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Research Article

Wildlife Hazard and Airports, an Emprical Analysis of Birdstrikes at Benazir International Airport, Islamabad, Pakistan

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Abstract | Pakistan is a signatory to the Convention on International Civil Aviation. Like many other countries, bird strike risk to aviation is increasing at most of the airports in the country. Analysis of bird strike data of Benazir Bhutto International Airport, Islamabad 2005-12 collected from Civil Aviation Authority Pakistan; revealed that annual average number of bird strikes were 26.62±2.11. Birds of prey mainly, Pariah Kites (*Milvas migrans*) were reported to be involved in 72% of the strikes. Seasonal variation in bird strikes revealed that most of the bird strikes occurred during the period (July-October), then in (March-June) and least during the winter period (November-February).Relationship between meteorological and bird strike data suggested that there was a significant positive correlation between bird strikes and maximum temperature (r=0.452, p=0.000), minimum temperature (r=0.422, p=0.000), and rainfall (r = 0.242, p = 0.017).Information drawn by this study could be incorporated into bird control practices at the airfield. Management efforts could be intensified during periods of high bird activity.

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Keywords | Bird strike, Aircraft, Bird strike data, Benazir Bhutto international airport, Pakistan

Introduction

Collisions between birds and aircraft (bird strikes) cause severe threat to aviation industry all around the world. Many human lives and aircrafts have been affected by these collisions. Total number of fatal accidents due to bird strikes, from 1912 to 2010, has been recorded to 56, killing 276 people and destroying 108 civil aircraft (Thorpe, 2010). Allan (2002) estimated that bird strikes incidences annually cost civil aviation over US$ 1.2 billion worldwide. Annual losses to US civil aviation due to wildlife strikes (98 percent involving birds) have been estimated to at least $ 677 million (Dolbeer et al., 2011). Bird strikes are equally hazardous to military flight operations. Since, 1960, at least 250 military aircrafts and 120 military persons have lost their lives in these collisions (Cleary et al., 1999). Richardson and West (2000) have reported 286 serious bird strike accidents to military aircraft from 32 countries during the period (1959-1999). Out of these 286 accidents, 63 were fatal which resulted in loss of at least 141 human lives (137 on board and 4 on the ground).

Bird strike risk to aviation is also alarmingly increasing at most of the airports in Pakistan. According to Civil Aviation Authority (CAA), Pakistan, 85 incidents of bird strikes took place only at Allama Iqbal

International Airport, Lahore, Pakistan since 2002. On June 25th, 2013 a PIA's Airbus 310 (two engine aircraft with 240 passengers capacity), experienced a bird hit on one of its engines. A Russian-made Il-76 cargo plane crashed in November 2010 in Pakistan's largest city Karachi, killing eight crewmembers on board and 12 on ground, the likely cause was the damage of the aircraft engine caused by a bird strike. According to (Khan, 1998) bird strikes are a threat to flying aircraft of Pakistan Air Force Bases. In May 1967, a Martin B-57 Canberra experienced bird strike ingestion. The aircraft crashed and the pilot lost his life in this accident. Allan et al. (1999) have reported 40 strikes; 21 known and 19 unknown, with bird species having over 2 kg of body weight, from 1983 to 1998, in Pakistan.

Several studies have been conducted to analyse civilian and military bird strike data base all over the world (Dolbeer and Eschenfelder, 2003; Allan et al., 1999; Cleary et al., 1999). However, the major difficulty faced by the researchers in understanding the available data arise from incomplete and incorrect sources being presented by different institutions (Allan et al., 1999). The current status of data on bird strike issue is deficient in Pakistan, thus some basic information were needed to be generated. For this purpose, past bird strike data of BBI Airport, was analyzed to assess bird strike hazard.

The objectives of the study were to assess the bird strike hazard at BBI Airport, Islamabad and to explore effect of meteorological factors on bird strikes. The information generated by this study would highlight the periods of high bird activity so that management efforts could be intensified during these periods. This analysis may prove useful to people in the aviation industry trying to reduce the bird strikes at their airfields.

Materials and Methods

Study site

BBI Airport, Islamabad (previously called Islamabad International Airport) (IATA: ISB, ICAO: OPRN) which is the third largest airport of the country is located in the fourth most populous city of Rawalpindi in Pakistan. The airport is located in, at Latitude: 33° 36' 59" N, Longitude: 73° 05' 57" E at an elevation of about 508 m (ASL). The airfield is shared with the transport and liaison squadrons of Pakistan Air Force (PAF). Therefore, it is also referred as Nur Khan Base (PAF). Pakistan Civil Aviation Authority (CAA) is the main operator. The main runway is known as '12/30' based upon compass bearings. It is 3,287 m in length and is made of asphalt. There is also a secondary runway, called 27/09, it is 2,590 m in length and 23 m wide. According to CAA, over 3,136,664 passengers used Islamabad International Airport in the year 2008-2009 and 34,025 aircraft movements were registered during this period.

Climatic conditions

Local climatic conditions are typified with a humid subtropical climate with long and hot summers, a monsoon and short wet winters. Annual average temperature varies from 4 °C to 38 °C and is rarely below 1 °C in winter or above 42 °C in summer. Meteorological data of the airport obtained from Pakistan Meteorological Department for eight-year period from 2005-2012 revealed that mean minimum temperature in winter (Nov-Feb) was 5.8 °C and mean maximum temperature in this period was 21.12 °C. During the spring months (March–April) these measurements were 14 °C and 28.7 °C, respectively. In summer months (May–June) these ranged between 23 °C and 38 .31 °C. During the months of July–August which covers monsoon period mean minimum and maximum temperatures were 25.18 °C and 34.45 °C, respectively. These climatic factors reported for autumn period (September -October) were 18.5 °C and 31.90 °C. Mean monthly rainfall for the winter, spring, summer, monsoon and fall seasons were 53.56 mm, 59.24 mm, 62.30 mm, 286.03 mm and 87.4 mm, respectively. The average annual rainfall is 990 mm, most of which occurs in the monsoon season. The relative humidity ranges from 40 % (May) to 70 % (August).

Data collection and analysis

Bird strike data, of BBI Airport for the year (2005-2012) was provided by Civil Aviation Authority personnel. As this airfield is also shared by transport and liaison squadron of Pakistan Air Force, bird strike data (2005-2012) of Nur Khan Base provided by Air Head Quarters Islamabad, were also included in our data set. Meteorological data of BBI Airport was obtained by Pakistan Meteorological Department. For seasonal analysis, data were grouped into following season: winter (November to February), spring (March-April), summers (May-June), monsoon (July-August) and fall (September-October).

Kruskal-Wallis test was applied to observe difference in number of bird strikes occurring in all five seasons. The Pearson's correlation was used to determine relationship between bird strikes and climatic factors including maximum temperature, minimum temperature, and rainfall. Statistical analyses were performed using the SPSS version 22.0. $P<0.01$ and $P<0.05$ was considered to indicate a statistically significant difference.

Results and Discussion

Eight year (2005-2012) bird strike data obtained of BBI Airport Islamabad is presented in Figure 1. In total 213 bird strikes were recorded (including both the CAA and PAF birdstrikes). Average annual number of bird strikes was 26.62 ± 2.11. Occurrence of bird strikes at BBI Airport could be attributed to the presence/activity of common bird species found in the vicinity of the airfield (Table 1). These bird species were found to be attracted to rich feeding, roosting and nesting places at and around BBI Airport. Variety of bird species are reported to be involved in bird strikes worldwide. Dolbeer et al. (1993) recorded at least 56 species of birds struck by aircraft at JFK International Airport, New York, from 1979-1992. Dolbeer (2006) also reported in an analysis of the National Wildlife Strike database of Civil Aviation in the US that for strikes at < 500 feet, passerines, gulls and terns, pigeon and doves and raptors were the identified species group most frequently struck.

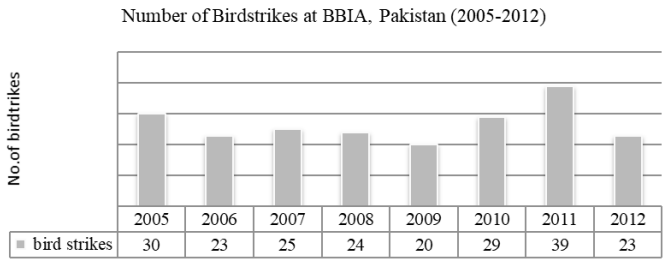

Figure 1: *Number of bird strike occurred at BBIA, Pakistan during (2005-2012).*

Monthly and seasonal analysis

Analysis of the data on the basis birdstrikes occurring during each month of all eight years is given in (Figure 2) and seasonal distribution of bird strikes is given in (Figure 3). Preliminary data analysis revealed, that mean monthly bird strikes were 1.12 ± 0.34 in winters (Nov- Dec- Jan-Feb), 1.87 ± 0.79 in spring (Mar- Apr), 2.31 ± 0.65 in summers (May-Jun), 3.37 ± 0.58 in monsoon and 3.5 ± 0.63 in fall (Sep-Oct) (Figure 3). The trend depicts that seasonal factors may influence number of bird strikes. Bird strikes remained low during winters (Nov-Feb) gradually increased in spring (March-April) then in summer (May-June) and peaked in monsoon (July-August) and in fall (Sep-Oct) (Figure 2).

Table 1: *List of bird species observed at and around BBI airport.*

Sr. No	Species	Common Name
1	*Milvus migrans*	Pariah Kite
2	*Aquila rapax nipalensis*	Stappe Eagle
3	*Acridotheres tristis*	Common myna
4	*Acridotheres ginginianus*	Bank myna
5	*Acridotheres fuscus*	Jungle Myna
6	*Corvus Splendens*	House crow
7	*Passer domesticus*	House sparrow
8	*Columba livia*	Feral Pigeon
9	*Columba livia domestica*	Domestic pigeon
10	*Streptopelia decaocto*	Indian ring Dove
11	*Spilopelia senegalensis*	Laughing dove
12	*Dicrurus macrocercus*	Black Drongo
13	*Upupa epops*	Hoopoe
14	*Cinnyris asiaticus*	Purple Sunbird
15	*Fulica atra*	Coot
16	*Gallinula chloropus*	Moorhen
17	*Coracias benghalensis*	Indian Roller/Blue Jay
18	*Apus affinis*	House Swift
19	*Pycnonotus cafer*	Red vented bulbul
20	*Pycnonotus leucogenys*	White cheeked bulbul
21	*Halcyon smyrnensis*	White throated King Fisher
22	*Alcedo Atthis*	Common King Fisher/ Small Blue King Fisher
23	*Psittacula krameri*	Rose-ringed parakeet
24	*Anas platyrhynchos*	Mallard
25	*Columbia livia*	Blue rock pigeon
26	*Ardeola grayii*	Indian pond heron
27	*Motacilla cinerea*	Grey wagtail
28	*Motacilla alba*	White wagtail
29	*Egretta alba*	Large Egret
30	*Little Egret*	Lesser Egret
31	*Accipiter badius*	Indian Sparrow Hawk
32	*Hirundo fluvicola*	Indian Cliff Swallow
33	*Francolinus Francolinus*	Black Partridge
34	*Francolinus pondicerianus*	Grey Partridges
35	*Cuculus canorus*	Common Cuckoo
36	*Charadrius dubius*	Little Ringed Plover

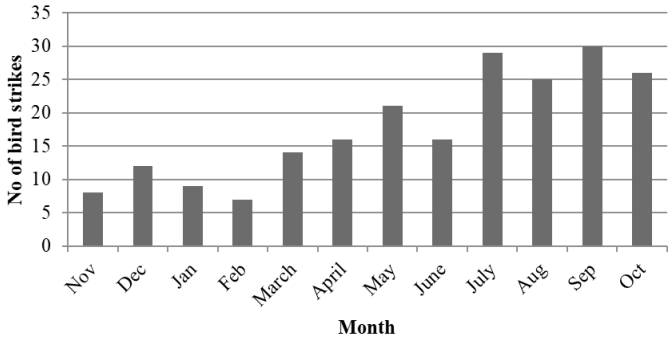

Figure 2: *Monthly distribution of bird strikes at BBIA, Islamabad (2005-2012).*

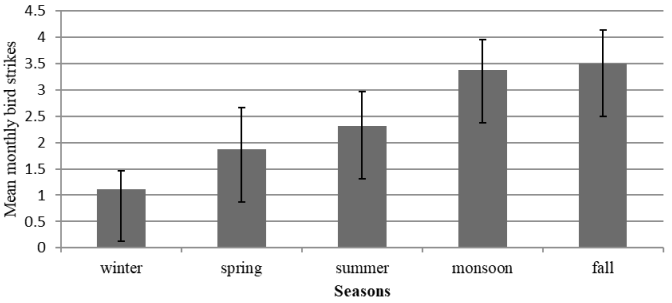

Figure 3: *Mean monthly seasonal distribution of birdstrikes at BBIA, Islamabad (2005-2012).*

Analysis by using Kruskal-Wallis test showed statistically significant difference between number of bird strikes occurring in all five seasons ($p = 0.001$) with a mean rank of 8.44 for winter, 17.12 for spring 19.00 for summer, 29.31 for monsoon and 28.62 for fall.

Seasonal analysis revealed that aircraft were more prone to bird strikes in (Jul-Oct) which also includes monsoon period, then in (Mar-Jun) and least in (Nov-Feb), with peaks occurring in September and October followed by July and August. This could be attributed to the fledging of inexperienced young kites and other birds in the vicinity of the airfield. Similar study by (Küsters' and Scheller, 1998) on bird strikes with military aircraft and flight altitudes of raptors in Germany also confirms that Kestrels (almost exclusively recently fledged birds) were involved mainly in strikes occurring in summers (July-September), on the other hand, raptors, flying high using thermal currents, showed two peaks, the first one from March to May and the second from July to September. Studies have shown that good thermals in spring or in August / September are positively correlated with flight height, thus increasing the risk of bird strike. In an analysis of bird strikes in United States Wang (2010) has also reported that bird strike keep increasing in May and arrives its peak value in August, bird strike keep its high value in September and drops to a very low value in December. These results are in agreement with our findings. Breeding cycle of kite, fledging of young birds and availability of food during the period (Jul-Oct) could be one of the reasons of increased strike rate in this period. It also suggests that thermalling activity associated with Pariah Kite behavior could be a key risk issue at BBI airport. Similar results have been reported by McCracken (1976) in an analysis of past bird strike data of United States Air Force, that twice a year during spring (April, May) and fall (August, September, October, November) bird strike rate increased significantly. (Dolbeer, 1998) also reported that months of July to October, especially August, are the months with highest strike rate below 500 feet probably due to the addition of large number of recently fledged birds. According to (Burger, 1985; Kelly et al., 2001) young birds are less skillful than older birds at avoiding aircraft. In our study, less number of strikes were recorded during winter season (Nov-Feb). This could again be related with the breeding cycle of kites, this is the period when female kites lay eggs(Jan-Mar) and remain sitting in their nests most of the time, till eggs are hatched (Mar-May) and young ones leave their nests (Jun-Aug).Keeping in mind the bird behavior, its feeding nesting and reproductive cycles, effective management techniques could be practiced to mitigate bird strikes at airfields.

Correlation between bird strikes and meteorological factors

Correlation between bird strikes and three climatic factors, maximum and minimum temperature and rainfall were calculated. Results indicated that there was a rise in number of bird strikes with rise in temperature (Figure 4), a significant positive correlation was found between bird strikes and maximum temperature ($r= 0.452$, $P= 0.000$). Similarly, the increasing trend in number of bird strikes was observed with rise in minimum temperature, significant positive correlation was found between minimum temperature and bird strikes ($r= 0.422$, $P= 0.000$). Results also revealed that rainfall was also positively correlated with bird strikes ($r= 0.242$, $P= 0.017$) (Figure 5). Local climatic conditions do have an effect on bird strikes frequency (Manktelow, 2000). High temperature may encourage birds of prey, mainly involved in bird strikes, to soar high up in the air (Küsters' and Scheller, 1998) or these birds may come to the runways to sunbathe (Manktelow, 2000). In our study Pariah Kites were observed to soar high up in the air, occupying most of the airspace, in

the vicinity of BBIA. Previous studies (Gabrey and Dolbeer, 1996) and have shown that rainfall also induce conditions that lead to increase in bird strikes. Highest numbers of bird strikes were observed during rainy season (Jul-Oct) at BBI airport. These results support the view that rainfall may influence the bird strike incidents. This could be attributed to the availability of more food to birds on rainy days, as worms, frogs and other soil invertebrate may come to the surface in wet season (Allan and Watson, 1990).

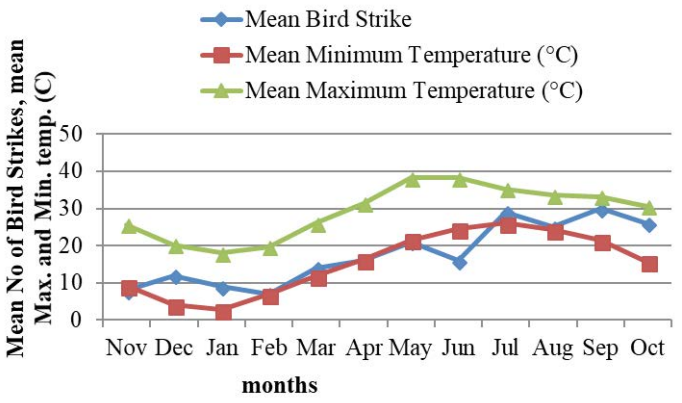

Figure 4: *Relationship between birdstrike, mean maximum and minimum temperature.*

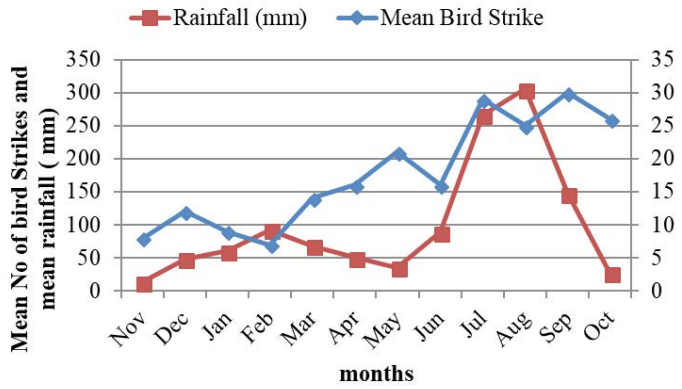

Figure 5: *Relationship between Bird strike and rainfall.*

Analysis of bird strike data BBIA (2005-2012) of civil aircraft also revealed that in 57 percent of strikes cases, species remained unknown. However, of all strikes with known bird species, the major threat was birds of prey mainly, Pariah Kite (*Milvas migrans)* which accounted for 72 percent of the cases. Monthly distribution of number of kites, during this eight-year period showed that relatively more kite strikes occurred during the months of June, July and August (Figure 6).

Bird strike data analysis revealed that Pariah Kites (*Milvas migrans*) were involved in majority of the cases. These birds of prey were observed soaring high and occupying most of the airspace in the vicinity of the airport. Kites were observed feeding on carrion, frogs, lizards, insects, rats, dead animals killed in road accidents and fish from water bodies of Lai and Soan flowing in the vicinity of BBI Airport. These bird species were also observed exploiting feed resources in open garbage dumps in the city. Similar bird problem has been observed in other developing countries. Aerodromes of India reported by where *Milvus migrans* were reported to be numerous and hazardous for aircraft operation and were attracted to huge quantities of food available in waste thrown out of slaughter houses and garbage dumps in the vicinity of aerodromes (Matthew et al.,1998). Studies conducted by (Upadhyaya and Dolbeer, 2001) at Tribhuvan International airport Nepal also suggested that birds of prey were major hazardous bird species at this airport, which were attracted to solid waste dumping site, nearby jungle area providing nesting and roosting sites, and garbage filling station near river bank in the close vicinity. Buurma and Dekker, 1996 reported that these birds of prey usually soar at higher altitudes using thermal currents and are thus most likely to be struck with aircraft travelling at greater velocity, resulting in greater damage.

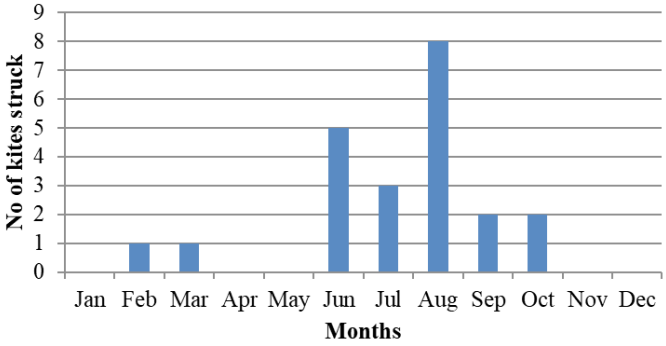

Figure 6: *Monthly distribution of kites struck at BBIA, Islamabad during (2005-2012).*

Conclusions and Recommendations

Information drawn by this study could be incorporated into bird hazard management plan of the BBI Airport, Islamabad. Management efforts could be intensified during periods of high bird activity. A critical action needed to be done by the airport authorities, is to identify species correctly and to maintain records systematically, so that bird

behavioral oriented, management practices may be implemented to control bird strikes at the airports.

Author's Contribution

Sameera Arshad: Conceived the idea, Wrote abstract, Methodology, Did SPSS analysis, Conclusion, Data collection, Data entry in SPSS and analysis, Result and discussion, introduction, References.
Arshad Mahmood Malik: Technical input at every step, Overall Management of the article, Data collection, Data entry in SPSS and analysis.
Iftikhar Hussain: Technical input at every step, Overall Management of the article, Conclusion.

References

Allan, J.R., J.C. Belland and V.S. Jackson. 1999. An assessment of the world-wide risk to aircraft from large flocking birds. First joint annual meeting, Vancouver, BC.

Allan, J.R. and A.P. Orosz. 2001. The costs of bird strikes to commercial aviation. Pages 218–226 in Bird strike 2001 in Proceedings of the bird strike committee-USA/Canada meeting.

Allan, J.R. 2002. The costs of bird strike and bird strike prevention. In L. Clark, J.Hone, J.A. Shivik, R.A. Watkins, K.C. Vercauteren, and J.K. Yoder (Eds.), Human conflicts with wildlife: Economic considerations. Proce. third NWRC special Symp. Nat. Wildlife Res. Center, Fort Collins, CO, USA, pp. 147–152.

Allan, J.R. and L.A. Watson. 1990. The impact of a lumbricide treatment on the fauna of airfield grassland. Proce. Bird Strike Comm. Eur. 20: 531-541.

Burger, J. 1985. Factors affecting bird strikes on aircraft at a coastal airport. Biol. Conserv. 33:1–28. https://doi.org/10.1016/0006-3207(85)90002-3

Buurma, L. and A. Dekker. 1996. Eurobase: Potential lessons from military bird strike statistics. Proc. 23rd Bird Strike Committee Europe, London. WP-6. pp. 81-89.

Cleary, E.C., S.E. Wright and R.A. Dolbeer. 1999. Wildlife hazard management at airport: A manual for airport personnel. Federal aviation administration and U.S. Dep. Agric. / Wildl. Ser., Washington, D.C. 248.

Cramp, S. and K.E.L. Simmons. 1983. The birds of the western palearctic Volume III: Waders to Gulls. Handbook of the birds of Europe, the Middle East and North Africa. Oxf. Univ. Press.

Dolbeer, R. A. 1993. Shooting Gulls reduces strikes with aircraft at John F. Kennedy International Airport. Wildl. Soc. Bull.21:442-450.

Dolbeer, R.A., S.E. Wright, J. Weller and M.J. Begier. 2011. Wildlife strikes to civil aircraft in the United States, 1990–2010. Washington, DC, USA: Fed. Aviat. Adm. Serial Rep. No. 17.

Dolbeer, R.A. 2006. Height distribution of birds recorded by collisions with aircraft. J. Wildlife Manage. 70: 1345–1350. https://doi.org/10.2193/0022-541X(2006)70[1345:HDOBRB]2.0.CO;2

Dolbeer, R.A. 1998. Population dynamics: the foundation of wildlife damage management for the 21st century. Pages 2–11 in R.O. Baker and C. Crabb, editors. Proc. 18th Vertebr. Pest Conf. Univ. Calif., Davis, USA. https://doi.org/10.5070/V418110312

Dolbeer, R.A. and P. Eschenfelder. 2003. Amplified bird-strike risks related to population increases of large birds in North America. Pages 49-67 in Proc. 26th Int. Bird Strike Committee Meet. (Volume 1). Warsaw, Poland.

Gabrey, S.W. and R.A. Dolbeer. 1996. Rainfall effects on bird-aircraft collisions at two United States airports. Wildl. Soc. Bull. 24: 272-275.

Richardson, W.J. and T. West. 2000. Serious bird-strike accidents to military aircraft: updated list and summary. Pages 67–98 Proc. Int. Bird Strike Committee Meet. Amsterdam, The Netherlands.

Richardson, W.J. and West. 2000. Serious bird strike accidents to military aircraft: updated list and summary. Proc. Int. Bird Strike Committee. 25: 67-98.

Thrope, J. 1997. The implication of recent serious bird strike accidents and multiple engine ingestion. Bird Strike Committee, Boston, MA 11.

Thorpe, J. 2003. Fatalities and destroyed aircraft due to bird strikes,1912–2002. Pages 85–113 Proc. 26th Int. Bird Strike Committee Meet. Int. Bird Strike Committee, 5–9 May 2003, Warsaw, Poland.

Thorpe, J. 2005. Fatalities and destroyed aircraft due to bird strikes, 2002–2004 (with an appendix of animal strikes). Pages 17–24 in Proceedings of the 27th International Bird Strike Committee

meeting. Volume 1. Int. Bird Strike Committee, 23–25 May 2005, Athens, Greece.

Thorpe, J. 2010. Update on fatalities and destroyed civil aircraft due to bird strikes with appendix for 2008 and 2009. Pages 1–9 in Proceedings of the 29th International Bird Strike Committee meeting. Int. Bird Strike Committee, 21–24 September 2010, Cairns, Australia.

Thorpe, J. 2012. 100 years of fatalities and destroyed civil aircraft due to bird strikes. Proc. 30th Int. Bird Strike Committee Meet. Stavanger, Norway. (http://www.int-birdstrike.org).

Matthew, D. N., S. Sreekumar, K. T. Joseph, M. Gangadharan, T. T. Jacob and M. Mahesh Kumar. 1998. Experiences of the voluntary zoologist and experts of the Calicut University, in reducing bird hazards in the aerodromes of Trivandrum, Cochin, Calicut, Mangalore and Ramnad, India. International Bird Strike Committee, 24th Meeting, Stara Lesna, Slovakia. Paper 16, p 1-15.

Manktelow, S. 2000. The effect of local weather conditions on bird-aircraft collisions at British airports. Proc. Bird Strike Committee Amsterdam, 317-329.

Küsters and Scheller. 1998. Bird strikes with military aircraft and flight altitudes of raptors in Germany. Int. Bird Strike Committee. 24/ WP 26.

Kelly, T.C., R. Bolger and M.J.A. O'Callaghan. 2001. Seasonality of bird strikes: Towards a behavioral explanation. Proc. Int. Bird Strike Committee USA/ Canada 3rd joint Ann. Meet. Calgary, AB, 205-208.

Khan, A.A. 1998. Air accidents in spite of high efficiency. Def. J. (Pak.), Aug. 1998 issue. Available at www.defencejournal.com/aug98/ airaccidents.htm

McCracken, P.R. 1976. Bird strikes and the air force. Bird control seminar Proc.

Upadhyaya, B. K. and R. A. Dolbeer. 2001. Management of bird and other wildlife hazards at Tribhuvan International Airport, Kathmandu, Nepal. Bird Strike Committee USA/Canada, 3rd Joint Annual Meeting, Calgary, AB. p. 179-185.

Wang, J. 2010. Analysis of bird strikes in the United States.