Avifaunistic study in mangrove forest stretch along the lagoon Epe Lagos Nigeria for sustainable tourism

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Abstract
This study investigated the avifauna within the mangrove forests along the Epe Lagoon in Lagos, Nigeria, with a focus on promoting sustainable tourism. Its primary objective was to establish a foundational knowledge base for future research endeavors and to aid in the development of conservation strategies aimed at safeguarding bird diversity. The research site was divided into three zones: undisturbed forest, secondary forest, and wetland areas. Bird species diversity was assessed using the line transect method, with a total of 30 transect lines randomly distributed across the study area, with 10 in each zone. These lines were surveyed three times a week over three months, encompassing both wet (May, July, and September) and dry (November, January, and March) seasons in 2023. Surveys were conducted from 6:00 to 10:00 in the morning and from 4:00 to 6:00 p.m., during which all birds observed on the ground, in vegetation, or flight were identified and counted. The findings revealed a total of 198 bird species belonging to 44 families and 18 orders, with an abundance of 481 individual birds recorded in the study area, highlighting its significance in supporting bird species diversity. Analysis of the family composition of bird species identified Pycnonotidae as the most abundant with 13 species, followed by Muscicapidae and Accipitridae, each with 12 species.

Keywords: Bird species, diversity, mangrove forest, sustainable, tourism
Introduction

Mangrove forests stand as remarkable ecosystems, teeming with biodiversity and playing crucial roles in coastal protection, carbon sequestration, and habitat provision for countless species. Mangroves notably host vibrant species like kingfishers and bee-eaters (Norhayati et al., 2009). Shorebirds, characterized by varied bill shapes, are typically small to medium-sized wading birds known for their gregarious nature and preference for wetland habitats where they both feed and breed. Many shorebirds partake in extensive migrations, covering distances of up to 12,000 km from their breeding grounds to wintering areas. Among these intricate habitats lies a stretch along the Lagoon Epe in Lagos, Nigeria, offering a haven for avian life amidst its labyrinthine roots and tidal rhythms (Spalding et al., 1997; Akintola et al., 2011). This introduction sets the stage for a bird species study aimed at understanding the richness, distribution, and ecological significance of birdlife within this unique mangrove landscape, with a particular focus on fostering sustainable tourism practices. Nestled within the vibrant cityscape of Lagos, the lagoon Epe mangrove forest represents a sanctuary of natural heritage, serving as a vital refuge for both resident and migratory bird species. (Ajado & Edokpayi, 2003) The juxtaposition of urban development and natural serenity underscores the significance of conserving this ecological gem, not only for its intrinsic value but also for the opportunities it presents in promoting sustainable tourism. Avifauna studies, which delve into the diversity, behavior, and habitat preferences of birds, offer valuable insights into the health and functioning of ecosystems (Hogarth, 2007). In the context of the Lagoon Epe mangroves, such studies provide a lens through which to assess the ecological integrity of this ecosystem, identify key species of conservation concern, and inform management strategies for sustainable development. Sustainable tourism stands as a beacon of responsible travel, emphasizing the harmonization of economic growth with environmental protection and social equity. By conducting an avifaunistic study in the mangrove forest along the Lagoon Epe, we aim not only to enhance our understanding of avian communities but also to pave the way for the integration of ecotourism initiatives that celebrate the natural wonders of this locale while safeguarding its ecological integrity for future generations (Okosodo et al., 2018). Mangrove forests are among the most biodiverse ecosystems on the planet, supporting a myriad of bird species that rely on these coastal habitats for nesting, foraging, and resting during migration. By incorporating bird watching activities into eco-tourism itineraries, stakeholders can promote conservation awareness, generate economic benefits for local communities, and foster a deeper
appreciation for the natural wonders of mangrove forests. Furthermore, sustainable tourism development in mangrove areas requires a holistic approach that considers the needs of both wildlife and human communities. Through stakeholder engagement, collaborative management strategies can be devised to balance conservation objectives with socio-economic goals, ensuring that tourism activities contribute to the long-term well-being of both people and nature (Duke et al., 2007). In Nigeria, the mangrove forest faces threats from population growth, industrial development, and increased agricultural activity (FAO, 2007). Therefore, it is imperative to conduct a study on the abundance and diversity of bird species in this ecosystem. Such research would serve as a foundational resource for future studies and enable the formulation of conservation strategies aimed at preserving bird diversity.

**Material and methods**

**Study area**

Epe, situated at approximately latitude 6°31'N and longitude 4°E, lies to the northeast of the Lagos Metropolitan Area. Positioned between 30 and 60 meters above sea level, Epe represents a riverine landscape with slightly elevated terrain (Okorie, 2012). It stands in proximity to the Lagos shoreline, with the Lekki lagoons situated behind it, maintained as conservation areas. Characterized by a climate marked by consistent precipitation throughout the year, Epe experiences high relative humidity and elevated temperatures. The presence of numerous water bodies in the vicinity influences the local climate by moderating temperatures. Rainfall predominantly constitutes the precipitation pattern, averaging around 400 mm annually. The area delineates two distinct seasons: the wet season spanning from April to November, and the dry season prevailing from December to March. The estimated yearly maximum temperature hovers around 30°C, while the average annual minimum temperature stands at 23.8°C (Mengistu, 2007). Throughout the year, relative humidity remains consistently high in Epe, ranging from 60% in January to surpassing 80% in July (Balogun, 2015). It typically peaks between 7 and 10 in the morning and declines between 1 and 4 in the afternoon. Epe is situated within Nigeria's tropical sub-humid region, specifically within the mangrove forest swamp habitat. This ecosystem comprises freshwater wetlands along riverbanks and a mixture of salt and freshwater wetlands along lagoon shores. Vegetation in this ecological zone includes raffia palms, densely bushed silt-rooted trees, red mangroves, and mangrove shrubs. Additionally, extending from Ikorodu to the
northwest of Epe town is the lowland tropical rainforest, which has undergone human-induced alterations such as deforestation. According to a population census conducted in 1963, the area was inhabited by 130,390 individuals. The Lagoon with its tributaries forms major part of the wetland. The large areas of wetland are covered with swamp forest. The Raphia palm (*Raphiasudanica*), the *Elaeisguineensis*, *Nesogordoniapapaverifera*, *Myrianthuspreussi*, *Napoleonavogelii* are dominant trees in the study area (Keay, 1989).

**Data collection**

The research area was segmented into three zones: undisturbed forest, secondary forest, and wetland areas. To assess bird species diversity, data collection employed the line transect method (Sutherland, 2009). Within each zone, 10 transect lines were randomly positioned, totaling 30 transect lines across the study area. These lines were traversed three times a week over three months, covering both wet (May, July, and September) and dry (November, January, and March) seasons. Surveys were conducted from 6:00 to 10:00 in the morning and from 16:00 to 18:00 in the afternoon. All birds observed on the ground, in vegetation, or in flight were identified and counted. Groups of birds of the same species within a 10-meter radius were tallied together. Bird identification was facilitated using binoculars (7x50 magnification) and distance estimates were obtained using a digital range finder. For unidentified birds, physical descriptions were recorded and later cross-referenced with the field guide book of West African birds (Borrow & Demey, 2011). Additionally, nocturnal bird species presence was confirmed using bird calls within the study sites (Okosodo et al., 2016).

**Statistical analysis**

The data gathered during the field survey were inputted into an Excel spreadsheet (version 15) for subsequent analysis. Both descriptive statistics (including tables, frequency, percentage frequency, as well as graph representations such as pie and bar charts) and analytical statistics were employed. The Past Model was utilized to analyze bird species diversity, while SHE analysis was conducted to assess floristic composition. Furthermore, the relationship between bird species diversity and habitat variables was explored.

**Results**
The Shannon_H diversity index shows that a total of 198 bird species belonging 44 families and 18 orders and abundance stood at 481 bird species were recorded in the study area, which indicates support for bird species diversity Table 1. The result of the family composition of bird species in the study indicates that Pycnonotidae has 13 bird species which is the highest, this followed by Muscicapidae and Accipitridae with 12 bird species each Figure 2. SHE analysis was carried to the preference of the bird species and their habitat, it was positive relationship between bird species and the habitat Figure 3 Checklist of bird species in the study area Table 2.

**Table 1.** Diversity index of bird species in the study area

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**Figure 2.** Family composition of bird species in the study area
Figure 3. SHE analysis of bird species in the study area

Table 2. Checklist of bird species in the study area

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<tr>
<th>Family</th>
<th>Scientific Name</th>
<th>Common Name</th>
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<td>Aquila Africana</td>
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<td></td>
<td>Circaetus gallicus</td>
<td>Short Toed Snake Eagle</td>
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</table>
### Alcedinidae

- *Falco cuvierii* - African Hobby
- *Falco biarmicus* - Lanner Falcon
- *Polyboroides typus* - African Harrier Hawk
- *Ceyx lecontei* - African Dwarf Kingfisher
- *Halcyon badia* - Chocolate-Backed Kingfisher
- *Halcyon malimbica* - Blue-Breasted Kingfisher
- *Halcyon badia* - Chocolate Backed Kingfisher
- *Halcyon leucocephala* - Grey Headed Kingfisher
- *Ispidina picta* - African Pigmy Kingfisher
- *Ceryle rudis* - Pied Kingfisher
- *Alcedo cristata* - Malachite Kingfisher
- *Megaceryle maxima* - Giant Kingfisher
- *Halcyon senegalensis* - Woodland Kingfisher

### Anatidae

- *Dendrocygna viduata* - White Faced Whistling Duck
- *Pteronetta hartlaubii* - Hartlaub's Duck
- *Sarkidiornis melanotos* - Knob Bellied Duck

### Apodidae

- *Cypsiurus parvus* - African Palm Swift
- *Apus pallidus* - Little Swift

### Ardeidae

- *Ardea alba* - Great Egret
- *Bubulcus ibis* - Cattle Egret
- *Ardeola ralloides* - Squacco Heron
- *Ixobrychus minutus* - Little Egret
- *Nycticorax nycticorax* - Black Crowned Night Heron
- *Gorsachius leuconotus* - White Back Night Heron
- *Egretta alba* - Great Egret
- *Ardea meanocephala* - Black-Headed Heron
- *Ardea cinerea* - Grey Heron
- *Ardea melanocephala* - Black Headed Heron
- *Ixobrychus minutus* - Little Bittern

### Anhingidae

- *Anhinga rufa* - African Darter

### Bucerotidae

- *Apus affinis* - African Pied Hornbill
- *Tockus faciatus* - African Grey Hornbill
- *Lophoceros nasutus* - Black and white Hornbill
- *Bycanistes fistulator* - Piping Hornbill

### Burhinidae

- *Burhinus senegalensis* - Senechal Thick Knee

### Campephagidae

- *Horizocerus albocrisatus* - Blue Cuckoo Shrike

### Capitonidae Lybiidae

- *Cyanograulus azureus* - Hairy-Breasted Barbet
- *Tricholaema hirsute* - Red-Rumped Tinkeredbird
- *Lybius bidentatus* - Double Toothed Barbet
- *Lybius vielloti* - Viellot Babet
Pogoniulus atroflavus  Naked-Faced Barbet
Gymnobucco calvus  Speckled Tinkerbird
Pogoniulus scolopaceus  Yellow-Fronted Tinkerbird
Pogoniulus chrysoconus  Bristled-Nosed Barbet
Gymnobucco peli  Yellow-Throated Tinkerbird

Caprimulgidae
Pogoniulus subsulphureus  Standard-Winged Nightjar
Macrodipteryx longipenis  Standard Winged Nightjar
Caprimulgus nigricapularis  Black-Shouldered Nightjar

Charadriidae
Charadrius marginatus  White-Fronted Plover
Charadrius tricolor  Three Banded Plover
Charadrius forbesi  Kittlitzs Plover
Pluvianus aegyptius  Egyptian Plover
Charadrius pecuarius  Common Ring Plover
Charadrius hiaticula  Kentish Plover
Charadrius alexandrinus  Lesser Black Winged Lapwing
Vanellus lugubris  Spur Winged Lapwing
Vanellus spinosus  African Wattled Lapwing
Vanellus senegalus  Black-Shouldered Nightjar

Cisticolidae
cerviniventris  Black-Head Rufous Warbler
Cisticola erythrops  Red-Faced Ccisticola
Hylia prasina  Grey Longbill
Camaroptera chloronota  Olive-Green Camaroptera
Prinia bairdii  Banded Prinia
Camaroptera brevicaudata  Grey Backed Camaroptera
Prinia subflava  Tawny- Flanked Prinia
Apalis jacksoni  Black Throated Apalis

Columbidae
Treron calvus  African Green Pigeon
Turtur brehmeri  Blue Headed Wood Dove
Spilopelia senegalensis  Laughing Dove
Streptopelia semitorquata  Red Eyed Dove
Turtur tympanistria  Tambourine dove

Coraciidae
urystomus glaucurus  Broad Billed Roller
Coracias abyssinicus  Abyssinian Roller
Coracias cyanogaster  Blue Bellied Rolle

Cuculidae
Chrysococcyx cupreus  African Emerald Cuckoo
Centropus grillii  Black Coucal
Cuculus clamosus  Black Cuckoo
hrysococcyx caprius  Diederik Cuckoo
Cercococcyx mechi  Dusky Long-Tailed Cuckoo
Chrysococcyx klaas  Klaas's cuckoo
Centropus senegalensis  Senegal Coucal
Ceuthmochares aereus  
Yellowwbill

Dicruridae

Dicrurus adsimilis  
Fork-Tailed Drongo

Estrildidae

Spermestes bicolor  
Black-and-White Mannikin

Nigrita bicolor  
Chestnut-Breasted Negrofinch

Nigrita canicapillus  
Grey-Headed Negrofinch

Nigrita luteifrons  
Pale-Fronted Negrofinch

Lagonosticta senegala  
Red-Billed Firefinch

Cryptospiza reichenovii  
Red-Faced Crimsonwing

Spermophaga ruficapilla  
Red-Headed Bluebill

Spermophaga haematina  
Western Bluebill

Nigrita fusconotus  
White-Breasted Nigrita

Parmoptila rubrifrons  
Red-Fronted Antpecker

Parmoptila woodhousei  
Woodhouse’s (Red-Headed) Antpecker

Glareolidae

Glareola pratincola  
Collard Pratincole

Cursorius temminckii  
Temminck's Courser

Glareola pratincola  
Grey Pratincole

Podica senegalensis  
African Finfoot

Tringa ochropus  
Green Sandpiper

Actitis hypoleucos  
Common Sandpiper

Tringa erythropus  
Spotted Redshank

Hirundinidae

Cecropis abyssinica  
Lesser striped swallow

Psalidoprocte obsura  
Fanti Saw-Wing

Hirundo rustica  
Barn Swallow

Hyliidae

Hylopsar purpureiceps  
Green Combec

Indicatoridae

Cecropis semirufa  
Cassin's honeyguide

Prodotiscus insignis  
Red-Eyed Puffback

Dryoscopus senegalensis  
Lagden’s Bush Shrike

Jacanidae

Actophilornis africanus  
African Jacana

Malaconotidae

Malaconotus lagdeni  
Large-Billed Puffback

Dryoscopus sabini  
Sabine’s Puffback

Meropidae

Dryoscopus sabini  
Black Bee-Eater

Merops gularis  
Little Bee-Eater

Merops pusillus  
White-Throated Bee-Eater

Monarchidae

Merops albicolis  
Chestnut-Capped Flycatcher

Macrosphenidae

Sylvietta virens  
Green Hylia

Macrosphenus concolor  
Rufous-Crowned Eremomela

Trochocercus nitens  
Blue-Shouldered Robin-Chat

Muscinipidae

Myiagra castaneigular  
African Forest-Flycatcher, Blue-Headed Crested Flycatcher

Fraseria ocreata  

Macrosphenus concolor  
Rufous-Crowned Eremomela

Trochocercus nitens  
Blue-Shouldered Robin-Chat

Cossypha cyanocampter  
Forest Robin

Stiphrops erythrothorax  
Forest Scrub Robin
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Rostratulidae
- *Rostratula benghalensis*  
  Greater Painted snipe
- *Gallinaga gallinaga*  
  Common Snipe
- *Gallinaga media*  
  Great Snipe

Recurvirostridae
- *Himantopus himantopus*  
  Black-Winged Stilt

Scolopacidae
- *Tringa nebularia*  
  Common Greenshank
- *Tringa tetanus*  
  Redshank
- *Tringa erythropus*  
  Spotted Redshank
- *Tringa ochropus*  
  Green Sandpiper
- *Actitis Hypoleucos*  
  Common Sandpiper
- *Calidris alba*  
  Sanderling
- *Numenius americanus*  
  Whimbrel
- *Limosa limosa*  
  Black-Tailed Godwit

Scopidae
- *Scopus umbretta*  
  Harmmerkop

Strigidae
- *Strix woodfordii*  
  African Wood Owl

Sturnidae
- *Poeoptera lugubris*  
  Narrow-Tailed Starling
- *Hylopsar purpureiceps*  
  Purple-Headed Starling

Zosteropidae
- *Neocossyphus poensis*  
  Pin-Tail Whaydah

**Discussion**

Monitoring the species composition, relative abundance, diversity, and habitats of wetland-dependent birds is crucial for analyzing population trends. This helps to pinpoint and emphasize the primary reasons behind species decline, attributed to increasing pressure from human activities (Arijesuyo, 2011). Altogether, a total of 198 bird species from 44 families were documented during the field survey. Ninety two percent of these bird species were classified as hydrophilic species which were Palearctic migrants. This is consist with (Komar, 2006), (Okosodo & Sarada, 2021) who reported that mangrove wetland bird species are adapted to a semi-aquatic life, being important components of aquatic ecosystems. Additionally, they mentioned that these birds
primarily inhabit areas surrounded by water, where they find sustenance in the form of insects, worms, snails, amphibians, toads, lizards, snakes, mice, and fish. Bos (2009) highlighted the richness of bird populations in wetlands, emphasizing that various bird taxa worldwide extensively utilize wetlands and their resources. He further noted the diverse adaptations of birds to exploit wetlands and other aquatic environments, encompassing anatomical, morphological, and behavioral changes. The study area sustains bird species despite the prevalence of human activities such as fishing, gathering firewood, and engaging in small-scale arable farming. This observation aligns with findings by Nabeelah Bibi et al. (2019), who noted that the term "Mangal" encompasses mangrove forest communities along with other living components like microbes, fungi, animals, and other plants associated with mangroves. Mangroves serve as valuable sources of various products including honey, medicinal resources, food, and as important habitats and breeding grounds for bird species and other wildlife species. This corresponds with findings from previous research indicating a significant abundance of preferred food resources in wetland forests. The cultivated land offers vital foraging opportunities for numerous European farmland bird species (Robinson et al., 2001). Vegetation other than crops within the study fields serves as a crucial source of seeds and, equally importantly, attracts insects. (Marshall et al., 2003). Different categories of bird species appear to exhibit varied responses to changes in land use (Matlock Jr. et al., 2003). For instance, insectivorous birds are known to demonstrate pronounced reactions to alterations in land use patterns. In annual agricultural areas, there was a 50% reduction in the mean number of insectivorous bird sightings per visit compared to control areas. It has been noted that the size of an area plays a significant role in determining the density of bird species per square kilometer, with larger areas generally hosting fewer bird species per unit area (Robinson et al. 2001). The Shannon diversity index indicated high diversity levels across both seasons, with most resident species being present throughout the year. Most the migratory bird species utilizes the area on annual basis, the reason the lagoon stretch is relative undisturbed and empty into the gulf of Guinea. Mangroves are also known as tidal forests, marine forests, marsh forests, or ocean rain forests (Naidoo, 2016). Pearson (2011) found that tropical mangrove wet evergreen forests harbor a greater number of uncommon bird species compared to other types of habitats (Mohd-Azlan, et al., 2012) observed that birds choose vegetation characteristics based on how a particular habitat influences their access to food, potential mates, or susceptibility to predators. This aligns with the notion that modifying habitats and altering population compositions can impact avian populations.
The present study suggests a positive correlation between the number of recorded bird species and the proportion of different land use types.

**Conclusion**

This research revealed that the Epe mangrove forest boasts a high density and diverse range of bird species, making it a crucial habitat for both native and migratory birds. The local government should design ecotourism activities that minimize disturbance to bird populations and their habitats thereby increasing that internal generated revenue (IGR) of the council. Develop educational programs to raise awareness about the importance of avifauna conservation among tourists and local communities. Incorporate bird watching tours and interpretive signage along designated trails to enhance visitor experiences while promoting conservation awareness. Establish a monitoring program to track changes in avifaunal populations and habitats over time. Collaborate with local stakeholders, including government agencies, NGOs, and community groups, to implement conservation actions and adaptive management strategies. Periodically review and update management plans based on new research findings and changing environmental conditions.

**Acknowledgements**

The authors extend their sincere appreciation to the Staff and Management of Epe Local Government Area in Lagos, with special gratitude towards the Director of the Forestry Department, for their invaluable support throughout the study duration. Additionally, we express our gratitude to the local residents whose assistance was indispensable during the data collection phase.

**References**


