



# **Status of Restricted-Range Bird Species of East African Coastal Forests in Five South Coast Forest of Kenya**

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## **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

## **Article Information**

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## **ABSTRACT**

**Aims:** The aim of this study was to determine the status of restricted-range bird species of East African coastal biome, particularly within the Southern coastal forests of Kenya and as a proxy of the conservation value of the current existing fragmented forests.

**Study Design:** Ecological survey design, using point counts method.

**Place and Duration of Study:** The study was carried out in south-coast forests of Kenya within Kwale County between July 2007 and February, 2008.

**Methodology:** Five forests out of more than 10 forest fragments differing in sizes were randomly selected in the coastal area between the coastline and about 60 km inland within Kwale County, Kenya. Point counts were systematically placed at each forest, spaced at least 200 m from each other hence three forests namely Marenje, Nzombo and Mrima had 50 point counts each owing to their large size, while Diani and Kaya Waa had 15 and 7 point counts respectively.

**Results:** The findings showed that nearly half (48%) of the restricted-range bird species of East African Coastal Biome are found in the south coast forests of Kenya, 78% of which are truly forest birds. Some specific forest species such as *Anthus sokokensis* has been lost here while the occupancy range of *Anthreptes reichenowi* seems to have shrank from earlier records. Though all

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forests are found to be important, larger forests are particularly critical for the conservation of these birds. This means forests are the only refuge remaining for the restricted-range bird species in coastal Kenya.

**Conclusion:** The south coast forest fragments should be conserved irrespective of size, but the management should mainly aim at maintaining larger forests as the only way of ensuring persistent occupancy of East African Coastal biome restricted-range species.

*Keywords: East African coastal biome; restricted-range species; South coast forests of Kenya; avifaunal species.*

## 1. INTRODUCTION

Restricted-range bird species are land-bird species that are estimated to have had a breeding range of not more than 50,000 km<sup>2</sup> since historical times i.e. 1800 [1]. Globally, about more than 25% of the total birds (i.e. 2,623 bird species) have been identified as restricted-range species, and mainly occurring in 218 'Endemic Bird Areas' (EBAs) globally [2] and the majority of them (66%) are classified as globally threatened. Restricted-range species, therefore, occurs mainly in the EBAs, an area defined as having the distribution of two or more of the restricted-range species that overlap [1]. EBAs, although covers less than 5% of the world land surface, are noted as significant for biological resources richness, making it high priority areas for conservation [2].

In Africa, there are 1,300 Important Bird Areas (IBAs) in total covering an area of over 2 million km<sup>2</sup> equivalent to about 7% of the land area. Within the continent also, Birdlife International has listed 68 EBAs with a total of 407 restricted-range species all within the 15 biomes with a number of species whose range is restricted to that biome, for example, East African Coast biome has 38 restricted-range species [3].

East African coastal forests IBAs, within East African Coast biome, has 29 restricted-range species being in Kenyan side (hence recognised as part of EBAs), 7 of which are within identified EBAs of Kenya, Somalia and Tanzania [2-4]. East African Coastal Forests (which occur as part of the EBA and East Africa coast biome (EACB)) extend along the east coast of Africa along the coast of the Indian Ocean, from southern Somalia in the north, through coastal Kenya and Tanzania to the Limpopo River in southern Mozambique. It is also part of what is known as The Northern Zanzibar-Inhambane Coastal Forest Mosaic eco-region and falls entirely within the Swahilian regional centre of endemism [5]. Currently, the forests are highly

fragmented with over 200 separate forest patches that are highly threatened by human activities surrounding it [6,7] especially agricultural practices. Despite the fragmented nature of the forests, they are part of the biodiversity hotspot and are globally recognised as areas of great biological importance and diversity [8,9]. It is also a recognised centre of avifaunal endemism and has red data species many of which are restricted to the forests of Kenya and Tanzania [10]. East Africa Coast biome has a total of 43 sites designated as Important Bird Areas (IBAs) by BirdLife International [11,12]. Of these, 19 sites are in Kenya and 24 sites are in Tanzania. IBAs is a network of key sites for bird conservation identified using a globally agreed set of criteria based on the presence of populations of birds that are globally threatened, restricted in range, congregatory or characteristic of a particular biome [4]. These coastal forests of East Africa is divided into two ecoregions: the Northern Zanzibar-Inhambane coastal forest mosaic, which extends from southern Somalia through coastal Kenya to southern Tanzania, and includes the islands of Zanzibar and Pemba, and the Southern Zanzibar-Inhambane coastal forest mosaic, which extends from southern Tanzania along the Mozambique coast to the mouth of the Limpopo

(<https://www.worldwildlife.org/ecoregions/at0125>) ; [13]. Although there is reported 29 species of restricted-range species of birds in Kenyan side of East Africa Coast Biome [3,4], the current status remain unknown, despite after many years of increased human population and continued encroachment and destruction of coastal forests of Kenya, particularly the south coast forests that have received less attention in research.

It is reported that the distribution of endemic and biome restricted-range species are incompletely known in East African coastal forest owing to the fact that some forests are difficult to access [14]. The distribution of the 29 biome restricted-range bird species within the Northern Zanzibar-

Inhambane coastal forest mosaic is fragmented, some are endemics, and most of which are forest specialists and are confined to the remaining forested patches within the mosaic of habitats. The previous studies have reported that of the endemic bird species in the East African coastal forests, four are restricted to the island of Pemba (*Treron pembaensis*, *Nectarinia pembae*, *Zosterops vaughani* and *Otus pembaensis*), one in the lower Tana River (*Cisticola restrictus*), and the rest are mainly in the mainland coastal forest remnants including the coastal forests of southern Kenya (e.g. *Erythrocerus holochlorus*, *Anthus sokokensis*, *Ploceus golandi*, and *Campethera mombassica*) [15,8]. The remaining strict endemic is found in coastal grasslands in Kenya, *Anthus melindae*. The most restricted species on the mainland is Clarke's weaver (*Ploceus golandi*), which is known only from Arabuko-Sokoke and one adjacent forest in coastal Kenya [16]. The current status of these endemic and biome restricted species of birds in East African coastal forests should, therefore, be determined, and especially their richness, abundance and distribution. In addition, since south coast forests of Kenya are now patchily distributed and has a number of endemic and restricted-range species of birds typical of East Africa coastal forests [15,8], and yet the area has not been studied intensively unlike the northern forests north of Mombasa such as Arabuko-Sokoke forest, this study is also aimed at determining the current species richness, distribution and abundance of East African Coastal biome-restricted species within different sized fragmented forests. Further, since the previous studies in south coast forests of Kenya noted that Sokoke Scops Owl *Otus ireneae* was not yet been found in these forests despite being recorded in nearby parts of East Usambara Mountains in Tanzania [15,8], this study thus served as an additional further check of *Otus ireneae* presence/absence. Previously, Sokoke Pipit *Anthus sokokensis*, Plain Backed-sunbird *Anthreptes reichenowi* and Fischer's turaco *Tauraco fischeri*, had also been recorded in some of the forest patches in south coast of Kenya but not in others, despite the near proximity of the forests concerned to each other [8], for example, *Anthreptes reichenowi* was not observed in Diani and Kaya Waa forests before, but had been noted to have been fairly abundant in Dzombo Hill, Marenje, and Mrima Hill forests [8]. The *Anthus sokokensis*, a globally threatened and restricted range species was recorded in Dzombo Hill forest and Marenje [15] but not in Mrima, Kaya Waa and Diani forests. This study

was therefore aimed at determining if the above were still the case in five south coast forests of Kenya.

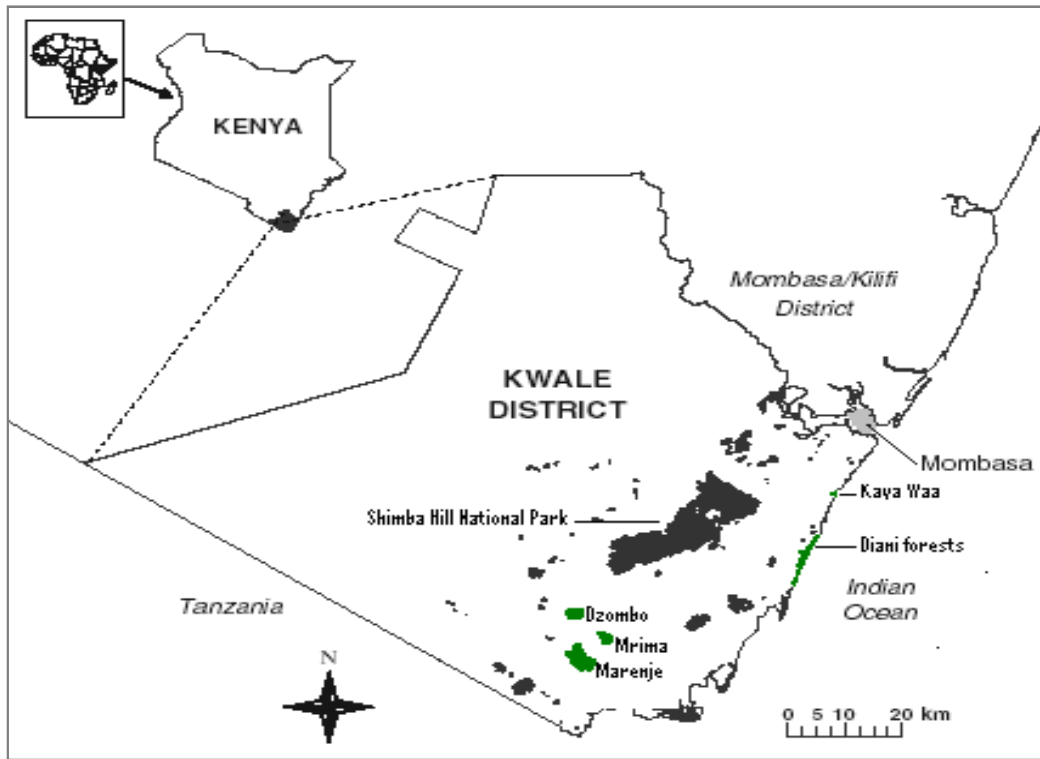
## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was carried out in Kaya Waa (20 ha), Diani (80 ha), Mrima Hill (250 ha), Dzombo Hill (259 ha), and Marenje (1480 ha) forests, all within Kwale County in south coast of Kenya. All sites are designated IBAs [8,4] (Fig. 1). The five forests are within Northern Zanzibar-Inhambane coastal forest mosaic and cover very small portion relative to the whole of Eastern African coastal forests (restricted-range bird species range), which span from southern Somalia, through coastal Kenya and Tanzania to the Limpopo River in southern Mozambique. The forests are currently under different management authorities namely: Kenya Forest Service (managed as Forest Reserves), National Museums (as National Monuments) and Traditional Council of Elders (as Kayas).

### 2.2 Selection of Sampling Sites

Suggestion by earlier researchers was followed on placement and use of transects and point counts stations used in data collection during this study [18]. The first sampling transects (Measuring 850 m long towards the interior of the forest) was purposely placed by choosing the starting point based on forest configuration and ease of accessibility, and choosing a particular angle of placement (with reference to Magnetic North) which was maintained in the subsequent transects in each forest. This was followed by systematic placement of the subsequent transects each placed at an interval of 200 m from the other transects and maintaining the angle of placement as the initial transect in each forest. Along each of the 850 m long transect in each forest, 5 point counts stations were placed at 200 m interval, with starting point count at 50 m from the forest edge. 10 transects (50 point count stations) were placed in Marenje, Mrima and Dzombo forests due to their larger sizes and 3 (15 point counts stations) and 2 (10 point count stations) transects were placed in Diani and Kaya Waa forests respectively, being the maximum point counts these two forests could accommodate owing to their smaller size. Transect aided in the placement of point counts stations which were used as sampling sites in bird data collection.



**Fig. 1. Map of Study area showing studied forest fragments (painted green) (Adapted and modified from [17])**

### 2.3 Data Collection

Point count method was used to collect the data on both nocturnal and diurnal birds, using both calls and sight to identify birds. Point counts at each forest fragment were distributed at least 200 m from each other with three largest forest Marenje, Mrima and Nzombo having 50 points counts within each while the two small forests, Diani and Kaya Waa having 15 and 10 point counts respectively, the only that could be accommodated within these forests because of the size. Diurnal birds were surveyed between 06:00 am and 10:00 am, and nocturnal ones between 19:00 hrs and 23:00 hrs. Each species of bird was identified at each point count, and the number of individuals recorded and their distances from the centre of point count station estimated. Surveys were conducted four times for diurnal birds and twice for nocturnal birds in each forest. Nocturnal survey was done during the times of moonlight by walking the set transects slowly, stopping and listening for ten minutes after every 200 m (at point count stations). In between the point count stations, the recorded call of *Otus irenae* was played in order to further check for its presence.

### 2.4 Analysis

The analysis for this study was more of descriptive statistics. The presence of Eastern Africa coastal forest and biome restricted-range bird species were only focused on this study, considering their species richness, distribution, and abundance in each of the forests surveyed. The number of species of birds was used to show species richness, while the number of individuals (averaged from the number of times survey was done) was used to determine the abundance. Species presence/absence in each forest was used to determine their distribution. Only those species recorded within 25 m radius were used in the analysis. Birds were characterised on the basis of their forest dependency as forest specialists, forest generalists, forest visitors and non-forest birds following [19].

## 3. RESULTS

### 3.1 Species Richness and Distribution

Fourteen out of the 29 EACB restricted-range bird species confined to Eastern Africa coastal

forests of Kenya were recorded during the study. These included 5 forest specialists (Here after abbreviated as FS), 6 forest generalists (hereafter abbreviated as FG), 2 forest visitors (hereafter abbreviated as FV), and 1 none-forest bird (hereafter referred to as Non-F) (Fig. 2).

The three larger forests (Marenje, Dzombo and Mrima) had the highest records of species richness (11, 9, and 10 respectively) relative to the two smaller forests (Diani and Kaya Waa) which had 7 and 6 numbers of EACB restricted-range bird species of Eastern Africa coastal forests respectively (Fig. 3 and Table 1).

According to this study, 4 forest specialists were common e.g. *Anthreptes reichenowi* (Plain-backed sunbird) was recorded in 3 forests, *Phyllastrephus fischeri* (Fischer's greenbul) recorded in all 5 forests, *Phyllastrephus debilis*

(Tiny greenbul) and *Erythrocerus holochlorus* (Little-yellow flycatcher) were both recorded in 4 forests. Three forest generalists were common e.g. *Tauraco fischeri* (Fischer's turaco) and *Lamprotornis corruscus* (Black-bellied starling) were found in all forests while *Campethera mombassica* (Mombasa woodpecker) was found in 4 forests. On the other hand, *Pogoniulus simplex* (Eastern green Tinkerbird), a forest specialist, and 3 forest generalists were rare, found only in two of the five forests surveyed. The Non-F bird species were almost rare only found in three of the five forests (Table 1). The bird abundance distribution trend follows that of species richness with Marenje, Dzombo, Mrima, Diani and Kaya Waa having 145, 92, 135, 46 and 11 respectively (Table 1). This trend is almost positively related with the forest size, except for Dzombo Hill forest.

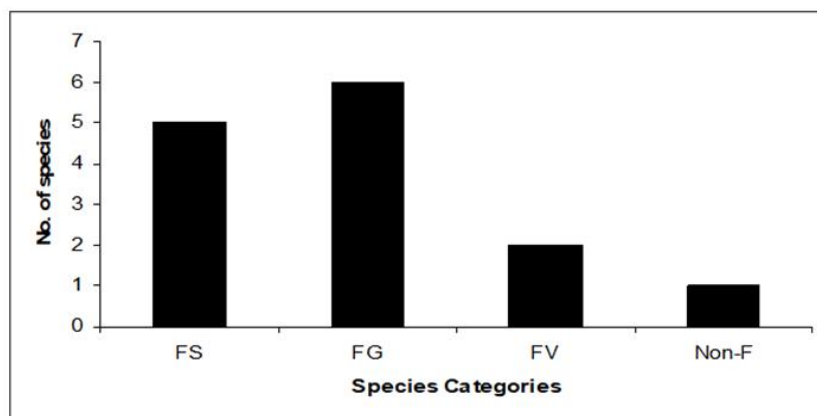


Fig. 2. Species richness distribution of East Africa Coastal forest biome restricted-range bird species forest-dependent bird categories

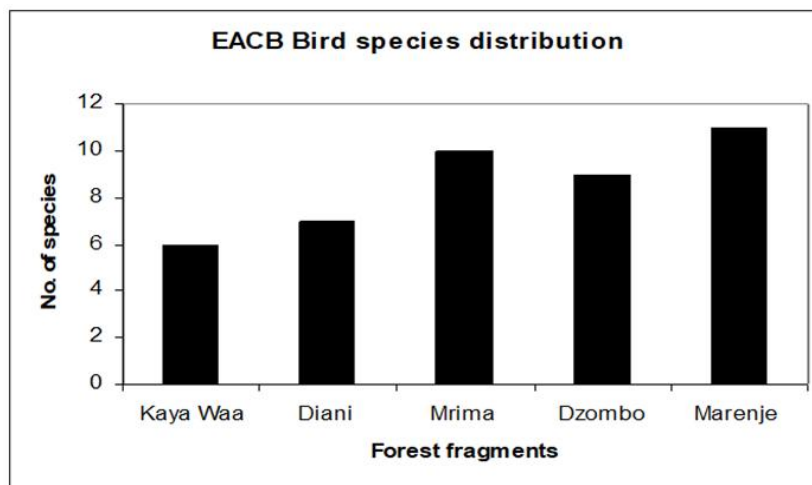


Fig. 3. Species richness distribution of east Africa Coastal forest restricted-range bird species

**Table 1. Distribution and abundance of East African Coast Biome species**

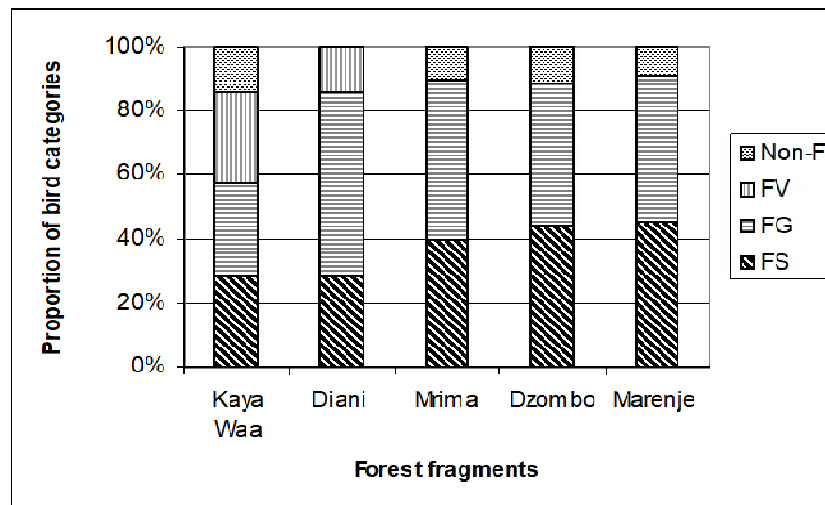
EACB Species	Cat*.	20 ha	80 ha	250 ha	259 ha	1480 ha	Abundance	# forest occupied
		Kaya Waa	Diani	Mrima	Dzombo	Marenje		
<i>Anthreptes reichenowi</i>	FS	0	0	15	8	13	36	3
<i>Pogoniulus simple</i>	FS	0	0	0	0	4	4	1
<i>Phyllastrephus fischeri</i>	FS	2	5	31	15	24	77	5
<i>Phyllastrephus debilis</i>	FS	3	0	30	18	30	81	4
<i>Erythrocerus holochlorus</i>	FS	0	9	11	18	23	61	4
<i>Circaetus fasciolatus</i>	FG	0	1	2	0	0	3	2
<i>Poicephalus cryptoxanthus</i>	FG	0	0	0	2	3	5	2
<i>Turaco fischeri</i>	FG	1	2	9	5	8	25	5
<i>Campethera mombasica</i>	FG	0	1	4	6	6	17	4
<i>Prionops scopifrons</i>	FG	0	0	5	0	3	8	2
<i>Lamprotornis corruscus</i>	FG	1	26	27	19	30	103	5
<i>Lybius melanopterus</i>	FV	2	2	0	0	0	4	2
<i>Nectarinia veroxii</i>	FV	2	0	0	0	0	2	1
<i>Halcyon senegaloides</i>	Non-F	0	0	1	1	1	3	3
<b>Total no. of species</b>		<b>6</b>	<b>7</b>	<b>10</b>	<b>9</b>	<b>11</b>		
<b>Total abundance</b>		<b>11</b>	<b>46</b>	<b>135</b>	<b>92</b>	<b>145</b>	<b>429</b>	

\*Cat means category of birds

From this study, it is evident that the majority of Eastern Africa coastal forest restricted-range species found in south coast forest of Kenya are truly forest dependent, all being forest specialists and generalists. True forest birds (forest specialists and generalists) of East African coastal forests and biome restricted-range species form more than 50% of the species recorded and more than 80% in larger forests (Fig. 4). Forest visitors and none-forest birds form a very small proportion within the fragments, especially in larger forests.

### 3.2 Occurrence of the Species in the EBA and Biome-restricted Species Study Sites

Of the seven East African coastal forests endemic bird area sites that meet the A2 criterion [11], two forests sites (Dzombo hill and Marenje forests) had the restricted range bird species *Tauraco fischeri* but not *Anthus sokokensis* as has been earlier recorded [15]. Marenje and Mrima Hill forests were also the sites that meet the A3 criterion (site selected to ensure adequate

**Fig. 4. East African Coastal Biome bird species distribution by categories**

representation of all species restricted to a given biome, both across the biome as a whole and for all of its species in each range state) and both had *Anthreptes reichenowi* as the only restricted-range species here, and together with *Tauraco fischeri* (both classified as Near-Threatened) are the only two species recorded during the study, out of the 40 species of global conservation concern that regularly occur in Kenya [20].

#### 4. DISCUSSION

From literature, 29 bird species out of 38 of restricted-range in East Africa coastal forests are found in Kenya's coastal forests [11], while the rest are spread to the Tanzanian side of the coastal biome. This means 76% of the east African coastal forest restricted-range species are distributed in Kenyan part. Of the 29 species on Kenya's coastal forests, 22 (76%) are truly forest dependent birds (being either forest specialists or generalist). The larger forests such as Marenje and Mrima could be having highest species richness of restricted range birds owing to their larger size, hence more niche availability for food sources, breeding and cover relative to the smaller forests. 14 (48 %) of the 29 species were recorded in south coast forests of Kenya during this study and 11 (38%) of which were truly forest dependent birds. The rest were two forest visitors while the other one species was a non-forest bird. It is clear from the foregoing and from number of truly forest dependent bird species of the coastal forests and especially of south coast forests of Kenya that forest is very critical within the coastal ecosystems for the survival of coastal restricted-range forest bird species of which they form the majority, even within a given forest fragment in the south coast of Kenya. The number of forest dependent bird species relative to visitors and non-forest birds, found in any given study forest was generally high, indicating that large portions of the study sites still form suitable forest habitat for eastern African coastal restricted-range bird species, despite extensive destruction and fragmentation [17] within and near each of the surveyed forests. There were slightly more forest generalists than specialists in each of the five forests surveyed (Fig. 4). This could probably be so because generalists are normally adapted to wide range of habitats (they have broader dietary, nesting or breeding habitat requirements and adapt more easily to presence of human [21,22] than specialists who are adapted to narrow range, have specialized requirements and are more extinction prone [23-25]. The fewer number of

forest visitors and non-forest birds recorded might signify that they have been attracted to the sites by non-forest conditions that have been created through forest destruction and fragmentations [19].

The negative ecological effect of forest fragmentation in south coast forests of Kenya, leading to creation of smaller forest fragments of different sizes is clearly seen from the current results on bird species richness and abundance distribution. The number of bird species and abundance distribution of various categories, especially for forest dependents increased from smaller forests fragments to larger fragments. This may imply that smaller sized forests have insufficient critical resources and conditions that can be found in larger forests [26,27]. It may also mean that unsuitable adverse conditions are likely to be found in smaller forests thus avoided by the majority of forest dependent birds. Species that exists only in large intact forest habitats are likely to be vulnerable to habitat loss and, given the rapid expansion of anthropogenic activities, face imminent extinction. This study also support the likely direct link between bird species richness and the size of forests as has been observed elsewhere [28,29] in coastal forests of East Africa, although similar trend had also been observed [30] in Chilean temperate rainforest who did find lower avian species richness at small forest fragments than in large fragments. In the same south coast forests of Kenya, similar trends [17] had been found on the species of Colobus, where the presence of *Colobus angolensis palliatus* were increasingly becoming rare as patch area diminishes. The results also agree with findings that patch size correlate with abundance for the majority of conservation important bird species [31]. This is also consistent with other previous research that showed a strong correlation between presence, species richness and abundance of birds with forest area [22,24,25,32,33,34,35] particularly for tropical lowland forest-dependent birds.

According to this study, forest specialist birds e.g. *Pogoniulus simplex* and *Anthreptes reichenowi* are rare and almost rare birds found in one and three forests respectively and restricted to only larger forests. The restriction of these birds to larger forests is probably due to the presence of their specialized habitat needs. Occupancy of *Pogoniulus simplex* in only one fragment may be an indication that the requirements of this bird are severely affected and probably its status is now reducing as a

result. It is probably a species to watch as the impact of fragmentation and habitat interference may be having greater negative impact on its survival within the coastal forests of Kenya. Forest generalists, whose distribution were only restricted to two or only one forest, and therefore shown as rare, are *Circaetus fasciolatus* (Southern banded snake eagle), *Poicephalus cryptoxanthus* (Brown-headed parrot) and *Prionops scopifrons* (Chestnut-fronted helmetshrike). The habitat requirements for these species are probably, just like for some forest specialists, are likely to be affected by anthropogenic activities and therefore restricted to few forest fragments where they can access their resources and survival conditions. This finding support the fact that larger forests support higher abundances of rare bird species [36,37].

## 5. CONCLUSION

The presence of East Africa Coastal forest restricted-range forest specialist birds in all forest in the current study suggests that the birds are able to utilize at least all the components of the fragmented forest, irrespective of forest size and habitat types. This is with the exception of those more specialized bird species which may be more sensitive to changes in forest conditions, and are found only in specific habitats such as in larger forests. Conservation and management of all forests, therefore, irrespective of size should be of paramount importance for total conservation of species, especially those restricted to coastal forests of East Africa. The small number or absence of forest specialists in small forest fragments illustrates the extremely high conservation value of the remaining large forests in Kenya's coast for restricted-range bird species. It is probably only within the largest remaining forests that the species most vulnerable to forest fragmentation and disturbance, for instance, the rare or less common forest specialists, such as *Antheptes reichenowi*, *Pogoniulus simplex* (which were found only on large forest in this study) and *Anthus sokokensis* (now probably locally extinct) can be conserved. This seems to support the concept that single large forest design is effectively suitable to conserve all species of conservation concern rather than several small ones under the SLOSS 'Single large or several small' concept of reserve design [38]. The small forests even if being several, might each loose specific critical habitat components required by some species for their occupancy of a habitat. The increase of forest visitors is probably an

indication of a change in forest structure, towards becoming woodlands and thickets that meet their requirements.

Conservation and management of forest should, therefore, strive to maintain larger forests, increase connectivity and do more forest management activities especially in smaller forest fragments.

## 6. RECOMMENDATIONS

There are many factors that determine the distribution and abundance of restricted-range bird species in coastal forests of east Africa. The current study did not examine the contribution of other factors despite their importance e.g. forest structure but only considered forest size on bird abundance of south coast forests of Kenya. Probably many other factors are responsible or interact with forest structure to influence distribution, abundance and habitat preference of these birds. Studies on the effect of these factors and species-specific ecological studies are therefore needed to address these issues and for more clarity on habitat preference. Priority should be given to rare and patchily distributed restricted-range species of East Africa Coastal forests.

Based on these findings, I recommend that large forest remnants be conserved in south coast of Kenya. Smaller forests to be also conserved with probably structural complexity enhanced more so that bird species diversity and other biodiversity can persist. Smaller forest fragments be given greater attention in research and I recommend similar studies to be replicated elsewhere in the coastal forest of Kenya to establish the generality of these findings.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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