0.0031 | 0.02 |
| 17. | Forest Batis | <i>Batis mixta</i> | Platysteiridae | Passeriformes | 14 | 0.0433 | 0.14 |
| 18. | Fork-tailed Drongo | <i>Dicrurus adsimilis</i> | Dicruridae | Passeriformes | 14 | 0.0433 | 0.14 |
| 19. | Green-capped Eromela | <i>Eremomela scotops</i> | Cisticolidae | Passeriformes | 3 | 0.0093 | 0.04 |
| 20. | Grey-backed | <i>Camaroptera</i> | Cisticolidae | Passeriformes | 1 | 0.0031 | 0.02 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|-------------------------------|---------------------------------|----------------|---------------|---------------------------|-------------------------|--------------------------------------|
| | Camaroptera | <i>brevicaudata</i> | | | | | |
| 21. | Hartlaub's Marsh Widowbird | <i>Euplectes hartlaubi</i> | Ploceidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 22. | Hildebrandt's Francolin | <i>Pternistis hildebrandti</i> | Phasianidae | Galliformes | 11 | 0.0341 | 0.12 |
| 23. | Hill Babbler | <i>Pseudoalcippe abyssinica</i> | Sylviidae | Passeriformes | 3 | 0.0093 | 0.04 |
| 24. | Laughing Dove | <i>Spilopelia senegalensis</i> | Columbidae | Columbiformes | 1 | 0.0031 | 0.02 |
| 25. | Lead-coloured Flycatcher | <i>Myiagra rubecula</i> | Monarchidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 26. | Lesser Honeyguide | <i>Indicator minor</i> | Indicatoridae | Piciformes | 4 | 0.0124 | 0.05 |
| 27. | Marsh Warbler | <i>Acrocephalus palustris</i> | Sylvioidea | Passeriformes | 2 | 0.0062 | 0.03 |
| 28. | Miombo Double-colored Sunbird | <i>Cinnyris manoensis</i> | Nectariniidae | Passeriformes | 3 | 0.0093 | 0.04 |
| 29. | Mountain Greenbul | <i>Arizelocichla nigriceps</i> | Pycnonotidae | Passeriformes | 9 | 0.0279 | 0.10 |
| 30. | Namaqua Dove | <i>Oena capensis</i> | Columbidae | Columbiformes | 1 | 0.0031 | 0.02 |
| 31. | Olive-flanked Robin-chat | <i>Cossypha anomala</i> | Muscicapidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 32. | Orange Ground-thrush | <i>Geokichla gurneyi</i> | Turdidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 33. | Pale Batis | <i>Batis soror</i> | Platysteiridae | Passeriformes | 13 | 0.0402 | 0.13 |
| 34. | Pale Flycatcher | <i>Bradornis pallidus</i> | Muscicapidae | Passeriformes | 2 | 0.0062 | 0.03 |
| 35. | Pin-tailed Drongo | <i>Dicrurus macrocercus</i> | Dicruridae | Passeriformes | 3 | 0.0093 | 0.04 |
| 36. | Rattling Cisticola | <i>Cisticola chiniana</i> | Cisticolidae | Passeriformes | 4 | 0.0124 | 0.05 |
| 37. | Red-billed Firefinch | <i>Lagonosticta senegala</i> | Estrildidae | Passeriformes | 10 | 0.0310 | 0.11 |
| 38. | Red-billed Oxpeker | <i>Buphagus erythrorhynchus</i> | Sturnidae | Passeriformes | 2 | 0.0062 | 0.03 |
| 39. | Red-chested Cuckoo | <i>Cuculus solitarius</i> | Cuculidae | Cuculiformes | 3 | 0.0093 | 0.04 |
| 40. | Red-eyed Dove | <i>Streptopelia</i> | Columbidae | Columbiformes | 3 | 0.0093 | 0.04 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|--------------|-------------------------|----------------------------------|---------------|------------------|---------------------------|-------------------------|--------------------------------------|
| | | <i>semitorquata</i> | | | | | |
| 41. | Red-faced Crimsonwing | <i>Cryptospiza reichenovii</i> | Estrildidae | Passeriformes | 2 | 0.0062 | 0.03 |
| 42. | Ring-necked Dove | <i>Streptopelia capicola</i> | Columbidae | Columbiformes | 5 | 0.0155 | 0.06 |
| 43. | Scarlet-chested Sunbird | <i>Chalcomitra senegalensis</i> | Nectariniidae | Passeriformes | 19 | 0.0588 | 0.17 |
| 44. | Spotted Flycatcher | <i>Muscicapa striata</i> | Muscicapidae | Passeriformes | 2 | 0.0062 | 0.03 |
| 45. | Square-tailed Drongo | <i>Dicrurus ludwigii</i> | Dicruridae | Passeriformes | 11 | 0.0341 | 0.12 |
| 46. | Square-tailed Nightjar | <i>Caprimulgus fossii</i> | Caprimulgidae | Caprimulgiformes | 2 | 0.0062 | 0.03 |
| 47. | Variable Sunbird | <i>Cinnyris venustus</i> | Nectariniidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 48. | Village Indigobird | <i>Vidua chalybeata</i> | Viduidae | Passeriformes | 6 | 0.0186 | 0.07 |
| 49. | White-browed Coucal | <i>Centropus superciliosus</i> | Cuculidae | Cuculiformes | 4 | 0.0124 | 0.05 |
| 50. | Yellow-bellied Greenbul | <i>Chlorocichla flaviventris</i> | Pycnonotidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 51. | Yellow Bishop | <i>Euplectes capensis</i> | Ploceidae | Passeriformes | 22 | 0.0681 | 0.18 |
| 52. | Yellow-fronted Canary | <i>Crithagra mozambicus</i> | Fringillidae | Passeriformes | 1 | 0.0031 | 0.02 |
| 53. | Yellow-vented Bulbul | <i>Pycnonotus barbatus</i> | Pycnonotidae | Passeriformes | 7 | 0.0217 | 0.08 |
| TOTAL | | | | | 323 | | 3.47 |

Appendix IV: Abundance and Diversity indices of Birds recorded in Masimavalafu forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = $-\sum (Pi \ln Pi)$) |
|-----|---------------------------------|--------------------------------|----------------|-----------------|---------------------------|-------------------------|---|
| 1. | African Black-headed Oriole | <i>Oriolus larvatus</i> | Oriolidae | Passeriformes | 12 | 1.8 | 0.074 |
| 2. | African Citril | <i>Serinus citrinelloides</i> | Fringillidae | Passeriformes | 7 | 1.1 | 0.049 |
| 3. | African Crowned Eagle | <i>Stephanoaetus coronatus</i> | Accipitridae | Accipitriformes | 2 | 0.3 | 0.018 |
| 4. | African Firefinch | <i>Legonosticta ribricata</i> | Estrildidae | Passeriformes | 17 | 2.6 | 0.095 |
| 5. | African Golden Oriole | <i>Oriolus auratus</i> | Oriolidae | Passeriformes | 2 | 0.3 | 0.018 |
| 6. | African Golden-breasted Bunting | <i>Emberiza flaviventris</i> | Emberizidae | Passeriformes | 10 | 1.5 | 0.064 |
| 7. | Amythest Sunbird | <i>Chalcomitra rubescens</i> | Nectariniidae | Passeriformes | 22 | 3.4 | 0.115 |
| 8. | Arrow-marked Babbler | <i>Turdoides jardineii</i> | Leiothrichidae | Passeriformes | 32 | 4.9 | 0.148 |
| 9. | Bateleur | <i>Terathopius ecaudatus</i> | Accipitridae | Accipitriformes | 1 | 0.2 | 0.010 |
| 10. | Bearded Woodpecker | <i>Chloropicus namaquus</i> | Picidae | Piciformes | 4 | 0.6 | 0.031 |
| 11. | Black and white Mannkin | <i>Lonchura bicolor</i> | Estrildidae | Passeriformes | 32 | 4.9 | 0.148 |
| 12. | Black Cuckoo-shrike | <i>Campephaga flava</i> | Campephagidae | Passeriformes | 3 | 0.5 | 0.025 |
| 13. | Black-backed Puffback | <i>Dryoscopus gambensis</i> | Malaconotidae | Passeriformes | 12 | 1.8 | 0.074 |
| 14. | Black-crowned Tchagra | <i>Tchagra senegala</i> | Malaconotidae | Passeriformes | 7 | 1.1 | 0.049 |
| 15. | Black-Shouldered kite | <i>Elanus caeruleus</i> | Accipitridae | Accipitriformes | 6 | 0.9 | 0.043 |
| 16. | Broad-tailed Paradise-Whydah | <i>Vidua obtusa</i> | Viduidae | Passeriformes | 13 | 2.0 | 0.078 |
| 17. | Brown-hooded Kingfisher | <i>Halcyon albiventris</i> | Alcedinidae | Coraciiformes | 1 | 0.2 | 0.010 |
| 18. | Brown-naked Parrot | <i>Poicephalus gulielmi</i> | Psittacidae | Psittaciformes | 5 | 0.8 | 0.037 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = $-\sum (Pi \ln Pi)$) |
|-----|--------------------------------|---------------------------------|---------------|-----------------|---------------------------|-------------------------|---|
| 19. | Cabanis's Bunting | <i>Emberiza cabanisi</i> | Emberizidae | Passeriformes | 8 | 1.2 | 0.054 |
| 20. | Cardinal Woodpecker | <i>Dendrapicos fuscescens</i> | Picidae | Piciformes | 3 | 0.5 | 0.025 |
| 21. | Chin-spot Batis | <i>Batis Molitor</i> | Platysteirdae | Passeriformes | 19 | 2.9 | 0.103 |
| 22. | Cinnamon-breasted Rock Bunting | <i>Emberiza tahapisi</i> | Emberizidae | Passeriformes | 2 | 0.3 | 0.018 |
| 23. | Collared Sunbird | <i>Hedydipna collaris</i> | Nectariniidae | Passeriformes | 7 | 1.1 | 0.049 |
| 24. | Common Bulbul | <i>Pycnonotus barbatus</i> | Pycnonotidae | Passeriformes | 18 | 2.8 | 0.099 |
| 25. | Common Scimitarbill | <i>Rhinopomastus cyanomelas</i> | Phoeniculidae | Bucerotiformes | 6 | 0.9 | 0.043 |
| 26. | Crowned Hornbill | <i>Tockus albeterminatus</i> | Bucerotidae | Bucerotiformes | 17 | 2.6 | 0.095 |
| 27. | Eastern Chanting-Goshawk | <i>Malierax poliopterus</i> | Accipitridae | Accipitriformes | 1 | 0.2 | 0.010 |
| 28. | Eastern nicator | <i>Nicator gularis</i> | Caprimulgidae | Passeriformes | 1 | 0.2 | 0.010 |
| 29. | Eastern Saw-wing | <i>Psalidoprocne orientalis</i> | Hirundinidae | Passeriformes | 17 | 2.6 | 0.095 |
| 30. | Emerald-spotted Wood-Dove | <i>Turtur chalcospilos</i> | Columbidae | Columbiformes | 4 | 0.6 | 0.031 |
| 31. | Familiar Chat | <i>Cercomela familiaris</i> | Muscicapidae | Passeriformes | 3 | 0.5 | 0.025 |
| 32. | Fawn-breasted Waxbil | <i>Estrilda paludicola</i> | Estrildidae | Passeriformes | 19 | 2.9 | 0.103 |
| 33. | Fork-tailed Drongo | <i>Dicrurus adsimilis</i> | Dicruridae | Passeriformes | 18 | 2.8 | 0.099 |
| 34. | Fulleborn's Black Boubou | <i>Laniarius fuelleborni</i> | Malaconotidae | Passeriformes | 2 | 0.3 | 0.018 |
| 35. | Greater Honeyguide | <i>Indicator indicator</i> | Indicatoridae | Piciformes | 4 | 0.6 | 0.031 |
| 36. | Grey-headed Kingfisher | <i>Halcyon leucocephala</i> | Alcedinidae | Coraciiformes | 1 | 0.2 | 0.010 |
| 37. | Hamerkop | <i>Scopus umbretta</i> | Scopidae | Pelecaniformes | 3 | 0.5 | 0.025 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = $-\sum (P_i \ln P_i)$) |
|-----|---------------------------|-----------------------------------|---------------|-----------------|---------------------------|-------------------------|---|
| 38. | Helmeted Guinefowl | <i>Numida meleagris</i> | Numididae | Galliformes | 4 | 0.6 | 0.031 |
| 39. | Little Banded Goshawk | <i>Accipiter badius</i> | Accipitridae | Accipitriformes | 2 | 0.3 | 0.018 |
| 40. | Little Bee-eater | <i>Merops pusillus</i> | Meropidae | Coraciiformes | 30 | 4.6 | 0.142 |
| 41. | Little Greenbul | <i>Eurillas virens</i> | Pycnonotidae | Passeriformes | 9 | 1.4 | 0.059 |
| 42. | Lizard Buzzard | <i>Kaupifalco monogrammicus</i> | Accipitridae | Accipitriformes | 1 | 0.2 | 0.010 |
| 43. | Miombo Rock-Thrush | <i>Monticola angolensis</i> | Muscicapidae | Passeriformes | 3 | 0.5 | 0.025 |
| 44. | Namaqua Dove | <i>Oena capensis</i> | Columbidae | Columbiformes | 2 | 0.3 | 0.018 |
| 45. | Olive Sunbird | <i>Cyanomitra veroxii</i> | Nectariniidae | Passeriformes | 10 | 1.5 | 0.064 |
| 46. | Olived-flanked Robin-chat | <i>Cossypha anomala</i> | Muscicapidae | Passeriformes | 1 | 0.2 | 0.010 |
| 47. | Olive-headed Weaver | <i>Ploceus olivaceiceps</i> | Ploceidae | Passeriformes | 1 | 0.2 | 0.010 |
| 48. | Piping Cisticola | <i>Cisticola fulvipillus</i> | Cisticolidae | Passeriformes | 1 | 0.2 | 0.010 |
| 49. | Purple Granadier | <i>Uraeginthus ianthinogaster</i> | Estrildidae | Passeriformes | 1 | 0.2 | 0.010 |
| 50. | Purple-crested Turaco | <i>Tauraco porphyreolophus</i> | Musophagidae | Musophagiformes | 7 | 1.1 | 0.049 |
| 51. | Rattling Cisticola | <i>Cisticola chiniana</i> | Cisticolidae | Passeriformes | 8 | 1.2 | 0.054 |
| 52. | Red-caped Robin-Chat | <i>Cossypha natalensis</i> | Muscicapidae | Passeriformes | 1 | 0.2 | 0.010 |
| 53. | Red-collared Widowbird | <i>Euplactes ardens</i> | Ploceidae | Passeriformes | 6 | 0.9 | 0.043 |
| 54. | Red-necked Spurfowl | <i>Pternistis afer</i> | Phasianidae | Galliformes | 3 | 0.5 | 0.025 |
| 55. | Retz's Helmet-shrike | <i>Prionops retzii</i> | Prionopidae | Passeriformes | 65 | 10.0 | 0.230 |
| 56. | Ring-necked Dove | <i>Streptopelia capicola</i> | Columbidae | Columbiformes | 10 | 1.5 | 0.064 |
| 57. | Rufous-bellied Tit | <i>Melaniparus</i> | Paridae | Passeriformes | 1 | 0.2 | 0.010 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = $-\sum (P_i \ln P_i)$) |
|--------------|--------------------------|----------------------------------|---------------|----------------|---------------------------|-------------------------|---|
| | | <i>rufiventris</i> | | | | | |
| 58. | Scarlet-chested Sunbird | <i>Chalcomitra senegalensis</i> | Nectariniidae | Passeriformes | 5 | 0.8 | 0.037 |
| 59. | Southern Cordon-bleu | <i>Uraeginthus angolensis</i> | Estrildidae | Passeriformes | 1 | 0.2 | 0.010 |
| 60. | Southern Red Bishop | <i>Euplectes orix</i> | Ploceidae | Passeriformes | 4 | 0.6 | 0.031 |
| 61. | Speckled Mousebird | <i>Colius striatus</i> | Coliidae | Coraciiformes | 4 | 0.6 | 0.031 |
| 62. | Swallow-tailed Bee-eater | <i>Merops hirundineus</i> | Meropidae | Coraciiformes | 7 | 1.1 | 0.049 |
| 63. | Tawny-flanked Prinia | <i>Prinia subflava</i> | Cisticolidae | Passeriformes | 21 | 3.2 | 0.111 |
| 64. | Tropical Boubou | <i>Laniarius aethiopicus</i> | Malaconotidae | Passeriformes | 8 | 1.2 | 0.054 |
| 65. | Trumpeter Hornbill | <i>Bycanistes bucinator</i> | Bucerotidae | Bucerotiformes | 13 | 2.0 | 0.078 |
| 66. | Variable Sunbird | <i>Cinnyris venusta</i> | Nectariniidae | Passeriformes | 1 | 0.2 | 0.010 |
| 67. | Village Indigobird | <i>Vidua chalybeata</i> | Viduidae | Passeriformes | 3 | 0.5 | 0.025 |
| 68. | White-browed Robin-Chat | <i>Cossypha heuglini</i> | Muscicapidae | Passeriformes | 4 | 0.6 | 0.031 |
| 69. | White-browed Scrub-Robin | <i>Cercotrichas leucophrys</i> | Muscicapidae | Passeriformes | 5 | 0.8 | 0.037 |
| 70. | White-winged Widowbird | <i>Euplactes albonotatus</i> | Ploceidae | Passeriformes | 42 | 6.5 | 0.177 |
| 71. | Yellow Bishop | <i>Euplectes capensis</i> | Ploceidae | Passeriformes | 22 | 3.4 | 0.115 |
| 72. | Yellow-bellied Greenbul | <i>Chlorocichla flaviventris</i> | Pycnonotidae | Passeriformes | 2 | 0.3 | 0.018 |
| TOTAL | | | | | 649 | | 3.742 |

Appendix V: Abundance and Diversity indices of Birds recorded in Kimelembe forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|------------------------------|---------------------------------|----------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 1. | African Black-headed Oriole | <i>Oriolus larvatus</i> | Oriolidae | Passeriformes | 8 | 3.5 | 0.118 |
| 2. | African Citril | <i>Serinus citrinelloides</i> | Fringillidae | Passeriformes | 3 | 1.3 | 0.057 |
| 3. | African Dusky Flycatcher | <i>Muscicapa adusta</i> | Muscicapidae | Passeriformes | 1 | 0.4 | 0.024 |
| 4. | African Firefinch | <i>Legonosticta ribricata</i> | Estrildidae | Passeriformes | 4 | 1.8 | 0.071 |
| 5. | African Paradise-flycatcher | <i>Terpsiphone viridis</i> | Monarchidae | Passeriformes | 1 | 0.4 | 0.024 |
| 6. | Amythest Sunbird | <i>Chalcomitra rubescens</i> | Nectariniidae | Passeriformes | 5 | 2.2 | 0.084 |
| 7. | Black Cuckoo-shrike | <i>Campephaga flava</i> | Campephagidae | Passeriformes | 2 | 0.9 | 0.042 |
| 8. | Black-backed Puffback | <i>Dryoscopus gambensis</i> | Malaconotidae | Passeriformes | 2 | 0.9 | 0.042 |
| 9. | Black-crowned Tchagra | <i>Tchagra senegala</i> | Malaconotidae | Passeriformes | 3 | 1.3 | 0.057 |
| 10. | Black-shouldered Kite | <i>Elanus caeruleus</i> | Accipitridae | Accipitriformes | 1 | 0.4 | 0.024 |
| 11. | Broad-tailed Paradise-Whydah | <i>Vidua obtusa</i> | Viduidae | Passeriformes | 3 | 1.3 | 0.057 |
| 12. | Brown-necked Parrot | <i>Poicephalus gularis</i> | Psittacidae | Psittaciformes | 2 | 0.9 | 0.042 |
| 13. | Cardinal Woodpecker | <i>Dendropicus fuscescens</i> | Picidae | Piciformes | 2 | 0.9 | 0.042 |
| 14. | Chin-spot Batis | <i>Batis Molitor</i> | Platysteiridae | Passeriformes | 1 | 0.4 | 0.024 |
| 15. | Collared Sunbird | <i>Hedydipna collaris</i> | Nectariniidae | Passeriformes | 11 | 4.9 | 0.147 |
| 16. | Common Bulbul | <i>Pycnonotus barbatus</i> | Pycnonotidae | Passeriformes | 10 | 4.4 | 0.138 |
| 17. | Common Scimitarbill | <i>Rhinopomastus cyanomelas</i> | Phoeniculidae | Bucerotiformes | 1 | 0.4 | 0.024 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|-------------------------------|----------------------------------|---------------|----------------|---------------------------|-------------------------|--------------------------------------|
| 18. | Crowned Hornbill | <i>Tockus albeterminatus</i> | Bucerotidae | Bucerotiformes | 10 | 4.4 | 0.138 |
| 19. | Eastern Nicator | <i>Nicator gularis</i> | Nicatoridae | Passeriformes | 1 | 0.4 | 0.024 |
| 20. | Fork-tailed Drongo | <i>Dicrurus adsimilis</i> | Dicruridae | Passeriformes | 10 | 4.4 | 0.138 |
| 21. | Giant Kingfisher | <i>Megaceryle maxima</i> | Alcedinidae | Coraciiformes | 1 | 0.4 | 0.024 |
| 22. | Hamerkop | <i>Scopus umbretta</i> | Scopidae | Pelecaniformes | 1 | 0.4 | 0.024 |
| 23. | Helmeted Guineafowl | <i>Numida meleagris</i> | Numididae | Galliformes | 6 | 2.7 | 0.096 |
| 24. | Little Greenbul | <i>Eurillas virens</i> | Pycnonotidae | Passeriformes | 2 | 0.9 | 0.042 |
| 25. | Miombo Double-collard Sunbird | <i>Cinnyris manoensis</i> | Nectariniidae | Passeriformes | 7 | 3.1 | 0.108 |
| 26. | Mottled Swift | <i>Apus aequatorialis</i> | Apodidae | Apodiformes | 12 | 5.3 | 0.156 |
| 27. | Mountain Wagtail | <i>Motacilla clara</i> | Motacillidae | Passeriformes | 10 | 4.4 | 0.138 |
| 28. | Narina Trogon | <i>Apaloderma narina</i> | Trogonidae | Trogoniformes | 1 | 0.4 | 0.024 |
| 29. | Olive Sunbird | <i>Cyanomitra olivacea</i> | Nectariniidae | Passeriformes | 9 | 4.0 | 0.128 |
| 30. | Pale-billed Hornbill | <i>Tockus pallidirostris</i> | Bucerotidae | Bucerotiformes | 10 | 4.4 | 0.138 |
| 31. | Rattling Cisticola | <i>Cisticola chiniana</i> | Cisticolidae | Passeriformes | 11 | 4.9 | 0.147 |
| 32. | Red-necked Spurfowl | <i>Pternistis afer</i> | Phasianidae | Galliformes | 3 | 1.3 | 0.057 |
| 33. | Retz's Helmet-shrike | <i>Prionops retzii</i> | Prionopidae | Passeriformes | 1 | 0.4 | 0.024 |
| 34. | Ring-necked Dove | <i>Streptopelia capicola</i> | Columbidae | Columbiformes | 1 | 0.4 | 0.024 |
| 35. | Scaly-throated Honeyguide | <i>Indicator variegatus</i> | Indicatoridae | Piciformes | 1 | 0.4 | 0.024 |
| 36. | Scarlet-chested Sunbird | <i>Chalcomitra senegalensis</i> | Nectariniidae | Passeriformes | 2 | 0.9 | 0.042 |
| 37. | Shelly's Greenbul | <i>Arizelocichla masukuensis</i> | Pycnonotidae | Passeriformes | 6 | 2.7 | 0.096 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|--------------|------------------------------|----------------------------------|---------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 38. | Southern Banded Snake-Eagle | <i>Circaetus Fasciolatus</i> | Accipitridae | Accipitriformes | 1 | 0.4 | 0.024 |
| 39. | Southern Black Flycatcher | <i>Melaenornis pammelaina</i> | Muscicapidae | Passeriformes | 10 | 4.4 | 0.138 |
| 40. | Souza's Shrike | <i>Lanius souzae</i> | Laniidae | Passeriformes | 1 | 0.4 | 0.024 |
| 41. | Tawny-flanked Prinia | <i>Prinia subflava</i> | Cisticolidae | Passeriformes | 5 | 2.2 | 0.084 |
| 42. | Tropical Boubou | <i>Laniarius aethipicus</i> | Malaconotidae | Passeriformes | 2 | 0.9 | 0.042 |
| 43. | Trumpeter Hornbill | <i>Bycanistes bucinator</i> | Bucerotidae | Bucerotiformes | 22 | 9.7 | 0.227 |
| 44. | Variable Sunbird | <i>Cinnyris venusta</i> | Nectariniidae | Passeriformes | 9 | 4.0 | 0.128 |
| 45. | White-breasted Cuckoo-Shrike | <i>Coracina pectoralis</i> | Campephagidae | Passeriformes | 1 | 0.4 | 0.024 |
| 46. | White-Browed Scrub-Robin | <i>Cercotrichas leucophrys</i> | Muscicapidae | Passeriformes | 1 | 0.4 | 0.024 |
| 47. | White-rumped Swift | <i>Apus caffer</i> | Apodidae | Apodiformes | 1 | 0.4 | 0.024 |
| 48. | Whyte's Barbet | <i>Stactolaema wytii</i> | Lybiidae | Piciformes | 2 | 0.9 | 0.042 |
| 49. | Yellow-bellied Greenbul | <i>Chlorocichla flaviventris</i> | Pycnonotidae | Passeriformes | 4 | 1.8 | 0.071 |
| 50. | Yellow-breasted Apalis | <i>Apalis flavida</i> | Cisticolidae | Passeriformes | 2 | 0.9 | 0.042 |
| TOTAL | | | | | 226 | | 3.505 |

Appendix VI: Abundance and Diversity indices of Birds recorded in Iwela forest

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|-----------------------------|--------------------------------|---------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 1. | African Black-headed Oriole | <i>Oriolus larvatus</i> | Oriolidae | Passeriformes | 6 | 1.9 | 0.075 |
| 2. | African Citril | <i>Serinus citrinelloides</i> | Fringillidae | Passeriformes | 1 | 0.3 | 0.018 |
| 3. | African Crowned Eagle | <i>Stephanoaetus coronatus</i> | Accipitridae | Accipitriformes | 1 | 0.3 | 0.018 |
| 4. | African firefinch | <i>Legonosticta ribricata</i> | Estrildidae | Passeriformes | 7 | 2.2 | 0.084 |
| 5. | African Fish-eagle | <i>Haliaeetus vocifer</i> | Accipitridae | Accipitriformes | 2 | 0.6 | 0.032 |
| 6. | African Green-pegion | <i>Treron calva</i> | Columbidae | Columbiformes | 1 | 0.3 | 0.018 |
| 7. | African Paradise-flycatcher | <i>Terpsiphone viridis</i> | Monarchidae | Passeriformes | 2 | 0.6 | 0.032 |
| 8. | African Pied Wagtail | <i>Motacilla aguimp</i> | Motacillidae | Passeriformes | 3 | 0.9 | 0.044 |
| 9. | African Yellow White-eye | <i>Zosterops senegalensis</i> | Zosterooidae | Passeriformes | 3 | 0.9 | 0.044 |
| 10. | Amythest Sunbird | <i>Chalcomitra rubescens</i> | Nectariniidae | Passeriformes | 8 | 2.5 | 0.092 |
| 11. | Bateleur | <i>Terathopius ecaudatus</i> | Accipitridae | Accipitriformes | 2 | 0.6 | 0.032 |
| 12. | Black Cuckoo-shrike | <i>Campephaga flava</i> | Campephagidae | Passeriformes | 1 | 0.3 | 0.018 |
| 13. | Black-backed Puffback | <i>Dryoscopus gambensis</i> | Malaconotidae | Passeriformes | 11 | 3.4 | 0.116 |
| 14. | Black-chested Snake-Eagle | <i>Circaetus pectoralis</i> | Accipitridae | Accipitriformes | 1 | 0.3 | 0.018 |
| 15. | Black-collared Barbet | <i>Lybius minor</i> | Lybiidae | Piciformes | 4 | 1.3 | 0.055 |
| 16. | Black-crowned Tchagra | <i>Tchagra senegala</i> | Malaconotidae | Passeriformes | 4 | 1.3 | 0.055 |
| 17. | Black-fronted Bush-shrike | <i>Telophorus nigrifrons</i> | Malaconotidae | Passeriformes | 1 | 0.3 | 0.018 |
| 18. | Black-throated Wattle-eye | <i>Platysteira peltata</i> | Platysteirdae | Passeriformes | 1 | 0.3 | 0.018 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|--------------------------------|-----------------------------------|---------------|------------------|---------------------------|-------------------------|--------------------------------------|
| 19. | Cardinal Woodpecker | <i>Dendrapicos fuscescens</i> | Picidae | Piciformes | 3 | 0.9 | 0.044 |
| 20. | Chin-spot Batis | <i>Batis Molitor</i> | Monarchidae | Passeriformes | 10 | 3.1 | 0.109 |
| 21. | Cinnamon Bracken Warbler | <i>Bradypterus cinnamomeus</i> | Locustellidae | Passeriformes | 2 | 0.6 | 0.032 |
| 22. | Cinnamon-breasted Rock Bunting | <i>Emberiza tahapisi</i> | Emberizidae | Passeriformes | 3 | 0.9 | 0.044 |
| 23. | Collared Sunbird | <i>Hedydipna collaris</i> | Nectariniidae | Passeriformes | 3 | 0.9 | 0.044 |
| 24. | Common Bulbul | <i>Pycnonotus barbatus</i> | Pycnonotidae | Passeriformes | 14 | 4.4 | 0.137 |
| 25. | Crowned Hornbill | <i>Tockus albeterminatus</i> | Bucerotidae | Bucerotiformes | 10 | 3.1 | 0.109 |
| 26. | Eastern Bearded Scrub-Robin | <i>Cercotrichas quadrivirgata</i> | Muscicapidae | Passeriformes | 3 | 0.9 | 0.044 |
| 27. | Eastern Paradise-whydah | <i>Vidua paradisaea</i> | Viduidae | Passeriformes | 22 | 6.9 | 0.184 |
| 28. | Emerald-spotted Wood-Dove | <i>Turtur afer</i> | Columbidae | Columbiformes | 9 | 2.8 | 0.101 |
| 29. | Fiery-necked Nightjar | <i>Caprimulgus pectoralis</i> | Caprimulgidae | Caprimulgiformes | 1 | 0.3 | 0.018 |
| 30. | Fork-tailed Drongo | <i>Dicrurus adsimilis</i> | Dicruridae | Passeriformes | 13 | 4.1 | 0.130 |
| 31. | Giant Kingfisher | <i>Megaceryle maxima</i> | Alcedinidae | Coraciiformes | 1 | 0.3 | 0.018 |
| 32. | Grey-backed Camaroptera | <i>Camaroptera brachyura</i> | Cisticolidae | Passeriformes | 3 | 0.9 | 0.044 |
| 33. | Hamerkop | <i>Scopus umbretta</i> | Scopidae | Pelecaniformes | 7 | 2.2 | 0.084 |
| 34. | Helmeted Guineafowl | <i>Numida meleagris</i> | Numididae | Galiformes | 10 | 3.1 | 0.109 |
| 35. | Kurrichane Thrush | <i>Turdus libonyana</i> | Turdidae (1) | Passeriformes | 2 | 0.6 | 0.032 |
| 36. | Lead-colored Flycatcher | <i>Myiagra rubecula</i> | Monarchidae | Passeriformes | 3 | 0.9 | 0.044 |
| 37. | Little Bee-eater | <i>Merops pusillus</i> | Meropidae | Coraciiformes | 10 | 3.1 | 0.109 |
| 38. | Little Greenbul | <i>Andropadus ansorgei</i> | Pycnonotidae | Passeriformes | 2 | 0.6 | 0.032 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|-----|--------------------------|--------------------------------|----------------|-----------------|---------------------------|-------------------------|--------------------------------------|
| 39. | Livingstone's Turaco | <i>Tauraco livingstonii</i> | Musophagidae | Musophagiformes | 2 | 0.6 | 0.032 |
| 40. | Mountain Wagtail | <i>Motacilla clara</i> | Motacillidae | Passeriformes | 8 | 2.5 | 0.092 |
| 41. | Narina Trogon | <i>Apaloderma narina</i> | Trogonidae | Trogoniformes | 3 | 0.9 | 0.044 |
| 42. | Olive Sunbird | <i>Cyanomitra olivacea</i> | Nectariniidae | Passeriformes | 4 | 1.3 | 0.055 |
| 43. | Olive-flanked Robin-chat | <i>Cossypha anomala</i> | Muscicapidae | Passeriformes | 1 | 0.3 | 0.018 |
| 44. | Orange Ground-Thrush | <i>Geokichla gurneyi</i> | Turdidae | Passeriformes | 2 | 0.6 | 0.032 |
| 45. | Pale Batis | <i>Batis soror</i> | Platysteiridae | Passeriformes | 1 | 0.3 | 0.018 |
| 46. | Pale-billed Hornbill | <i>Tockus pallidirostris</i> | Bucerotidae | Bucerotiformes | 14 | 4.4 | 0.137 |
| 47. | Peters's Twinspot | <i>Hypargos niveoguttatus</i> | Estrildidae | Passeriformes | 4 | 1.3 | 0.055 |
| 48. | Purple-crested Turaco | <i>Tauraco porphyreolophus</i> | Musophagidae | Musophagiformes | 2 | 0.6 | 0.032 |
| 49. | Red-faced Crombec | <i>Sylvietta whytii</i> | Macrosphenidae | Passeriformes | 3 | 0.9 | 0.044 |
| 50. | Red-headed Weaver | <i>Anaplectes rubriceps</i> | Ploceidae | Passeriformes | 1 | 0.3 | 0.018 |
| 51. | Red-necked Spurfowl | <i>Francolinus afer</i> | Phasianidae | Galliformes | 4 | 1.3 | 0.055 |
| 52. | Retz's Helmet-shrike | <i>Prionops retzii</i> | Prionopidae | Passeriformes | 3 | 0.9 | 0.044 |
| 53. | Ring-necked Dove | <i>Streptopelia capicola</i> | Columbidae | Columbiformes | 3 | 0.9 | 0.044 |
| 54. | Rufous-bellied Tit | <i>Melaniparus rufiventris</i> | Paridae | Passeriformes | 4 | 1.3 | 0.055 |
| 55. | Shelly's Sunbird | <i>Cynniris shelleyi</i> | Nectariniidae | Passeriformes | 2 | 0.6 | 0.032 |
| 56. | Striped Pipit | <i>Anthus lineiventris</i> | Motacillidae | Passeriformes | 1 | 0.3 | 0.018 |
| 57. | Swallow-tailed Bee-eater | <i>Merops hirundineus</i> | Meropidae | Coraciiformes | 1 | 0.3 | 0.018 |
| 58. | Tawny Eagle | <i>Aquila rapax</i> | Accipitridae | Accipitriformes | 1 | 0.3 | 0.018 |

| No. | Common name | Scientific Name | Family | Order | Number of observation (i) | Relative abundance (Pi) | Diversity index (H' = -Σ (Pi ln Pi)) |
|--------------|---------------------------|----------------------------------|---------------|----------------|---------------------------|-------------------------|--------------------------------------|
| 59. | Tropical Boubou | <i>Laniarius major</i> | Malaconotidae | Passeriformes | 25 | 7.8 | 0.200 |
| 60. | Trumpeter Hornbill | <i>Bycanistes bucinator</i> | Bucerotidae | Bucerotiformes | 11 | 3.4 | 0.116 |
| 61. | Variable Sunbird | <i>Cinnyris venustus</i> | Nectariniidae | Passeriformes | 2 | 0.6 | 0.032 |
| 62. | White-bellied Sunbird | <i>Cynniris talatala</i> | Nectariniidae | Passeriformes | 1 | 0.3 | 0.018 |
| 63. | White-browed Scrub-Robin | <i>Cercotrichas leucophrys</i> | Muscicapidae | Passeriformes | 2 | 0.6 | 0.032 |
| 64. | White-tailed Lark | <i>Mirafra africanoides</i> | Alaudidae | Passeriformes | 14 | 4.4 | 0.137 |
| 65. | Wire-tailed Swallow | <i>Hirundo smithii</i> | Hirundinidae | Passeriformes | 1 | 0.3 | 0.018 |
| 66. | Yellow-bellied Greenbul | <i>Chlorocichla flaviventris</i> | Pycnonotidae | Passeriformes | 2 | 0.6 | 0.032 |
| 67. | Yellow-breasted Apalis | <i>Apalis flavida</i> | Cisticolidae | Passeriformes | 2 | 0.6 | 0.032 |
| 68. | Yellow-fronted Tinkerbird | <i>Pogoniulus chrysoconus</i> | Lybiidae | Piciformes | 5 | 1.6 | 0.065 |
| TOTAL | | | | | 319 | | 3.794 |

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