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Seasonal variations in the structure of avian community in Zambezi riparian forest

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Abstract

Seasonal variations in the structure of avian community in Zambezi riparian forest. Among the different biomes in southern Africa, tropical riparian forests appear to be especially rich in terms of biodiversity, but little is known about avian communities occupying these forests. In this paper, bird counts were conducted in May, July–August, and October–November in 2013 and 2014. The line transect method was used. A transect 16.6 km long was designed along the Zambezi River between S 17.4975 E 24.3478 and S 17.4874 E 24.447. In total, 146 bird species were recorded. The number of species detected each season varied from 95 to 100. The number of dominant species was consistently low, varying between 2 and 3 depending on the month. However, the cumulative dominance and the dominance index were much higher in the dry season (May–August) than in the wet season (October–November). Two species were dominant each month: *Euplectes axillaris* and *Pycnonotus tricolor*. *Vidua macroura* and *Estrilda astrild* were dominant only in October, while *Streptopelia capicola* was dominant only in May. The group of subdominants was much more diverse than dominants and included 13 species. The Shannon diversity index increased between July and November from 3.45 to 4.05 but Simpson's diversity index did not show any seasonal trend. Pielou's evenness index was higher in the wet season (0.82–0.88) than in the dry season (0.76–0.79). The proportions of the main feeding guilds were much the same throughout the year, except for November, when the proportion of insectivores markedly increased, while that of granivores decreased. Riparian forest corridors in urbanized environments may be viewed as main instruments for offsetting the negative effects of habitat loss and fragmentation.

Dataset published through GBIF (Doi: 10.15470/0ssr1v)

Key words: Community ecology, Population density, Riparian forests

Resumen

Cambios en la estructura de la población aviar del bosque de ribera del río Zambeze según la estación. Entre los diferentes biomas del sur de África, los bosques de ribera tropicales son excepcionalmente ricos en cuanto a biodiversidad, pero no se han estudiado suficientemente las poblaciones aviares de estas zonas. Para este artículo, se hicieron recuentos de pájaros durante los meses de mayo, julio–agosto, octubre y noviembre de 2013 y 2014. Se usó el método de transecto lineal. Se diseñó un transecto de 16,6 km de longitud a lo largo del río

Zambeze entre las coordenadas S 17.4975 E 24.3478 y S 17.4874 E 24.447. En total, se registraron 146 especies de pájaros. El número de especies registrado en cada estación varía entre 95 y 100. El número de especies dominantes es muy bajo, entre 2 y 3 según el mes. Aun así, la dominancia acumulada y el índice de dominancia son mucho más elevados durante la estación seca (mayo–agosto) que durante la húmeda (octubre–noviembre). Hay dos especies dominantes en todos los meses: *Euplectes axillaris* y *Pycnonotus tricolor*. *Vidua macroura* y *Estrilda astrild* solo son dominantes en octubre, mientras que *Streptopelia capicola* solo lo es en mayo. El grupo de especies subdominantes es más diverso que el de las dominantes, e incluye 13 especies. El índice de diversidad de Shannon aumenta entre julio y noviembre de 3,45 a 4,05, mientras que el índice de diversidad de Simpson no muestra ningún patrón estacional. El índice de homogeneidad de Pielou es más elevado durante la estación húmeda (0,82–0,88) que durante la seca (0,76–0,79). La proporción de los grupos tróficos no experimenta cambios significativos a lo largo del año, salvo en noviembre, cuando la proporción de insectívoros aumenta notablemente, mientras que la de granívoros decrece. Los corredores de bosque de ribera en entornos urbanizados se pueden convertir en la principal solución para compensar los efectos negativos de la pérdida y fragmentación de hábitats.

Datos publicados en GBIF (Doi: 10.15470/0ssr1v)

Palabras clave: Sinecología, Densidad de población, Bosques de ribera

Resum

Canvis en l'estructura de la població aviària del bosc de ribera del riu Zambezi segons l'estació. Entre els diferents biomes del sud de l'Àfrica, els boscos de ribera tropicals són excepcionalment rics des del punt de vista de la biodiversitat, però no s'han estudiat gaire les poblacions aviàries que viuen en aquestes zones. Per al treball d'aquest article, es van fer recomptes d'ocells durant els mesos de maig, juliol–agost, octubre i novembre del 2013 i del 2014. Es va fer servir el mètode de transsecte lineal. Es va dissenyar un transsecte de 16,6 km de longitud al llarg del riu Zambezi entre les coordenades S 17.4975 E 24.3478 i S 17.4874 E 24.447. En total, es van registrar 146 espècies d'ocells. El nombre d'espècies registrat a cada estació varia entre 95 i 100. El nombre d'espècies dominants és molt baix, entre 2 i 3 segons el mes. Tot i això, la dominància acumulada i l'índex de dominància són molt més elevats durant l'estació seca (maig–agost) que durant la humida (octubre–novembre). Hi ha dues espècies dominants cada mes: *Euplectes axillaris* i *Pycnonotus tricolor. Vidua macroura* i *Estrilda astrild* només són dominants a l'octubre, mentre que *Streptopelia capicola* només ho és al maig. El grup d'espècies subdominants és més divers que el de les dominants, i inclou 13 espècies. L'índex de diversitat de Shannon augmenta entre el juliol i el novembre de 3,45 a 4,05, mentre que l'índex de diversitat de Simpson no mostra cap patró estacional. L'índex d'homogeneïtat de Pielou és més elevat durant l'estació humida (0,82–0,88) que durant la seca (0,76–0,79). La proporció dels grups tròfics no experimenta gaires canvis al llarg de l'any, tret del novembre, quan la proporció d'insectívors augmenta de manera notable, mentre que la de granívors decreix. Els corredors de bosc de ribera en entorns urbanitzats es poden convertir en la solució principal per a compensar els efectes negatius de la pèrdua i la fragmentació d'hàbitats.

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Paraules clau: Sinecologia, Densitat de població, Boscos de ribera

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Introduction

Among the various biomes in southern Africa tropical riparian forests are especially rich in terms of biodiversity (Mendelsohn et al., 2009). Most of these forests occur in Zambezi, Limpopo, and Okavango, and a few smaller river valleys. Little is known about avian communities occupying these forests. Their structure has been studied in acacia savanna in Eswatini (Monadjem, 2003, 2005), in acacia savanna along the Vaal River in South Africa (Seymour and Simmons, 2008), and in *Tamarix* vegetation in Karoo, South Africa (Brooke, 1992).

In other parts of the world, species diversity and community structure of birds associated with tropical riparian forests have been studied along the Paraiba do Sul River in Atlantic Forests, São Paulo State, Brazil (Laurenco and Toledo, 2019); in Alta Foresta, Mato Grosso, Brazil (Lee and Peres, 2007); gallery forests in Costa Rica (Seaman and Schulze, 2010); rainforest in New Guinea (Korejs et al., 2023); monsoonal forest in Hong Kong (Chan et al., 2008); oil palm–forest mosaic in Malaysia (Azman et al., 2011; Michell et al., 2018); savanna in Australia (Woinarski et al., 2000), and forests in south–western Australia (Palmer and Bennett, 2006). All these studies reported comparatively high bird species diversity and high population densities of some species.

The purpose of this study was to determine month–to–month changes in the structure of an avian community in a riparian forest in Namibia, regarding: 1) species diversity, 2) dominance structure, and 3) population densities of particular species making up the community.

Material and methods

Study area

This study was conducted in Zambezi riparian forest located on the right bank of the river between Katima Mulilo and Kalimbeza, Zambezi Region, NE Namibia.

This riparian forest is composed of main tree species such as African teak *Pterocarpus angolensis*, albizias *Albizia* spp., apple leaves *Lonchocarpus nelsii*, burkea *Burkea africana*, combretum *Combretum* spp., camel–thorn *Acacia erioloba*, other acacias *Acacia* spp., jackal berry *Diospyros mespiliformis*, mopane *Colophospermum,* pod mahogany *Afzelia quanzensis* silver cluster–leaf *Terminalia sericea*, sausage tree *Kigelia africana*, Sycomore fig *Ficus sycomorus*, white bauhinia *Bauhinia petersiana*, Zambezi teak *Baikiaea plurijuga*. and silver tree *Terminalis* spp. There are also some rural places (traditional houses with gardens; small arable plots, and pastures for sheep and cattle). This riparian forest is interlaced with water canals (back waters) with reedbeds, rushes and other water vegetation, and grassy depressions that are flooded almost on an annual basis.

The dry season in Katima Mulilo lasts from May to September, and the wet season lasts from October to April. I analysed two types of seasonal variations, month–to–month (May–July–August–October–November) and dry season (May+July–August) versus wet season (October+November). Figure 1 shows the monthly distribution of rainfall in 2013 and 2014. The total rainfall was much the same in both years (423 mm in 2013 vs. 428 mm in 2014 (http://www.weatherandclimate.com/namibia/zambezi/katima–mulilo; http://www.meteona.com/index.php/climate/rainprogress/katima).

Methods

Counts on transects were conducted in May, July–August, October and November in 2013 and 2014. The line transect method, American version (Sutherland, 1996; Bibby et al., 2012) was used to quantify avian assemblages (linear population density expressed as the average number of potentially breeding pairs/10 km) along the study transect. This transect was 16.6 km long and was designed along the Zambezi River between S 17.4975 E

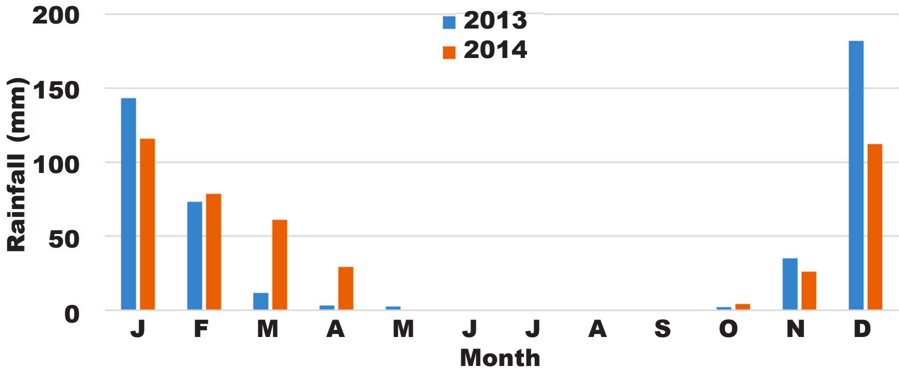

Fig. 1. Monthly rainfall in Katima Mulilo in 2013 and 2014.

Fig. 1. Precipitaciones mensuales en Katima Mulilo en 2013 y 2014.

24.3478 and S 17.4874 E 24.447 (fig. 2). The transect was divided into six sections. Each section was surveyed in one morning, so that to cover the whole transect, four mornings were required in a given month.

Counts were conducted in the mornings by walking slowly from 6 a.m. till 11 a.m. and recording all seen and heard birds. For resident birds, a breeding pair was a census unit, while for non–resident species, the census unit was an individual.

Dominance is expressed as the percentage of the total number of pairs of a given species in relation to the total number of all pairs of all species recorded. Dominant species: > 5 %, subdominant: 2–4.99 %.

The following guilds were distinguished: diet (G, granivorous; I, insectivorous; F, frugivorous; N, nectarivorous; R, carnivorous); nesting (T, in trees or shrubs; H, in holes; B, in/on buildings; V, herbaceous vegetation); habitat (F, forest interior; E, ecotone, forest/open area; O, open area, grassland/savanna); residency (R, resident throughout the year; A, intra–African migrant; C, nomad).

The following indices were used to characterize the diversity and evenness of the communities:

Shannon's diversity index: $H' = -\sum p_i \ln p_i$
where pi is the proportion of breeding pairs belonging to the ith species. The minimum value of *H'* is 0 (it indicates no diversity, i.e. only one species was recorded), and there is no upper limit to *H'*. The maximum value would occur if all species have the same number of breeding pairs.

Simpson's diversity index: $D = ((\sum n\ (n - 1))/N\ (N - 1)$
where n is the total number of breeding pairs belonging to a given species; N, the total number of breeding pairs of all species. D ranges between 0 and 1, 1 represents infinite diversity and 0, no diversity.

Pielou's evenness index: $J' = (-\sum p_i \ln p_i)/\ln S$,
where p_i is the proportion of breeding pairs belonging to the i^{th} species; S, the total number of species. *J'* varies between 0 and 1. The lesser the variation between species in a community, the higher the *J'*.

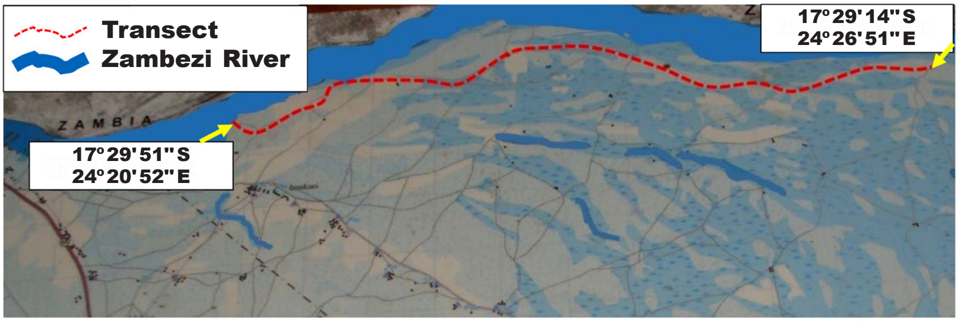

Fig. 2. Location of the transect on the right bank of the Zambezi River between Katima Mulilo and Kalimbeza in north–eastern Namibia.

Fig. 2. Ubicación del transecto a la derecha de la orilla del río Zambeze, entre Katima Mulilo y Kalimbeza, al nordeste de Namibia.

Community dominance index: $DI = (n_1 + n_2)/N$
where n_1, n_2 are the number of pairs of two most abundant species; N, the total number of pairs of all species.

Sörensen's Coefficient: $I = 2C / A + B$
where A is the number of bird species in one breeding season; B, the number of bird species in another breeding season; and C, the number of bird species common to both breeding seasons.

Table 1. Month–to–month characterization of bird community in Zambezi riparian forest. Overall density is a linear density of all breeding pairs of all species/10 km: Np, number of pairs; Nsp, number os species; D, overall density; Da, Cumulative dominance; Di, dominance index; Nd, Number of dominance.

Tabla 1. Descripción de la población de pájaros en el bosque de ribera de Zambeze según los meses. La densidad total es la densidad lineal de todas las parejas reproductoras de todas las especies/10 km: Np, número de pares; Nsp, número de especies; D, densidad total; Da, dominancia acumulada; Di, índice de dominancia; Nd, Número de dominancia.

Season/month	Np	Nsp	D	Da	Di	Nd	*H'*	*J'*	*D*
Dry									
May	1,116	99	558.0	24.3	0.24	2	3.73	0.82	0.95
July/Aug	857	95	428.5	33.4	0.33	2	3.45	0.76	0.92
Wet									
Oct	1,097	100	548.5	33.8	0.28	3	3.63	0.79	0.99
Nov	749	100	374.5	14.4	0.14	2	4.05	0.88	0.96

The χ^2–test was used to test differences in population densities between months and between wet and dry season. For statistical testing, only those species with at least 10 breeding pairs in all four seasons were taken (expected value > 5).

Systematics and nomenclature of bird species follow Hockey et al. (2005).

Results

A total of 146 bird species were recorded (table 1, appendix 1, dataset published through GBIF, DOI: 10.15470/0ssr1v). The number of species detected each month varied from 95 to 100 (table 1). The number of dominant species was consistently low, varying between 2 and 3, depending on the month. The cumulative dominance and the dominance index were much higher in July–August and October than in May and November, but no differences were found between the dry season and the wet season (table 1).

Only two species were dominant each month: the fan–tailed widowbird *Euplectes axillaris* and the dark–capped bulbul *Pycnonotus tricolor*. The group of subdominants was much more diverse than dominants and included 13 species (appendix 1).

Shannon diversity index increased between July and November from 3.45 to 4.05, while Simpson's diversity index did not show any seasonal trend. Pielou's evenness index was higher in the wet season (0.82–0.88) than in the dry season (0.76–0.79).

Seasonal differences were statistically tested for 41 of the 146 species. Significant month–to–month differences in population densities were shown for 29 species (table 2). Among these nine were insectivores, eight were granivores, and seven were frugivores. The remaining five represented other guilds. The most marked changes in population densities were recorded for the pin–tailed whydah and the fan–tailed widow (appendix 1). No statistical differences were seen for 12 species (table 2). Of the 41 species, 16 were more common in the dry season than in the wet season, while for 14 other species the reverse was true (table 2).

The proportions of the main feeding guilds were much the same throughout the year, except for November, when the proportion of insectivores markedly increased, while that of granivores, decreased (fig. 3A). There were two main nesting guilds (together > 80 % in each month), birds nesting on trees or shrubs, and birds nesting in herbaceous vegetation. While the proportion of the latter decreased with the advance of the wet season, the proportion of tree/shrub nesting birds increased (fig. 3B). More than 95 % of all birds were African residents in all months, but the proportion was slightly lower in the season than in the dry season. The reverse was recorded for the intra–African migrant, while the Palearctic migrants were, as expected, recorded only in the wet season (fig. 3C).

Discussion

The number of resident breeding bird species recorded in Zambezi riparian forest (n = 146 species) is higher than that in riparian rain forests in other parts of Africa the world. Monadjem (2003, 2005) recorded 128 species (including non–breeding species) in riparian Acacia savanna in Swaziland. In Malaysian riparian forest, 92 species were recorded (Saad et al., 2012); 90 species in Costa Rica (Seaman and Schulze, 2010); and 88 species in the Atlantic Forest in Brazil (Laurenco and Toledo, 2019). The higher number of species recorded in Zambezi riparian forest can be linked to its more diversified environment. Beside typical forest, there are oxbows (with reedbeds, rushes and other water vegetation), wetlands, forest clearings, etc.

The proportions of three main feeding guilds in Zambezi riparian forest distinguishes this community from other avian communities studied to date in southern Africa, where either granivores or insectivores compose the bulk of communities (Dean and Milton, 2001; Dean et al., 2002; Kopij, 2006, 2013a, 2013b, 2014a, 2014b, 2015, 2017, 2019, 2020a, 2020b,

Table 2. Month–to–month and dry vs. wet season differences in population densities of bird species in Zambezi riparian forest. Level of significance: ** $p < 0.01$; * $p < 0.5$; –$p > 0.5$.

*Tabla 2. Diferencias mensuales y entre la estación seca y la húmeda en cuanto a las densidades de población de especies de pájaros en el bosque de ribera de Zambeze. Nivel de significación: ** p < 0,01, * p < 0,5, –p > 0,5.*

	Month–to–moth		**Dry *vs.* wet season**	
	χ^2	***p***	χ^2	***p***
Pin–tailed whydah	345.6	**	62.9	**d>w
Fan–tailed widowbird	98	**	4.4	*d>w
Red–eyed dove	52.2	**	81.8	**d<w
Blue waxbill	41.5	**	22.4	**d>w
Cattle egret	37.1	**	7.4	*d<w
Cape turtle–dove	34	*	20.7	**d>w
White–faced duck	33.5	**	38.4	**d>w
Swainson's francolin	30.2	**	9.4	**d<w
Yellow–breasted apalis	26.1	**	1.5	
Terrestrial brownbul	24.7	**	0.2	**d>w
White–bellied sunbird	23.6	**	11.3	*d>w
Nectarinidae spp.	23.1	**	5.9	**d>w
Red–faced mousebird	16.8	**	8.2	**d<w
Common waxbill	16.6	*	7.1	**d<w
African pygmy–goose	16.1	**	0.2	**d>w
Yellow–bellied greenbul	15.3	**	16.9	**d<w
Rattling cisticola	11.9	**	9.7	*d>w
Tawny–flanked prinia	11.6	**	4.6	*d>w
Emerald–spotted dove	11.5	**	4.1	**d>w
Orange–breasted bush–shrike	11.5	**	7.7	**d<w
Reed cormorant	11.4	**	2.7	*d>w
Dark–capped bulbul	10.7	*	4.5	
Hartlaub's babbler	10.7	*	1.9	**d>w
African jacana	10.5	*	7.7	**d<w
White–browed coucal	10.2	*	1.5	
Schalow's turaco	8.7	*	1.3	**d<w
Wattled lapwing	8.3	*	7.4	**d<w
Senegal coucal	8.1	*	6.7	*d<w
Southern masked weaver	7.9	*	0.0	d=w
Little bee–eater	6.6	–	0.7	
Crested francolin	6	–	0.7	
Long–billed crombec	5.6	–	0.0	
Tchagra spp.	5.2	–	2.0	
White–browed robin–chat	4.9	–	2.6	
White–browed scrub–robin	3.1	–	8.3	**d<w
Crested barbet	2.9	–	9.0	**d<w
Grey lorie	2.7	–	1.2	
African fish eagle	2	–	8.0	**d>w
Fork–tailed drongo	1.5	–	0.4	
Red–billed firefinch	1	–	13.8	**d>w
Black–collared barbet	0.4	–	5.0	*d<w

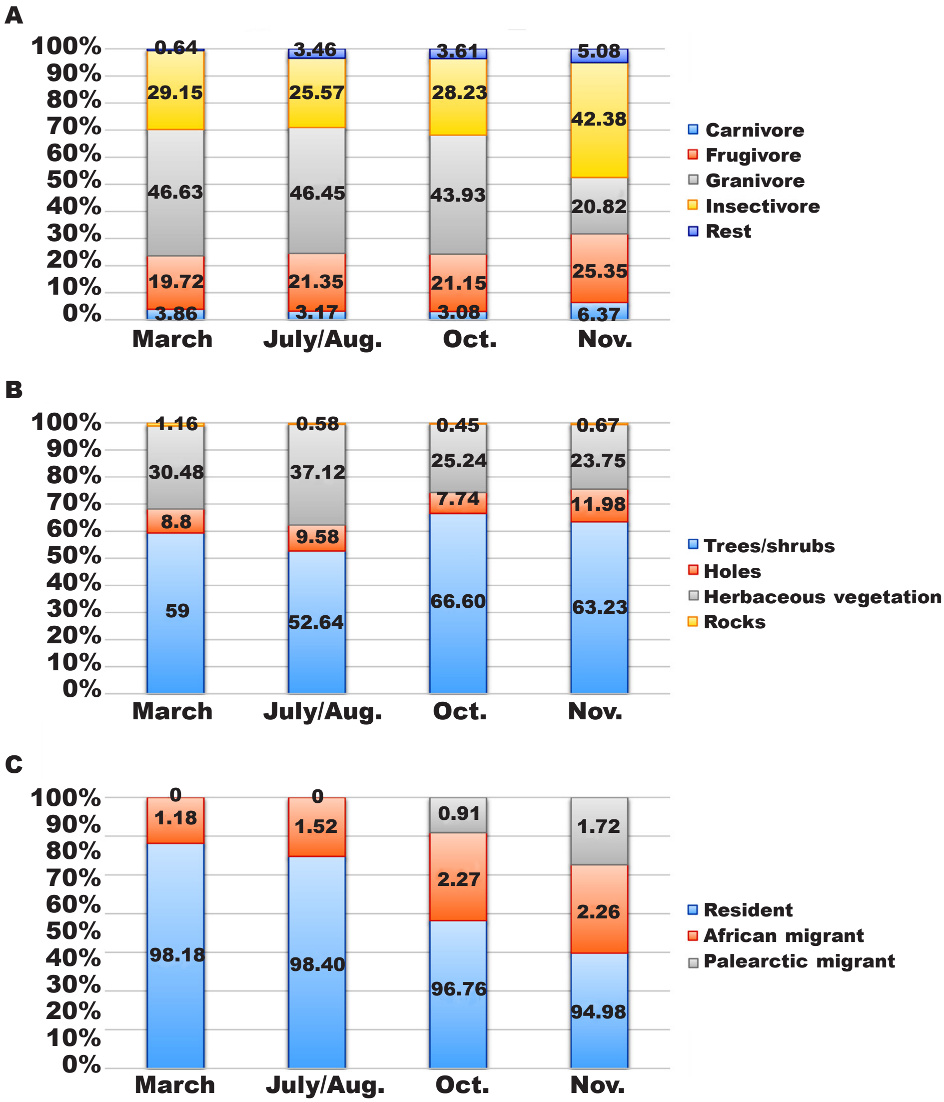

Fig. 3. Month–to–month changes in main guilds of birds in Zambezi riparian forest according to diet (A), nesting (B), and residency (C).

Fig. 3. Cambios mensuales en los principales grupos tróficos de pájaros en el bosque de ribera del río Zambeze según la dieta(A), la anidación (B) y la residencia (C).

2021a, 2021b, 2021c, 2022; Monadjem, 2003, 2005; Seymour and Simmons, 2008; Parker, 2012). Insectivores were much more numerous than other guilds, even in the neighbouring seasonal Kalahari Forest (Kopij, 2017). In riparian forests, the fruit trees are usually abundant and may benefit frugivorous birds (especially bulbuls), while seeds for granivorous birds may not be as abundant as in more open savanna or grassland biomes. Typical granivores, such as doves and sparrows, may therefore breed in riparian forests in lower density than in a neighbouring, more open habitats dominated by grasses. In a riparian rain forest in Malaysia, insectivores and frugivores were the main guilds, but there was no granivore guild (Saad et al., 2012).

In regard to the number of breeding species and their densities, species composition differs only slightly from month to month. The amount of water is probably the main limiting factor, governing both the distribution and population densities of most bird species in Africa. However, water is always available in riparian forests and, therefore unlikely to be a limiting factor, and it probably has little effect on the primary productivity and the abundance of seeds, fruits or insects, which constitute the main food resources for most bird species breeding in this biome.

The high number of species and high population density of some species suggest that riparian forests play an important role as breeding and feeding habitats for birds, especially for species of frugivores and nectarivores. For some forest species, riparian forests may act as corridors that allow for dispersal, migration, and free movements within a mosaic of natural and human modified environments (Seaman and Schulze, 2010). In this way, corridors may also increase the level of biodiversity. Riparian forest corridors in urbanized environments may be viewed as main instruments for offsetting the negative effects of habitat loss and fragmentation, such as reductions in population sizes, reductions in immigration rates, changes in community structures, and invasions of alien species (Turner, 1996; Lee and Peres, 2007).

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Appendix 1. Number of breeding pairs (N), linear population density (Den: pairs/10 km) and dominance (Dom) on 16.6 km long transect in Zambezi riparian forest. Eudominant (> 10%), dominant (5–9.9%) and subdominant (2–4.9%) species are in bold. Abbreviation for guilds: Diet (G, granivorous; I, insectivorous; F, frugivorous; N, nectarivorous; R, carnivorous); Nest, nesting (T, in trees or shrubs; H, in holes; B, in/on buildings; V, herbaceous vegetation); Res, residency (R, resident throughout the year; A, intra–African migrant; C, nomad; P, Palearctic migrant).

Apéndice 1. Número de parejas reproductivas (N), densidad lineal de la población (Den: parejas/10 km) y dominancia (Dom) a lo largo del transecto de 16,6 km en el bosque de ribera del río Zambeze. Se marcan en negrita las especies superdominantes (> 10%), dominantes (5–9,9%) y subdominantes (2–4,9%). Abreviaturas para los grupos: Diet (dieta: G, granívoros; I, insectívoros; F, frugívoros; N, nectarívoros; R, carnívoros). Nest (anidación: T, en árboles o arbustos; H, en madrigueras; B, en edificios; V, en plantas herbáceas; Res (residencia: R, residente durante todo el año; A, migrante intraafricano; C, nómada; P, migrante paleárctico).

		Guilds			May			July/August			October			November		
Scientific species name	Common species name	Diet	Nest	Res	N	Den	Dom	N	Den	Dom	N	Den	Dom	N	Den	Dom
African cuckoo	*Cuculus gularis*	I	T	A	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
African darter	*Anhinga melanogaster*	C	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
African fish eagle	*Haliaeetus vocifer*	C	T	R	4	2.4	0.4	4	2.4	0.5	5	3.0	0.5	8	4.8	1.1
African golden oriole	*Oriolus auratus*	I	T	R	3	1.8	0.3	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
African grey hornbill	*Tockus nasutus*	F	H	R	11	6.6	1.0	2	1.2	0.2	1	0.6	0.1	3	1.8	0.4
African harrier–hawk	*Polyboroides typus*	C	T	R	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
African hoopoe	*Upupa africana*	I	H	R	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
African jacana	*Actophilornis africanus*	I	V	R	17	10.2	1.5	19	11.4	2.2	5	3.0	0.5	9	5.4	1.2
African marsh harrier	*Circus ranivorus*	C	V	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
African openbill	*Anastomus lamelligerus*	I	T	A	3	1.8	0.3	3	1.8	0.4	4	2.4	0.4	5	3.0	0.7
African paradise flycatcher	*Terpsiphone viridis*	I	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
African pipit	*Anthus cinnamomeus*	I	V	R	2	1.2	0.2	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
African pygmy goose	*Nattapus auritus*	V	V	R	0	0.0	0.0	5	3.0	0.6	14	8.4	1.3	6	3.6	0.8
Arrow–marked babbler	*Turdides jardineii*	I	T	R	0	0.0	0.0	0	0.0	0.0	3	1.8	0.3	1	0.6	0.1
Bearded woodpecker	*Dendropicos namaquus*	I	H	R	5	3.0	0.5	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Black crake	*Amaurornis flavirostra*	I	V	R	0	0.0	0.0	0	0.0	0.0	2	1.2	0.2	1	0.6	0.1
Black–backed puffback	*Dryoscopus cubla*	I	T	R	3	1.8	0.3	2	1.2	0.2	9	5.4	0.8	14	8.4	1.9
Black–collared barbet	***Lybius torquatus***	F	H	R	**24**	**14.5**	**2.2**	**21**	**12.7**	**2.5**	20	12.0	1.8	**21**	**12.7**	**2.8**
Black–crowned tchagra	*Tchagra senegala*	I	T	R	2	1.2	0.2	1	0.6	0.1	2	1.2	0.2	6	3.6	0.8
Black–shouldered kite	*Elanus caeruleus*	C	T	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Blacksmith lapwing	*Vanellus armatus*	I	V	R	6	3.6	0.5	1	0.6	0.1	1	0.6	0.1	3	1.8	0.4
Black–winged stilt	*Himantopus himantopus*	I	V	R	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0
Blue waxbill	***Uraeginthus angolensis***	G	T	R	**53**	**31.9**	**4.8**	**21**	**12.7**	**2.5**	17	10.2	1.6	11	6.6	1.5
Bradfield's hornbill	*Tockus bradfieldi*	F	H	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Brown firefinch	*Lagonosticta nitidula*	G	T	R	3	1.8	0.3	2	1.2	0.2	2	1.2	0.2	0	0.0	0.0
Brown–crowned tchagra	*Tchagra australis*	I	T	R	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0	1	0.6	0.1
Brown–hooded kingfisher	*Halcyon albiventris*	I	H	R	2	1.2	0.2	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Brubru	*Nilaus afer*	I	T	R	2	1.2	0.2	3	1.8	0.4	4	2.4	0.4	9	5.4	1.2
Burchell's starling	*Lamprotornis australis*	F	H	R	0	0.0	0.0	0	0.0	0.0	6	3.6	0.6	8	4.8	1.1
Cape starling	*Lamprotornis nitens*	F	H	R	8	4.8	0.7	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Cape turtle dove	***Streptopelia capicola***	G	T	R	**61**	**36.7**	**5.5**	**40**	**24.1**	**4.7**	**32**	**19.3**	**2.9**	12	7.2	1.6
Cardinal woodpecker	*Dondropicos fuscescens*	I	H	R	1	0.6	0.1	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1
Carmine bee–eater	*Merops nubicoides*	I	H	A	3	1.8	0.3	4	2.4	0.5	6	3.6	0.6	6	3.6	0.8
Cattle egret	*Bubulcus ibis*	I	T	R	17	10.2	1.5	0	0.0	0.0	0	0.0	0.0	4	2.4	0.5
Chinspot batis	*Batis molitor*	I	T	R	5	3.0	0.5	3	1.8	0.4	2	1.2	0.2	4	2.4	0.5
Cisticola	*Cisticola* spp.	I	V	R	4	2.4	0.4	3	1.8	0.4	7	4.2	0.6	2	1.2	0.3
Collared sunbird	*Hedydipna collaris*	N	T	R	3	1.8	0.3	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1
Common scimitarbill	*Rhinopomastus cyanomelas*	I	H	R	2	1.2	0.2	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0
Common waxbill	***Estrilda astrild***	G	T	R	**25**	**15.1**	**2.2**	**28**	**16.9**	**3.3**	**55**	**33.1**	**5.0**	**30**	**18.1**	**4.0**
Coppery–tailed coucal	*Centropus cupreicaudus*	I	T	R	0	0.0	0.0	2	1.2	0.2	0	0.0	0.0	0	0.0	0.0
Coucal	*Centropus* spp.	I	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	2	1.2	0.3
Crested barbet	*Trachyphonus vaillantii*	F	H	R	20	12.0	1.8	11	6.6	1.3	14	8.4	1.3	14	8.4	1.9
Crested francolin	*Francolinus sephaena*	G	V	R	9	5.4	0.8	6	3.6	0.7	17	10.2	1.6	12	7.2	1.6
Crowned lapwing	*Vanellus coronatus*	I	V	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Dark–napped bulbul	***Pycnonotus tricolor***	F	T	R	**91**	**54.8**	**8.2**	**66**	**39.8**	**7.7**	**69**	**41.6**	**6.3**	**53**	**31.9**	**7.1**
Dickinson's kestrel	*Falco dickinsoni*	I	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Diederick cuckoo	*Chrysococcyx caprius*	I	T	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Dusky lark	*Pinarocorys nigricans*	G	V	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Dusky sunbird	*Nectarinia fusca*	N	T	R	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0
Dwarf bittern	*Ixobrychus sturmii*	I	V	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	2	1.2	0.3
Egyptian goose	*Alopochen aegyptiacus*	V	V	R	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1
Emerald cuckoo	*Chrysococcyx cupreus*	I	T	A	0	0.0	0.0	2	1.2	0.2	1	0.6	0.1	1	0.6	0.1
Emerald–spotted dove	***Turtur chalcospilos***	G	T	R	**27**	**16.3**	**2.4**	**28**	**16.9**	**3.3**	14	8.4	1.3	11	6.6	1.5
Fan–tailed widowbird	***Euplectes axillaris***	G	V	R	**180**	**108.4**	**16.1**	**220**	**132.5**	**25.7**	**150**	**90.4**	**13.7**	**55**	**33.1**	**7.3**
Flapped lark	*Miratra rufocinnamomea*	G	V	A	8	4.8	0.7	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1
Fork–tailed drongo	*Dicrurus adsimilis*	I	T	R	11	6.6	1.0	7	4.2	0.8	7	4.2	0.6	10	6.0	1.3
Gabar goshawk	*Micronisus gabar*	C	T	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	2	1.2	0.3
Giant kingfisher	*Megaceryle maxima*	C	H	R	0	0.0	0.0	0	0.0	0.0	2	1.2	0.2	5	3.0	0.7
Golden–tailed woodpecker	*Campethera abingoni*	I	H	R	1	0.6	0.1	3	1.8	0.4	0	0.0	0.0	4	2.4	0.5
Greater honeyguide	*Indicator indicator*	I	H	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Green pigeon	*Treron calva*	F	T	R	1	0.6	0.1	1	0.6	0.1	2	1.2	0.2	4	2.4	0.5
Green wood hoopoe	*Phoeniculus purpureus*	I	H	R	0	0.0	0.0	2	1.2	0.2	0	0.0	0.0	1	0.6	0.1
Green–backed heron	*Butorides striatus*	C	V	R	2	1.2	0.2	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Green–winged pytilia	*Pytilia afra*	G	T	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Grey go–away–bird	*Corythaixoides concolor*	F	T	R	15	9.0	1.3	11	6.6	1.3	8	4.8	0.7	9	5.4	1.2
Grey heron	*Ardea cinerea*	C	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Grey–headed parrot	*Halcyon leucocephala*	F	H	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Grey–rumped swallow	*Pseudhirundo griseopyga*	I	H	A	0	0.0	0.0	1	0.6	0.1	9	5.4	0.8	0	0.0	0.0
Ground hornbill	*Bucorvus leadbeateri*	F	H	R	0	0.0	0.0	3	1.8	0.4	4	2.4	0.4	3	1.8	0.4
Hadeda ibis	*Bostrychia hagedash*	I	T	R	3	1.8	0.3	1	0.6	0.1	0	0.0	0.0	2	1.2	0.3
Hamerkop	*Scopus umbretta*	C	T	R	0	0.0	0.0	2	1.2	0.2	4	2.4	0.4	5	3.0	0.7
Hartlaub's babbler	*Turdoides hartlaubii*	I	T	R	21	12.7	1.9	11	6.6	1.3	12	7.2	1.1	5	3.0	0.7
Hawk	*Accipiter* spp.	C	T	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Jacobin cuckoo	*Clamator jacobinus*	I	T	A	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Kurrichane buttonquail	*Turnix sylvatica*	I	V	A	2	1.2	0.2	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Laughing dove	*Spilopelia senegalensis*	G	T	R	6	3.6	0.5	5	3.0	0.6	0	0.0	0.0	1	0.6	0.1
Lesser striped swallow	*Hirundo abyssinica*	I	B	R	13	7.8	1.2	5	3.0	0.6	2	1.2	0.2	0	0.0	0.0
Lesser swamp warbler	*Acrocephalus gracilirostris*	I	V	R	4	2.4	0.4	4	2.4	0.5	4	2.4	0.4	0	0.0	0.0
Lilac–breasted roller	*Coracias caudata*	I	H	R	3	1.8	0.3	1	0.6	0.1	1	0.6	0.1	2	1.2	0.3
Little bee–eater	*Merops pusillus*	I	H	R	2	1.2	0.2	10	6.0	1.2	5	3.0	0.5	4	2.4	0.5
Little egret	*Egretta garzetta*	C	T	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	2	1.2	0.3
Little grebe	*Tachybaptus ruficollis*	I	V	R	0	0.0	0.0	4	2.4	0.5	1	0.6	0.1	0	0.0	0.0
Lizard buzzard	*Kaupifalco monogrammicus*	C	T	R	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1
Long–billed crombec	*Sylvietta rufescens*	I	T	R	7	4.2	0.6	9	5.4	1.1	16	9.6	1.5	7	4.2	0.9
Magpie shrike	*Corvinella melanoleuca*	I	T	R	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Marico sunbird	*Nectarinia mariquensis*	N	T	R	1	0.6	0.1	0	0.0	0.0	1	0.6	0.1	2	1.2	0.3
Meyer's parrot	*Poicephalus meyeri*	F	H	R	5	3.0	0.5	6	3.6	0.7	2	1.2	0.2	3	1.8	0.4
Mourning collared dove	*Streptopelia decipiens*	G	T	R	1	0.6	0.1	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Namaqua dove	*Oena capensis*	G	T	R	2	1.2	0.2	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Orange–breasted bush–shrike	*Telophorus sulfureopectus*	I	T	R	4	2.4	0.4	7	4.2	0.8	18	10.8	1.6	9	5.4	1.2
Pied crow	*Corvus albus*	O	T	R	4	2.4	0.4	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Pied kingfisher	*Ceryle rudis*	C	H	R	2	1.2	0.2	3	1.8	0.4	2	1.2	0.2	3	1.8	0.4
Pin–tailed whydah	***Vidua macroura***	G	T	R	**30**	**18.1**	**2.7**	0	0.0	0.0	**152**	**91.6**	**13.9**	0	0.0	0.0
Purple heron	*Ardea purpurea*	C	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Rattling cisticola	***Cisticola chiniana***	I	V	R	**30**	**18.1**	**2.7**	**18**	**10.8**	**2.1**	9	5.4	0.8	**18**	**10.8**	**2.4**
Red–backed shrike	*Lanius collurio*	I	T	P	0	0.0	0.0	0	0.0	0.0	3	1.8	0.3	1	0.6	0.1
Red–billed firefinch	*Lagonostica senegala*	G	T	R	7	4.2	0.6	8	4.8	0.9	11	6.6	1.0	9	5.4	1.2
Red–billed oxpecker	*Buphagus erythrorynchus*	I	H	R	4	2.4	0.4	2	1.2	0.2	0	0.0	0.0	1	0.6	0.1
Red–billed spurfowl	*Pternistes adspersus*	G	V	R	7	4.2	0.6	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Red–billed teal	*Anas erythrorhyncha*	V	V	R	0	0.0	0.0	3	1.8	0.4	0	0.0	0.0	0	0.0	0.0
Red–eyed dove	***Streptopelia semitroquata***	G	T	R	**51**	**30.7**	**4.6**	**28**	**16.9**	**3.3**	15	9.0	1.4	3	1.8	0.4
Red–faced mousebird	*Urocolius indicus*	F	T	R	8	4.8	0.7	23	13.9	2.7	13	7.8	1.2	4	2.4	0.5
Reed cormorant	*Microcarbo africanus*	C	T	R	21	12.7	1.9	7	4.2	0.8	9	5.4	0.8	8	4.8	1.1
Rufous–bellied heron	*Butorides rufiventris*	C	T	R	0	0.0	0.0	3	1.8	0.4	1	0.6	0.1	3	1.8	0.4
Schalow's turaco	*Tauraco schalowi*	F	T	R	8	4.8	0.7	4	2.4	0.5	16	9.6	1.5	14	8.4	1.9
Senegal coucal	*Centropus senegalensis*	I	T	R	9	5.4	0.8	14	8.4	1.6	21	12.7	1.9	24	14.5	3.2
Southern black tit	*Parus niger*	I	H	R	2	1.2	0.2	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Southern brown–throated weaver	*Ploceus xanthopterus*	G	T	R	5	3.0	0.5	0	0.0	0.0	3	1.8	0.3	0	0.0	0.0
Southern grey–headed sparrow	*Passer diffusus*	G	H	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Southern masked weaver	*Ploceus velatus*	G	T	R	13	7.8	1.2	2	1.2	0.2	11	6.6	1.0	9	5.4	1.2
Southern red bishop	*Euptectus orix*	G	V	R	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0
Spotted flycatcher	*Muscicapa strita*	I	H	P	0	0.0	0.0	0	0.0	0.0	2	1.2	0.2	4	2.4	0.5
Squacco heron	*Ardeola ralloides*	C	T	R	6	3.6	0.5	0	0.0	0.0	4	2.4	0.4	4	2.4	0.5
Striped kingfisher	*Halcyon chelicuti*	I	H	R	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1
Sunbird	Nectarinidae spp.	N	T	R	3	1.8	0.3	17	10.2	2.0	11	6.6	1.0	0	0.0	0.0
Swainson's spurfowl	*Francolinus swainsonii*	G	V	R	16	9.6	1.4	3	1.8	0.4	0	0.0	0.0	2	1.2	0.3
Swamp boubou	***Laniarius bicolor***	I	T	R	**23**	**13.9**	**2.1**	**17**	**10.2**	**2.0**	20	12.0	1.8	**24**	**14.5**	**3.2**
Tawny eagle	*Aquila rapax*	C	T	R	0	0.0	0.0	1	0.6	0.1	1	0.6	0.1	0	0.0	0.0
Tawny–flanked prinia	***Prinia subflava***	I	V	R	19	11.4	1.7	14	8.4	1.6	**36**	**21.7**	**3.3**	**27**	**16.3**	**3.6**
Tchagra	*Tchagra* spp.	I	T	R	2	1.2	0.2	3	1.8	0.4	7	4.2	0.6	8	4.8	1.1
Terrestrial brownbul	*Phyllastrephus terrestris*	F	T	R	8	4.8	0.7	15	9.0	1.8	35	21.1	3.2	12	7.2	1.6
Thick–billed weaver	*Amblyospiza albifrons*	G	T	R	0	0.0	0.0	3	1.8	0.4	0	0.0	0.0	0	0.0	0.0
Thrush nightingale	*Luscinia luscinia*	I	T	P	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	4	2.4	0.5
Trumpeter hornbill	*Bycanistes bucinator*	F	H	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	0.6	0.1
Village indigobird	*Vidua chalybeata*	G	T	R	3	1.8	0.3	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Wattled lapwing	*Vanellus senegallus*	I	V	R	15	9.0	1.3	5	3.0	0.6	6	3.6	0.6	6	3.6	0.8
Wattled starling	*Creatophora cinerea*	F	T	R	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	4	2.4	0.5
Whiskered tern	*Chlidonias hybrida*	C	V	R	2	1.2	0.2	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
White–backed duck	*Thalassornis leuconotus*	V	V	R	0	0.0	0.0	0	0.0	0.0	6	3.6	0.6	3	1.8	0.4
White–bellied sunbird	*Nectarinia talatala*	F	T	R	3	1.8	0.3	10	6.0	1.2	28	16.9	2.6	16	9.6	2.1
White–browed coucal	*Centropus superciliosus*	I	T	R	3	1.8	0.3	3	1.8	0.4	13	7.8	1.2	8	4.8	1.1
White–browed robin–chat	***Cercotrichas leucophrys***	I	T	R	**26**	**15.7**	**2.3**	16	9.6	1.9	**31**	**18.7**	**2.8**	**23**	**13.9**	**3.1**
White–browed scrub–robin	*Erythropygia leuconotus*	I	T	R	12	7.2	1.1	5	3.0	0.6	10	6.0	0.9	8	4.8	1.1
White–crested helmet–shrike	*Prionops plumatus*	I	T	R	9	5.4	0.8	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
White–crowned lapwing	*Vanellus albiceps*	I	V	R	6	3.6	0.5	5	3.0	0.6	6	3.6	0.6	2	1.2	0.3
White–faced duck	*Dendrocygna viduata*	V	V	R	8	4.8	0.7	3	1.8	0.4	3	1.8	0.3	25	15.1	3.3
Willow warbler	*Phylloscopus trochilus*	I	T	P	0	0.0	0.0	0	0.0	0.0	5	3.0	0.5	4	2.4	0.5
Wood sandpiper	*Tringa glareola*	I	V	R	1	0.6	0.1	0	0.0	0.0	1	0.6	0.1	0	0.0	0.0
Woodland kingfisher	*Halcyon senegalensis*	I	H	R	0	0.0	0.0	2	1.2	0.2	0	0.0	0.0	1	0.6	0.1
Yellow white–eye	*Zosterops senegalensis*	F	T	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Yellow–bellied greenbul	***Chlorocichla flaviventris***	F	T	R	15	9.0	1.3	2	1.2	0.2	7	4.2	0.6	**18**	**10.8**	**2.4**
Yellow–billed hornbill	*Tockus leucomelas*	F	H	R	1	0.6	0.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Yellow–billed kite	*Milvus parasitus*	C	T	A	2	1.2	0.2	2	1.2	0.2	3	1.8	0.3	2	1.2	0.3
Yellow–breasted apalis	***Apalis flavida***	I	T	R	13	7.8	1.2	1	0.6	0.1	8	4.8	0.7	**25**	**15.1**	**3.3**
Yellow–fronted tinkerbird	*Pogoniulus chrysocomus*	F	H	R	0	0.0	0.0	6	3.6	0.7	6	3.6	0.6	3	1.8	0.4
Zitting cisticola	*Cisticola juncidis*	I	V	R	0	0.0	0.0	0	0.0	0.0	2	1.2	0.2	8	4.8	1.1
Total					1,116	672.3	100	857	516.3	100	1,097	660.8	100	749	451.2	100