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ASSESSING BIRD SPECIES ABUNDANCE AND DISTRIBUTION FOR BIRDSTRIKE RISK MANAGEMENT AT MAKURDI AIRPORT, BENUE STATE, NIGERIA

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Abstract

Birdstrikes, or collisions between aircraft and birds, represent a critical challenge to Aviation safety and operational efficiency. This study investigates birdstrike risks at Makurdi Airport, Nigeria, with the objectives of assessing bird species abundance and distribution, evaluating birdstrike occurrences, and ranking species by their Aviation Risk Safety Value (ARSV). Field surveys using the line transect method recorded 21 bird species across four transects, revealing significant variations in species abundance and diversity. The Rufous-cane Warbler emerged as the most abundant and high-risk species. Existing mitigation measures, including habitat modification and scaring techniques, were assessed, highlighting the need for species-specific strategies. Recommendations include real-time bird activity monitoring, habitat alterations, and tailored deterrence methods to effectively mitigate birdstrike risks.

Keywords: Bird strike, Species diversity, Aviation safety, Habitat management, Makurdi Airport

INTRODUCTION

Birdstrikes, defined as collisions between aircraft and birds during any phase of flight, represent a significant and ongoing safety issue for the aviation industry. With the global rise in air traffic, the likelihood of such incidents has also increased (Hedayati and Sadighi, 2015). These strikes primarily occur during takeoff and landing, when aircraft operate within the low-altitude airspace frequently used by birds (Juračka *et al*., 2021). The resulting collisions can inflict severe damage on vital aircraft components such as electromagnetic dome, wing leading edges, and engines, posing risks to both safety and operational efficiency (Metz *et al*., 2021). The impact is not limited to commercial aviation but also extends to military operations, where bird strikes disrupt missions and increase maintenance costs.

Historically, bird strikes have played pivotal roles in aviation safety advancements. A prominent example is US Airways Flight 1549, famously known as the "Miracle on the Hudson." In January 2009, the aircraft suffered dual engine failure after colliding with a flock of Canada geese, necessitating an emergency landing on the Hudson River (Wrigley, 2018). The first recorded bird strike, however, dates back to 1905 and was documented by the Wright brothers (Coban and Bahar, 2018).

In Nigeria, bird strikes remain a pressing concern for the aviation sector. For instance, a Dana Air MD-83 aircraft suffered engine failure following a bird strike at Murtala Muhammed Airport in Lagos, resulting in an emergency return to the airport (Egwumah *et al*., 2018). Between 2005 and 2010, the Nigerian Civil Aviation Authority (NCAA) reported 209 bird strike incidents, accounting for 24% of aviation accidents and costing airline operators approximately N15 billion annually (Haruna, 2011). Bird activity near airports is influenced by several factors, including the availability of food, water, breeding sites, and inadequate vegetation management. These elements create attractive environments for birds, increasing the risk of bird-aircraft collisions.

Understanding bird behavior in airport environments requires an integration of ecological theories and risk management principles. McNamara *et al*. 2011 proposed a method to predict organisms' optimal survival strategies by utilizing environmental characteristics and cues. This framework emphasizes the importance of environmental cues and timing in influencing animal behavior, which can be applied to predict bird activity patterns around airports. Additionally, the concept of habitat selection theory suggests that birds choose habitats based on resource availability and safety from predators. Airports, with their expansive grasslands and minimal human disturbance, can inadvertently provide such habitats, attracting various bird species. Blackwell *et al*., 2013) discussed the conflicting priorities in managing airport grasslands to balance aviation safety and wildlife conservation. Recent studies on bird activity at airports focus on radar monitoring, habitat management, and species-specific behavior. Avian radar systems enhance real-time tracking, but their long-term reliability needs further research. Habitat modification, such as vegetation control, reduces bird presence, yet standardized guidelines are lacking. Species-specific studies remain limited, despite certain birds posing higher risks due to their flight patterns and adaptability. Further research is needed to refine mitigation strategies and establish best practices for minimizing bird hazards at airports. This study seeks to address the issue of bird strikes at Makurdi Airport by assessing the abundance and distribution of bird species in the vicinity of Makurdi Airport. Evaluating birdstrike occurrences and identifying the species involved. Ranking surveyed bird species by their Aviation Risk Safety Value (ARSV) and proposing cost-effective and sustainable mitigation strategies to minimize birdstrike risks.

MATERIALS AND METHODS

Study Area

Makurdi Airport, located in Makurdi, Benue State. The geographic coordinates of this airport are 7º42’14’’ North and 8º36’50’’ East. Makurdi Airport is 113m above sea level. The Airport commenced operations in 1983; The Airport was both for military and civilian use but presently all civilian activities including staffs of Federal Airport Authority Makurdi are bound from the runways. The length of the runway is 2996m and the surface is concrete.

Climate

Makurdi's climate features two distinct seasons: a dry season (November to April) and a wet season (May to October), with peak rainfall occurring from late July to September. Temperatures range from 39.4°C (maximum) to 18.4°C (minimum), with an annual rainfall of approximately 1,238 mm and relative humidity above 78% (NIMET, 2017).

Methods

Birds census techniques

The study was conducted over a six-month period, covering both the rainy and dry seasons, to account for seasonal variations in bird activity. Four line transects, perpendicular to the runway, were established to cover the airport's vegetation. Transect lengths varied, with Transect 3 measuring 2,996 m, transect 1 measuring 900 m, transect 2 measuring 220 m, and Transect 4 measuring 120 m, with each transect extending 50 m on either side.

Bird censuses were conducted from 7:00–11:00 AM and 4:00–6:00 PM, aligning with peak bird activity periods when many species are most active for foraging and movement (Egwumah *et al.*,2018). These timeframes ensure a higher probability of detecting a broad range of species. Observations were made using 10×50 Vortex binoculars and included species identification, activity, and abundance. Identification was aided by a field guide (Borrow and Demey, 2014). To complement direct observations, secondary data were obtained from the Federal Airport Authority's Wildlife Hazard Control Unit.

Data analysis

Species diversity was calculated using the Shannon-Weaver Index (1963). Bird strike risk was ranked using the Aviation Risk Safety Value (ARSV) as outlined by the International Bird Strike Committee (IBSC, 2002) and adopted by Egwumah *et al.*, 2018).

RESULTS AND DISCUSSION

Bird Species Composition

Figure 1 shows that a total of 21 bird species from 15 families were recorded during the survey. The Rufous-cane Warbler was the most abundant species, with 35 Thirty-Five individuals observed, while the Senegal Coucal was the least abundant, with only 4 four individuals recorded.

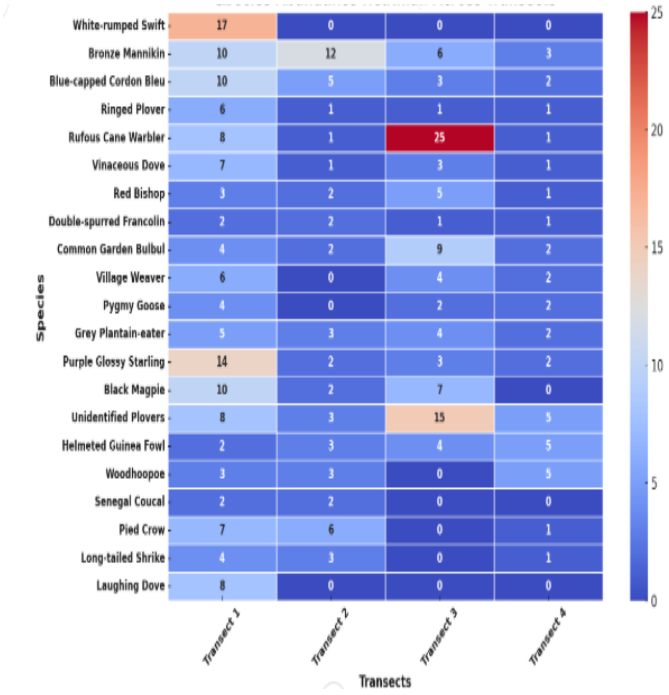

Figure 1 Bird Species Abundance Heatmap across Transect at Makurdi Airport

Species Diversity and Evenness Indices

Table 1 shows that species diversity varied across the transects, with Transect 1 exhibiting the highest Shannon Diversity Index (H' = 2.88) and Transect 3 showing the lowest (H' = 2.37). Species evenness values ranged from 0.85 to 0.95, indicating a relatively balanced distribution of species across the study area.

Table 1: Species Diversity and Evenness Indices

Transect	Shannon Index (H')	Species Evenness (E)
1	2.88	0.95
2	2.59	0.91
3	2.37	0.85
4	2.70	0.93

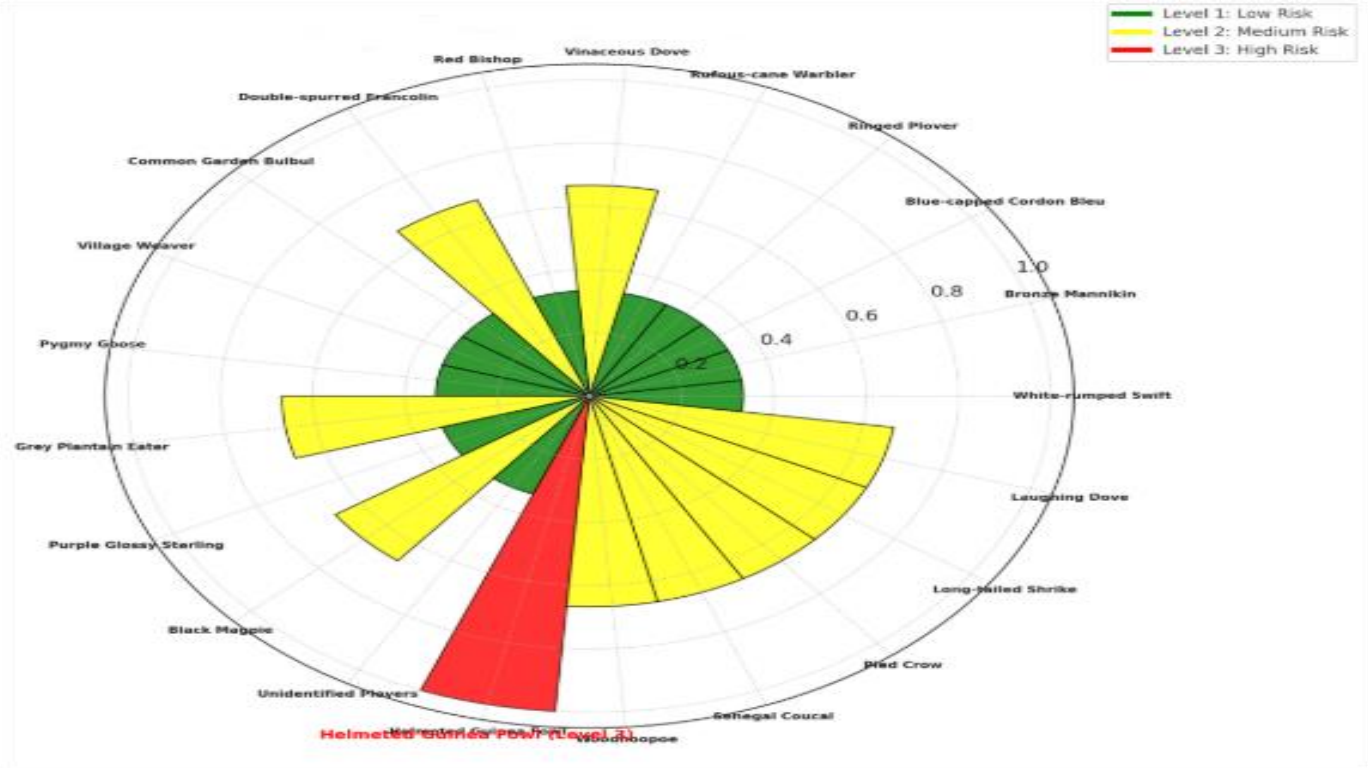

Figure 2: Radial chart showing the distribution of bird species across the different ASRV levels

Table 2: Secondary Data from Airport Authority

Department	Number of Bird Strikes Reported	Most Frequent Species Involved	Mitigation Measures Implemented
Wildlife Hazard Control Unit	5	Unknown	Habitat modification Scaring techniques

Source: FAAN Makurdi, 2024

Discussion

The study evaluated bird species abundance and distribution around Makurdi Airport, Benue State, with implications for birdstrike risk management. A total of 21 bird species from 15 families were identified, highlighting the rich avian biodiversity in the vicinity of the airport. The Rufous-cane Warbler, with 35 individuals observed, was the most abundant species, while the Senegal Coucal, with only 4 individuals, was the least.

Bird species diversity indices revealed notable spatial variation across the transects. Transect 1 exhibited the highest Shannon Diversity Index (H′=2.88H' = 2.88H′=2.88), indicating greater species richness and evenness compared to Transect 3 (H′=2.37H' = 2.37H′=2.37). The relatively high evenness values (ranging from 0.85 to 0.95) suggest that species were uniformly distributed across the study area, reducing the dominance of any single species in most transects. However, this balanced distribution poses a challenge to risk management as a variety of species might contribute to birdstrikes, rather than a single dominant one.

While five birdstrike incidents were recorded by the Wildlife Hazard Control Unit, the lack of species-specific identification limits the ability to implement precise mitigation strategies. Future studies should incorporate carcass recovery and genetic identification methods to ascertain high-risk species more accurately (Allan, 2000). Additionally, bird activity hotspots identified in Transect 1 and Transect 3 should be prioritized for enhanced mitigation efforts.

Comparing the findings from Makurdi Airport with similar studies at other airports reveals consistent patterns in bird activity influencing birdstrike risks. For instance, studies at Lagos and Kano Airports (Adeniran *et al*., 2020) report high bird diversity near runways, with starlings and plovers frequently involved in birdstrike incidents. Similarly, global research (Dolbeer, 2011) emphasizes that airports in savanna and grassland regions experience heightened bird activity due to habitat suitability. The observed risk levels at Makurdi align with these findings, indicating a broader trend where grassland-dwelling and open-field species pose persistent threats to flight safety. However, variations in species composition highlight the necessity of location-specific risk assessments (Blackwell and Seamans, 2011).

The Aviation Risk Safety Value (ARSV) ranking based on species abundance and activity near the airport identified the Rufous-cane Warbler, Purple Glossy Starling, and Unidentified Plovers as high-risk species due to their abundance and potential to interfere with flight operations. Risk mapping (Figure 1) further highlighted critical areas where these species are concentrated. For instance, transect 1 and transect 3 exhibited significant bird activity, necessitating intensified mitigation measures in these zones.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Bird strikes continue to pose a significant safety and economic challenge to the global aviation industry, with particularly severe implications for regions like Nigeria, where birdstrike incidents account for a substantial proportion of aviation accidents. The findings highlight the need for a proactive and data-driven approach to birdstrike risk management, incorporating species identification, ranking by Aviation Risk Safety Value (ARSV), and targeted mitigation strategies.

Recommendation

The findings emphasize the need for comprehensive birdstrike risk management strategies that incorporate real-time monitoring of high-risk species and their

movements, The Proposed strategies include utilizing radar and visual observation tools to monitor bird activity in real time. Altering habitats discourages high-risk species from frequenting critical airport zones.

Deploying tailored deterrence techniques, such as bioacoustics or falconry, to address the behaviours of species like the Rufous-cane Warbler.

Training airport personnel to identify high-risk species and implement mitigation protocols effectively.

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