

# Aircraft flight safety and birds strikes management in Aminu Kano International Airport, Nigeria

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**Abstract.** Aircraft flight collision with bird is a threat to aviation industry in most global large commercial airports, according to international aviation's report. For instance, John F. Kennedy International (New York) tops the list of Federal Aviation Administration (FAA) report data in which aircraft suffered serious damage with 80 from 1990 to mid-2008. The study examined the frequency, period of the year, birds species and aircraft models involved in flight collision with bird around Aminu Kano International Airport in Nigeria. Data were sourced from oral interview, personal observation and questionnaire administration to the port authority and the villages at the airport periphery. The study reveals that twelve (12) bird species were involved in forty four (44) strikes at the airport between the year 2001 to 2010 and mostly during the rainy seasons. Distribution of these strikes by flight stage indicated that 32, 25 and 20% occurred on approach, landing roll, and takeoff stage respectively, while the remaining 23% occurred at other phases. Using the International Bird Strike Committee strike rate (per 10,000 flights), the computed strike rate for this airport is 8 per 10,000 flights. It is therefore recommended that 'Bird Strike Avoidance Radar' equipment is to be installed at major airports in the country, while land uses like cereal farming that attracts birds around the airport be discouraged.

**Keywords:** Aviation safety, airport management, bird strikes, birds ranking, hybrid turboprop aircraft.

## INTRODUCTION

In December 1903, the first powered flight was said to be airborne, while the first reported bird strike occurred on 7 September, 1905 as recorded by Oliver Wright in his diary, when his aircraft hit a red-winged blackbird as he flew over a cornfield near Dayton Ohio. The first person to die as a result of bird strike on 3<sup>rd</sup> April, 1912 was Calbraith Rodgers when his aircraft struck a gull along

boards the aircraft with the intention of flight until such time as all such persons have disembarked, where a person is fatally or seriously injured, the aircraft sustains damage or structural failure or the aircraft is missing or is completely inaccessible (IIS, 1994).

An analysis of the time and rate of bird strike incidents, species composition, number of birds involved in strikes



**Figure 1.** Location and approach view of Aminu Kano International Airport, Kano, Nigeria.

The onset of the jet age revolutionized air travel, but magnified the bird strike problem. Early piston-powered aircraft were noisy and relatively slow which enhances birds' avoidance of these aircraft, and should any strikes occur, there is little or no damage. However, modern jet aircraft are faster and relatively quiet, and their engine fan blades are often more vulnerable than propellers to wildlife-strike damage. When turbine-powered aircraft collide with birds, serious structural damage and engine failure can occur. A bird strike, identified as the collision between bird and aircraft, has been the cause of many accidents in air travel and in Nigeria it has severely threatened safety and led to aircraft damage that cost the airlines of over US\$0.123 billion annually. The Federal Airports Authority of Nigeria (FAAN) stated that, in 2006 bird strikes caused 115 incidents that accounted for 17.4% of the total air incidents that year.

### **Aim and objectives**

This study is aimed at examining the incidence of bird strike in one of the Nigeria's major international airport to equip the policy makers for the purpose of enhancing aviation safety through the following objectives:

i) Assess the level of bird strike occurrence and the species.

in Nigeria commenced operations in 1936. Proceeding this year, Kano recorded the first ever aviation operation in the country when a Royal Air Force aircraft operated by the British colonialist landed in the city at a polo ground in 1925. This reconnaissance flight during the World War I later developed into regular military flights. The standardization of the airport development actually started in 1930s, thus transforming the city of Kano into a veritable hub rivalled only by Khartoum in the continent. The historical status and the operation functionality of the airport made it to be crowned the Kano Flight Information Region (FIR), see the front view of the airport in Figure 1. In fact, the airport play hosts to KLM the longest-serving foreign airline in Nigeria which started operations since 1947 and since 1957, the airport has been operating for 24 h with Comet 15, DC-6 and Argon flights becoming the first to use the main runway. Major international flights and Muslim pilgrimages to Mecca in the northern Nigeria are from Kano airport.

As an international airport, it has two runways (06/24 and 05/23) that are used for public and military flights respectively. Commuting aircrafts include: B747, A310, DC-10, Lj45, C550, HS125, Fokker100, D225, DASH-8, TB-9, C201 etc. The airport has cargo balloon sheds operated by Nigerian Aviation Handling Company (NAHCO) and Sky Power Handling Company Limited (SAHCOL) and they both uses up to date cargo handling

**Table 1.** Annual aircraft accident records globally (ACRO, 2012).

| Year | No. of death | No of accident |
|------|--------------|----------------|
| 2012 | 794          | 119            |
| 2011 | 828          | 117            |
| 2010 | 1,115        | 130            |
| 2009 | 1,103        | 122            |
| 2008 | 884          | 156            |
| 2007 | 971          | 147            |
| 2006 | 1,294        | 166            |
| 2005 | 1,459        | 185            |
| 2004 | 771          | 172            |
| 2003 | 1,230        | 199            |
| 2002 | 1,413        | 185            |
| 2001 | 4,140        | 200            |
| 2000 | 1,582        | 189            |
| 1999 | 1,138        | 211            |

strike occurred on 4<sup>th</sup> October, 1960 when a Lockheed L-188 Electra flew through a flock of starlings during take-off which damaged all the four engines. The aircraft crashed into Boston Harbour U.S.A, killing 62 out of the 72 passengers. In fact, according to Thomas 1990, on the average, aircraft crashes every eighteen months as a result of bird strike related incidents.

Airport wildlife hazard management is a science itself and is based upon a thorough understanding of the airport environment and the problem species. In South Africa a unique partnership exists between the Airports Company of South Africa (ACSA) and the Endangered Wildlife Trust (EWT). The aim of this partnership is to minimise bird strikes and other interactions between wildlife and airport facilities at ACSA airports by applying environmentally sensitive management techniques. Research is focussed on finding the most applicable and practical wildlife hazard solutions for airports in an African environment.

For instance, African vultures are said to be among the largest flying birds today, with wingspans up to three meters and weights up to 11 kg. They are famous for their ability to ride high above ground level in thermals, perhaps on occasions up to 10,000 m above sea level, and they may even take advantage of jet streams. At least one species has a unique form of haemoglobin

for comparison with their data. This approach may be invaluable in identifying and documenting birds in Kano and its environs. They presented results in a systematic list (as indicated below) that summarizes observations for 165 species. A total number of species observed during the Lake Chad Bird Migration Project was 311, out of which 105 were pale arctic migrants. At least 4 species occurred with both resident and Palearctic subspecies (Black Kite, Hoopoe, Rufous Scrub-Robin and Olivaceous Warbler).

In a study conducted by Woronecki et al. (1992) and the U.S. Food and Drug Administration (FDA) on safety, efficacy and clinical trials required to register alpha-chloralose (A-C) for capturing nuisance waterfowl and pigeons, they carried out 11 field trials in 4 states, capturing 587 waterfowl and 1,370 pigeons with 8% mortality for ducks, 0% for geese, and 6% for pigeons thereby discovering the Most Effective Dose (MED) to be 30 and 60 mg of A-C/kg of body weight for capturing waterfowl and pigeons, respectively.

In the USA, wildlife-aircraft collisions (wildlife strikes) pose safety risks to aircraft and cost civil aviation over \$390 million annually. Barras and Seamans, (2002) reviewed published studies to summarize findings on habitat management techniques that have shown potential for wildlife strike reduction. Habitat components

**Table 2.** The main advantages and disadvantages of approaches to model a bird (Alexander et al., 2006).

| Model      | Advantages   | Disadvantages   |
|------------|--|---|
| Lagrangian | Low CPU time, wide choice of the contact algorithms. | Mesh distortion, eroding nodes moves independently from each other.   |
| SPH        | Mesh-free method, no mesh distortion                 | Impossible to describe the contact between the bird and blade's edge. |
| ALE        | No mesh distortion                                   | High CPU time, requires high number of ALE cells.                     |

Source: Alexander et al. (2006).

mowed vegetation plots (40 to 88 ha) at John F. Kennedy International Airport (JFK), New York, in 1998 and 1999 to determine which management strategy would best reduce wildlife use of the airport. They counted more birds per 5-min observation period in unmowed plots than mowed plots in both 1998 (9.0 versus 7.9) and 1999 (11.7 versus 8.6). Maximum vegetation height was greater ( $P < 0.05$ ) for unmowed areas than mowed areas after mowing commenced in 1998 and 1999 for each two-week monitoring period. In 1998 and 1999, vegetation density was also higher ( $P < 0.05$ ) for unmowed plots for 13 of 14 sampling periods. The species composition of vegetation differed ( $\chi^2 = 20.54$ ,  $df = 3$ ,  $P < 0.01$ ) among mowed and unmowed plots. Mowed plots contained a higher percentage of grasses (81% versus 68%), and a lower percentage of forbs (16% versus 25%) and woody plants (1% versus 4%) than unmowed plots.

Vegetation was generally sparse in both unmowed and mowed plots, a consequence of the poor, sandy soils on much of the airport. Thirty-three small mammals were captured from three species in unmowed plots and 12 individuals of one species in mowed plots in 1999. Small mammal populations increased seasonally in unmowed plots, but remained constant in mowed plots over the same time period. They recommended that JFK switch from the unmowed vegetation management regime in place since 1986 to a regime of maintaining vegetation mowed at 15 to 25 cm in height. This management strategy should reduce bird and small mammal use of grassland areas at JFK. They concluded by recommending further research to examine the use of alternative vegetation types to improve ground cover and vegetation density at JFK while minimizing attraction to

SPH model, see comparison in Table 2), as a tool to investigate the consequences of a bird strike and penetration inside the airframe of a turbofan intake. Eventually, a model particularly suitable to analyze such a complicated event, namely the SPH model, has been identified. This model is deemed reliable and feasible to be used to accurately analyse the dynamics of the event and, hence, to be used as part of a methodology to design high-efficiency bird-proof structures.

Also according to Alexander et al. (2006), in SPH calculation the contact between the bird and blades is based on NODES\_TO\_SURFACE contact algorithm and the total CPU time for SPH calculation is eight hours as presented in Figures 2 and 3.

According to Beason (2006), assessment of wildlife hazards to aviation in the airport environment is typically initiated by conducting a Wildlife Hazard Assessment (WHA). Ecological relationships between wildlife populations and habitat are usually discerned through observations during the course of one annual cycle. He opined that proximate hazards, on the airport, are well defined during the WHA process, however, off-airport features also can attract wildlife. Wildlife species can transit airport property travelling to and from habitat attractants. During a WHA, common wildlife sampling techniques are employed to determine species, their approximate numbers, and through association an index of potentially attractive habitat. Continuous observations could provide a more complete picture but would require greater sampling effort. Radar, Beason argued, is a tool that has demonstrated efficacy to automatically monitor wildlife at greater distances than can be achieved through traditional techniques. Modern systems also have the ability to record a variety of spatial and temporal variables

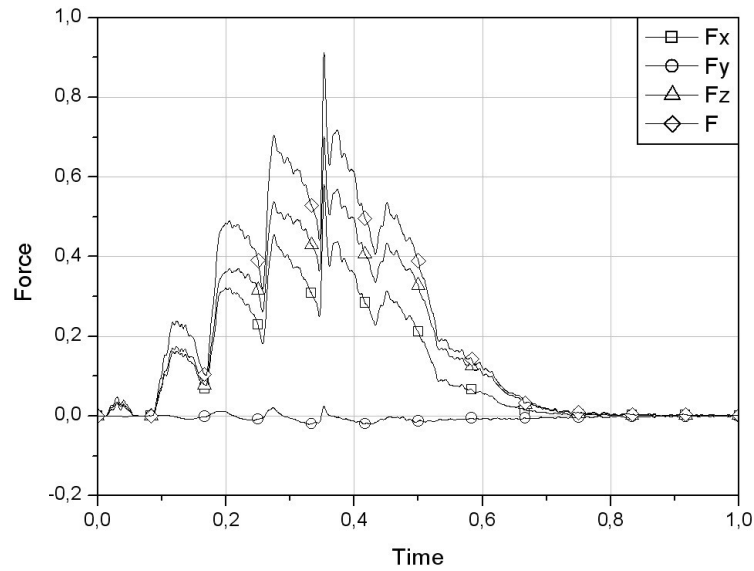


Figure 2. Forces of the contact interaction of the bird and blade (SPH).

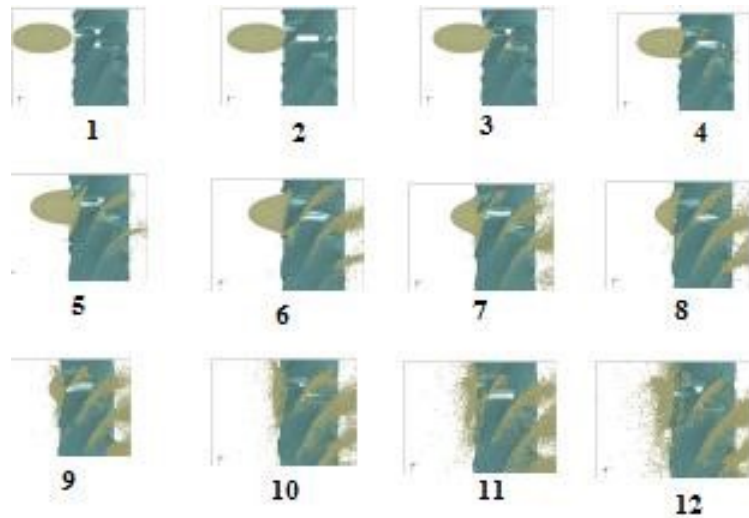


Figure 3. Sequential views of the interaction of the bird and blades (SPH).

migrants include 171 Palaearctic, 55 Afro tropical and four Malagasy migrant species. Non-migrant species are very mobile as well. The bulk of migratory birds visiting or passing through Kenya use the Rift Valley, coast, eastern

an attempt to rectify the situation, aspects of the feeding ecology of birds presenting a potential hazard at the airport were investigated (Kok and Ordino, 2002). Plant surveys indicated that the study area can be classified as

**Table 3.** Sampled villages and their sample size.

| Village            | Population | Sample size |
|--------------------|------------|-------------|
| Jaba               | 10,000     | 60          |
| Dan Rimi           | 8,000      | 50          |
| Takokey            | 6,500      | 40          |
| Bukavu Barrack     | 5,000      | 30          |
| Rimaye             | 5,000      | 30          |
| FAAN Quarters      | 4,000      | 25          |
| Takurza            | 3000       | 20          |
| NAF Base           | 3000       | 20          |
| Zango              | 2500       | 15          |
| Police Barrack     | 2500       | 15          |
| Kumantaka          | 2300       | 15          |
| NAF Medical Centre | 1000       | 10          |
| Sabon Birni        | 500        | 5           |
| Kanyan Amana       | 350        | 5           |
| Rafin Mallam       | 250        | 5           |
| Alafa              | 200        | 5           |

carrier, experienced over 34 incidents of bird strike attacks on its aircraft, costing the management over N3.2 billion to fix its aircraft struck by birds. Another operator (Dana Air) lost over N270 million in 2010 due to the attack of birds on its aircraft. Harold Demuren, Director General of the Nigerian Civil Aviation Authority (NCAA), had in June 2010 lamented that bird strike incidents account for over 40 percent of all incidents that occur within the airports, adding that the Mallam Aminu Kano International Airport, is among the list of airports where aircraft engines and other parts had been badly damaged by such occurrence (Dumerun, 2010). Over 850 species of birds have been documented in the country (Shobakin, 2009).

Gustafson et al. (2003) reviewed the status of the avifauna in extreme northeast Nigeria based on observations made from 1997 to 2000. A total of 311 bird species were encountered, of which 105 were Palearctic migrants. Eight birds new to Nigeria were observed and several others new to the area were found to be more common than earlier thought. They compared their observations with those from the 1960s, when the area was intensively studied, and noted several sharp declines. Among such declines are the disappearance of colonies of herons, egrets and cormorants; this is related

competition for water.

## METHODOLOGY

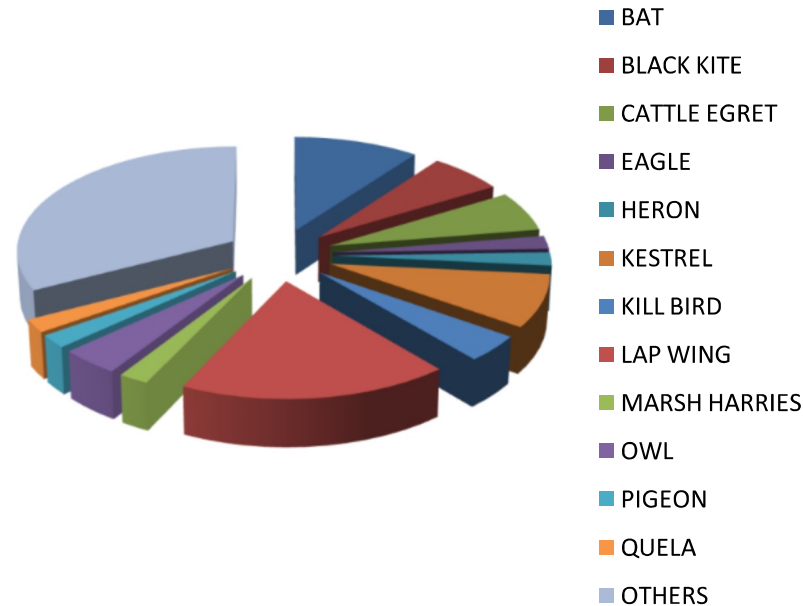
This study uses questionnaire survey and field observation as the main instrument employed to source for primary data. Two sets of questionnaires that focused on the character of the birds, the environmental conditions and agricultural practices within a radius of 15 km from the airport that attracts birds to feed, nest, or roost at or within the vicinity of the airport environment were designed and administered to the flight crew members and neighbouring communities around the airport. Table 3 shows the list of villages covered in the study.

Observatory survey was carried out around the taxiway, the two runways (06/24, 05/23), apron as well as the approach and climb out area of the airport. Other areas surveyed using slow driven car include the airport perimeter fencing, water hydrant and refused dump sites.

Secondary data were collected from the staffs of FAAN in the Wild Life Hazard Control Unit, Environment and Airport Safety Management System Departments. Others include Airline Operational staff, Aviation Fire and Rescue Services and Air Traffic Controllers and some members of the Airport Bird/Wildlife Hazard Control Committee. In addition two local bird 'experts' from the neighbouring villages of Jaba and Fanisau were also interviewed particularly on the character, population, size, and behaviour of local and migratory bird species.

## Data analysis techniques

In evaluating and rank the risk of bird strikes specie, the Aviation Safety Ranking Value [ASRV] postulated by International Bird Strike Committee (IBSC, 2002) was used. This ranking value separates birds into five levels according to the potential impact and cost to aircraft. Level 1 without significant impact on air traffic safety, Level 2 has low potential danger, Level 3 intermediate potential danger; Level 4 has high potential danger, while Level 5 has very high potential danger. These levels are evaluated based on size of each bird species (mainly weight), the social pattern and behaviour of the species, and its movements (short and long distance) and the



**Figure 4.** Bird Strike according species 2001 to 2010.

species are common in this part of the country and that twenty two of them are residents while five are migrants. The character, behaviour, and size of these birds also differ from specie to specie. The study also reveals that twelve bird species were involved in bird strikes from 2001 to 2010, and that Lapwing species has the highest strikes of nine times followed by Bats with five and Kestrel with Four. Figure 4 shows the distribution.

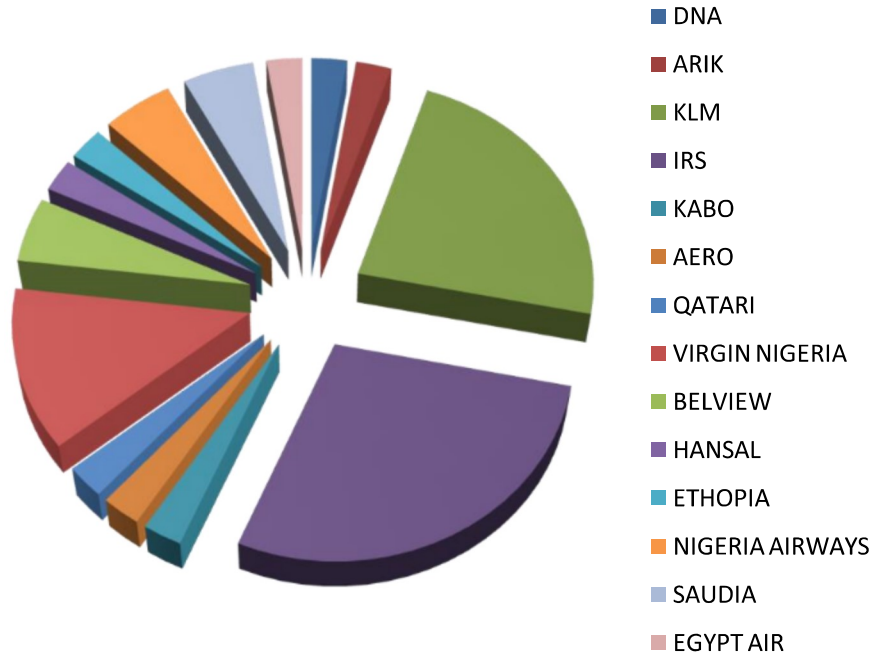
The majority of bird strikes reported during the study period involved solitary small birds and they occurred during the rainy season from April to October.

#### **Birds strike according aircraft**

Aircrew generally are expected to report any involvement in bird strike to the appropriate port authority for record and planning purposes. The survey data reveals that 39 of the 44 cases of birds' strikes were reported by airlines. The breakdown reveals that IRS Airline and KLM have the highest reported cases 28 and 23% respectively. Figure 5 shows the display of the birds strike according to airlines.

which is 8. In addition, 44 flights out of 55,205 flights that operated from MAKIA experienced bird strike. The estimated percentage of bird strike is 0.08%. Bird strike incidence at MAKIA may therefore be described as high. This is a conservative estimate and may not reflect the actual reality at the airport. About 76% of respondents indicated sighting either wounded or dead birds within 15km radius particularly along the approach paths of runways 24/23 and 06/05. Pilots and airline official are reluctant to report bird strike for several reasons. In addition, ATC authorities have no established guidelines and procedures for reporting or dealing with bird strike emergencies. For these reasons, bird strike incidences at the airport are under reported.

The gradual increase in bird strike may not necessarily be connected with steady increase in traffic movement. Series of interviews conducted with air traffic controllers, safety management office staff, environmental department workers, and members of the bird/wildlife hazard control unit point to the fact that the increase is a result of the establishment of the B/WHC Unit in 2006. This Unit is made of trained personnel with a published manual and procedures to identify, document, report



**Figure 5.** Bird strike reported by Airlines 2001 to 2010.



**Figure 6.** Jet engine blade damaged by bird strike (source, ATSB).





**Figure 7.** Hybrid turboprop and jet airbuses at the airport taxi.

demonstrate no run-on time, only safe shutdown. None of the engines currently flying are designed or built to survive an ingestion of a 3.5 - 7 kg goose, pelican, stork, vulture or 12 kg swan. In addition, aircraft windshields are certified to withstand the impact of a 1.8 kg bird at the design cruising speed of the aircraft. The windshields must not fail or spall (allow flying glass shards). Eschenfelder (2001) further demonstrated that three crew members were injured by flying glass when their aircraft struck small birds at 250 knots or less in three separate incidents with B-737 and DC-9 aircraft in 1997. The question is: are there significant difference in bird strike vulnerability between Jet and Turboprop aircraft. A comparative analysis of the two may give some illumination to this.

### **Turboprops**

Turboprops on the other hand (especially on longer routes) are slower, louder (“...with average cabin noise of 77-79dBA...”), more cramped than their regional jet counterparts do not fly as high as larger jets, and are more prone to turbulence. According to the Airliners net Forum moderator “The flying public has a perception that propellers are an old, outdated technology”. But they have long range acoustics to scare birds. Although, Saab and ATR aircraft are rather big, especially the 2002, June 7, 3 models, and Q400 is Bombardier’s answer for a regional turboprop that replaces a jet, while behaving like

(NCAR).

During the period studied, 42 bird strikes were recorded involving 14 different airlines that include: Dana Air, Arik Air, KLM, IRS Airline, Kabo Air, Aero Contractors, Qatari Airlines, Virgin Nigeria, Belview Airlines, Hamsal Air, Ethiopia Airlines, Nigerian Airways, Saudi Arabian Airline, and Egypt Air. These airlines operated at least 10 different aircraft types as indicated in Figure 8.

### **Airport ecological management**

The clustering of birds in any given area is a function of the environmental setting that tends to act as a point of attraction. The availability of assorted grain crops, human garbage and food wastes makes Mallam Aminu Kano International Airport attractive to birds. It is observed that grass is cut very low at the edge of Runway 06/24, exposing large population of insects most notably grasshoppers and centipedes, which attracts cattle egrets. Large flocks of quelea have been observed during the rainy season. Pigeons and dove are common birds of this area. There is a steady source of grain crop grown during the rainy season which supports these birds.

Outside the airport and on the approach ends of both runway 06/24 and 05/23, are been cultivated to farm maize, millet and sorghum in places such as Bukava barrack, Jaba and Alafa villages (Figure 9).

Kano Airport can be described as a sanctuary amidst hash dry savannah area that provides shelter, food, water

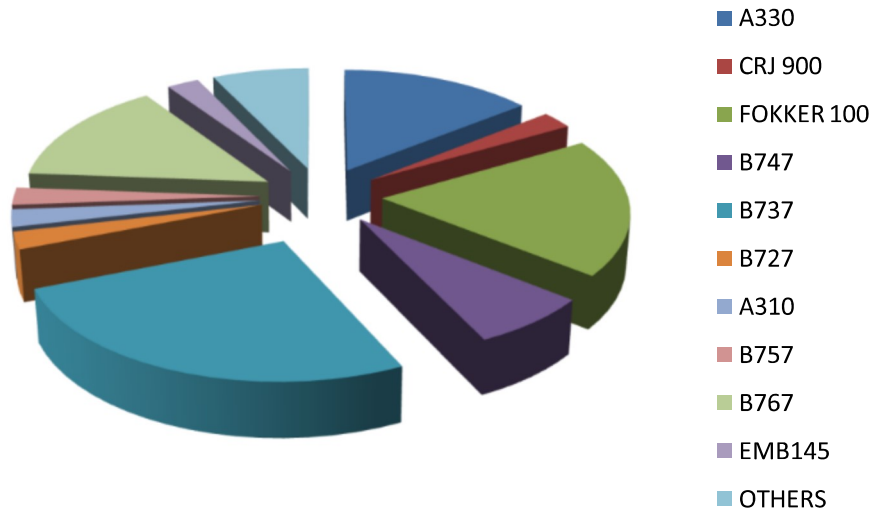


Figure 8. Bird strike by aircraft type 2001 to 2010.



Figure 9. Black kite loafing on airport apron stand.

### Ranking of birds hazard level

Birds' species are evaluated based on their size (mainly weight), behaviour, movement (short and long distance)

the monetary aspect as it affects their operational profitability. It is difficult to obtain an accurate estimate of the cost of bird strikes for airline and aerodrome operations, let alone the cost of bird hazard

**Table 4.** Common bird species observed at MAKIA (ASRV).

| S/N | Species name        | Scientific name                  | Body size (cm) | Status category | Range category |
|-----|---------------------|----------------------------------|----------------|-----------------|----------------|
| 1   | Abdim storck        | <i>Ciconia abdimi</i>            | 75 – 80        | M               | R              |
| 2   | Abyssinian roller   | <i>Coracias abyssinicus</i>      | 28 – 30        | M               | C              |
| 3   | Bat hawk            | <i>Macheiramphus alcinus</i>     | 41 – 45        | R               | U              |
| 4   | Black headed heron  | <i>Ardea melanocephala</i>       | 92 – 96        | R               | U              |
| 5   | Black kite          | <i>Milvus migrans</i>            | 50 – 60        | Mp              | C              |
| 6   | Buffalo weaver      | <i>Bubalornis albirostris</i>    | 22 – 24        | R               | C              |
| 7   | Cattle egret        | <i>Bubulus ibis</i>              | 48 – 56        | R               | C              |
| 8   | Common BulBul       | <i>Pycnonotus barbatus</i>       | 18 – 20        | R               | C              |
| 9   | Crested lark        | <i>Galerida cristata</i>         | 15 – 17        | R               | C              |
| 10  | Dove                | <i>Streptopelis senegalensis</i> | 23 – 25        | R               | C              |
| 11  | Eagle               | <i>Hieraatus spilogaster</i>     | 60 – 70        | R               | C              |
| 12  | Finches             | <i>Serinus leucopygius</i>       | 10 – 11.5      | R               | R              |
| 13  | Francolin           | <i>Fringilla monticola</i>       | 30 – 35        | R               | C              |
| 14  | Kestrel             | <i>Falco naumanni</i>            | 30 – 38        | R               | C              |
| 15  | Lapwing             | <i>Vanellus tectus</i>           | 21 – 25        | R               | C              |
| 16  | Little swift        | <i>Apus affinis</i>              | 12 – 13.5      | R               | C              |
| 17  | Marsh harrier       | <i>Circus ranivorus</i>          | 44 – 50        | R               | U              |
| 18  | Night jar           | <i>Macrodipteryx longipennis</i> | 21 – 22        | M               | C, f           |
| 19  | Northern red bishop | <i>Euplectes franciscanus</i>    | 11 – 12        | R               | C, f           |
| 20  | Owl                 | <i>Tyto alba</i>                 | 33 – 36        | R               | C              |
| 21  | Pied crow           | <i>Corvus albus</i>              | 46 – 50        | R               | C              |
| 22  | Quela               | <i>Quela quela</i>               | 11 – 13        | M               | C              |
| 23  | Red billed hornbill | <i>Tockus erythrorhynchus</i>    | 40 – 48        | R               | C, f           |
| 24  | Senegal coucol      | <i>Centropus senegalensis</i>    | 36 – 40        | R               | C              |
| 25  | Speckled pigeon     | <i>Columba guinea</i>            | 35 – 40        | R               | C              |
| 26  | Starlings           | <i>Lamprotormis caudatus</i>     | 20 – 51        | R               | C, f           |
| 27  | Village weaver      | <i>Ploceus cucullatus</i>        | 15 – 17.5      | R               | C              |

Key: L = Large, M = Medium, S = Small, R = Resident, Mi = Migrant, f = Field bird, fc = Flocking, h = High/Soaring, r = Raptor, s = Scarce, c = Common.

aircraft struck by birds (Osa-Okunbor, 2010). Similarly, Jacky Hathiramani the Managing Director of Dana Airlines reported losing USD1.7 million to a bird strike involved with one of its aircraft in 2010. Stave Mahowu, Chairman of Airline Operators of Nigeria (AON), was quoted stating that the airlines were bleeding financially to fix damaged blades of aircraft due to bird strikes running into the billions of dollars (Adekola, 2010). In fact, industry expert estimate that a single engine blade cost about USD36,000. The Director-General, of the Nigeria Civil Aviation Authority (NCAA), was also quoted saying

managed.

## CONCLUSION AND RECOMMENDATION

The presence of varieties of bird species within the vicinity of Kano Airport is significant and the propensity of these birds colliding with aircraft is real, which is a menace to the aviation industry.

It is apparent that bird strike reporting is highly dependent on the willingness of airline officials, and the

airport. The following recommendations are therefore given as a solution to the menace:

- i) Modern equipments like 'Bird Strike Avoidance Radar' should be installed in the international airports in the country. This will go a long way in reducing strike occurrences.
- ii) Hybrid Turboprop aircrafts should be used more for local flights since it scared birds more than jets because of its relative noise and blade design, while bird repellents should be built into jet aircraft and airports.
- iii) Scavenging birds will be kept away from the airports if garbage are well disposed off as at when due by the catering services. The sanitary condition of the airport should therefore be of high standard.
- iv) The Bird/Wildlife Hazard Control (B/WHC) unit of all the nations' international airports should be well trained and equipped with current equipments that can repel birds around the ports.
- v) Grain and fruit farming activities in particular should be discouraged or kept at a reasonable distance away from the airport since they act as birds feeding place.

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