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The Impact of Anthropization on Avian Diversity in the Masako Forest Reserve (Tshopo, DR Congo)

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ABSTRACT

This study assesses the impact of anthropization on the avian diversity of the Masako Forest Reserve (Tshopo, DR Congo), a protected area experiencing significant degradation due to human activities such as deforestation, agriculture, and urbanization. These pressures lead to habitat fragmentation and homogenization, threatening local birdlife. Conducted from February to July 2024, the study sampled birds across four habitat types (young fallow, old fallow, cultivated fields, forest fragments) using mist nets and observations. A total of 614 specimens representing 35 bird species were recorded, dominated by Passeriformes, particularly *Eurillas virens* and *Cyanomitra olivacea*. Fallow lands exhibited greater species richness than forest fragments. Shannon, Evenness, and Simpson indices revealed low overall diversity, with a strong dominance by a few species, indicating a disturbed avian community. Species like *Cyanomitra olivacea* demonstrate high adaptability, being present in all habitats, while others are highly specialized. Anthropogenic activities, including illegal hunting and overexploitation of resources, are the primary causes of this fragmentation and reduction in avian biodiversity.

1. Introduction

1.1. General Context of the Study

Biodiversity, a fundamental pillar of ecosystems, faces increasing pressures, largely due to human activities (Bapeamoni, 2014). Among these pressures, anthropization stands out as a major process. It refers to all transformations of natural environments under the influence of human interventions, whether direct (urbanization, deforestation, resource exploitation) or indirect (climate change). These alterations lead to profound and often irreversible modifications in the structure and functioning of ecosystems, affecting biodiversity, biogeochemical cycles, and ecosystem services (Harold et al., 2022).

The consequences of anthropization are manifold and devastating: habitat fragmentation and destruction, pollution, climatic alterations, introduction of exotic species, and overexploitation of natural resources. These combined factors reduce species richness, isolate populations, and decrease the resilience of ecosystems to natural disturbances (Low, 2002). Forest reserves play a crucial role in biodiversity conservation, acting as vital refuges for many species, including avifauna. They are breeding grounds and strongholds against the harmful effects of habitat fragmentation (Iyongo et al., 2012). However, even these protected areas are not immune to anthropogenic pressures. The Masako Forest Reserve (RFM), located near Kisangani in the Democratic Republic of Congo, is a striking example. Formerly characterized by a rich diversity of forest habitats, this reserve has undergone significant deforestation and land conversion due to the expansion of human activities.

This comparative study aims to assess the impact of this anthropization on the avian diversity of the RFM. Based on previous research and recent observations, we seek to determine the current composition of the avifauna, identify the most affected and most resilient species, and highlight the specific human practices that threaten bird populations in this region.

1.2. Problem Statement

Forest reserves are vital for biodiversity conservation, serving as habitat refuges and breeding grounds for avifauna. However, these ecosystems are experiencing an alarming decline due to human activities. The Masako Forest Reserve (RFM), near Kisangani, perfectly illustrates this trend, having experienced massive deforestation and the conversion of its forests into fields and settlement areas (Mulotwa, 2008).

This degradation, where deforestation, intensive agriculture, and urbanization fragment and homogenize habitats, drastically reduces species diversity (Laudelout, 2014, Ladle, 2011). Practices such as slash-and-burn cultivation, logging, and charcoal production directly impact the RFM's birdlife (Iyongo, 2012, Stattersfield et al., 1998).

In this context of profound alteration, this study aims to determine the current composition of the RFM's avifauna after these anthropogenic disturbances. Our key questions are: Which bird species are most affected? Which ones are resilient? And what specific human practices harm this birdlife?

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2. Methodological Approach

2.1. Study Area

The Masako Forest Reserve is located 15 km northeast of Kisangani city (0°36'N and 25°13'E), Tshopo Province in the Democratic Republic of Congo.

Figure 1 shows the location of the Masako Forest Reserve.

This reserve covers an area of approximately 2,105 ha and is bordered to the northeast and west by the Tshopo River, and is crossed by 13 streams. The region's climate is of the "Afi" type according to the Köppen classification, characterized by average temperatures exceeding 18°C and rainfall greater than 60 mm per month throughout the year (Juakaly, 2007).

The evolution of the vegetation demonstrates the impact of anthropization. While previous studies (Makana, 1986; Kahindo, 1988; Mabay, 1994) described the RFM as harboring primary forests (dominated by *Gilbertiodendron dewevrei* or mixed), old and young secondary forests, as well as shrub and herbaceous fallow lands, the current situation is drastically different. Primary and secondary forests have now virtually disappeared due to various human activities, leaving only residual fragments. The landscape is now dominated by fallow lands, clear signs of land conversion.

2.2. Sampling Methods

The study was conducted from February to July 2024. Bird sampling was carried out in four representative habitat types of the current RFM: young fallow (JJ), old fallow (JV), cultivated fields (CHA), and forest fragments (FF). Twelve mist nets (12 m long, 2.5 m wide, 30 mm² mesh) were installed, forming three capture stations per habitat. Surveys were conducted every two hours to retrieve live specimens.

Bird identification was based on morphological criteria (plumage color, legs, beak, etc.) using electronic keys (Merlin Bird, Ian and Ryan, 2010). All captured specimens were marked (clipping the tip of the first toe on the left foot) before release. Tissue samples were taken from some specimens for potential molecular analyses. In addition to captures, monitoring points were established for visual observation (NATURA-TREK binoculars) and vocalization recording (Merlin Bird app). Difficult identifications were confirmed in the laboratory.

3. Results

3.1. Systematic overview of birds in the RFM

Investigations conducted in the Masako Forest Reserve recorded a total of 614 bird specimens. These specimens represent a diversity of 35 species, distributed among 29 genera, 16 families, and 7 orders.

The table below details the systematic composition of the identified birds, with their counts and relative abundances. Passeriformes appear to constitute a major order in the recorded diversity, with the Pycnonotidae and Nectariniidae families particularly well-represented in terms of species and individuals. Notably, the species *Eurillas virens* (147 individuals, 23.94% relative abundance) and *Cyanomitra olivacea* (83 individuals, 13.52% relative abundance) already show a notable dominance.

3.2. Distribution of inventored species by Habitat

Among the 614 bird specimens collected in the RFM, 222 specimens (36.2%) were from young fallow (JJ), 182 specimens (29.6%) from old fallow (JV), 122 specimens (19.9%) from forest fragments (FF), and 88 specimens (14.3%) from cultivated fields (CHA), as shown in the table 2.

Regarding species richness, young fallow accounted for 20 species, old fallow 21, cultivated fields 14, while forest fragments counted 8.

3.3. Analysis of bird species constancy by habitat Type

This analysis highlights the constancy of different bird species within the studied habitats.

Cynomitra olivacea, *Eurillas latirostris*, *Eurillas virens*, and *Ispidina picta* are highly constant species (C% = 100%). Their presence in all habitat types indicates their great adaptability and broad habitat preference.

Species such as *Camaroptera brachyura*, *Cinnyris minullus*, *Estrilda nonnula*, *Hylia prasina*, *Centropus senegalensis*, *Corythaeola cristata*, *Eurystomus glaucurus*, *Nicator chloris*, *Pycnonotus tricolor*, *Spermestes fringiloides*, *Streptopelia semitoquarta*, and *Turtur afer* are considered moderately constant (C% = 50% or 75%). They were observed in a subset of the habitats, either two or three of the four types studied.

The other species, however, were found in only one of the four habitat types. This suggests a more specialized habitat preference, classifying them as less constant species (C% = 25%).

Specialist species for young fallow are: *Cisticola anonymus*, *Cisticola marginatus*, *Estrilda melpoda*, *Ispidina lecontei*, and *Spermestes bicolor*. For old fallow, we find: *Bleda syndactylus*, *Chlorocichla simplex*, *Chrysococcyx cupreus*, *Criniger calurus*, *Macrosphenus concolor*, *Neocossyphus poensis*, *Phyllastrephus icterinus*, *Platysteira castanea*, *Pyrenestes ostrinus*, and *Strix woodfordii*. Cultivated fields host *Halcyon senegalensis* and *Spermestes cucullata*. Finally, in the forest fragment, we observe *Lophoceros fasciatus* and *Terpsiphone viridis*.

20 bird species (57.14%) were captured in young fallow, 21 species (60%) in old fallow, 14 (40%) in cultivated fields, and 8 species (22.86%) in forest fragments. The detailed results of this analysis are presented in the table 3.

In terms of species richness, young fallow hosted 20 species, old fallow 21, cultivated fields 14, while the forest fragment counted 8.

3.4. Ecological diversity Indices

Three ecological indices were used in this study: Shannon, Evenness, and Simpson indices.

The Shannon index is low in all explored habitats, indicating that the community is dominated by one or a few species, with low species richness and an uneven distribution of individuals among species (H' less than 2). Evenness, also low (close to 0), suggests that a few species dominate the community, despite the presence of a large number of other species. This could result from the dominance of certain very abundant species, at the expense of less numerous species. The Simpson index confirms that the captured bird community is dominated by a few species, with little diversity, which translates into a 1-D close to 0, indicating a strong dominance of less diverse species.

Their presentation is illustrated in the table below.

Table 4: Ecological Diversity Indices

Indices	Habitats			
	JJ	JV	CHA	FF
Shannon	0,2664	0,3229	0,3839	0,2312
Equitabilité	0,3843	0,4658	0,5539	0,3335
Simpson_1-D	0,1387	0,1784	0,2243	0,1155

3.5. Anthropogenic activities in the RFM and their effects on avifauna

The anthropogenic activities carried out within the Masako Forest Reserve encompass various human practices likely to disrupt the ecosystem and biodiversity of this protected area. Among these activities are:

- Deforestation and logging: Despite the reserve's protected status, illegal logging practices, such as felling trees for charcoal production or construction timber, have led to habitat degradation and compromised vegetation regeneration.
- Subsistence agriculture: The expansion of agricultural land within the reserve causes forest habitat fragmentation and increased pressure on natural resources, thereby disrupting the ecological balance of the area.
- Housing construction: The establishment of housing within the Masako Forest Reserve itself represents a direct threat to the ecological integrity of the protected area. Although the reserve's main objective is biodiversity conservation, human presence within its perimeter leads to a series of negative effects.
- Illegal hunting: Although less widespread today, it targeted wild species for bushmeat, an activity that negatively affects local wildlife, including certain bird, mammal, and reptile species. This pressure directly impacts the structure and dynamics of animal populations.
- Excessive collection of medicinal plants and other natural resources: The overexploitation of plant resources for medicinal, food, or artisanal purposes has altered plant biodiversity, disrupted ecological relationships within the reserve, and compromised the survival of certain endemic plant species.

The anthropogenic activities described above likely have a significant negative impact on the avifauna of the Masako Forest Reserve because they lead to habitat fragmentation, which isolates bird populations, limits their movements, and increases their vulnerability to local extinction. Forest degradation prevents natural vegetation regeneration, modifying the ecosystem and favoring opportunistic plant species less suitable for native avifauna.

4. Discussions

4.1 Species richness and diversity

In this study, 614 bird specimens were recorded, belonging to 35 species, distributed among 29 genera, 16 families, and 7 orders. The Passeriformes order largely dominates in terms of diversity, with 9 families and 24 species, highlighting its importance in the local avifauna. The Pycnonotidae (7 genera, 8 species) and Estrildidae (3 genera, 6 species) families are the most diverse, confirming the predominance of passerines in the studied ecosystems. The most abundant species are *Eurillas virens*, *Cyanomitra olivacea*, and *Eurillas latirostris*, while others like *Terpsiphone viridis* and *Criniger calurus* are less frequent.

4.2 Comparison with previous studies

Our study recorded 35 bird species, with a clear dominance of Passeriformes, particularly the Pycnonotidae and Estrildidae families. However, this diversity is lower than previous observations by Upoki (1997, 2001) and Bapeamoni (2014) in the same region. This decrease is explained by recent anthropogenic impacts such as deforestation and habitat fragmentation, as well as a shorter data collection period. The persistence of Passeriformes is attributed to their high ecological plasticity and effective reproductive strategies, allowing them to adapt and maintain themselves in varied environments.

4.3 Factors explaining the observed variations

The difference in abundance and diversity between our results and those of previous studies can be attributed to several crucial factors. First, Upoki's research was conducted at a time when the RFM was not subject to current anthropogenic impacts. Deforestation, habitat fragmentation, and charcoal production have most likely altered bird population structure and species composition, leading to a decrease in biodiversity.

Second, the duration and period of data collection differ significantly. Our study was conducted over six months (February to July 2024), while Upoki's spanned several years (1986-1991). These temporal variations can influence the results due to seasonal and interannual cycles of bird populations, affecting their presence and abundance.

4.4 Adaptation of Passeriformes

The dominance of Passeriformes in all studies is explained by their high ecological plasticity. Their ability to adapt to a variety of habitats (forests, savannas, agricultural areas, urban environments), their diversified diet, and their prolific reproductive strategies (small size, short cycles) give them a competitive advantage, allowing them to quickly colonize new territories and maintain their populations in changing environments (Kapita et al., 2022, Murhabale, 2020, Chapin 1954, Olden et al., 2004).

4.5 Species distribution by habitats

The current study in the Masako Forest Reserve collected 614 bird specimens, showing a varied distribution across habitats. Young fallow (36.2%) and old fallow (29.6%) host the largest number of individuals, followed by forest fragments and cultivated fields.

Four species – *Cyanomitra olivacea*, *Ispidina picta*, *Eurillas virens*, and *Eurillas latirostris* – are present in all habitats, indicating their great adaptability. Other species like *Camaroptera brachyura* and *Hylia prasina* are also frequent.

4.6 Comparative analysis and implications

These observations are consistent with those of Upoki (2007) in the same reserve, who also noted a high concentration.

Table 1: Systematic overview of Bbirds in the RFM

Orders	Families	Genera	Species	Counts	(Ar)
Passeriformes	Pycnonotidae	Bleda	*Bleda syndactylus*	6	0.98
		Chlorocichla	*Chlorocichla simplex*	4	0.65
		Criniger	*Criniger calurus*	3	0.49
		Eurillas	*Eurillas latirostris*	70	11.40
			Eurillas virens	147	23.94
		Nicator	*Nicator chloris*	11	1.79
		Phyllastrephus	*Phyllastrephus icterinus*	17	2.77
		Pycnonotus	*Pycnonotus tricolor*	15	2.44
	Nectariniidae	Cinnyris	*Cinnyris minullus*	17	2.77
		Cyanomitra	*Cyanomitra olivacea*	83	13.52
	Estrildidae	Estrilda	*Estrilda nonnula*	20	3.26
			Estrilda melpoda	17	2.77
		Spermestes	*Spermestes bicolor*	11	1.79
			Spermestes cucullata	4	0.65
			Spermestes fringiloides	7	1.14
		Pyrenestes	*Pyrenestes ostrinus*	3	0.49
	Macrosphenidae	Macrosphenus	*Macrosphenus concolor*	2	0.33
	Cisticolidae	Camaroptera	*Camaroptera brachyura*	16	2.61
		Cisticola	*Cisticola marginatus*	6	0.98
			Cisticola anonymus	5	0.81
	Hyliidae	Hylia	*Hylia prasina*	51	8.31
	Turdidae	Neocossyphus	*Neocossyphus poensis*	3	0.49
	Platysteiridae	Platysteira	*Platysteira castanea*	6	0.98
	Monarchidae	Terpsiphone	*Terpsiphone viridis*	2	0.33
Bucerotiformes	Bucerotidae	Lophoceros	*Lophoceros fasciatus*	6	0.98
Columbiformes	Columbidae	Streptopelia	*Streptopelia semitoquarta*	5	0.81
		Turtur	*Turtur afer*	4	0.65
Coraciiformes	Alcedinidae	Halcyon	*Halcyon senegalensis*	10	1.63
		Ispidina	*Ispidina lecontei*	3	0.49
			Ispidina picta	22	3.58
	Coraciidae	Eurystomus	*Eurystomus glaucurus*	6	0.98
Cuculiformes	Cuculidae	Centropus	*Centropus senegalensis*	6	0.98
		Chrysococcyx	*Chrysococcyx cupreus*	8	1.30
Musophagiformes	Musophagidae	Corythaeola	*Corythaeola cristata*	14	2.28
Strigiformes	Strigidae	Strix	*Strix woodfordii*	4	0.65
Total	**7**	**16**	**29**	**35**	**614**

Legend: Ar = relative abundance

Table 2: Distribution of species by habitats

N°	English names	Species	Types of habitats			
			JJ	JV	CHA	LF
1	Red-tailed Bristlebill	*Bleda syndactylus*	0	6	0	0
2	Grey-backed Camaroptera	*Camaroptera brachyura*	7	3	6	0
3	Senegal Coucal	*Centropus senegalensis*	4	2	0	0
4	Simple Greenbul	*Chlorocichla simplex*	0	4	0	0
5	African Emerald Cuckoo	*Chrysococcyx cupreus*	0	8	0	0
6	Little Green Sunbird	*Cinnyris minullus*	13	2	2	0
7	Chattering Cisticola	*Cisticola anonymus*	5	0	0	0
8	Winding Cisticola	*Cisticola marginatus*	6	0	0	0
9	Great Blue Turaco	*Corythaeola cristata*	0	5	0	9
10	Red-tailed Greenbul	*Criniger calurus*	0	3	0	0
11	Olive Sunbird	*Cyanomitra olivacea*	13	15	22	33
12	Orange-cheeked Waxbill	*Estrilda melpoda*	17	0	0	0
13	Black-crowned Waxbill	*Estrilda nonnula*	5	5	10	0
14	Yellow-whiskered Greenbul	*Eurillas latirostris*	23	26	6	15
15	Little Greenbul	*Eurillas virens*	57	53	7	30
16	Broad-billed Roller	*Eurystomus glaucurus*	2	0	4	0
17	Woodland Kingfisher	*Halcyon senegalensis*	0	0	10	0
18	Green Hylia	*Hylia prasina*	17	9	0	25
19	African Dwarf Kingfisher	*Ispidina lecontei*	3	0	0	0
20	African Pygmy Kingfisher	*Ispidina picta*	15	2	3	2
21	African Pied Hornbill	*Lophoceros fasciatus*	0	0	0	6
22	Grey-backed Longbill	*Macrosphenus concolor*	0	2	0	0
23	White-tailed Ant-thrush	*Neocossyphus poensis*	0	3	0	0
24	Western Nicator	*Nicator chloris*	7	4	0	0
25	Icterine Greenbul	*Phyllastrephus icterinus*	0	17	0	0
26	Chestnut Wattle-eye	*Platysteira castanea*	0	6	0	0
27	Dark-capped Bulbul	*Pycnonotus tricolor*	11	0	4	0
28	Black-bellied Seedcracker	*Pyrenestes ostrinus*	0	3	0	0
29	Blue-billed Mannikin	*Spermestes bicolor*	11	0	0	0
30	Bronze Mannikin	*Spermestes cucullata*	0	0	4	0
31	Magpie Mannikin	*Spermestes fringiloides*	2	0	5	0
32	Red-eyed Dove	*Streptopelia semitoquarta*	2	0	3	0
33	African Wood Owl	*Strix woodfordii*	0	4	0	0
34	African Paradise Flycatcher	*Terpsiphone viridis*	0	0	0	2
35	Blue-spotted Wood Dove	*Turtur afer*	2	0	2	0
Total		**35**	**222**	**182**	**88**	**122**
		Relative abondance (%)	**36,2**	**29,6**	**14,3**	**19,9**

Legend: JJ = young fallow, JV = old fallow, CHA = cultivated field, FF = forest fragment

Table 3: Analysis of Species Constancy by Habitat

Species	Types of habitats				C%
	JJ	JV	CHA	LF	
Bleda syndactylus	0	1	0	0	25
Camaroptera brachyura	1	1	6	0	75
Centropus senegalensis	1	1	0	0	50
Chlorocichla simplex	0	1	0	0	25
Chrysococcyx cupreus	0	1	0	0	25
Cinnyris minullus	1	1	1	0	75
Cisticola anonymus	1	0	0	0	25
Cisticola marginatus	1	0	0	0	25
Corythaeola cristata	0	1	0	1	50
Criniger calurus	0	1	0	0	25
Cyanomitra olivacea	1	1	1	1	100
Estrilda melpoda	1	0	0	0	25
Estrilda nonnula	1	1	1	0	75
Eurillas latirostris	1	1	1	1	100
Eurillas virens	1	1	1	1	100
Eurystomus glaucurus	1	0	1	0	50
Halcyon senegalensis	0	0	1	0	25
Hylia prasina	1	1	0	1	75
Ispidina lecontei	1	0	0	0	25
Ispidina picta	1	1	1	1	100
Lophoceros fasciatus	0	0	0	1	25
Macrosphenus concolor	0	1	0	0	25
Neocossyphus poensis	0	1	0	0	25
Nicator chloris	1	1	0	0	50
Phyllastrephus icterinus	0	1	0	0	25
Platysteira castanea	0	1	0	0	25
Pycnonotus tricolor	1	0	1	0	50
Pyrenestes ostrinus	0	1	0	0	25
Spermestes bicolor	1	0	0	0	25
Spermestes cucullata	0	0	1	0	25
Spermestes fringiloides	1	0	1	0	50
Streptopelia semitoquarta	1	0	1	0	50
Strix woodfordii	0	1	0	0	25
Terpsiphone viridis	0	0	0	1	25
Turtur afer	1	0	1	0	50
Total 35	**20**	**21**	**14**	**8**	
Ar (%)	**57,14**	**60**	**40**	**22,86**	

Legend: JJ = young fallow, JV = old fallow, CHA = cultivated field, FF = forest fragment

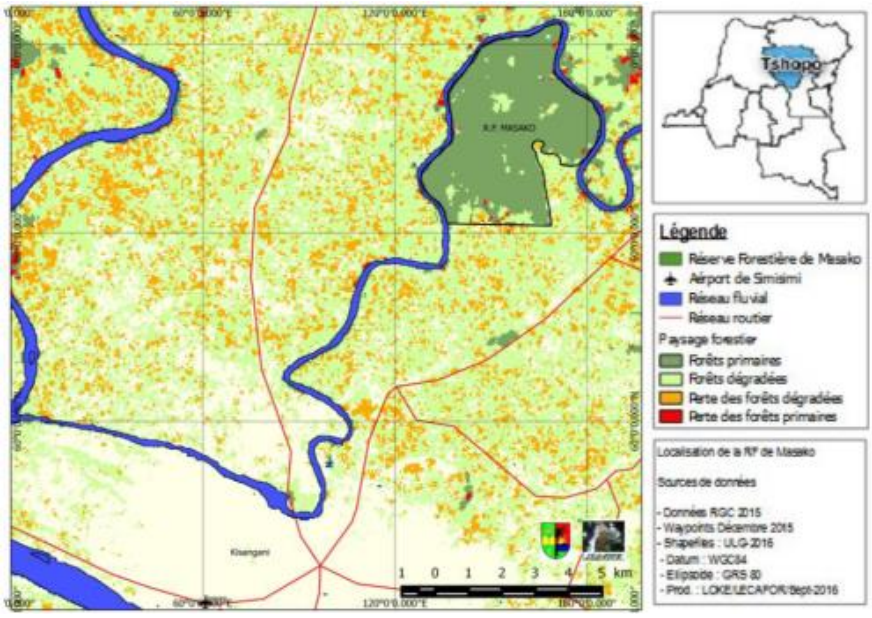

Figure 1: Location of the Masako Forest Reserve (Source: Kusia, 2016)

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