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Avian Diversity of the Masako Forest Reserve after Anthropization (Tshopo Province, Democratic Republic of the Congo)

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Abstract

Anthropization is one of the main drivers of forest ecosystem degradation and strongly affects biodiversity. This study analyzes the comparative diversity of the avifauna in the Masako Forest Reserve (RFM) before and after anthropogenic disturbances. Data were collected between February and July 2024 using mist nets and observation points across different habitat types, including young and old fallows, croplands, and forest fragments. The results show a marked decline in avifauna, with a local loss of approximately 77% of the species initially recorded. Specialized forest species are the most affected, while the persistent species are mostly generalists, tolerant to disturbed environments. Recolonization remains very low. The disappearance of species with concerning conservation status, such as *Psittacus erithacus*, highlights a real risk of local extinction and underscores the negative impact of human activities on the ecological integrity of the RFM, calling for strengthened conservation measures.

Keywords: Avifauna; anthropization; biodiversity; Masako Forest Reserve.

INTRODUCTION

Anthropization, defined as the set of transformations imposed on natural environments by human activities, is currently one of the main drivers of alteration in tropical ecosystems. Urbanization, deforestation, shifting slash-and-burn agriculture, natural resource exploitation, and habitat fragmentation induce profound, often irreversible changes in the structure and functioning of ecological systems. These transformations affect biodiversity, disrupt natural cycles, and reduce ecosystem resilience to disturbances (Barnagaud, 2012; Vranken et al., 2011). In many regions of Central Africa, these anthropogenic pressures lead to rapid degradation of forest habitats, accompanied by a significant decline in biological diversity.

The Masako Forest Reserve (MFR), located in the central part of the Democratic Republic of the Congo, in Tshopo Province, represents one of the major forest ecosystems in the region (Juakaly, 2007). This reserve harbors remarkable biodiversity and plays a crucial role in ecological regulation (Upoki, 2001), biodiversity conservation, and the provision of ecosystem services to local populations. However, despite its protected status, the MFR is currently experiencing increasing anthropogenic pressure, characterized by the expansion of agricultural land, logging activities, charcoal production, and human settlement. These pressures contribute to forest habitat fragmentation and threaten the stability of the resident biological communities.

Among faunal groups sensitive to environmental changes, avifauna occupies a prominent position. Birds are widely recognized as reliable bioindicators due to their sensitivity to habitat alterations, their key roles in ecosystem functioning (e.g., pollination, seed dispersal, and insect population control), and the relative ease with which they can be surveyed. Assessing bird diversity in a context of anthropization provides valuable insights into ecosystem health and helps identify both vulnerable species and those capable of adapting to disturbances (Iyongo et al., 2009).

The present study aims to determine the current composition of avifauna in the Masako Forest Reserve in relation to the anthropogenic transformations observed over recent decades.

MATERIAL AND METHODS

Study area: The data for this study were collected in the Masako Forest Reserve, located 15 km northeast of Kisangani along the former Buta road, covering an area

of 2,105 ha. The reserve is bordered and drained by an extensive hydrographic network dominated by the Tshopo River and several streams, including Amandje, Amakasapoko, Magima, Masanga-Mabe, and the Masako stream (Juakaly, 2007). The reserve belongs to the bioclimatic zone of dense evergreen equatorial rainforest, characterized by a hot and humid climate of the Afi type according to Köppen classification, with temperatures consistently above 18°C and abundant, well-distributed rainfall throughout the year, associated with low thermal amplitude (Upoki, 2001).

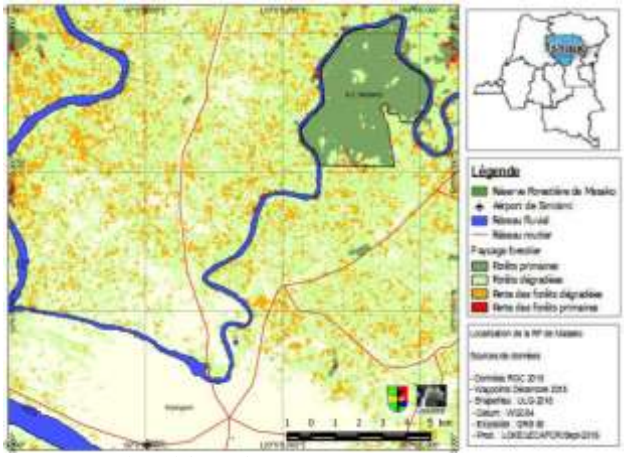

Figure 1. Location of the study area

Ecologically, the Masako Forest Reserve (MFR) historically exhibited high plant diversity organized into five main habitats: primary forest dominated by *Gilbertiodendron dewevrei*, old secondary forest characterized by a varied tree and shrub flora, young secondary forest dominated by *Musanga cecropioides*, shrub-dominated fallow with abundant herbaceous cover, and herbaceous fallow dominated by *Triumpheta cordifolia and Selaginella myosurus*. However, anthropization that began in the 2010s led to progressive deforestation, resulting in the near-complete disappearance of primary and secondary forests. Today, the reserve is mainly composed of young and old fallows, where only a few relic species from the former forest ecosystems remain.

Sampling was conducted from February to July 2024 in four representative habitats of the MFR: young fallow (JJ), old fallow (JV), fields (CHA), and forest fragments (FF). In each habitat, a capture station consisting of three Japanese mist nets (12 m × 2.5 m; mesh 30 mm²) was installed following the method of Howes and Bakewell (1989). The nets were set at 50 cm above the ground using 5 m poles and checked every two hours to retrieve captured birds. Specimens were identified based on morphological criteria (plumage, beak, legs, toes, periocular region), supplemented with the Merlin Bird and Ian & Ryan (2010) identification keys. Birds were then marked by a small clipping of the tip of the first toe on the left foot before being released. Some individuals were sampled for tissues (heart, muscle, liver, lung) for subsequent molecular analyses. In addition to mist-net captures, fixed observation points were established in each habitat using NATURA-TREK binoculars and acoustic recordings.

RESULTS

Comparative analysis of the avifauna of the MFR before and after anthropogenic disturbances

The comparative analysis of the avifauna of the Masako Forest Reserve before and after anthropogenic disturbances shows a significant impact on species diversity. Of the 152 species recorded, 151 species (99.3%) were present before anthropogenic disturbances, compared to 35 species (23%) after anthropization, indicating a local loss of 77% of the avifauna dversity (Table 1). This decline primarily affects forest specialist species, which are sensitive to habitat degradation and fragmentation, whereas the species persisting after disturbance are mostly generalist or disturbance-tolerant taxa.

Table 1. Inventory of the avifauna of the Masako Forest Reserve before and after anthropization.

Orders	Families	Species	Before	After	SC
Passeriformes	Pycnonotidae	*Baeopogon indicator*	+	-	LC
		Bleda eximia	+	-	LC
		Bleda syndactylus	+	+	LC
		Chlorocichla flavicollis	+	-	LC
		Chlorocichla simplex	+	+	LC
		Criniger calurus	+	+	LC
		Eurillas curvirostris	+	-	LC
		Eurillas gracilis	+	-	LC
		Eurillas latirostris	+	+	LC
		Eurillas virens	+	+	LC
		Ixonotus guttatus	+	-	LC
		Phyllastrephus albigularis	+	-	LC
		Phyllastrephus icterinus	+	+	LC
		Phyllastrephus xavieri	+	-	LC
		Pycnonotus barbatus	+	-	LC

Orders	Families	Species	Before	After	SC
		Pycnonotus tricolor	+	+	LC
	Nicatoridae	*Nicator chloris*	+	+	LC
		Nicator virco	+	-	LC
	Muscicapidae	*Alethe diademata*	+	-	LC
		Muscicapa cassini	+	-	LC
		Stiphrornis erythrothorax	+	-	LC
		Stizorhina fraseri	+	-	LC
	Turdidae	*Turdus pelios*	+	-	LC
		Neocossyphus poensis	+	+	LC
		Neocossyphus rufus	+	-	LC
	Pelllorneidae	*Trichastoma fulvescens*	+	-	LC
		Trichastoma albipectus	+	-	LC
		Trichastoma rufipennis	+	-	LC
	Monarchidae	*Terpsiphone rufiventer*	+	-	LC
		Terpsiphone viridis	+	+	LC
		Trochocercus nitens	+	-	LC
	Platysteiridae	*Diaphorophyia blissetti*	+	-	LC
		Dyaphorophyia castanea	+	+	LC
		Dyaphorophyia tonsa	+	-	LC
	Malaconotidae	*Tchagra australis*	+	-	LC
		Dryoscopus senegalensis	+	-	LC
		Laniarius leucorhynchus	+	-	LC
	Prunellidae	*Anthreptos collaris*	+	-	LC
		Anthreptos scimundi	+	-	LC
	Nectariniidae	*Cinnyris minullus*	+	+	LC
		Cyanomitra olivacea	+	+	LC
		Cyanomitra cyanolaema	+	-	LC
		Cyanomitra chloropygia	+	-	LC
	Motacillidae	*Motacilla aguimp*	+	-	LC
		Motacilla flava	+	-	LC
	Sturnidae	*Lemprotornis splendidus*	+	-	LC
	Oriolidae	*Oriolus brachyrhynchus*	+	-	LC
		Oriolus nigripennis	+	-	LC
	Acrocephalidae	*Acrocephalus arundinaceus*	+	-	LC
		Acrocephalus scirpaccus	+	-	LC
		Acrocephalus rufescens	+	-	LC
	Cisticolidae	*Camaroptera brevicaudata*	+	-	LC
		Camaroptera chloronata	+	-	LC
		Camaroptara superciliaris	+	-	LC
		Cisticola marginatus	+	+	LC
		Cisticola anonymus	+	+	LC
		Cisticola galactotes	+	-	LC
		Camaroptera brachyura	+	+	LC
		Prinia leucopogon	+	-	LC
		Prinia subflava	+	-	LC
	Macrosphenidae	*Sylvietta denti*	+	-	LC
		Sylvietta virens	+	-	LC
	Phylloscopidae	*Phylloscopus trechilus*	+	-	LC
	Hirundinidae	*Hirundo rustica*	+	-	LC
		Hirundo semirufa	+	-	LC
		Psalidoprocne nitens	+	-	LC
	Calyptomenidae	*Smithornis rufolateralis*	+	-	LC
	Ploceidae	*Amblyospiza albifrons*	+	-	LC
		Brachycope anomala	+	-	LC
		Ploceus ocularis	+	-	LC
		Malimbus coronatus	+	-	LC
		Malimbus malimbicus	+	-	LC
		Malimbus nitens	+	-	LC
		Quelea cardinalis	+	-	LC
		Ploceus cucullatus	+	-	LC
		Ploceus aurantius	+	-	LC
		Ploceus nigerrimus	+	-	LC
		Ploceus pelzelni	+	-	LC

Orders	Families	Species	Before	After	SC
	Passeridae	*Passer griseus*	+	-	LC
	Estrildidae	*Nigrita bicolor*	+	-	LC
		Nigrita canacapilla	+	-	LC
		Nigrita fusconata	+	-	LC
		Mandingoa nitidula	+	-	LC
		Parmoptila rubrifrons	+	-	LC
		Spermophaga haematina	+	-	LC
		Spermophaga poliogenys	+	-	LC
		Estrilda nonnula	+	+	LC
		Estrilda melpoda	+	+	LC
		Spermestes bicolor	+	+	LC
		Spermestes cucullata	+	+	LC
		Spermestes fringiloides	+	+	LC
		Pyrenestes ostrinus	+	+	LC
	Macrosphenidae	*Macrosphenus concolor*	+	+	LC
	Dicruridae	*Dicrurus adsimilis*	+	-	LC
	Hyliidae	*Hylia prasina*	+	+	LC
Piciformes	Lybiidae	*Buccanodon duchaillui*	+	-	LC
		Gymnobucco bonapartei	+	-	LC
		Pogoniulus atroflavus	+	-	LC
		Pogoniulus leucolaima	+	-	LC
		Pogoniulus subsulphureus	+	-	LC
		Pogoniulus scolopaceus	+	-	LC
		Trachylaema purpuratus	+	-	LC
		Tricholaema hirsuta	+	-	LC
	Indicatoridae	*Indicator conirostris*	+	-	LC
		Indicator exilis	+	-	LC
		Indicator maculatus	+	-	LC
	Picidae	*Sasia africana*	+	-	LC
		Campethera caroli	+	-	LC
		Campethera nivosa	+	-	LC
		Campethera permista	+	-	LC
Coraciiformes	Alcedinidae	*Alcedo leucogaster*	+	-	LC
		Alcedo quadribrachys	+	-	LC
		Halcyon badia	+	-	LC
		Halcyon leucocephala	+	-	LC
		Halcyon malimbicus	+	-	LC
		Halcyon senegalensis	+	+	LC
		Ispidina lecontei	+	+	LC
		Ispidina picta	+	+	LC
	Coraciidae	*Eurystomus glaucurus*	-	+	LC
	Meropidae	*Merops variegatus*	+	-	LC
		Merops muelleri	+	-	LC
Bucérotiformes	Bucerotidae	*Tropicranus albocristatus*	+	-	LC
		Ceratogymna atrata	+	-	LC
		Lophoceros fasciatus	+	+	LC
Columbiformes	Columbidae	*Streptopelia semitoquarta*	+	+	LC
		Turtur afer	+	+	LC
		Turtur brehmeri	+	-	LC
		Turtur tympanistria	+	-	LC
		Columba unicincta	+	-	LC
		Treron calvus	+	-	LC
Cuculiformes	Cuculidae	*Cuculus solitarius*	+	-	LC
		Centropus senegalensis	+	+	LC
		Ceuthmochares aereus	+	-	LC
		Chrysococcyx caprius	+	-	LC
		Chrysococcyx cupreus	+	+	LC
		Chrysococcyx klaas	+	+	LC
Caprimulgiformes	Caprimulgidae	*Caprimulgus batesi*	+	-	LC
		Caprimulgus inormatus	+	-	LC
Accipitriformes	Accipitridae	*Kaupifalco monogramicus*	+	-	LC
		Gypohierax angolensis	+	-	LC

Orders	Families	Species	Before	After	SC
		Milvus migrans	+	-	LC
		Polyboroides typus	+	-	LC
Musophagiformes	Musophagidae	*Corythaeola cristata*	+	+	LC
		Tauraco schuetti	+	-	LC
		Musophaga rossae	+	-	LC
Pelecaniformes	Ardeidae	*Ardea purpurea*	+	-	LC
		Bubulcus ibis	+	-	LC
Apodiformes	Apodidae	*Cypsiurus parvus*	+	-	LC
Psittaciformes	Psittacidae	*Psittacus erithacus*	+	-	EN
Galliformes	Numididae	*Numida meleagris*	+	-	LC
Trogoniformes	Trogonidae	*Apaloderrna narina*	+	-	LC
Strigiformes	Strigidae	*Strix woodfordii*	+	+	LC
Total 15	**42**	**152**	**151**	**35**	

Legend: (+) = Species present; (-) = Species absent; LC = Least Concern; EN = Endangered; SC = Conservation status.

According to their conservation status, the table above shows that most species are classified globally as "Least Concern" (LC), yet their local disappearance highlights a high vulnerability of the avifauna to human pressures. This is the case for the African Grey Parrot (**Psittacus erithacus**), a species threatened with extinction.

Overall, anthropization has led to a reduction in avian diversity and a significant alteration of the ecological integrity of the MFR.

Status of bird species presence in the MFR before and after anthropization

The Masako Forest Reserve (MFR) has undergone significant transformations due to human activities, negatively affecting the composition and presence of bird species. To better understand this impact on the avifauna, table 2 presents the status of bird species presence in the MFR before and after these disturbances.

Table 2. Status of bird species presence in the MFR before and after anthropization.

Categories	Definition	Number of species	%
Lost species	Present before, absent after	117	77
Resilient species	Present before and after	34	22,4
Recolonizing species	Absent before, present after	1	0,7
Total after	Collected after	35	23
Total before	Recorded before	151	99,3
Total before and after	Total species collected	152	100

Table 2 highlights a marked decline in the avifauna of the Masako Forest Reserve (MFR) following anthropogenic disturbances. Of the 152 species recorded, approximately 77% have disappeared, whereas only 22.4% have persisted. Recolonization remains almost nonexistent (0.7%), indicating a very limited recovery capacity of the habitat. These results demonstrate a substantial negative impact of human activities on forest habitats, leading to a significant loss of avian biodiversity.

Types of anthropogenic activities in the MFR

The anthropogenic activities observed within the MFR encompass several human practices that disrupt ecosystem functioning and threaten biodiversity within this protected area. The main activities include:

***Deforestation and logging*:** Despite the reserve's protected status, illegal logging activities—such as tree felling for charcoal production and construction timber—have contributed to the degradation of forest habitats and have compromised vegetation regeneration processes.

***Subsistence* agriculture:** The expansion of agricultural land within the reserve leads to habitat fragmentation and increased pressure on natural resources, thereby disrupting the ecological balance of the ecosystem.

***Construction of dwellings*:** The establishment of human settlements within the MFR constitutes a direct threat to its ecological integrity. Human presence within the reserve boundaries generates multiple disturbances, including land conversion, resource extraction, and increased anthropogenic pressure.

***Illegal hunting*:** Although currently less widespread, hunting for bushmeat has negatively affected wildlife populations, including birds, mammals, and reptiles. This pressure directly alters the structure and dynamics of animal communities.

***Overharvesting of medicinal plants and other natural resources*:** The excessive exploitation of plant

resources for medicinal, food, or artisanal purposes has reduced plant biodiversity, disrupted ecological interactions, and threatened the persistence of certain endemic species.

Overall, these anthropogenic activities exert a cumulative negative impact on the avifauna of the MFR. Habitat fragmentation isolates bird populations, restricts their movements, and increases their vulnerability to local extinction. In addition, forest degradation hampers natural regeneration processes, alters ecosystem structure, and promotes the proliferation of opportunistic plant species that are less suitable for native bird communities.

DISCUSSION

The comparative analysis of the avifauna of the M FR before and after anthropization highlights a severe decline in bird diversity, with nearly three-quarters of the initially recorded species lost. This decrease reflects a profound degradation of forest habitats, resulting mainly from deforestation, agricultural expansion, and urbanization, factors recognized as major drivers of biodiversity erosion (Sala et al., 2000; Gibson et al., 2011). The disappearance of forest specialist species confirms their high sensitivity to anthropogenic disturbances, due to their dependence on forest structure and continuity. This observation aligns with the findings of Olden et al. (2004), who demonstrated that human activities profoundly alter the composition and functioning of biological communities. Furthermore, the limited persistence of resilient species suggests that only species with high ecological plasticity are able to adapt to degraded environments.

The marginal presence of recolonizing species indicates a low recolonization dynamic, characteristic of heavily disturbed ecosystems, where opportunistic species tend to replace forest specialists, leading to functional impoverishment of communities. This process of biological substitution is consistent with observations made in other anthropized ecosystems. The disappearance of species with concerning conservation status, such as Psittacus erithacus and Ceratogymna atrata, underscores the increased vulnerability of threatened species to human pressures and reveals a risk of local extinction. Although the majority of species are classified as “Least Concern” by the IUCN, their local decline confirms that global statuses do not always reflect regional population dynamics. Finally, the results of this study are consistent with those reported by Iyongo et al. (2012) in the Masako Reserve and by Mutahinga (2019) in the Yangambi Biosphere Reserve, which highlighted the decisive influence of anthropogenic activities and habitat structure on faunal diversity.

CONCLUSIONS

The study of the comparative avian diversity in the Masako Forest Reserve (MFR) highlights the impact of anthropization on bird communities. The disappearance of 77% of the initially recorded species illustrates a severe decline, primarily affecting forest specialist species, while only generalist or disturbance-tolerant species persist. Recolonization is almost nonexisting, indicating low ecosystem resilience. The disappearance of species with concerning conservation status, such as Psittacus erithacus, reveals a real risk of local extinction. The main anthropogenic pressures identified deforestation, agricultural expansion, urbanization, hunting, and overexploitation of natural resources fragment habitats and compromise natural regeneration. These results confirm that anthropization seriously threatens the ecological integrity of the MFR and call for urgent strengthening of conservation measures and sustainable management practices to preserve avian biodiversity and the stability of local forest ecosystems.

Authors' Contributions: Bugentho E.P. and Upoki D.A. conceptualized the study; Bugentho E.P., Kapita B.L., and Lotana G.L. were responsible for data acquisition; Bugentho E.P., Ngbolua K.N., Gambalemoke S.M., and Upoki D.A. drafted the manuscript; and Bugentho E.P., Ngbolua K.N., Upoki D.A., and Gambalemoke S.M. validated the final version of the work. All authors read and approved the final version of the manuscript.

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