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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*, N*esogordoniapapaverifera*, *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 of 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 area the support 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

Diversity index	Dry season	Lower	Upper	Wet season	Lower	Upper
	198	189	198	164	154	164
Individuals	481	481	481	323	323	323
Dominance_D	0.005615	0.006678	0.007845	0.006336	0.007831	0.009096
Shannon_H	5.244	5.054	5.135	5.083	4.874	4.964
Evenness_e^H/S	0.9572	0.8145	0.8664	0.9837	0.8359	0.8849
Brillouin	4.685	4.534	4.598	4.439	4.282	4.346
Menhinick	9.028	8.618	9.028	9.125	8.569	9.125
Margalef	31.9	30.44	31.9	28.21	26.48	28.21
Equitability_J	0.9917	0.9611	0.9728	0.9968	0.9646	0.9759
Fisher_alpha	125.9	114.7	125.9	133.2	115.4	133.2

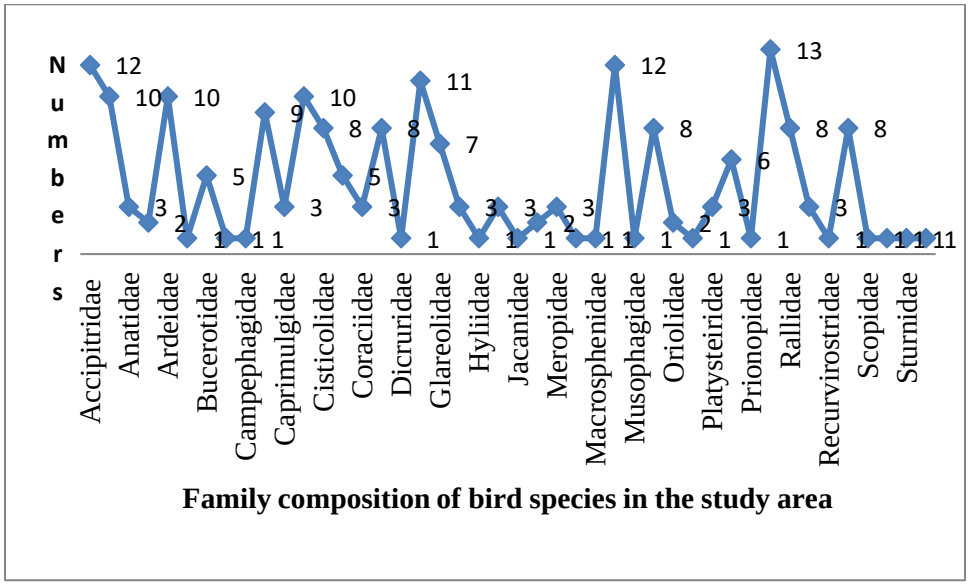

Figure 2. Family composition of bird species in the study area

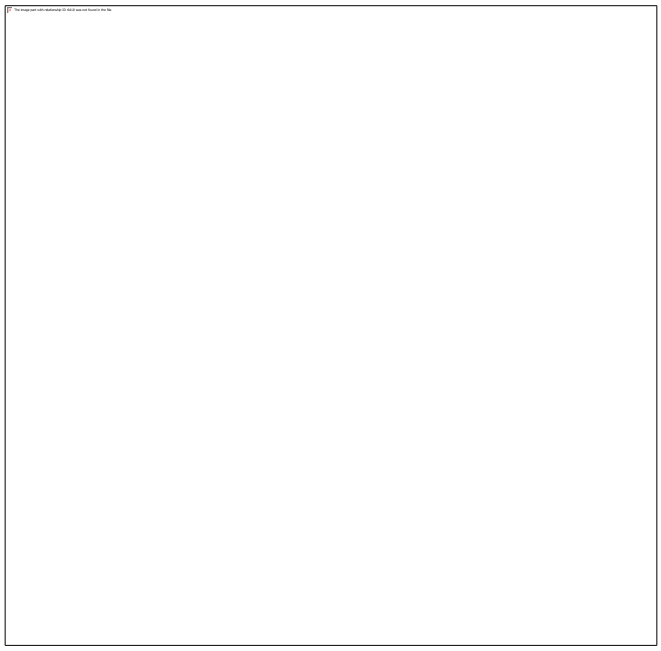

Figure 3. SHE analysis of bird species in the study area

Table 2. Checklist of bird species in the study area

Family	*Scientific Name*	Common Name
Accipitridae	*Aquila Africana*	Cassin's hawk Eagle
	Kaupifalco onogrammicus	Lizard Buzzard
	Hieraaetus wahlbergi	Wahlberg's Eagle
	Milvus aegyptius	Yellow Bill Kite
	Circus ranivorus	African Marsh HarrierC
	Circus pygargus	Montagu's Harrier
	Dryotriorchus spectabilis	Congo Sepent Eagle
	Gabar Goshawk	Milcronissus gabar
	Circaetus gallicus	Short Toed Snake Eagle

	Falco cuvierii	African Hobby
	Falcobiarmicus	Lanner Falcon
	Polyboroides typus	African Harrier Hawk
Alcedinidae	*Ceyx lecontei*	African Dwarf Kingfisher
	Halcyon badia	Chocolate-Backed Kingfisher
	Halcyon malimbica	Blue-Bresated 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
	Lsobrychus minutes	Little Egret
	Nycticorax nycticorax	Black Crowned Night Heronr
	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 minutes	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
	Tropicranus alpocristatus	white-Crested Hornbill
Burhinidae	*Burhinus senegalensis*	S3enegal Thick Knee
Campephagidae	*Horizocerus albocristatus*	Blue Cuckoo Shrike
Capitonidae Lybiidae	*Cyanograucalus 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
	Macrodipterys longipenis	Standard Winged Nightjar
	Caprimulgus nigriscapularis	Black-Shouldered Nightjar
Charadriidae	*Charadrius marginatus*	White-Fronted Plover
	Charadrius tricollaris	Three Banded Plover
	Charadriusforbesi	kittlitzs Plover
	Pluvianus aegyptius	Egyptuan Plover
	Charadrius pecuarious	Common Ring Plover
	Charadrius hiaticula	Kentish Plover
	Charadrius alexandrines	Lesser Black Winged Lapwing
	Vanellus lugubris	Spur Winged Lapwing
	Vanallus spinosus	African Wattled Lapwing
	Vanallus senegallus	Black-Shouldered Nightjar
Cisticolidae	*Bathmocercus 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	Llaughing 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 mechowi	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
	Psalidoprocne 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*	Aafrican 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 albicollis*	Chestnut -Capped Flycatcher
Macrosphenidae	*Sylvietta virens*	Green Hylia
Muscicapidae	*Myiagra castaneigular*	African Forest-Flycatcher,
	Fraseria ocreata	Blue- Headed Crested Flycatcher
	Macrosphenus concolor	Rufous- Crowned Eremomela
	Trochocercus nitens	Blue- Shouldered Robin- Chat
	Cossypha cyanocampter	Forest Robin
	Stiphrornis erythrothorax	Forest Scrub Robin

	Eremomela badiceps	Fire Crested Alethe
	Geokichla prince	White-Tailed Alethe
	Cercotrichas leucosticte	Lowland Akalat
	Sheppardia cyornithopsis	Pied Flycatcher
	Alethe castanea	Grey Ground Thrush
	Ficedula hypoleuca	Sooty Flycatcher
Musophagidae	*Muscicapa infuscate*	Guinea Turaco
Nectariniidae	*Tauraco persa*	Olive-Bellied Sunbird
	Cinnyris chloropygius	Buff-Throated Sunbird
	Chalcomitra adelberti	Collard Sunbird
	Hedydipna collaris	Green-Headed Sunbird
	Cyanomitra verticalis	Reichenbach1's Sunbird
	Anabathmis reichenbachii	Splendid Sunbird
	Sheppardia cyornithopsis	Supberb Sunbird
	Cinnyris coccinigastrus	Variable Sunbird
Oriolidae	*Cinnyris venustus*	Western Black-Headed Oriole
	Oriolus larvatus	Black-Winged Oriole
Phoeniculidae	*Oriolus hosii*	Forest Wood- Hoopoe
Platysteiridae	*Phoeniculus castaneiceps*	Chestnut Wattle-Eye
	Platysteira castanea	African shrike-flycatcher
	Megabyas flammulatus	Common Wattle-Eye
Ploceidae	*Platysteira cyanea*	Red- Headed Malimbe
	Malimbus rubricollis	Velliot's Black Weaver
	Ploceus nigerrimus	Red-Vented Malimbe
	Malimbus scutatus	Yellow Mantted Weaver
	Ploceus tricolor	Village Weaver
	Ploceus cuculatus	Ibadan Malimbe
Prionopidae	*Malimbus ibadanensis*	Red Billled Helmet-Strike
Pycnonotidae	*Prionops caniceps*	Ansorge's greenbul
	Eurillas ansorgei	Red-Tailed Bristlebill
	Bleda syndactylus	Common Bulbul
	Pycnonotus barbatus	Green-Tailed Bristlebill
	Bleda eximius	Honeyguide Greenbul
	Baeopogon indicator	Icterine Greenbul
	Phyllastrephus icterinus	Little Greenbul
	Threcelocichla leucopleura	Swamp Palm Bulbul
	Eurillas virens	Plain Greenbul
	Eurillas curvirostris	Simple Greenbul
	Chlorocichla simplex	Red-tailed leaflove
	Phyllastrephus scandens	Western Nicator
	Nicator chloris	Yellow Whiskered Greenbull
Rallidae	*Eurillas latirostris*	White Spotted Flutail

	Sarothrura pulchra	Common Moorhen
	Gallinula chloropus	Allen's Gallinlule
	Crecopsis egregia	African Crake
	apornia flavirostra	Black Crake
	Himantornis haematopus	Nkulengu Rail
	Canirallus oculeus	Grey Throated Rail
	Sarothrura pulchra	White Spotted Flutail
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	Blacк-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.

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