BIRD HAZARD TO AIRCRAFT IN INS GARUDA, NAVAL AIR STATION KOCHI

FINAL REPORT
2016-2018

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BIRD HAZARD TO AIRCRAFT IN INS GARUDA NAVAL AIR STATION, KOCHI

Final report of the Research Project RP/726/16

(Final report submitted to INS Garuda)

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January 2018

ABSTRACT OF THE PROJECT PROPOSAL

1. Project No. : KFRI/726/2016

2. Title of Project : Bird hazard to aircraft in INS Garuda, Naval Air Station, Kochi

3. Objectives
    1. To study the status, distribution and abundance of avifauna in INS Garuda, Naval Airbase, Kochi and buffer areas
    2. To study the habitat relationship of avian communities
    3. To train the aviation support personnel to identify bird species
    4. To suggest suitable control measures to mitigate bird hazard to aircraft

4. Date of commencement : January 2016

5. Scheduled date of completion : January 2018

6. Funding agency : Indian Navy (INS Garuda)

7. Project Team

    Principal Investigator : Dr. E. A. Jayson

    Consultant : Dr. D.N. Mathew

    Research Fellows : Mr. Aldred Kocherry & Mr. Riju P.

8. Study area : Naval Base, Kochi

9. Duration of study : 2 Years

10. Project budget : Rs. 11,11,855/-

CONTENTS

1. INTRODUCTION

This study was initiated in January 2016 with the financial support from Indian Navy. Dr. D.N. Mathew (Consultant) has been monitoring the birds in INS GARUDA for a long time voluntarily. This report is for the period from January 2016 to January 2018. An interim report of the project was submitted earlier in January 2017, incorporating the results up to December 2016. A bird strike sometimes called "birdstrike", bird ingestion (for an engine), bird hit, or BASH (for Bird Aircraft Strike Hazard) is a collision between an airborne animal (usually a bird or bat) and a human-made vehicle, especially aircraft. Recently the term "wildlife strike" has been introduced to denote the collision between animals and aircrafts. A bird or a flock of birds that suddenly arising from a runway or surrounding area may collide with an aircraft and cause the aircraft to crash, possibly resulting in the loss of human life. Damage caused to aircraft usually results from collision of one or more birds with the engines and/or fuselage. Although most bird strikes do not result in crashes, they do involve expensive structural and mechanical damage to aircraft. The incidence of this problem worldwide makes bird strike a serious economic problem also (Godin and Alfred, 1994).

As reported above bird strikes are hazardous to all aircraft. Even though birds can be controlled by many ways, managing the bird population through ecological means is the most suitable. Monitoring the biodiversity and movement of birds in airports is essential for reducing bird hazard in airports. This project was intended monitor the bird population, movement pattern and the diversity of fauna and flora in INS GARUDA of the Naval Airbase at Cochin. The aim of this project was to the reduce bird hazard and to apply nonviolent methods to control the bird population. Our motto is the concept of 'sharing the skies with the avian species', which is also the core theme of any sustainable development. As Indian wildlife is dwindling fast and as many of the invertebrates, pests of agriculture and hazardous insects like mosquitoes, are effectively controlled only by birds, nonviolent control of birds in aerodromes is of utmost importance to human welfare. Most of the common birds feed and digest weed seeds and are scavengers on animal waste, birds do have a very complicated role to play in ecosystem. Airports attract some bird species by providing them with resources such as food and nesting sites. Those birds can be hazardous to landing and departing aircraft.

Many studies have been conducted in India and abroad on the subject of bird hazard to aircraft. It is reported that on average, the aircraft of the U.S. Air Force incur 2,500 bird strikes annually (Lovell, 1997) and out of these, one human death occurs per 2,000 strikes (Neubauer,

1990). Most air crashes occur when a bird hits the windshield or is inducted into the engine. Sodhi (2002) reported that in terms of civilian aircraft, over 5,000 bird strikes were reported in the United States during 1999. Between 1950 and 1999, 286 serious bird-related accidents of military aircraft (in which the aircraft were destroyed or there were fatalities) occurred in 32 countries. These bird-strike incidents, at least in some cases, are minimum estimates because pilots only report 20 to 30% of actual strikes (Burger, 1985). Pilots are thought to under report bird strikes either because they are unaware of the strikes or because of the inconvenience of filing reports (Solman, 1978; Linnell *et al*., 1999). Sometimes, strikes by large bird species (>350 g) such as Brahminy Kites (*Haliastur indus*) and Cattle Egrets (*Bubulcus ibis*) go unreported by pilots (Sodhi, 2002).

The cost of the bird management program at the Christchurch International Airport in New Zealand is about twice that of repairs to aircraft that are damaged by bird strikes. However, that does not include the costs of lost flight time, passenger disruption, and passenger safety (Chilvers *et al.,* 1997). Annually, aircraft spend 461,000 h on ground in the United States due to bird strikes (Cleary *et al.,* 1999). The cost of bird strikes in terms of human morbidity and mortality has not been rigorously investigated (Neubauer, 1990). Other studies show that bird management actions have halved the cost of repairs to aircraft that are damaged by birds (Solman, 1973).

Air fields can provide good resources (e.g. foraging and nesting sites) for some bird species (Kershner and Bollinger, 1996). However, they can be hazardous habitats due to the danger of getting hit by an aircraft. The ability to avoid an aircraft may involve learning to judge the threat and flying in a manner to evade it successfully. As bird strikes typically occur four to six times per 10,000 aircraft movements, it is possible that most individual birds succeed in evading an aircraft.

More than 60 % of these collisions occur within the confines of airfields (Dolbeer and Wright, 2008), where airfield managers can reduce the chances of a strike by making the air operations area habitat unattractive to birds (Linnell *et al*., 2009) and by harassing or removing individual birds that remain despite airfield manipulations (Ball, 2009). On a given airfield, bird strikes are infrequent, irregular, and under reported (Linnell *et al.*, 1999). Visual monitoring techniques (e.g., bird censuses) are currently used to provide information on the community of birds present on the airfield and how those communities change over time. Visual monitoring, however, provides limited information on bird-strike threats. Given that

bird strikes continue to be grossly under reported and that relationships between bird censuses and management actions have not been robustly examined, the ability of airfield wildlife managers to receive timely feedback on the status of management actions designed to reduce bird hazards is limited (Dale, 2009; Dolbeer and Wright, 2009).

Klope *et al*., (2009) reported that an Index is needed that is more sensitive to changes in safety or threat-level to aircraft than actual bird-strike events. They have proposed a new metric, the Near-Miss Event (NME) index, that can serve the function of detecting changes in the probability of a birdstrike before a change in bird-strike frequency occurs. Near-miss is a term developed by NASA's Aviation Safety Reporting System to indicate 2 aircraft passing within 150 m of one another. They have limited the distance between aircraft and wildlife to 50 m. As a part of the Integration and Validation of Networked Avian Radars Project (Klope and Brand, 2007) under the U. S. Department of the Defence, tens of thousands of hours of avian radar data have been recorded at various airfields.

Birds are a serious threat to aircraft, particularly near airports. For civil aircraft about 75 % of all bird-strikes occur near airports. Birds are attracted to airports because they become habituated to the noise and traffic, and are attracted by the presence of areas for roosting, loafing, and feeding. Serious bird-strikes can be reduced around airports by reducing the number of birds, by making the birds get out of the way of airplanes, by having planes avoid birds. Airport personnel are usually involved only in controlling bird numbers or in dispersing them from the airport (Burger, 1983).

Collisions between birds and aircraft have caused damage to or destruction of, aircraft and loss of human life for more than 68 years. Birds are attracted to airfields by the large open spaces which they provide and, often by the availability of food, water and shelter, on or near the airfield. Birds attracted by open space can be driven away by trained persons furnished with suitable bird-dispersal equipment, while removal of food, water, and shelter, can reduce the attraction. Mass movement (migrations) by birds, especially large birds, create hazards for aircraft. Air traffic control radar can show the abundance, speed, and direction of movement of birds, while correlation of those movements with weather parameters permits development of bird movement hazard forecasts. Although the periods of high hazard are of short duration, use of these forecasts to make changes in flying training programmes has reduced losses of Canadian military aircraft through bird studies.

Automatic digital presentation of bird movement data gathered by radar has been tested at two airfields by air traffic controllers for possible use in vectoring scheduled civil aircraft away from hazardous concentrations of bird migrants. Reduction of bird hazards to aircraft depends upon human motivation. The necessary habitat control, bird dispersal and migration hazard forecasting, involve time-consuming, rather dull work that is repeated at prescribed intervals. Unless the work is always well done, bird-strikes on aircraft will continue and human lives and aircraft will be lost (Solman, 1981).

Linnell *et al*., (1996) recorded that bird strikes were positively correlated with mean monthly rainfall, perhaps due to increased seed production along runways during the rainy months, resulting in increased bird use in hazardous areas. Bird strike rates were also higher when winds were from a south-westerly direction and lower when cloud cover was 100 %. Larger, faster commercial air carriers exhibited higher strike rates than military or general aviation types, with engine ingestions being most common, followed by strikes on the windshield and nose. More bird strikes occurred during landings than takeoffs with strikes unevenly distributed along the runway. During the landing phase, more bird strikes than expected occurred at the point of touchdown, whereas most strikes occurred in the mid-portion of the runway during takeoffs.

Jeffrey (1998) reported that an electronic bibliography is available on the subject for the past 30 years. In an effort to "jump start" those researchers with bird hazard problems, the U.S. Air Force Research Laboratory has consolidated into a single document a significant portion of the literature on bird/aircraft interactions. This annotated bibliography of bird hazards to aircraft, termed ABBHA, is a compilation of citations with abstracts on a wide range of related topics such as bird strike tolerance engineering, bird hazard management and control, bird strike avoidance and bird remains identification.

In India also, many ornithologists worked on the problem of “birdstrike”. Satheesan (1996, 1999) explained how zero bird-strike rates can be achieved by any aerodrome by constant efforts and perseverance of a dedicated team as evidenced from the author’s experience on about 30 aerodromes in India. He stressed the importance of conducting survey of problem aerodromes every five years by an expert and the necessity of employing an Ornithologist at every aerodrome. Bird strike rates were brought down to zero at the Trivandrum International Airport in 1992 and 1993 and to a low level at the Bangalore Airport in 1993 as a result of implementation of recommendations given by a study team. Step by step

evaluation of and changes in policies and strategies followed by the Government as well as methods and gadgets employed by airport authorities and replication of successful experiments at problem airports hold the key to translating the dream, zero bird-strike rate, into reality.

Mathew *et al*., (2000) indicated that the Black Kites continue to strike aircrafts in the aerodromes at Calicut, Cochin and Trivandrum in Kerala, India, even though the Governments have taken some preventive measures. The tremendous increase of urban human population and failure in the waste disposal is contributing to the population surge in Black Kites. In Trivandrum and Calicut much of the garbage and animal wastes are transported to municipal waste dumps, but left unprocessed. There the wastes decay and pollute the atmosphere. They have reported a low-cost but eco-friendly method for using chicken waste as fertilizer developed by stall owners and planters in and around the town of Kondotty, situated close to Calicut aerodrome. Mathew *et al.,* (2000) reported that a bird aversion agent can be prepared by boiling neem (*Azadirachta indica*) leaves in water and Neem oil was also found to be an effective aversion agent.

Mishra *et al.,* (2013) detailed on a bird strike incident of a military gas turbine engine. The jet pipe temperature of the engine shoot up and rotor speed reduced suddenly during take-off roll. Long flame was noticed from the engine and aircraft crashed at runway end. Forensic analysis of remnants collected from flow passages confirmed the bird ingestion. Blockage of flow passages due to the presence of bird has led to engine surge and high gas temperature resulting in extensive damage of low pressure turbine module. The paper also proposes remedial measures to avoid such bird strikes during flight.

The operational area of the INS Garuda, Naval Air Station had frequent incidence of birds striking the aircraft. Bats also strike aircraft in few reported incidences in the past. All the investigators above have been connected with the work on birds in the one or other aerodromes in Kerala during the last two decades. Some of them were involved in research studies in the Cochin Naval Base also under an AR & DB project. The project was ended in 1994. Dr. D. N. Mathew maintains his interest in the reduction of bird hazard in both Naval and civilian aerodromes of Cochin. All these years, he has been advising the SFSO'S of both the institutions subject to logistic constraints. Dr. D.N. Mathew is a regular invitee since 1994 to the meeting of the International Bird Strike Committee (IBSC) of Europe and has been liaising between Indian aerodromes and IBSC (Mathew *et al.,* 1998). Experience gained in the six IBSC meetings abroad has helped in developing new techniques for bird hazard reduction

in Indian aerodromes from 1994 onwards. Dr. E.A. Jayson is a wildlife biologist working in the Kerala Forest Research Institute, Peechi, Thrissur of Kerala Government. He has extensively worked on the birds of different forest ecosystems and wetland birds. He has more than 36 years of experience in the field. Mr. Aldred Kocherry is an M. Sc. in Zoology having experience in faunal studies and Mr. Riju P. is also an M. Sc. in Zoology with 4 years of experience in faunal studies.

1.1 Objectives

The broad objectives of the study were to find out the composition of bird community in INS Garuda and also to suggest methods to reduce the bird population in INS Garuda. Detailed objectives are given below.

1. To study the status, distribution and abundance of avifauna in the Naval Airbase, Kochi and buffer areas.
2. To study the habitat relationship of avian communities.
3. To train the aviation support personnel to identify bird species.

2. STUDY AREA

The study was conducted in INS Garuda and the surrounding 10 km area during January 2016 to January 2018. INS Garuda is an Indian Naval Air Station located near Kochi, in the State of Kerala, India. Commissioned on 11 May 1953, it is the oldest operating air station of the Indian Navy. The air station is adjacent to INS Venduruthy and the headquarters of Southern Naval Command. INS Garuda is a major naval air training centre as well as an operational base. A separate civil enclave for domestic travellers was allowed to operate at INS Garuda, which remained operational until July 1999, when the Cochin International Airport was commissioned. Two runways are present in INS Garuda and the details are given in Table 01. Location of INS Garuda is given in Fig. 01. The 10 km area surrounding the INS GARUDA was also monitored to study the bird community (Fig. 02). This area is a metropolitan area of Cochin Corporation typically with the waste dumps. Western side is laces with Arabian Sea and other places are residential and commercial areas with interspersed backwaters.

Table 01. Details of runways in INS Garuda

Runways		
Direction	**Length (in meter)**	**Surface**
13/31	1,414	Asphalt
17/35	1,817	Asphalt

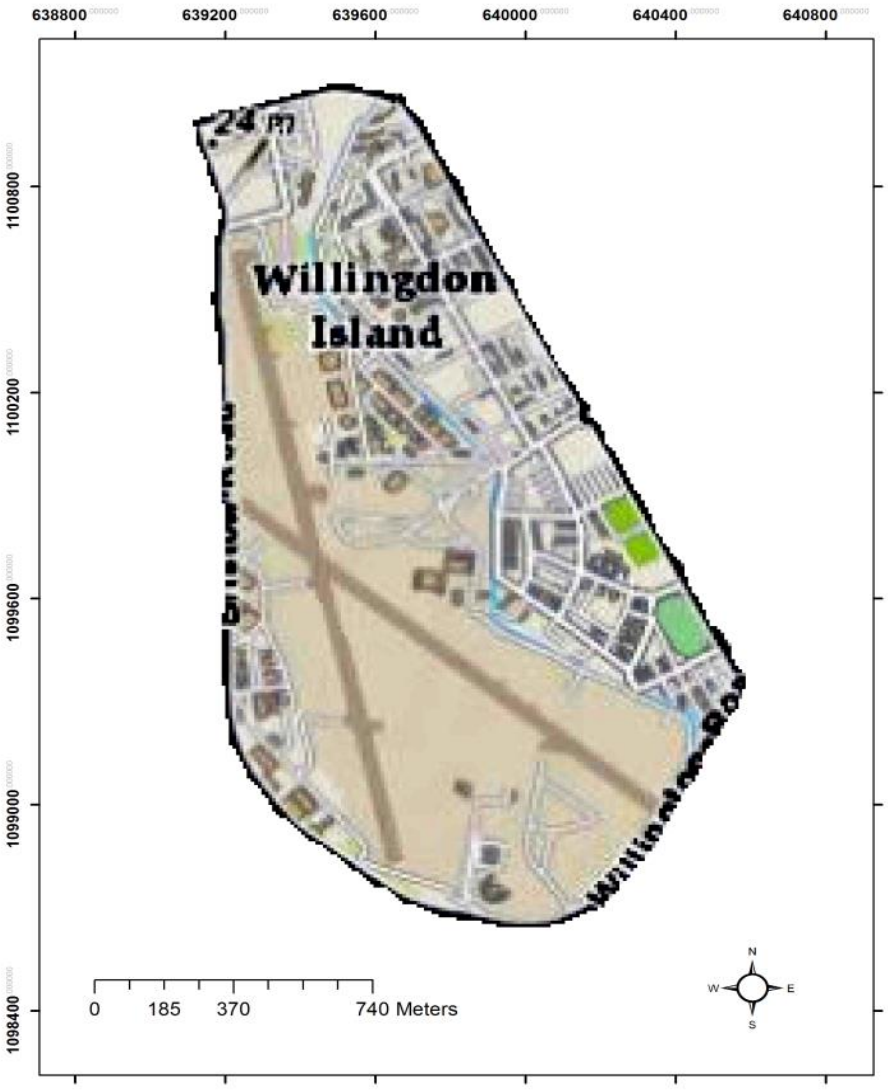

Fig. 01 Location of INS Garuda

3. METHODS

We surveyed the operational area and INS Garuda for bird activities and conducted the bird census by visual methods (Total count method). Similarly birds surrounding the 10 km monthly area of INS Garuda were also estimated using Point count method. The details are described below. Birds were identified with physical features using standard Field Guides (Ali and Ripley, 1983; Grimmet, 2001; Ali, 2003) A pair of binoculars was used for identifying birds. A minimum of 15 days were spent in field in each month.

3.1. Census of birds: Birds were identified based on the physical features with the help of field guides and reference books using a pair of binoculars and spotting scope (Bushnell 60x). Birds were estimated by total count method. Total Count Method was employed in INS GARUDA and point Count method was employed outside INS GARUDA. The census of birds were conducted from May 2016 to January 2018.

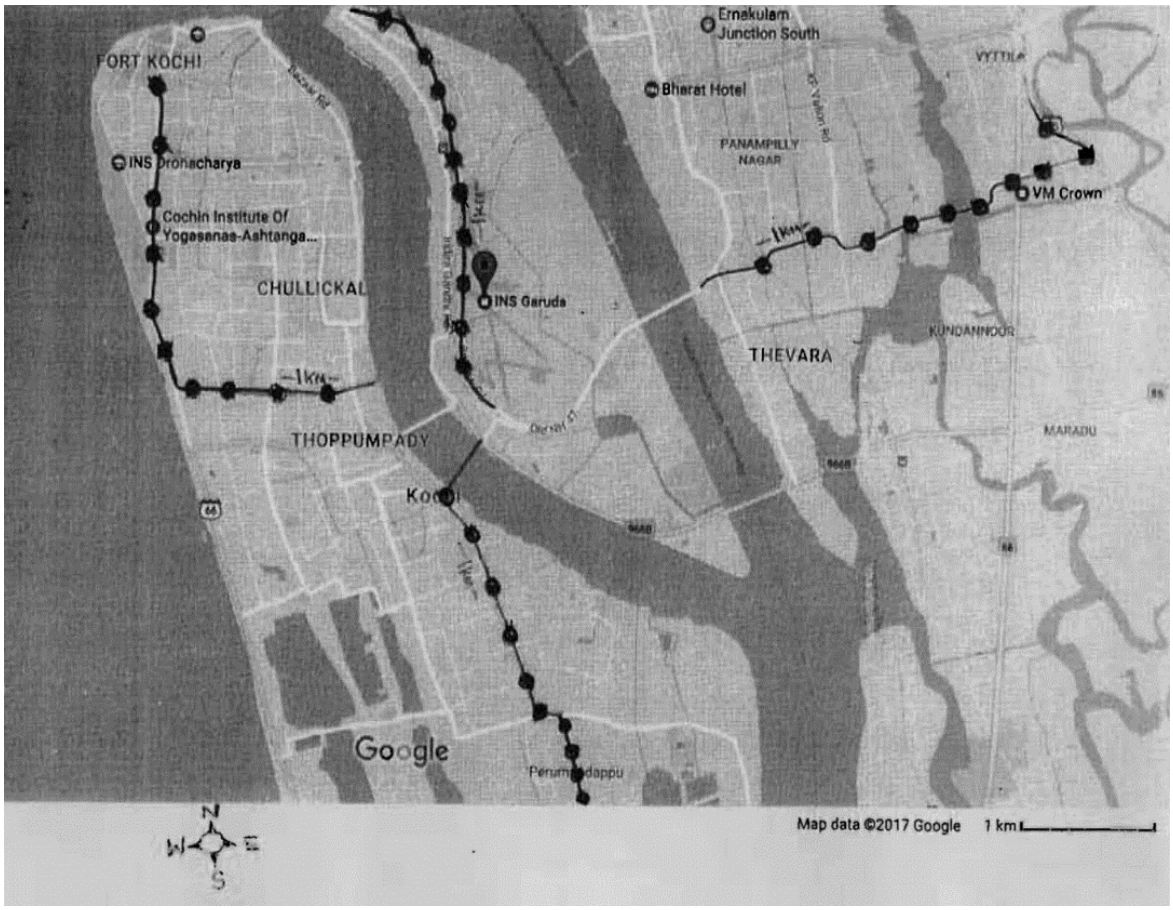

Fig. 02 Point Count sampling points outside INS Garuda

3.2. Habitat utilization

Exact location of the birds observed and activities were recorded during the surveys. Each habitat was identified in the study area, depending on the vegetation type and the "micro habitat" of birds. Plant species occurring in the INS Garuda and premises were identified with the help of a plant taxonomist Dr. V.B Sreekumar, Scientist, Department of Botany, Kerala Forest Research Institute, Peechi and provided with common names and scientific names.

3.3 Training of Navy personnel

A navy personnel always accompanied the survey party and training was given to identify the birds in the field. A talk on the Bird hazard problem in INS Garuda was also offered to the Navy officers. Participated in the interaction meeting called by the District Collector along with the SFSO and presented the problems and solutions to solve the issues.

4. RESULT

4.1. Avifauna in INS Garuda and outside

Twenty seven taxa of birds were identified from the INS Garuda and 30 species from the surrounding area. Out of these, three species are migratory and other species are Resident birds (Tables 02 and 03). Highest number of bird species were recorded in December 2017 and lowest in February 2016 and August 2017 in inside INS Garuda. In the same way highest number of bird species were recorded during December 2017 and lowest during October 2016 and February 2017 outside INS Garuda (Fig. 03). Highest number of birds were recorded during the month of July 2017 in INS Garuda and lowest in the month of June 2016. Similarly highest number of birds was recorded during the month of October 2017 and lowest in the month of July 2016 outside INS Garuda (Fig. 04).

Table 02. Species of birds recorded from INS Garuda

Sl. no.	Common name	Scientific name	Status	IUCN status
1.	Indian pond heron	*Ardeola grayii*	Resident	Least concern
2.	Black drongo	*Dicrurus macrocercus*	Resident	Least concern
3.	Red-wattled lapwing	*Vanellus indicus*	Resident	Least concern
4.	Common myna	*Acridotheres tristis*	Resident	Least concern
5.	Black kite	*Milvus migrans*	Resident	Least concern
6.	Brahminy kite	*Haliastur indus*	Resident	Least concern
7.	House crow	*Corvus splendens*	Resident	Least concern
8.	Little cormorant	*Microcarbo niger*	Resident	Least concern
9.	Median egret	*Ardea intermedia*	Resident	Least concern

10.	Purple heron	*Ardea purpurea*	Resident	Least concern
11.	Pied wagtail	*Motacilla alba*	Migratory	Least concern
12.	Little egret	*Egretta garzetta*	Resident	Least concern
13.	Blue rock pigeon	*Columba livia*	Resident	Least concern
14.	Shikra	*Accipiter badius*	Resident	Least concern
15.	Cattle egret	*Bubulcus ibis*	Resident	Least concern
16.	Large egret	*Ardea alba*	Resident	Least concern
17.	Indian roller	*Coracias benghalensis*	Resident	Least concern
18.	Lesser sand plover	*Charadrius mongolus*	Migratory	Least concern
19.	Barn swallow	*Hirundo rustica*	Migratory	Least concern
20.	Asian openbill stork	*Anastomus oscitans*	Resident	Least concern
21.	Black-crowned night heron	*Nycticorax nycticorax*	Resident	Least concern
22.	Scaly-breasted munia	*Lonchura punctulata*	Resident	Least concern
23.	Indian swiftlet	*Aerodramus unicolor*	Resident	Least concern
24.	White-breasted waterhen	*Amaurornis phoenicurus*	Resident	Least concern
25.	Oriental darter	*Anhinga melanogaster*	Resident	Near threatened
26.	Blue-tailed bee eater	*Merops philippinus*	Migratory	Least concern
27.	Black-headed ibis	*Threskiornis melanocephalus*	Resident	Near threatened

Table 03. Species of birds recorded Outside INS Garuda

Sl. no.	Common name	Scientific name	Status	IUCN status
1.	Indian pond heron	*Ardeola grayii*	Resident	Least concern
2.	Black drongo	*Dicrurus macrocercus*	Resident	Least concern

3.	Red-wattled lapwing	*Vanellus indicus*	Resident	Least concern
4.	Common myna	*Acridotheres tristis*	Resident	Least concern
5.	Black kite	*Milvus migrans*	Resident	Least concern
6.	Brahminy kite	*Haliastur indus*	Resident	Least concern
7.	House crow	*Corvus splendens*	Resident	Least concern
8.	Little cormorant	*Microcarbo niger*	Resident	Least concern
9.	Median egret	*Ardea intermedia*	Resident	Least concern
10.	Purple heron	*Ardea purpurea*	Resident	Least concern
11.	Blue-tailed bee eater	*Merops philippinus*	Migratory	Least concern
12.	Little egret	*Egretta garzetta*	Resident	Least concern
13.	Blue rock pigeon	*Columba livia*	Resident	Least concern
14.	White-cheeked barbet	*Psilopogon viridis*	Resident	Least concern
15.	Asian koel	*Eudynamys scolopaceus*	Resident	Least concern
16.	Large egret	*Ardea alba*	Resident	Least concern
17.	Black- rumped flame back	*Dinopium benghalense*	Resident	Least concern
18.	Red- vented bulbul	*Pycnonotus cafer*	Resident	Least concern
19.	Rose-ringed parakeet	*Psittacula krameri*	Resident	Least concern
20.	Oriental magpie robin	*Copsychus saularis*	Resident	Least concern
21.	Black-crowned night heron	*Nycticorax nycticorax*	Resident	Least concern
22.	Purple- rumped sun bird	*Leptocoma zeylonica*	Resident	Least concern
23.	Indian swiftlet	*Aerodramus unicolor*	Resident	Least concern
24.	House sparrow	*Passer domesticus*	Resident	Least concern
25.	Oriental darter	*Anhinga melanogaster*	Resident	Near threatened
26.	Rufous treepie	*Dendrocitta vagabunda*	Resident	Least concern

27.	Greater racket-tailed drongo	*Dicrurus paradiseus*	Resident	Least concern
28.	Jungle crow	*Corvus macrorhynchos*	Resident	Least concern
29.	White-breasted kingfisher	*Halcyon smyrnensis*	Resident	Least concern
30.	Crow pheasant	*Centropus sinensis*	Resident	Least concern

Indian fruit bat *Pteropus giganteus* was also recorded from outside the INS Garuda area.

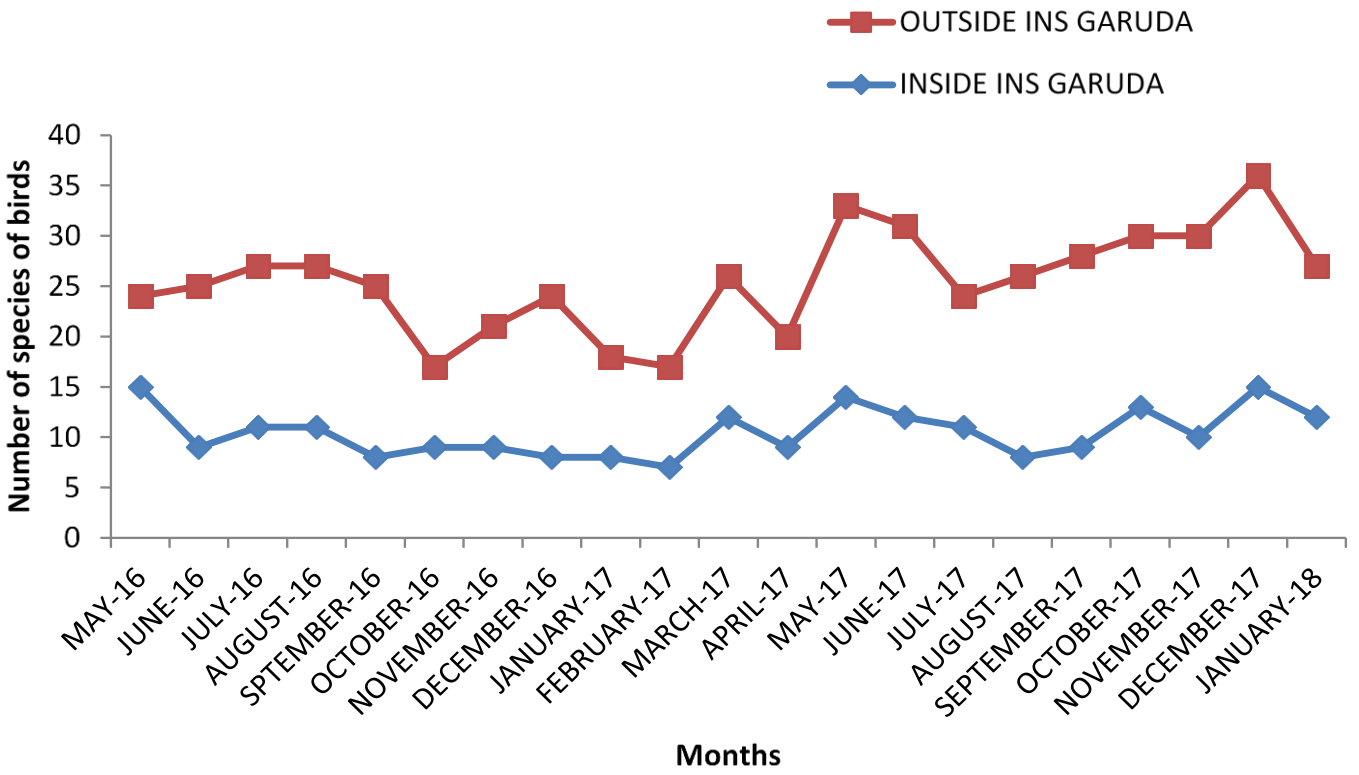

Fig. 03 Species of birds recorded from the INS Garuda and surrounding areas of INS Garuda

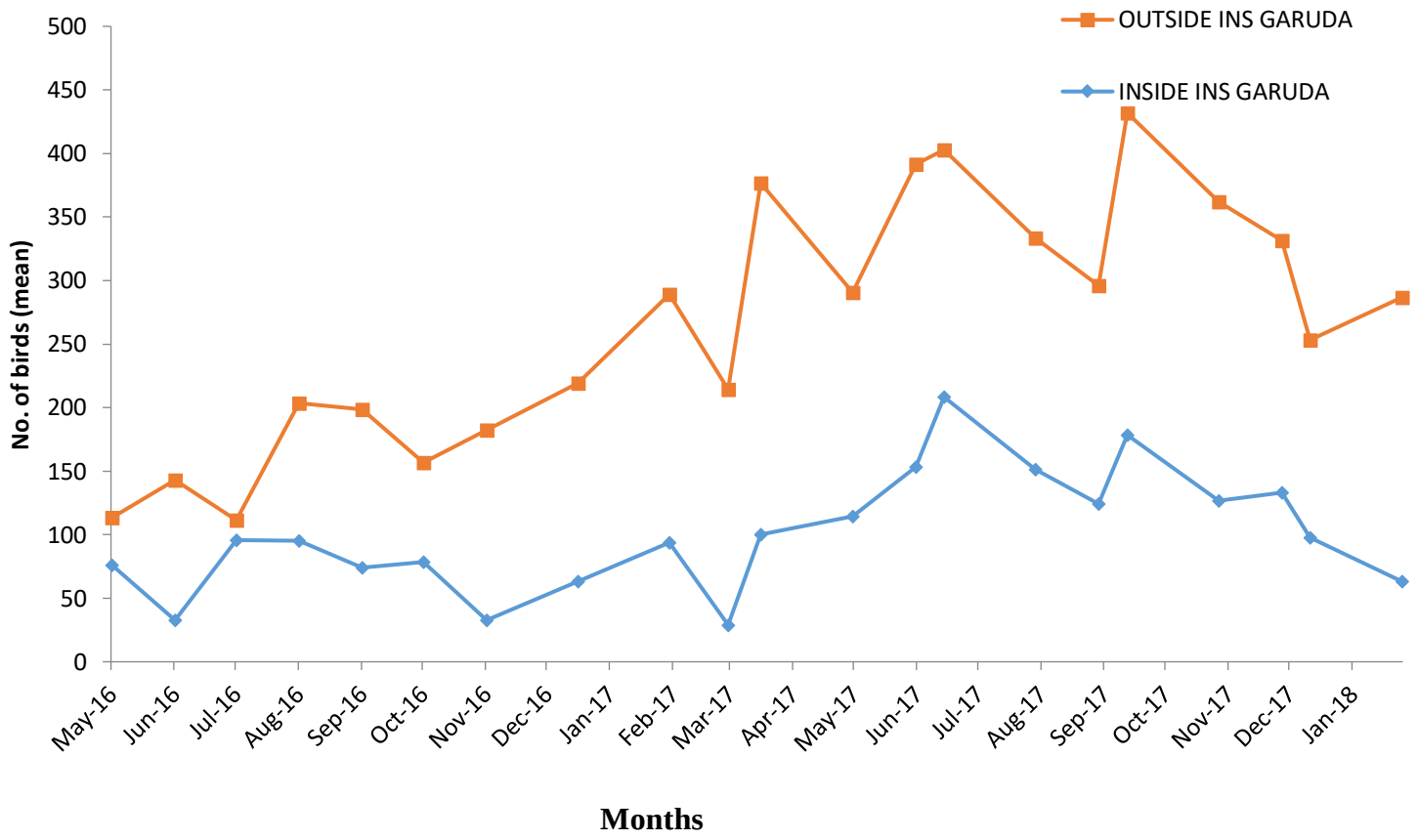

Fig. 04 Total number of birds recorded in each month in INS Garuda and surrounding areas of INS Garuda

4. 1 .1 Bird Communities in INS Garuda and Outside

Details of birds recorded from INS Garuda and the surrounding areas are given in the Tables given below. For each month two tables are presented representing the birds inside INS Garuda and birds recorded in the surrounding areas. In the month of December due to certain logistic reasons birds in the INS Garuda could not be censused. The occurrence of birds in the month of May 2016 in INS GARUDA is given in Table 04. Common myna and Red-wattled lapwing were recorded in maximum. Table 05 shows the number of species of birds recorded outside the air field during the months of May 2016 and May 2017 and House crow and Black kite was highest in number.

Table 04 Species of birds inside INS GARUDA in May 2016 and May 2017

Species	Scientific name	2016 (n=8)			2017 (n=8)			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**
Indian pond heron	*Ardeola grayii*	25	4.09	3.13	0	0	0	1.57
Black drongo	*Dicrurus macrocercus*	44	7.21	5.5	2	0.13	0.20	2.85
Redwattled lapwing	*Vanellus indicus*	114	18.69	14.25	230	15.54	23.80	19.03
Common myna	*Acridotheres tristis*	118	**19.34**	14.75	343	22.39	34.30	24.53
Black kite	*Milvus migrans*	80	13.11	10	220	14.36	22.0	16
Brahminy kite	*Haliastur indus*	11	1.80	1.38	60	3.92	6.0	3.69
House crow	*Corvus splendens*	36	2.12	4.5	0	0	0	2.25
Little cormorant	*Microcarbo niger*	2	0.32	0.25	31	2.02	3.10	1.68
Median egret	*Ardea intermedia*	9	1.47	1.13	6	0.39	0.60	0.87
Purple heron	*Ardea purpurea*	2	0.32	0.25	5	0.33	0.50	0.38
Pied wagtail	*Motacilla alba*	1	0.16	0.13	0	0	0	0.07
Little egret	*Egretta garzetta*	44	7.21	5.5	28	1.83	2.80	4.15
Blue rock pigeon	*Columba livia*	56	9.18	7	507	33.09	50.70	28.85
Shikra	*Accipiter badius*	1	0.16	0.13	0	0	0	0.07
Cattle egret	*Bubulcus ibis*	67	10.98	8.38	53	3.46	5.30	6.84
Night heron	*Nycticorax nycticorax*	0	0	0	5	0.33	0.50	0.25
Open bill stork	*Anastomus oscitans*	0	0	0	9	0.59	0.90	0.45
Blackheaded ibis	*Threskiornis melanocephalus*	0	0	0	25	1.63	2.50	1.25
		610			**1532**			**114.74**

Table 05 Species of birds Outside INS GARUDA in May 2016 and May 2017

Species	Scientific name	2016 (n=8)			2017 (n=8)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	2	0.73	0.25	37	1.94	4.63	2.44
Black drongo	*Dicrurus macrocercus*	1	0.33	0.13	6	0.31	0.75	0.44
Common myna	*Acridotheres tristis*	18	6.06	2.25	37	1.94	4.63	3.44
Black kite	*Milvus migrans*	56	18.85	7	103	5.40	12.88	9.44
Brahminy kite	*Haliastur Indus*	4	1.35	0.5	14	0.73	1.75	1.13
House crow	*Corvus splendens*	120	40.40	15	988	51.81	123.5	69.25
Blue rock pigeon	*Columba livia*	92	30.98	11.5	463	24.28	57.88	34.69
Crow pheasant	*Centropus sinensis*	2	0.73	0.25	0	0	0	0.13
Whitecheeked barbet	*Psilopogon viridis*	2	0.73	0.25	2	0.10	0.25	0.25
Little cormorant	*Microcarbo niger*	0	0	0	177	9.28	22.13	11.07
Little egret	*Egretta garzetta*	0	0	0	21	1.10	2.63	1.31
House sparrow	*Passer domesticus*	0	0	0	4	0.21	0.50	0.25
Asian koel	*Eudynamys scolopaceus*	0	0	0	7	0.37	0.88	0.44
Black headed ibis	*Threskiornis melanocephalus*	0	0	0	10	0.52	1.25	0.63
Large egret	*Ardea alba*	0	0	0	10	0.52	1.25	0.63
Night heron	*Nycticorax nycticorax*	0	0	0	20	1.05	2.50	1.25
Oriental darter	*Anhinga melanogaster*	0	0	0	3	0.16	0.38	0.19
Racket-tailed drongo	*Dicrurus paradiseus*	0	0	0	1	0.05	0.13	0.07
Red-vented bulbul	*Pycnonotus cafer*	0	0	0	2	0.10	0.25	0.13
Black-rumped flame back	*Dinopium benghalense*	0	0	0	2	0.10	0.25	0.13
		297		**37.13**	**1907**		**238.42**	**137.77**

Species of birds recorded in the INS GARUDA during the month of June is given in the Table 06 and outside INS GARUDA is given in Table 07. Black kite and Common crow were recorded in maximum in both the areas respectively.

Table 06 Species of birds inside INS GARUDA in June 2016 and June 2017

Species	Scientific name	2016 (n=6)			2017 (n=6)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	24	12.24	4	3	0.24	0.5	2.25
Black drongo	*Dicrurus macrocercus*	15	7.65	2.5	62	4.96	10.33	7.67
Redwattled lapwing	*Vanellus indicus*	37	18.88	6.17	145	11.6	24.17	6.42
Common myna	*Acridotheres tristis*	35	17.86	5.83	170	13.6	28.33	15.17
Black kite	*Milvus migrans*	44	**22.45**	7.33	140	11.2	23.33	17.08
Brahminy kite	*Haliastur indus*	4	2.04	0.67	14	1.12	2.33	15.33
House crow	*Corvus splendens*	3	1.53	0.50	0	0	0	1.5
Little cormorant	*Microcarbo niger*	4	2.04	0.67	3	0.24	0.5	0.25
Large egret	*Ardea alba*	1	0.51	0.17	0	0	0	0.585
Purple heron	*Ardea purpurea*	6	3.06	1	16	1.28	2.67	0.09
Pied wagtail	*Motacilla alba*	1	0.51	0.17	0	0	0	1.84
Little egret	*Egretta garzetta*	2	1.02	0.33	0	0	0	0.09
Blue-rock pigeon	*Columba livia*	19	9.69	3.17	684	54.72	114	58.59
Indian Roller	*Coracias benghalensis*	1	0.51	0.17	0	0	0	0.09
Oriental darter	*Anhinga melanogaster*	0	0	0	9	0.72	1.5	0.75
Asian openbill stork	*Anastomus oscitans*	0	0	0	2	0.16	0.33	0.17
Black crowned night heron	*Nycticorax nycticorax*	0	0	0	2	0.16	0.33	0.17

Table 07 Species of birds outside INS GARUDA Naval Base in June 2016 and June 2017

Species	Scientific name	2016 (n=8)			2017 (n=6)			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**
Indian pond heron	*Ardeola grayii*	2	0.30	0.33	22	1.88	3.67	2.00
Black drongo	*Dicrurus macrocercus*	5	0.75	0.83	1	0.09	0.17	0.5
Red-wattled lapwing	*Vanellus indicus*	4	0.60	0.67	0	0	0	0.33
Common myna	*Acridotheres tristis*	18	2.71	3	17	1.46	2.83	2.91
Black kite	*Milvus migrans*	154	23.22	25.67	60	5.14	10.00	17.83
Brahminy kite	*Haliastur indus*	18	2.71	3	16	1.37	2.67	2.83
House crow	*Corvus splendens*	263	**39.66**	43.83	698	59.76	116.33	80.08
Little cormorant	*Microcarbo niger*	39	5.88	6.50	240	20.55	40.00	23.25
Purple heron	*Ardea purpurea*	2	0.30	0.33	1	0.09	0.17	0.25
Blue rock pigeon	*Columba livia*	158	23.83	26.33	73	6.25	12.17	19.25
Blackrumped flame back	*Dinopium benghalense*	0	0	0	5	0.43	0.83	0.41
Whitecheeked barbet	*Psilopogon viridis*	0	0	0	2	0.17	0.33	0.16
Black crowned night	*Nycticorax nycticorax*	0	0	0	2	0.17	0.33	0.16
heron	*Eudynamys scolopaceus*	0	0	0	2	0.17	0.33	0.16
Asian koel	*Passer domesticus*	0	0	0	11	0.94	1.83	0.91
House sparrow	*Egretta garzetta*	0	0	0	6	0.51	1.00	0.5
Little egret	*Leptocoma zeylonica*	0	0	0	3	0.26	0.50	0.25
Purple-rumped sunbird	*Ardea intermedia*	0	0	0	3	0.26	0.50	0.25
Median egret	*Psittacula krameri*	0	0	0	2	0.17	0.33	0.16
Rose-ringed parakeet	*Copsychus saularis*	0	0	0	4	0.34	0.67	0.33
Oriental magpie robin								
		663		**110.49**	**1168**		**194.66**	**152.57**

Blue rock pigeon was the highest species recorded during the month of July 2016 in INS GARUDA and House crow outside INS GARUDA (Tables 08 and 09).

Table 08 Species of birds inside INS GARUDA in July 2016 and July 2017

Species	Scientific name	2016 (n=2)			2017 (n=7)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	3	1.57	1.5	4	0.38	0.57	1.03
Black drongo	*Dicrurus macrocercus*	5	2.61	2.5	29	2.73	4.14	3.32
Red-wattled lapwing	*Vanellus indicus*	52	27.22	26	157	14.80	22.43	24.21
Common myna	*Acridotheres tristis*	21	10.99	10.5	119	11.22	17.00	13.75
Black kite	*Milvus migrans*	41	21.47	20.5	160	15.08	22.86	21.68
Brahminy kite	*Haliastur Indus*	2	1.05	1	16	1.51	2.29	1.64
Purple heron	*Ardea purpurea*	1	0.52	0.5	3	0.28	0.43	0.46
Blue rock pigeon	*Columba livia*	65	**34.03**	32.5	397	37.42	56.71	44.60
Indian Roller	*Coracias benghalensis*	1	0.52	0.5	0	0	0	0.25
Black-headed ibis	*Threskiornis melanocephalus*	0	0	0	21	1.98	3.00	1.5
Little cormorant	*Microcarbo niger*	0	0	0	5	0.47	0.71	0.35
Scaly-breasted munia	*Lonchura punctulata*	0	0	0	150	14.14	21.43	10.71
		191		**95.5**	**1061**		**151.57**	**123.53**

Table 09 Species of birds outside INS GARUDA Naval Base in July 2016 and July 2017

Species	Scientific name	2016 (n=11)			2017 (n=6)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	15	1.28	1.25	16	1.47	2.67	1.96
Black drongo	*Dicrurus macrocercus*	3	0.25	0.25	0	0	0	0.12
Common myna	*Acridotheres tristis*	41	3.50	3.42	13	1.19	2.17	2.7

Black kite	*Milvus migrans*	44	3.76	3.67	86	7.88	14.33	9
Brahminy kite	*Haliastur indus*	3	0.25	0.25	26	2.38	4.33	2.29
House crow	*Corvus splendens*	781	**66.75**	65.08	587	53.80	97.83	81.45
Blue rock pigeon	*Columba livia*	170	14.52	14.17	185	16.96	30.83	22.5
White-cheeked barbet	*Psilopogon viridis*	2	0.17	0.17	3	0.27	0.50	0.33
Little cormorant	*Microcarbo niger*	44	3.76	3.67	148	13.57	24.67	14.17
Large egret	*Ardea alba*	2	0.17	0.17	0	0	0	0.08
Asian koel	*Eudynamys scolopaceus*	3	0.25	0.25	0	0	0	0.12
Red- vented bulbul	*Pycnonotus cafer*	2	0.17	0.17	0	0	0	0.08
Oriental magpie robin	*Copsychus saularis*	5	0.43	0.42	0	0	0	0.21
Purple- rumped sunbird	*Leptocomoa zeylonica*	12	1.02	1	0	0	0	0.5
Little egret	*Egretta garzetta*	11	0.94	0.92	0	0	0	0.46
House sparrow	*Passer domesticus*	32	2.73	2.67	4	0.37	0.67	1.67
Black-crowned night heron	*Nycticorax nycticorax*	0	0	0	12	1.10	2.00	1
Asian koel	*Eudynamys scolopaceus*	0	0	0	8	0.73	1.33	0.66
Oriental darter	*Anhinga melanogaster*	0	0	0	2	0.18	0.33	0.16
Greater coucal	*Centropus senegalensis*	0	0	0	1	0.09	0.17	0.08
		1170		**97.53**	**1091**			**139.68**

Black kite was highest in INS GARUDA during the month of August 2016 (Table 10) and House crow was maximum outside the airfield in August 2016 and August 2017 (Table 11).

Table 10 Species of birds inside INS GARUDA in August 2016 and August 2017

Species	**Scientific name**	**2016 (n=8)**			**2017 (n=5)**			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**

Indian pond heron	*Ardeola grayii*	12	1.58	1.5	45	7.25	9	5.25
Black drongo	*Dicrurus macrocercus*	30	3.95	3.75	10	1.61	2.00	2.87
Red-wattled lapwing	*Vanellus indicus*	140	18.42	17.5	80	12.88	16.00	16.75
Common myna	*Acridotheres tristis*	160	21.05	20	197	31.72	39.40	29.7
Black kite	*Milvus migrans*	282	**37.10**	35.25	139	22.38	27.80	31.52
Brahminy kite	*Haliastur indus*	34	4.47	4.25	8	1.29	1.60	2.92
Purple heron	*Ardea purpurea*	1	0.13	0.13	0	0	0	0.06
Blue rock pigeon	*Columba livia*	25	3.29	3.13	112	18.04	22.40	12.76
Indian roller	*Coracias benghalensis*	3	0.39	0.38	0	0	0	0.19
Little cormorant	*Microcarbo niger*	1	0.13	0.13	0	0	0	0.06
House crow	*Corvus splendens*	71	9.34	8.88	0	0	0	4.44
Little egret	*Egretta garzetta*	0	0	0	30	4.83	6	3.00
	Total no. of birds	**759**		**94.9**	**621**		**124.2**	**109.55**

Table 11 Species of birds outside INS GARUDA in August 2016 and August 2017

Species	**Scientific name**	**2016 (n=7)**			**2017 (n=8)**			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**
Indian pond heron	*Ardeola grayii*	15	1.33	2.14	39	2.84	4.88	3.51
Black drongo	*Dicrurus macrocercus*	2	0.17	0.29	5	0.36	0.63	0.46
Common myna	*Acridotheres tristis*	42	3.73	6.00	11	0.80	1.38	3.69
Black kite	*Milvus migrans*	47	4.17	6.71	134	9.75	16.75	11.73
Brahminy kite	*Haliastur indus*	1	0.09	0.14	10	0.73	1.25	0.069
House crow	*Corvus splendens*	729	**64.68**	104.14	914	66.47	114.25	109.19
Blue rock pigeon	*Columba livia*	233	20.67	33.29	169	12.29	21.13	27.21
White-cheeked barbet	*Psilopogon viridis*	2	0.17	0.29	0	0	0	0.14

Little cormorant	*Microcarbo niger*	32	2.84	4.57	41	2.98	5.13	4.85
Large egret	*Ardea alba*	2	0.17	0.29	4	0.29	0.50	0.39
Asian koel	*Eudynamys scolopaceus*	3	0.27	0.43	8	0.58	1.00	0.71
Oriental magpie robin	*Copsychus saularis*	2	0.17	0.29	2	0.15	0.25	0.27
Purple- rumped sun bird	*Leptocoma zeylonica*	2	0.17	0.29	7	0.51	0.88	0.58
House sparrow	*Passer domesticus*	13	1.15	1.86	19	1.38	2.38	2.12
Blackrumped flameback	*Dinopium benghalense*	1	0.09	0.14	0	0	0	0.07
Purple heron	*Ardea purpurea*	1	0.09	0.14	0	0	0	0.07
Oriental darter	*Anhinga melanogaster*	0	0	0	3	0.22	0.38	0.19
Red- vented bulbul	*Pycnonotus cafer*	0	0	0	2	0.15	0.25	0.12
Little egret	*Egretta garzetta*	0	0	0	2	0.15	0.25	0.12
Jungle crow	*Corvus levaillantii*	0	0	0	2	0.07	0.13	0.06
Black-crowned night heron	*Nycticorax nycticorax*	0	0	0	4	0.29	0.50	0.25
	Total no. of birds	**1127**		**161.01**	**1376**		**171.92**	**166.46**

Blue rock pigeon was maximum during the months of September 2016 and September 2017 inside INS GARUDA (Table 12) and House crow was the maximum recorded species in the same months outside the INS GARUDA air field (Table 13).

Table 12 Species of birds inside INS GARUDA in September 2016 September 2017

Species	**Scientific name**	**2016 (n=2)**			**2017 (n=5)**			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**

Black drongo	*Dicrurus macrocercus*	6	4.06	3	29	3.25	5.8	4.4
Red-wattled lapwing	*Vanellus indicus*	8	5.41	4	55	6.16	11	7.5
Common myna	*Acridotheres tristis*	6	4.06	3	286	32.03	57.2	30.1
Black kite	*Milvus migrans*	37	25	18.5	172	19.26	34.4	26.45
Brahminy kite	*Haliastur indus*	6	4.06	3	44	4.93	8.8	5.9
Blue rock pigeon	*Columba livia*	81	**54.73**	40.5	239	26.76	47.8	44.15
Indian Roller	*Coracias benghalensis*	2	1.36	1	0	0	0	0.5
Indian pond heron	*Ardeola grayii*	2	1.36	1	19	2.13	3.8	2.4
Lesser sand plover	*Charadrius mongolus*	0	0	0	31	3.47	6.2	3.1
Indian swiftlet	*Aerodramus unicolor*	0	0	0	18	2.02	3.6	1.8
	Total no. of birds	**148**		**74**	**893**		**178.6**	**126.3**

Table 13 Species of birds outside INS GARUDA in September 2016 and September 2017

Species	Scientific name	2016 (n=12)			2017 (n=6)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	15	0.93	1.15	40	2.63	6.67	3.91
Black drongo	*Dicrurus macrocercus*	3	0.19	0.23	2	0.31	0.33	0.28
Red- vented bulbul	*Pycnonotus cafer*	1	0.07	0.08	0	0	0	0.04
Common myna	*Acridotheres tristis*	14	0.84	1.08	10	0.66	1.67	1.37
Black kite	*Milvus migrans*	76	4.69	5.85	68	4.47	11.33	8.59
Brahminy kite	*Haliastur indus*	20	1.24	1.54	17	1.12	2.83	2.18
House crow	*Corvus splendens*	1103	**68.01**	84.85	813	53.49	135.50	110.1
Little cormorant	*Microcarbo niger*	49	3.02	3.77	57	3.75	9.50	7

Small Green barbet	*Psilopogon zeylanicus*	3	0.19	0.23	0	0	0	6.63
House sparrow	*Passer domesticus*	4	0.25	0.31	3	0.20	0.50	0.11
Jungle crow	*Corvus macrorhynchos*	1	0.06	0.08	1	0.07	0.17	0.40
Greater coucal	*Centropus sinensis*	1	0.06	0.08	2	0.13	0.33	0.12
Blue rock pigeon	*Columba livia*	323	19.92	24.85	470	30.92	78.33	0.20
Asian koel	*Eudynamys scolopaceus*	1	0.06	0.08	14	0.92	2.33	51.59
Rose-ringed parakeet	*Psittacula krameri*	4	0.25	0.31	4	0.26	0.67	1.20
Blackrumped flameback	*Dinopium benghalense*	2	0.13	0.15	0	0	0	0.49
Large egret	*Ardea alba*	2	0.13	0.15	1	0.07	0.17	0.07
Median egret	*Ardea intermedia*	0	0	0	2	0.13	0.33	0.16
White-cheeked barbet	*Psilopogon viridis*	0	0	0	5	0.33	0.83	0.16
Oriental darter	*Anhinga melanogaster*	0	0	0	5	0.33	0.83	0.41
Oriental magpie robin	*Copsychus saularis*	0	0	0	2	0.13	0.33	0.41
Purple- rumped sun bird	*Leptocoma zeylonica*	0	0	0	4	0.26	0.67	0.16 0.33
	Total no. of birds	**1622**		**124.79**	**1520**		**253.32**	**189.05**

In the month of October also, Blue rock pigeon continued to be the maximum recorded species in INS GARUDA (Table 14) and House crow was the most recorded species outside the airfield (Table 15).

Table 14 Species of birds inside INS GARUDA in October 2016 and October 2017

Species	**Scientific name**	**2016 (n=2)**			**2017 (n=5)**			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**

Black drongo	*Dicrurus macrocercus*	7	1.78	14	10	0.99	1.25	7.62
Red-wattled lapwing	*Vanellus indicus*	68	17.30	13.6	76	7.50	9.50	11.55
Common myna	*Acridotheres tristis*	28	7.13	5.6	141	13.92	17.63	11.61
Black kite	*Milvus migrans*	120	30.54	24	186	18.36	23.25	23.62
Brahminy kite	*Haliastur indus*	16	4.07	3.2	69	681	8.63	5.91
Little egret	*Egretta garzetta*	3	0.77	0.6	0	0	0	0.3
Blue rock pigeon	*Columba livia*	141	**35.86**	28.2	489	48.27	61.13	44.66
Indian Roller	*Coracias benghalensis*	3	0.77	0.6	2	0.20	0.25	0.42
Indian pond heron	*Ardeola grayii*	7	1.78	1.4	3	0.30	0.38	0.89
Purple heron	*Ardea purpurea*	0	0	0	2	0.20	0.25	0.12
Lesser sand plover	*Charadrius mongolus*	0	0	0	13	1.28	1.63	0.81
Black-crowned night	*Nycticorax nycticorax*	0	0	0	1	0.10	0.13	0.06
heron	*Aerodramus unicolor*	0	0	0	19	1.88	2.38	1.19
Indian swiftlet	*Egretta garzetta*	0	0	0	2	0.20	0.25	0.12
Little egret								
	Total no. of birds	**393**		**91.2**	**1013**		**126.66**	**108.93**

Table 15 Species of birds outside INS GARUDA in October 2016 and October 2017

Species	Scientific name	2016 (n=8)			2017 (n=8)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	5	0.79	0.63	47	2.50	5.88	3.25
Common myna	*Acridotheres tristis*	14	2.24	1.75	21	1.12	2.63	2.19
Black kite	*Milvus migrans*	18	2.88	2.25	46	2.45	5.75	4
House crow	*Corvus splendens*	453	**72.37**	56.63	1101	58.53	137.63	97.13
Little cormorant	*Microcarbo niger*	12	1.92	1.5	134	7.12	16.75	9.12
Blue rock pigeon	*Columba livia*	121	19.33	15.13	430	22.86	53.75	34.44

Black drongo	*Dicrurus macrocercus*	1	0.16	0.13	11	0.58	1.38	0.75
Asian koel	*Eudynamys scolopaceu*	2	0.32	0.25	17	0.90	2.13	1.19
Brahminy kite	*Haliastur Indus*	0	0	0	25	1.33	3.13	1.56
House sparrow	*Passer domesticus*	0	0	0	4	0.21	0.50	0.25
Jungle crow	*Corvus levaillantii*	0	0	0	5	0.27	0.63	0.31
Greater coucal	*Centropus senegalensis*	0	0	0	1	0.05	0.13	0.06
Oriental darter	*Anhinga melanogaster*	0	0	0	1	0.05	0.13	0.06
Median egret	*Ardea intermedia*	0	0	0	9	0.48	1.13	0.56
Large egret	*Ardea alba*	0	0	0	20	1.06	2.50	1.25
Indian swiftlet	*Aerodramus unicolor*	0	0	0	7	0.37	0.88	0.44
Blackrumped flame back	*Dinopium benghalense*	0	0	0	2	0.11	0.25	0.12
	Total no. of birds	**626**		**78.27**	**1881**		**235.18**	**156.72**

Black kite and House crow were the highest recorded species during the month of November in and around the INS GARUDA (Tables 16 and 17).

Table 16 Species of birds and bats inside INS GARUDA in November 2016 and November 2017

Species	Scientific name	2016 (n=5)			2017 (n=5)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Black drongo	*Dicrurus macrocercus*	6	3.68	1.2	7	1.05	1.40	1.3
Red-wattled lapwing	*Vanellus indicus*	39	23.93	7.8	23	3.45	4.60	6.2
Common myna	*Acridotheres tristis*	5	3.07	1	24	3.60	4.80	2.9
Black kite	*Milvus migrans*	65	**39.88**	13	83	12.46	16.60	14.8
Brahminy kite	*Haliastur indus*	10	6.14	2	14	2.10	2.80	2.4
Little egret	*Egretta garzetta*	14	8.59	2.8	21	3.15	4.20	3.5
Blue rock pigeon	*Columba livia*	2	1.23	0.4	309	46.40	61.80	31.1
Indian Roller	*Coracias benghalensis*	2	1.23	0.4	0	0	0	0.2
Lesser sand Plover	*Charadrius mongolus*	20	12.27	4	0	0	0	2
Barn swallow	*Hirundo rustica*	0	0	0	32	4.80	6.40	3.2
Median egret	*Ardea intermedia*	0	0	0	3	0.45	0.60	0.3
Indian fruit bat	*Pteropus giganteus*	0	0	0	150	22.52	30.00	15
	Total number	**163**		**32.6**	**666**		**133.2**	**82.9**

Table 17 Species of birds outside INS GARUDA in November 2016 and November 2017

Species	Scientific name	2016 (n=10)			2017 (n=15)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Indian pond heron	*Ardeola grayii*	35	2.34	3.5	80	2.52	5.00	4.25

Common myna	*Acridotheres tristis*	16	1.07	1.6	138	4.35	8.63	5.11
Black kite	*Milvus migrans*	38	2.54	3.8	369	11.64	23.06	13.43
Brahminy kite	*Haliastur indus*	3	0.20	0.3	58	1.83	3.63	1.96
House crow	*Corvus splendens*	952	**63.68**	95.2	1798	56.74	112.3	103.79
Little cormorant	*Microcarbo niger*	27	1.81	2.7	104	3.28	8	4.6
Little egret	*Egretta garzetta*	91	6.09	9.1	33	1.04	6.50	5.58
Blue rock pigeon	*Columba livia*	312	20.87	31.2	163	14.61	2.06	30.07
White-cheeked barbet	*Psilopogon viridis*	2	0.13	0.2	7	0.22	28.94	0.32
Black-headed ibis	*Threskiormis melanocephalus*	11	0.74	1.1	0	0	0.44	0.55
Median egret	*Ardea intermedia*	7	0.47	0.7	11	0.35	0.69	0.69
Greater Coucal	*Centropus sinensis*	1	0.07	0.1	1	0.03	0.06	0.08
House sparrow	*Passer domesticus*	0	0	0	13	0.41	0.81	0.40
Black drongo	*Dicrurus macrocercus*	0	0	0	7	0.22	0.44	0.22
Asian koel	*Eudynamys scolopaceus*	0	0	0	44	1.39	2.75	1.37
Jungle crow	*Corvus macrorhynchos*	0	0	0	3	0.09	0.19	0.09
Oriental darter	*Anhinga melanogaster*	0	0	0	5	0.16	0.31	0.15
Large egret	*Ardea alba*	0	0	0	8	0.25	0.50	0.25
Oriental magpie robin	*Copsychus saularis*	0	0	0	4	0.13	0.25	0.12
Blue-tailed bee eater	*Merops philippinus*	0	0	0	22	0.69	1.38	0.69
Red-wattled lapwing	*Vanellus indicus*	0	0	0	1	0.03	0.06	0.03
	Total no. of birds	**1495**		**149.5**	**2869**		**198.08**	**173.79**

In December due to logistic reasons observations could not be taken in the INS GARUDA, (To get an ideal graph of bird sighting in December we took an average number of Bird sighting in November 2016 & January 20017) but were recorded from outside the airfield and the House crow was the maximum recorded species (Table 18).

Table 18 Species of birds outside INS GARUDA in December 2016 and December 2017

Species	Scientific name	2016 (n=15)			2017 (n=10)			
		No. of birds	**Monthly %**	**Monthly mean**	**No. of birds**	**Monthly %**	**Monthly mean**	**Total mean**
Indian pond heron	*Ardeola grayii*	41	1.64	2.56	14	0.90	1.40	1.68
Black drongo	*Dicrurus macrocercus*	2	0.08	0.13	0	0	0	0.06
Common myna	*Acridotheres tristis*	46	1.85	2.88	26	1.67	2.60	2.74
Black kite	*Milvus migrans*	63	2.53	3.94	118	7.59	11.80	7.87
Brahminy kite	*Haliastur indus*	22	0.88	1.38	27	1.74	2.70	2.04
House crow	*Corvus splendens*	1601	**64.22**	100.06	933	60.00	93.30	96.68
Little cormorant	*Microcarbo niger*	67	2.69	4.19	103	6.62	10.30	7.24
White-cheeked barbet	*Psilopogon viridis*	4	0.16	0.25	0	0	0	0.12
Jungle crow	*Corvus macrorhynchos*	1	0.04	0.06	1	0.06	0.10	0.08
Blue rock pigeon	*Columba livia*	599	24.03	37.44	232	14.92	23.20	30.32
Asian koel	*Eudynamys scolopaceus*	6	0.24	0.38	36	2.32	3.60	1.99
Black-rumped flameback	*Dinopium benghalense*	1	0.04	0.06	0	0	0	0.03
Little egret	*Egretta garzetta*	16	0.64	1.00	13	0.84	1.30	1.15
Oriental magpie robin	*Copsychus saularis*	2	0.08	0.13	2	0.13	0.20	0.16
Median egret	*Ardea intermedia*	22	0.88	1.38	1	0.06	0.10	0.74
House sparrow	*Passer domesticus*	0	0	0	9	0.58	0.90	0.45
Rose-ringed parakeet	*Psittacula krameri*	0	0	0	5	0.32	0.50	0.25
Greater coucal	*Centropus senegalensis*	0	0	0	5	0.32	0.50	0.25
Rufous treepie	*Dendrocitta vagabunda*	0	0	0	2	0.13	0.20	0.1
Large egret	*Ardea alba*	0	0	0	11	0.71	1.10	0.55
White-cheeked barbet	*Psilopogon viridis*	0	0	0	4	0.26	0.40	0.2
Blue-tailed bee eater	*Merops philippinus*	0	0	0	10	0.64	1.00	0.5
White-breasted kingfisher	*Halcyon smyrnensis*	0	0	0	1	0.06	0.10	0.05
Red-wattled lapwing	*Vanellus indicus*	0	0	0	2	0.13	0.20	0.1
	Total no. of birds	**2493**		**155.84**	**1555**		**155.5**	**155.67**

Table 19 Species of birds inside INS GARUDA in January 2017 and January 2018

Species	Scientific name	2017 (n=2)			2018 (n=8)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Black drongo	*Milvus migrans*	10	5.32	5.00	10	1.98	1.25	3.12
Red-wattled lapwing	*Vanellus indicus*	10	5.32	5.00	26	5.16	3.25	4.12
Black kite	*Ardea alba*	47	25.00	23.5	120	23.81	15.00	19.25
Brahminy kite	*Haliastur Indus*	11	5.85	5.50	15	2.98	4.50	5
Purple heron	*Coracias benghalensis*	2	1.06	1.00	5	0.99	0.63	0.81
Little egret	*Egretta garzetta*	96	51.06	48.00	10	1.98	1.25	24.62
Blue rock pigeon	*Columba livia*	8	4.26	4.00	96	19.05	12.00	8
Indian roller	*Coracias benghalensis*	4	2.13	2.00	0	0	0	1
Barn swallow	*Hirundo rustica*	0	0	0	36	7.14	4.50	2.25
Large egret	*Ardea alba*	0	0	0	10	1.98	1.25	0.62
Common myna	*Acridotheres tristis*	0	0	0	113	22.42	14.13	7.06
Lesser sand plover	*Charadrius mongolus*	0	0	0	7	1.39	0.88	0.44
Asian open billed stork	*Anastomus oscitans*	0	0	0	14	2.78	1.75	0.87
	Total no. of birds	**188**		**94**	**462**		**60.39**	**77.19**

Table 20 Species of birds and bat outside INS GARUDA in January 2017 and January 2018

Species	Scientific name	2017 (n=8)			2018 (n=7)			
		No. of birds	Monthly %	Monthly mean	No. of birds	Monthly %	Monthly mean	Total mean
Common myna	*Acridotheres tristis*	20	1.28	2.5	19	1.21	2.71	2.60
House crow	*Corvus splendens*	1096	70.21	137.0	1.058	67.52	151.14	144.07
Blue rock pigeon	*Columba livia*	241	15.44	30.1	192	12.25	27.43	28.76
Little egret	*Egretta garzetta*	42	2.69	5.25	15	0.96	2.14	3.69
Little cormorant	*Microcarbo niger*	38	2.43	4.75	72	4.59	10.29	7.52
Black kite	*Milvus migrans*	58	3.72	7.25	85	5.42	12.14	9.69
Indian pond heron	*Ardeola grayii*	48	3.07	6.00	40	2.55	5.71	5.85
Brahminy kite	*Haliastur indus*	8	0.51	1.00	22	1.40	3.14	2.07
House sparrow	*Passer domesticus*	8	0.51	1.00	0	0	0	0.5
Asian koel	*Eudynamys scolopaceus*	2	0.13	0.25	37	2.36	5.29	2.77
Oriental magpie robin	*Copsychus saularis*	0	0	0	8	0.51	1.14	0.57
Jungle crow	*Corvus macrorhynchos*	0	0	0	3	0.19	0.43	0.21
Greater coucal	*Centropus senegalensis*	0	0	0	3	0.19	0.43	0.21
Large egret	*Ardea alba*	0	0	0	6	0.38	0.86	0.43
White-cheeked barbet	*Psilopogon viridis*	0	0	0	2	0.13	0.29	0.14
Indian fruit bat	*Pteropus giganteus*	0	0	0	5	0.32	0.71	0.35
	Total no. of birds	**561**		**195.1**	**510**		**223.85**	**209.47**

Table 21 Species of birds inside INS GARUDA in February 2017

Species	Scientific name	No. of birds	Monthly%	Monthly mean
Black kite	*Milvus migrans*	4	13.79	4
Barn swallow	*Hirundo rustica*	8	27.59	8
Brahminy kite	*Haliastur Indus*	4	13.79	4

House crow Blue rock pigeon Ashy prinia Cattle egret	*Corvus splendens* *Columba livia* *Prinia socialis* *Bubulcus ibis*	3 4 3 3	10.34 13.79 10.34 10.34	3 4 3 3
	Total no. of birds	**29**		**29**

Table 22 Species of birds Outside INS GARUDA in February 2017

Species	**Scientific name**	**No. of birds**	**Monthly%**	**Monthly mean**
House crow	*Corvus splendens*	586	63.21	117.20
Little cormorant	*Microcarbo niger*	37	3.99	7.40
Pond heron	*Ardeola grayii*	17	1.83	3.40
Little egret	*Egretta garzetta*	48	5.18	9.60
Black kite	*Milvus migrans*	32	3.45	6.40
Brahminy kite	*Haliastur Indus*	10	1.08	2.00
Asian koel	*Eudynamys scolopaceus*	2	0.22	0.40
Black drongo	*Dicrurus macrocercus*	1	0.11	0.20
Common myna	*Acridotheres tristis*	27	2.91	5.40
Blue rock pigeon	*Columba livia*	167	18.02	33.40
	Total no. of birds	**927**		185.40

Table 23 Species of birds inside INS GARUDA in March 2017

Species	**Scientific name**	**No. of birds**	**Monthly%**	**Monthly mean**
Black drongo	*Dicrurus macrocercus*	125	25.00	25.00
Black kite	*Milvus migrans*	15	3.00	3.00

Brahminy kite	*Haliastur Indus*	4	0.80	0.80
Indian roller	*Coracias benghalensis*	4	0.80	0.80
Common myna	*Acridotheres tristis*	141	28.20	28.20
Purple heron	*Ardea purpurea*	8	1.60	1.60
Little egret	*Egretta garzetta*	52	10.40	10.40
Red-wattled lapwing	*Vanellus indicus*	89	17.80	17.80
Asian open bill stork	*Anastomus oscitans*	9	1.80	1.80
Barn swallow	*Hirundo rustica*	1	0.20	0.20
Paddy field pipit	*Anthus rufulus*	22	4.40	4.40
Blue-tailed bee eater	*Merops philippinus*	30	6.00	6.00
	Total no. of birds	**500**		**100.00**

Table 24 Species of birds Outside INS GARUDA in March 2017

Species	**Scientific name**	**No. of birds**	**Monthly%**	**Monthly mean**
House crow	*Corvus splendens*	1121	57.84	160.14
Little cormorant	*Microcarbo niger*	227	11.71	32.43
Asian koel	*Eudynamys scolopaceus*	58	2.99	8.29
Blue rock pigeon	*Columba livia*	258	13.31	36.86
Little egret	*Egretta garzetta*	96	4.95	13.71
Black kite	*Milvus migrans*	83	4.28	11.86
Brahminy kite	*Haliastur Indus*	8	0.41	1.14
Jungle crow	*Corvus macrorhynchos*	4	0.21	0.57
Large egret	*Ardea alba*	4	0.21	0.57
Black-headed ibis	*Threskiornis melanocephalus*	2	0.10	0.29
Greater coucal	*Centropus senegalensis*	1	0.05	0.14
Common myna	*Acridotheres tristis*	60	3.10	8.57

Indian pond heron Oriental darter	*Ardeola grayii* *Anhinga melanogaster*	15 1	0.77 0.05	2.14 0.14
	Total no. of birds	**1938**		**276.86**

Table 25 Species of birds inside INS GARUDA Naval Base in April 2017

Species	**Scientific name**	**No. of birds**	**Monthly%**	**Monthly mean**
Black kite	*Milvus migrans*	310	33.92	38.75
Brahminy kite	*Haliastur Indus*	16	1.75	2.00
Red-wattled lapwing	*Vanellus indicus*	175	19.15	21.88
Asian open bill stork	*Anastomus oscitans*	4	0.44	0.50
Common myna	*Acridotheres tristis*	375	41.03	46.88
Little egret	*Egretta garzetta*	9	0.98	1.13
Median egret	*Ardea intermedia*	7	0.77	0.88
Purple heron	*Ardea purpurea*	14	1.53	1.75
Black drongo	*Dicrurus macrocercus*	4	0.44	0.50
	Total no. of birds	**914**		**114.25**

Table 26 Species of birds Outside INS GARUDA in April 2017

Species	**Scientific name**	**No. of birds**	**Monthly%**	**Monthly mean**
House crow	*Corvus splendens*	845	68.53	120.71
Blue rock pigeon	*Columba livia*	191	15.49	27.29

Large egret	*Ardea alba*	15	1.22	2.14
Indian pond heron	*Ardeola grayii*	43	3.49	6.14
Black kite	*Milvus migrans*	59	4.79	8.43
Common myna	*Acridotheres tristis*	25	2.03	3.57
Little cormorant	*Microcarbo niger*	27	2.19	3.86
Little egret	*Egretta garzetta*	11	0.89	1.57
Brahminy kite	*Haliastur indus*	2	0.16	0.29
White-cheeked barbet	*Psilopogon viridis*	4	0.32	0.57
Asian koel	*Eudynamys scolopaceus*	11	0.89	1.57
	Total no. of birds	**1233**		**176.14**

4.1.2 IMPORTANT BIRD SPECIES

4.1.2.1 INDIAN POND HERON (*Ardeola grayii*)

A resident bird, Indian pond heron were sighted only during the months of monsoon (June- August) in INS Garuda (Plate 01). They appear stocky with a short neck, short thick bill and buff-brown back. In summer, adults have long neck feathers. Its appearance is transformed from their dull colours when they take to flight, the white colour of the wings makes them very prominent during the breeding season also, there are records of individuals with red legs. They are common in India and are usually solitary foragers but numbers of them may sometimes feed in close proximity during the dry seasons when small wetlands have a high concentration of prey. They are semi-colonial breeders. They may also forage at garbage heaps. During dry seasons, they sometimes take to foraging on well watered lawns or even dry grassland. When foraging, they allow close approach and flush only at close range. They sometimes form communal roosts, often in avenue trees over busy urban areas (Ali, 2003). They have seen associated with the canals on the side of run ways and on the grassland surrounding the runway. Outside the INS Garuda they have been recorded in waste dumps and also in the wetlands. For controlling the Indian pond heron in the INS Garuda canals have to be drained and the water logging reduced to maximum. Monthly occurrence of Indian pond heron is given in the figures 05 & 06.

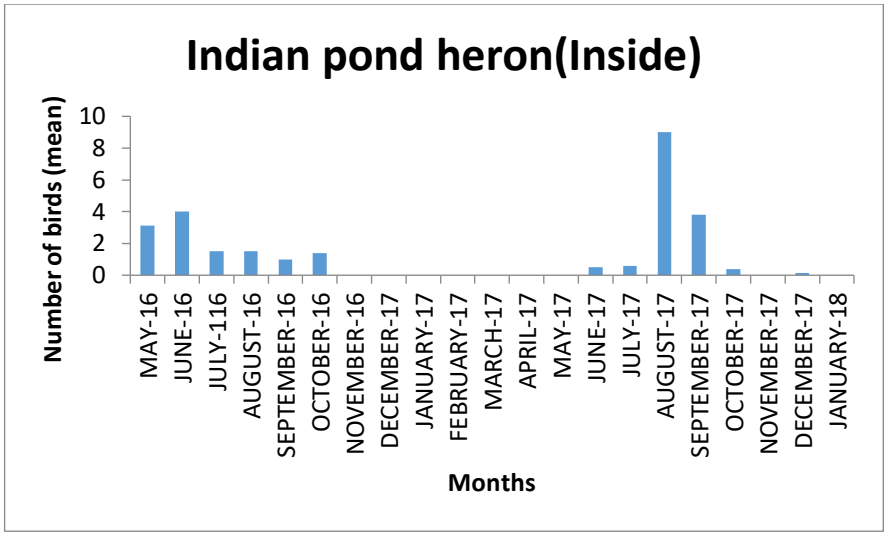

Fig.05 Monthly occurrence of Indian pond heron

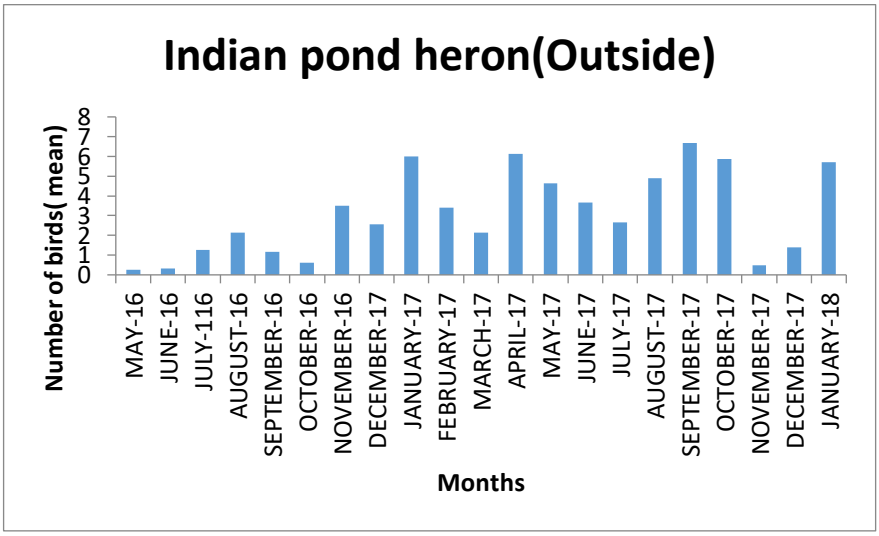

Fig.06 Monthly occurrence of Indian pond heron

4.1.2.2 BLACK DRONGO (*Dicrurus macrocercus*)

This resident bird is glossy black with a wide fork to the tail. Adults usually have a small white spot at the base of the gape (Plate 02). The iris is dark brown (not crimson as in the similar ashy drongo). The sexes cannot be told apart in the field. Juveniles are brownish and may have some white barring or speckling towards the belly and vent, and can be mistaken for the white-bellied drongo. First-year birds have white tips to the feathers of the belly, while

second-years have these white-tipped feathers restricted to the vent. The Black drongo is found predominantly in open country and usually perches and hunts close to the ground. They are mostly aerial predators of insects but also glean from the ground or off vegetation (Ali, 2003).

Black drongo become active very early at dawn and roost later than many other birds. They feed mainly on insects such as grasshoppers, cicadas, termites, wasps, bees, ants, moths, beetles and dragonflies. They sometimes fly close to tree branches, attempting to disturb any insects that may be present. Black drongo were observed perching on the posts (iron) and on fence posts and on some dried tree stumps. Once these perching posts were removed from the side of the runways, their population will get reduced. They associate with common mynas, cattle egrets and other birds that share a similar diet and habitat. As they mainly feed on insects, controlling of insects will reduce the population of Black drongo. During November 2017 and December 2017 plastic nails were introduced on the all available perching location. Some were fallow and constant care should be maintained to have perch steppes during all the time.

4.1.2.3 RED-WATTLED LAPWING (*Vanellus indicus*)

A resident bird commonly found in open areas, Red-wattled lapwings are large waders, about 35 cm long (Plate 03). The wings and back are light brown with a purple sheen, but head and chest and front part of neck are black. Prominently white patch runs between these two colours, from belly and tail, flanking the neck to the sides of crown. Short tail is tipped black. A red fleshy wattle in front of each eye, black-tipped red bill, and the long legs are yellow. In flight, prominent white wing are bars formed by the white on the secondary coverts. It breeds in the entire Indian subcontinent up to Kanyakumari. The breeding season is mainly March to August. The courtship involves the male puffing its feathers and pointing its beak upwards. The male then shuffles around the female. Several males may display to females and they may be close together. The eggs are laid in a ground scrape or depression sometimes fringed with pebbles, goat or hare droppings. About 3–4 black-blotched buff eggs shaped a bit like a peg-top (pyriform), 42x30 mm on average. Nests are difficult to find since the eggs are cryptically coloured and usually matches the ground pattern (Ali, 2003). Populations of Red-wattled lapwings are recorded from INS Garuda. They were sighted just outside the concrete runway in the grasslands. More of the population is congregated on the northern portion of the runway. Nesting of these species recorded many times. Control methods which could be adopted to control the population are the pricking of eggs. It is recorded that pricking of eggs is not

reducing the bird population as new individuals are replaced from the outside. Scaring using gunshots is a best method. The species is involved in bird strike in four incidences, which is the highest for any bird species. The highest number of them was recorded in the month of July 2016 in INS GARUDA (Fig.07) and highest was in June 2016 outside by INS GARUDA (Fig. 08). Northern side of the runway is having a rocky structure with leaves grass and pebbles where these birds found to lay eggs. The grass is allowed to grow in this area by ploughing the land the habitat will become unsuitable for nest building

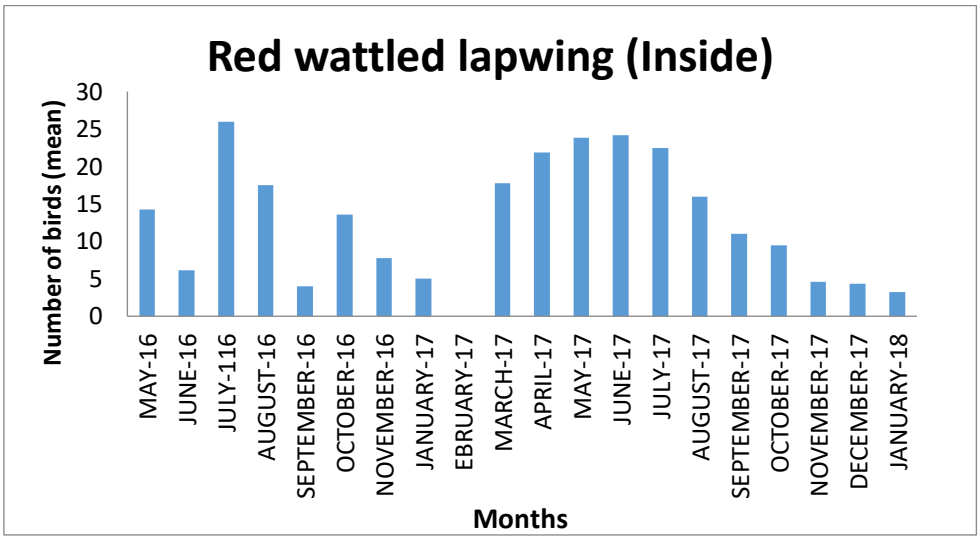

Fig. 07 Monthly occurrence of Red –wattled Lapwing

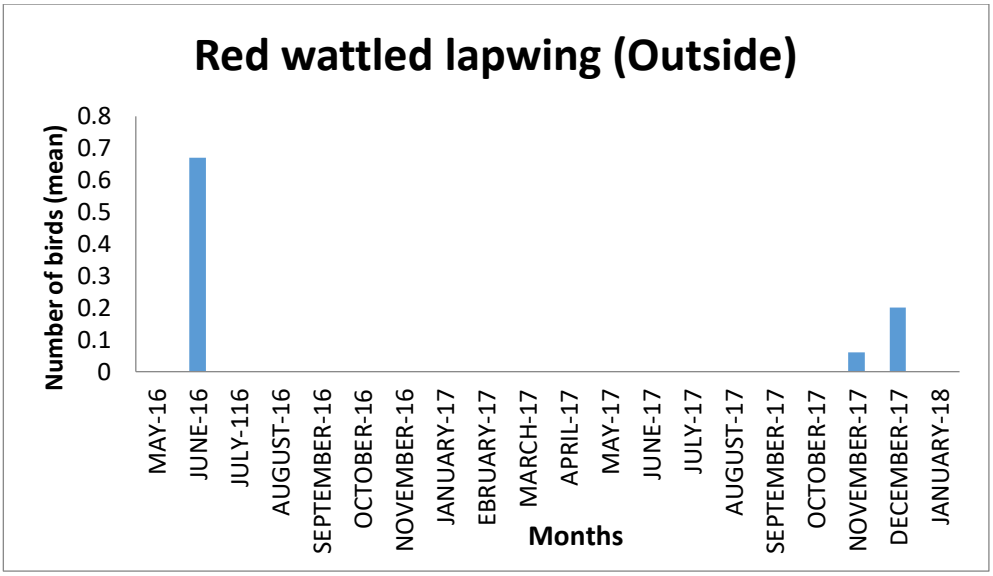

Fig. 08 Monthly occurrence of Red –wattled Lapwing

4.1.2.4 COMMON MYNA (*Acridotheres tristis*)

A resident bird, Common myna is readily identified by the brown body, black hooded head and the bare yellow patch behind the eye (Plate 04). The bill and legs are bright yellow. There is a white patch on the outer primaries and the wing lining on the underside is white. The sexes are similar and birds are usually seen in pairs. Common mynas pair for life. They breed through much of the year depending on the location, building their nest in a hole in a tree or wall. The Asian koel is sometimes brood parasitic on this species. Nesting material used by mynas include twigs, roots, tow and rubbish. Mynas have been known to use tissue paper, tin foil and sloughed off snake-skin. Common mynas roost communally throughout the year, either in pure or mixed flocks with jungle mynas, rosy starlings, house crows, jungle crows, cattle egrets, rose-ringed parakeets and other birds. The roost population can range from less than one hundred to thousands. The time of arrival of mynas to the roost starts before and ends just after sunset. The mynas depart before sunrise. The time and time span of arrival and departure, time taken for final settlement at the roost, duration of communal sleep, flock size and population vary seasonally (Ali, 2003). Common mynas are not seen extensively in INS Garuda. They have not posed any problem to flight safety. They can be easily scared away using gun shots. Highest population was recorded in the month of September 2017 in INS Garuda (Fig.9) and highest was in the months of March 2017 and November 2017 outside the surrounding areas (Fig.10).

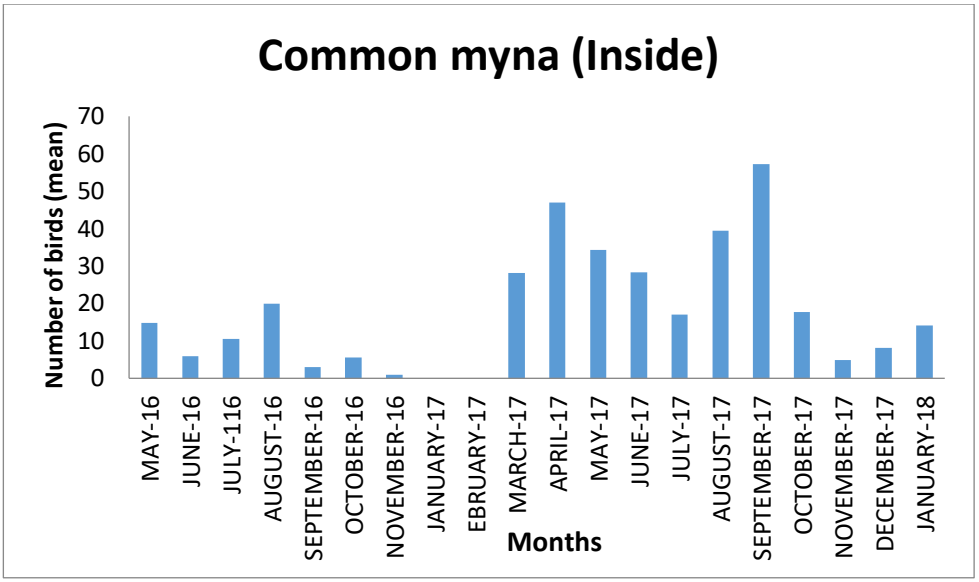

Fig. 09 Monthly occurrence of Common Myna

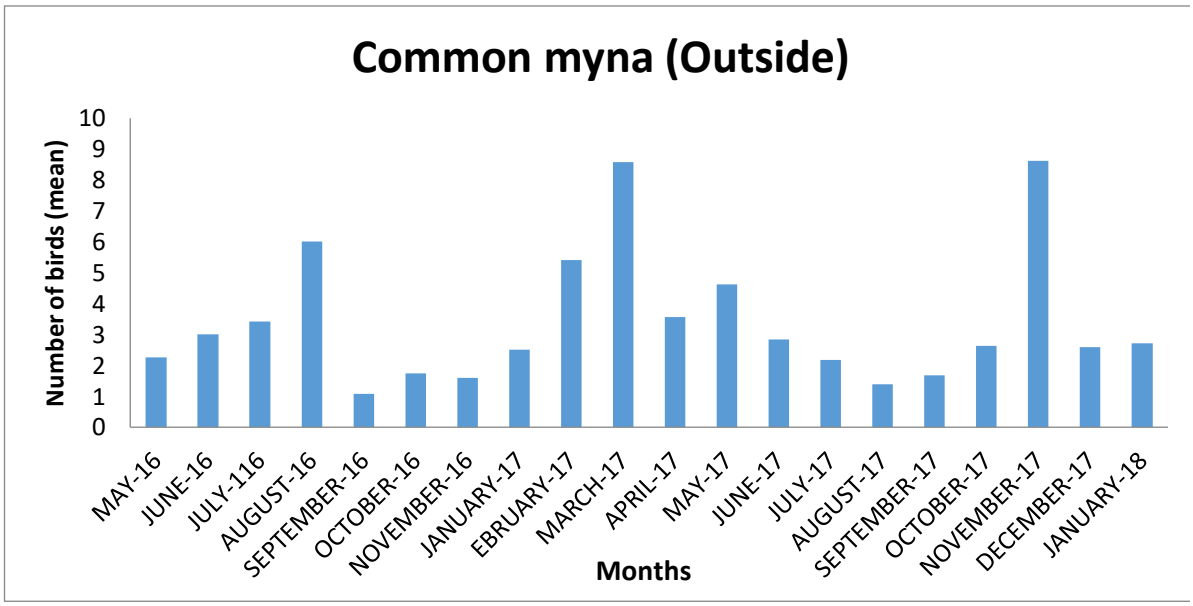

Fig. 10 Monthly occurrence of Common Myna

4.1.2.5 BLACK KITE (*Milvus migrans*)

Black kite is a resident bird and can be distinguished from red kites by the slightly smaller size, less forked tail (visible in flight), and generally dark plumage without any rufous (Plate 05). The sexes are alike. The upper plumage is brown but the head and neck tend to be paler. The patch behind the eye appears darker. The outer flight feathers are black and the feathers have dark cross bars and are mottled at the base. The lower parts of the body are pale brown, becoming lighter towards the chin. The body feathers have dark shafts giving it a streaked appearance. Black kites are most often seen gliding and soaring on thermals as they search for food. The flight is buoyant and the bird glides with ease, changing directions easily. They will swoop down with their legs lowered to snatch small live prey, fish, household refuse and carrion. They are opportunist hunters and have been known to take birds, bats, and rodents. They are attracted to smoke and fires, where they seek escaping prey. The Indian populations are well adapted to living in cities and are found in densely populated areas. The breeding season of black kites in India begins in winter (mainly January and February), the young birds fledging before the monsoons. The nest is a rough platform of twigs and rags placed in a tree (Ali, 2003). These species is a great threat to the flight safety. More than 10 birds are seen soaring over the runway during the daytime. Often they come and perch on the runway with their food. The best method of scaring these birds is by firing gun shots. The food provided by the waste dump outside INS Garuda is factor which encourages the population of Black Kites. The waste disposal without processing very near to INS Garuda should be stopped. To achieve this objective continuous interaction with Civilian authorities is needed. Highest population was recorded in the month of April 2017 in INS Garuda (Fig.11) and highest in the month of June 2016 in surrounding areas (Fig.12).

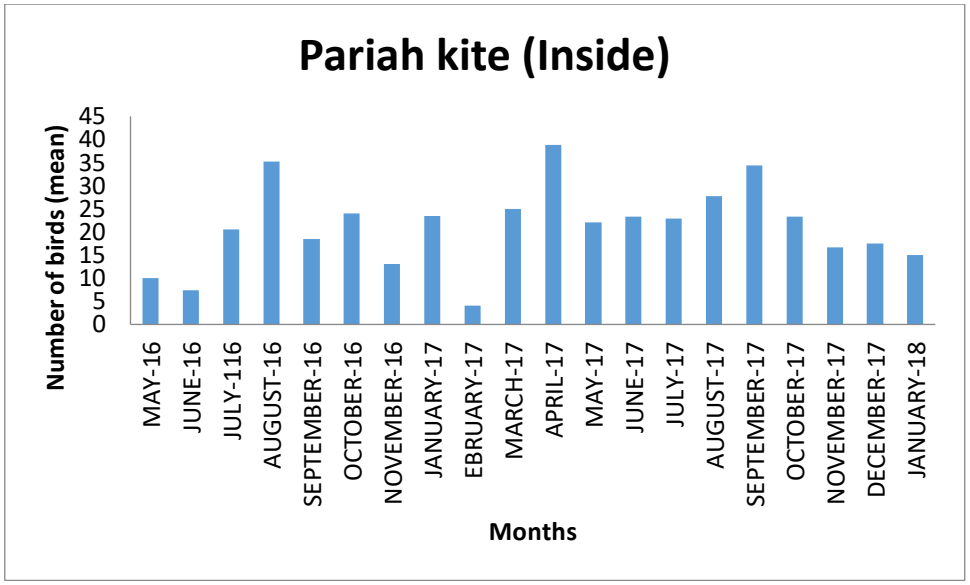

Fig.11 Monthly occurrence of Black kite

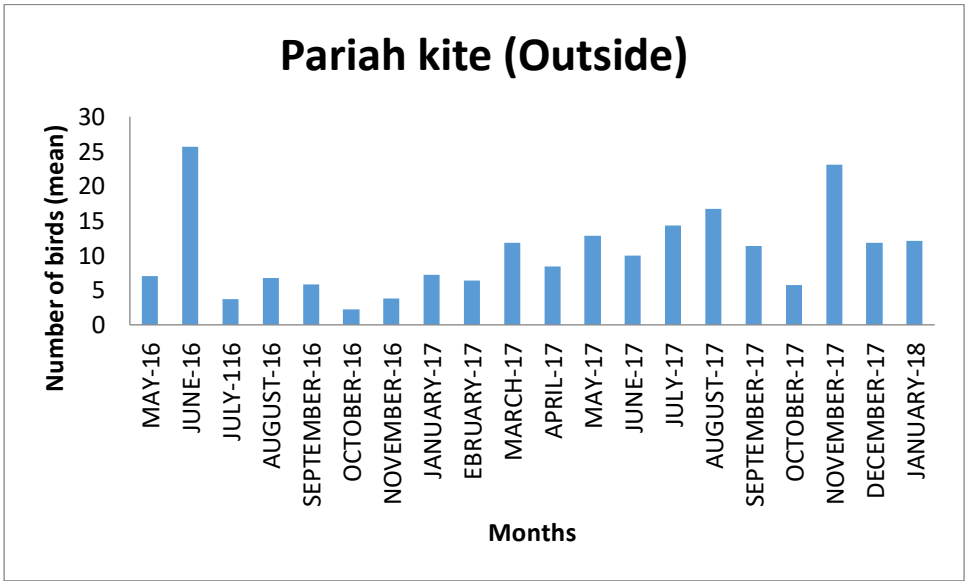

Fig.12 Monthly occurrence of Black kite

4.1.2.6 BRAHMINY KITE (*Haliastur indus*)

A resident bird, Brahminy kite is distinctive and contrastingly coloured, with chestnut plumage except for the white head and breast and black wing tips (Plate 06). The juveniles are browner, but can be distinguished from both the resident and migratory races of black kites in Asia by the paler appearance, shorter wings, and rounded tail. The pale patch on the underwing carpal region is of a squarish shape. They perform seasonal movements associated with rainfall in some parts of their range. The breeding season in South Asia is from December to April. They show considerable site fidelity nesting in the same area year after year. In some rare instances they have been seen to nest on the ground under trees. A clutch of two dull white or bluish-white oval eggs measuring 52 x 41 mm is laid. Both parents take part in nest building and feeding but it is suggested that only the female incubates. The incubation period is about 26 to 27 days (Ali, 2003). This species is rarely sighted in INS Garuda. But as the fishing harbor is very nearby, many birds are recorded as feeding on the dead fish discarded from the harbor.

4.1.2.7 HOUSE CROW (*Corvus splendens*)

The house crow is also known as the Indian, grey-necked, Ceylon or Colombo crow, is a common bird of the crow family that is of Asian origin but now found in many parts of the world (Plate 07). It is between the jackdaw and the carrion crow in size (40 cm in length) but is slimmer than either. The forehead, crown, throat and upper breast are a richly glossed black, whilst the neck and breast are a lighter grey-brown in colour. The wings, tail and legs are black. There are regional variations in the thickness of the bill and the depth of colour in areas of the plumage. It has a widespread distribution in southern Asia. It is associated with human settlements throughout its range, from small villages to large cities. Most food is taken from the ground, but also from trees as opportunity arises. They are highly opportunistic birds and have omnivorous diet, they can survive on nearly anything that is edible. These birds can be seen near market places and garbage dumps, foraging for scraps (Ali, 2003).The species is rare inside INS Garuda but plenty outside the surroundings. Highest number of house crow were recorded during the month of August 2016 inside INS Garuda (Fig. 13) and highest was recorded during the month of March 2017 outside INS Garuda (Fig. 14)

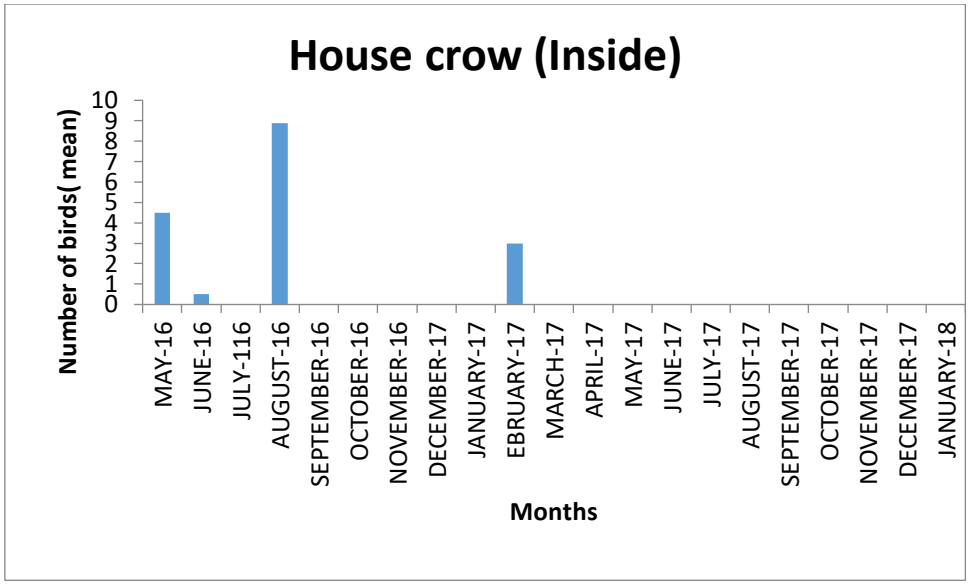

Fig.13 Monthly occurrence of House crow

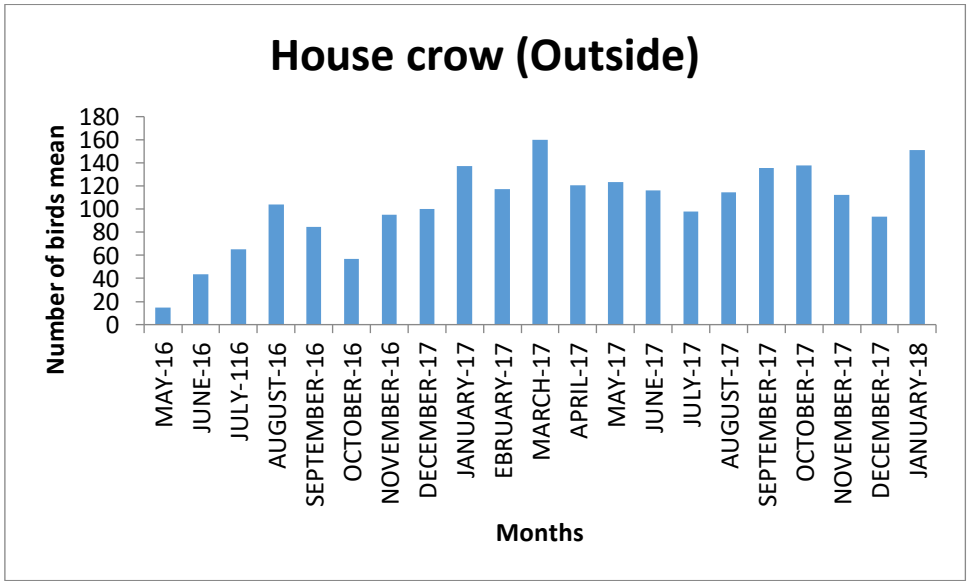

Fig.14 Monthly occurrence of House crow

4.1.2.8. LITTLE CORMORANT (*Microcarbo niger*)

The little cormorant is resident bird with about 50 cm long and only slightly smaller than the Indian cormorant (*Phalacrocorax fuscicollis*) (Plate 08). The species is found in all wetlands and water bodies of Kerala. It is a common resident bird this is the most common water bird found in wetlands and heronries of Kerala. Large congregation have been reported from Vembanad wetlands and Kole wetlands. Breeding is reported from many locations in Kerala. It inhabits wetlands, ranging from small village ponds to large lakes, and sometimes tidal estuaries. Little cormorants tend to forage mainly in small loose groups and are often seen foraging alone. They swim underwater to capture their prey, mainly fish. They propel themselves underwater using their webbed feet. Captured fishes are often brought up to the surface to swallow them (Ali, 2003).The bird visited INS Garuda during the monsoon months. The best way to repel this species to drain the canals and water logged areas near the INS Garuda

4.1.2.9 LARGE EGRET (*Ardea alba)*

Standing up to 1 m tall, this species can measure 80 to 104 cm in length and have a wingspan of 131 to 170 cm (Plate 09). Body mass can range from 700 to 1,500 g, with an average of around 1,000 g. It is thus only slightly smaller than the great blue or grey heron (*A. cinerea*). Apart from size, large egret can be distinguished from other white egrets by its yellow bill, black legs and feet, though the bill may become darker and the lower legs lighter in the breeding season. In breeding plumage, delicate ornamental feathers are borne on the back. The species breeds in colonies in trees close to large lakes with reed beds or other extensive wetlands, preferably at height of 3.0–12.2 m. It begins to breed at 2–3 years of age by forming monogamous pairs each season. It is unknown if the pairing carries over to the next season. The male selects the nest area, starts a nest and then attracts a female. The nest, made of sticks and lined with plant material, could be up to 3 feet across. Up to six bluish green eggs are laid at one time. Both sexes incubate the eggs and the incubation period is 23–26 days. The young are fed by regurgitation by both parents and they are able to fly within 6–7 weeks (Ali, 2003). A rare species in INS Garuda.

4.1.2.10. PURPLE HERON (*Ardea purpurea)*

The purple heron is a large bird, 78–97 cm in length with a standing height from 70 to 94 cm and a 120–152 cm wingspan (Plate 10). However, it is slender for its size, weighing only 0.5 to 1.35 kg. It is somewhat smaller than the grey heron, from which it can be distinguished by its darker reddish-brown plumage and in adults, its darker grey back. Adults have the forehead and the crown of the head black, with a dark stripe down the back of the neck that terminates in a slender, dangling crest. This is shorter than the crest of the grey heron and does not exceed 140 mm. The sides of the head and the neck are buffish chestnut, with dark streaks and lines down either side of the whole the neck. The mantle is oily brown and the upper scapular feathers are elongated but not the lower ones. The rest of the upper parts and the tail are brownish grey. The purple heron inhabits marshes, lagoons and lakes surrounded by dense vegetation. It may frequent mangrove swamps on the coast but it usually chooses freshwater habitats, particularly locations with reed beds (*Phragmites*). It is most active at dawn and dusk, roosting with other birds in the middle of the day and at night, but increasing its diurnal activity while rearing young. It feeds in shallow water, grabbing its prey with its powerful beak. It will often wait motionless for prey, or slowly stalk its victim (Ali, 2003). A rare species in INS Garuda.

4.1.2.11. LITTLE EGRET (*Egretta garzetta)*

It is a white bird with a slender black beak, long black legs and, in the western race, yellow feet (Plate 11). As an aquatic bird, it feeds in shallow water and on land, consuming a variety of small creatures. It breeds colonially, often with other species of water birds, making a platform nest of sticks in a tree, bush or reed bed. A clutch of bluish-green eggs is laid and incubated by both parents. The young fledge at about six weeks of age. The adult little egret is 55–65 cm long with an 88–106 cm wingspan, and weighs 350–550 g. Its plumage is normally entirely white, although there are dark forms with largely bluish-grey plumage. In the breeding season, the adult has two long plumes on the nape that form a crest. These plumes are about 150 mm and are pointed and very narrow. There are similar feathers on the breast, but the barbs are more widely spread. The little egret's habitat varies widely, and includes the shores of lakes, rivers, canals, ponds, lagoons, marshes and flooded land, the bird preferring open locations to dense cover. On the coast it inhabits mangrove areas, swamps, mudflats, sandy beaches and reefs. Little egrets are sociable birds and are often seen in small flocks.

Nevertheless, individual birds do not tolerate others coming too close to their chosen feeding site, though this depends on the abundance of prey (Ali, 2003).

4.1.2.12. BLUE ROCK PIGEON (*Columba livia*)

The adult of the nominate subspecies of the rock dove is 29 to 37 cm long with a 62 to 72 cm wingspan (Plate 12). Weight for wild or feral rock doves ranges from 238–380 gm though overfed domestic and semi-domestic individuals can exceed normal weights. It has a dark bluish-grey head, neck, and chest with glossy yellowish, greenish, and reddish-purple iridescence along its neck and wing feathers. The iris is orange, red or golden with a paler inner ring, and the bare skin round the eye is bluish-grey. The bill is grey-black with a conspicuous off-white cere, and the feet are purplish-red. Its habitat is natural cliffs, usually on coasts. Its domesticated form, the feral pigeon, has been widely introduced elsewhere, and is common, especially in cities, over much of the world (Ali, 2003). The species is seen crossing the air field very of few during the day time. They have been recorded as roosting and breeding in the FCI stockyard and breeding in the old buildings. As food is available in plenty from the spillage of grain population is flourishing. As they do flying across the INS Garuda after feeding for other activities like sun bathing they pose great threat to moving planes. The species was involved in two hits one in February 2016 and another one in December 2016 and both strikes were during take-off. Highest number of Blue rock pigeon was recorded in the month of September in INS Garuda and the highest population recorded in the month of August in the surrounding areas. After the Co-ordination committee meeting with the District Collector, Some measures were taken by the FCI authorities. But the population is still depended on FCI warehouse. Highest number of Blue rock pigeons were recorded during June 2017 in inside INS Garuda (Fig. 15) and highest number of blue rock pigeons were recorded during September 2017 outside INS Garuda (Fig.16).

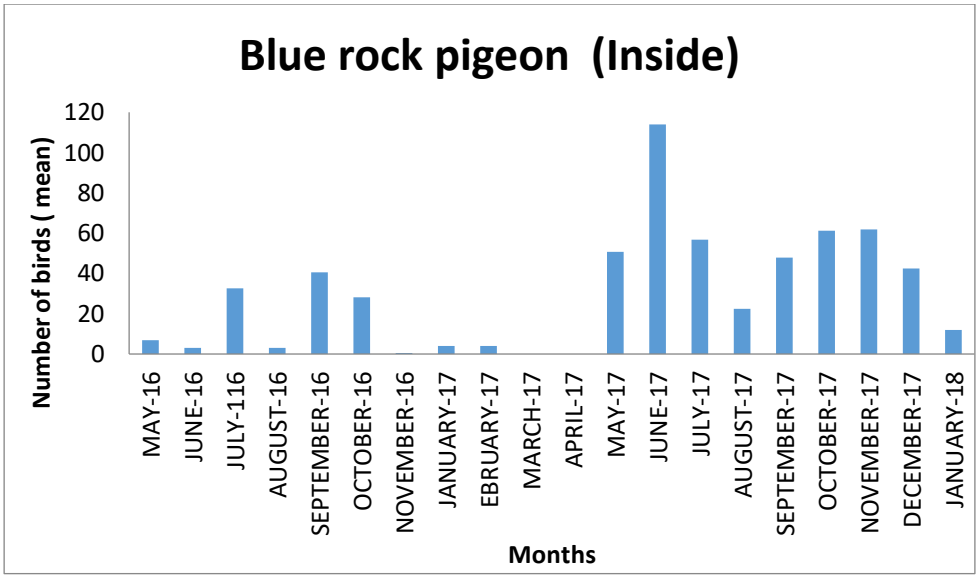

Fig. 15 Monthly occurrence of Blue Rock Pigeon

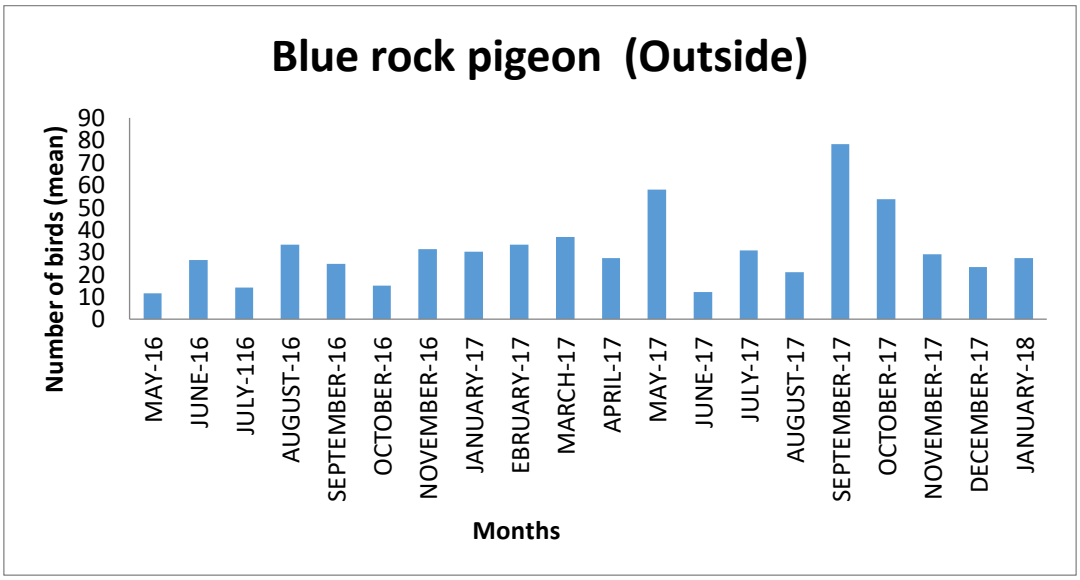

Fig. 16 Monthly occurrence of Blue Rock Pigeon

4.1.2.13. INDIAN ROLLER (*Coracias benghalensis)*

The Indian roller is a stocky bird about 26–27 cm long and can only be confused within its range with the migratory European roller (Plate 13). The breast is brownish and not blue as in the European Roller. The crown and vent are blue. The primaries are deep purplish blue with a band of pale blue. The tail is sky blue with a terminal band of Prussian blue and the central feathers are dull green. The neck and throat are purplish lilac with white shaft streaks. The bare

patch around the eye is ochre in colour. The three forward toes are united at the base. Rollers have a long and compressed bill with a curved upper edge and a hooked tip. The nostril is long and exposed and there are long rictal bristles at the base of the bill (Ali, 2003). The main habitat is cultivation, thin forest and grassland. They are often seen perched on roadside electric wires. The species is not involved in birdstrike during the period.

4.1.2.14. PIED WAGTAIL (*Motacilla alba*)

It has a combination of black mantle and black head with white supercilium separates it from all subspecies of white (Plate 14). Sexes are similar, and show no variation in non-breeding plumage. First-winter is similar, but with greyer crown and mantle. Juvenile has brownish-grey head, mantle and breast, with white supercilium. Voice call is a distinctive, loud chiz-zat. Song is a clear, high-pitched jumble of loud, pleasant whistling notes. The habitat includes banks of rivers, lakes, canals, and irrigation barrages (Ali, 2003). So far the bird species is not involved in any birdstrike.

4.1.2.15. MEDIAN EGRET (*Ardea intermedia)*

The intermediate egret, median egret, smaller egret, or yellow-billed egret (*Ardea intermedia*) is a medium-sized heron (Plate 15). Some taxonomists put the species in the genus *Egretta* or *Ardea*. It is a resident breeder from East Africa across the Indian subcontinent to Southeast Asia and Australia. This species, as its scientific name implies, is intermediate in size between the great egret and smaller white egrets like the little egret and cattle egret, though nearer to little than great. It is about 56–72 cm long with a 105–115 cm wingspan and weighs c. 400 g with all-white plumage, generally dark legs and a thickish yellow bill. Breeding birds may have a reddish or black bill, greenish yellow gape skin, loose filamentous plumes on their breast and back, and dull yellow or pink on their upper legs (regional variations). The sexes are similar and so far not involved in birdstrike during the period (Ali, 2003).

4.1.2.16. SHIKRA *(Accipiter badius)*

Shikra (*Accipiter badius*) is a small bird of prey in the family Accipitridae found widely distributed in Asia and Africa (Plate 16). The shikra is a small raptor (26–30 cm long) and like most other *Accipiter* hawks, this species has short rounded wings and a narrow and somewhat long tail. Adults are whitish on the underside with fine rufous bars while the upper parts are

grey. The lower belly is less barred and the thighs are whitish. Males have a red iris while the females have a less red (yellowish orange) iris and brownish upper parts apart from heavier barring on the underparts. The females are slightly larger. The mesial stripe on the throat is dark but narrow. In flight the male seen from below shows a light wing lining (underwing coverts) and has blackish wing tips. The shikra is found in a range of habitats including forests, farmland and urban areas. They are usually seen singly or in pairs. The flight is typical with flaps and glides. During the breeding season pairs will soar on thermals and stoop at each other. Their flight usually draws alarms among smaller birds and squirrels. They feed on rodents, squirrels, small birds, small reptiles (mainly lizards but sometimes small snakes and insects. Small birds usually dive through foliage to avoid a shikra and a Small Blue Kingfisher has been observed diving into water to escape. Babblers have been observed to rally together to drive away a shikra. They will descend to the ground to feast on emerging winged termites, hunt at dusk for small bats (such as *Cynopterus sphinx*) and in rare instances they may even resort to feed on carrion. In one instance a male was found feeding on a dead chick at the nest. Their calls are mimicked by drongos and this behaviour is thought to aid in stealing food by alarming other birds that the drongos associate with. The breeding season in India is in summer from March to June (Ali, 2003).

4.1.2.17. GREATER COUCAL (*Centropus sinensis*)

The greater coucal or crow pheasant (*Centropus sinensis*), is a large non-parasitic member of the cuckoo order of birds, the Cuculiformes. A widespread resident in Asia, from India, east to south China, Nepal and Indonesia, it is divided into several subspecies, some being treated as full species (Plate 17). They are large, crow-like with a long tail and coppery brown wings and found in wide range of habitats from jungle to cultivation and urban gardens. They are weak fliers, and are often seen clambering about in vegetation or walking on the ground as they forage for insects, eggs and nestlings of other birds. They have a familiar deep resonant call which is associated with omens in many parts of its range. This is a large species of cuckoo at 48 cm. The head is black, upper mantle and underside is black glossed with purple. The back and wings are chestnut brown. There are no pale shaft streaks on the coverts. The eyes are ruby red. Juveniles are duller black with spots on the crown and there are whitish bars on the underside and tail. There are several geographic races and some of these populations are sometimes treated as full species. The sexes are similar in plumage but females are slightly larger (Ali, 2003).

4.1.2.18. WHITE- CHEEKED BARBET (*Psilopogen viridis)*

The white-cheeked barbet or small green barbet (*Psilopogon*) is a species of barbet found in southern India (Plate 18). It is very similar to the more widespread brown-headed barbet (or large green barbet) (*Psilopogon zeylanica*) but this species has a distinctive supercilium and a broad white cheek stripe below the eye and is endemic to the forest areas of the Western Ghats and adjoining hills. The brown-headed barbet has an orange eye-ring but the calls are very similar and the two species occur together in some of the drier forests to the east of the Western Ghats. Like all other Asian barbets they are mainly frugivorous although they may sometimes eat insects and they use their bills to excavate nest cavities in trees. Like many other barbets of Asia, these are green, sit still, and perch upright making them difficult to spot. During the breeding season which begins at the start of summer their calls become loud and constant especially in the mornings. The call, a monotonous *Kot-roo ... Kotroo...* starting with an explosive *trrr* is not easily differentiated from that of the brown-headed barbet. During hot afternoons, they may also utter a single note *wut* not unlike the call of Collared scops owl or coppersmith barbet. Other harsh calls are produced during aggressive encounters.

The head is brownish streaked with white, sometimes giving it a capped appearance. The bill is pale pinkish. The length is 165-185 mm, head of 51-53mm and tail of 60-67mm. Size varies from the larger northern birds to the southern ones. These birds are mostly frugivorous, but will take winged termites and other insects opportunistically. They feed on the fruits of various *Ficus* species including *Ficus benjamina* and *Ficus mysorensis*. When foraging they are quite aggressive and will attempt to chase other barbets, koels and other frugivores (Ali, 2003).

4.1.2.19. ASIAN KOEL (*Eudynamys scolopaceus)*

The Asian koel (*Eudynamys scolopaceus*) is a member of the cuckoo order of birds, the Cuculiformes (Plate 19). It is found in the Indian Subcontinent, China, and Southeast Asia. The Asian koel is a brood parasite that lays its eggs in the nests of crows and other hosts, who raise its young. They are unusual among the cuckoos in being largely frugivorous as adults. The Asian koel is a large, long-tailed, cuckoo measuring 39–46 cm. The male of the nominate race is glossy bluish-black, with a pale greenish grey bill, the iris is crimson, and it has grey legs and feet. The female of the nominate race is brownish on the crown and has rufous streaks on the head. The back, rump and wing coverts are dark brown with white and buff spots. The

underparts are whitish, but are heavily striped. The other subspecies differ in colouration and size. The upper plumage of young birds is more like that of the male and they have a black beak. They are very vocal during the breeding season (March to August in the Indian Subcontinent), with a range of different calls. The familiar song of the male is a repeated *koo-Ooo*. The female makes a shrill *kik-kik-kik*... call. Calls vary across populations (Ali, 2003).

4.1.2.20. RED-VENTED BULBUL (*Pycnonotus cafer)*

The red-vented bulbul is easily identified by its short crest giving the head a squarish appearance (Plate 20). The body is dark brown with a scaly pattern while the head is darker or black. The rump is white while the vent is red. The black tail is tipped in white. Sexes are similar in plumage, but young birds are duller than adults. The typical call has been transcribed as *ginger beer* but a number of sharp single note calls likened as *pick* are also produced. Their alarm calls are usually responded to and heeded by many other species of bird (Ali, 2003).

4.1.2.21. ORIENTAL MAGPIE ROBIN (*Copsychus saularis*)

The oriental magpie-robin (*Copsychus saularis*) is a small passerine bird that was formerly classed as a member of the thrush family Turdidae, but now considered an Old World flycatcher (Plate 21). They are distinctive black and white birds with a long tail that is held upright as they forage on the ground or perch conspicuously. Occurring across most of the Indian subcontinent and parts of Southeast Asia, they are common birds in urban gardens as well as forests. They are particularly well known for their songs and were once popular as cage birds. This species is 19 cm long, including the long tail, which is usually held cocked upright. It is similar in shape to the smaller European robin, but is longer-tailed. The male has black upper parts, head and throat apart from a white shoulder patch. The underparts and the sides of the long tail are white. Females are greyish black above and greyish white. Young birds have scaly brown upper parts and head. It is mostly seen close to the ground, hopping along branches or foraging in leaf-litter on the ground with cocked tail. Males sing loudly from the top of trees or other high perches during the breeding season (Ali, 2003).

4.1.2.22. PURPLE-RUMPED SUNBIRD (*Leptocoma zeylonica)*

The purple-rumped sunbird (*Leptocoma zeylonica*) is a sunbird endemic to the Indian Subcontinent (Plate 22). They are small in size, feeding mainly on nectar but sometimes take insects, particularly when feeding young. They can hover for short durations but usually perch to suck nectar from flowers. They build a hanging pouch nest made up of cobwebs, lichens and plant material. Males are brightly coloured but females are olive above and yellow to buff

below. Males are easily distinguished from the purple sunbird by the light coloured underside while females can be told apart by their whitish throats. Purple-rumped sunbirds are tiny at less than 10 cm long. They have medium-length thin down-curved bills and brush-tipped tubular tongues, both adaptations for nectar feeding. In the Western Ghats, it can overlap in some areas with the crimson-backed sunbird but the male of that species has reddish upper parts, a broader breast band and generally darker eyes. The female has a white throat followed by yellowish breast. The upper side is olive or brownish. The upper tail coverts are black and a weak supercilium may be visible (Ali, 2003).

4.1.2.23. HOUSE SPARROW (*Passer domesticus)*

The house sparrow (*Passer domesticus*) is a bird of the sparrow family Passeridae, found in most parts of the world (Plate 23). One of about 25 species in the genus *Passer*, the house sparrow is native to most of Europe, the Mediterranean region, and much of Asia. Females and young birds are coloured pale brown and grey, and males have brighter black, white, and brown markings. It is strongly associated with human habitations, and can live in urban or rural settings. Though found in widely varied habitats and climates, it typically avoids extensive woodlands, grasslands, and deserts away from human development. It feeds mostly on the seeds of grains and weeds, but it is an opportunistic eater and commonly eats insects and many other foods. Its predators include domestic cats, hawks, owls, and many other predatory birds and mammals. Because of its numbers, ubiquity, and association with human settlements, the house sparrow is culturally prominent. It is extensively, and usually unsuccessfully, persecuted as an agricultural pest, but it has also often been kept as a pet, as well as being a food item and a symbol of lust and sexual potency and commonness and vulgarity. Though it is widespread and abundant, its numbers have declined in some areas (Ali, 2003). The species is listed as “least concern” in the IUCN Red List.

4.1.2.24. CATTLE EGRET (*Bubulcus ibis)*

Cattle egrets were originally native to parts of Asia, Africa and Europe, it has undergone a rapid expansion in its distribution and successfully colonised much of the rest of the world in the last century (Plate 24). It is a white bird adorned with buff plumes in the breeding season. It nests in colonies, usually near bodies of water and often with other wading birds. The nest is a platform of sticks in trees or shrubs. Cattle egrets exploit drier and open habitats more than other heron species. Their feeding habitats include seasonally inundated grasslands, pastures, farmlands, wetlands and paddy fields. They often accompany cattle or other large mammals,

catching insect and small vertebrate prey disturbed by these animals. Some populations of the cattle egret are migratory and others show post-breeding dispersal. The adult cattle egret has few predators, but birds or mammals may raid its nests, and chicks may be lost to starvation, calcium deficiency or disturbance from other large birds. This species maintains a special relationship with cattle, which extends to other large grazing mammals; wider human farming is believed to be a major cause of their suddenly expanded range. The cattle egret removes ticks and flies from cattle and consumes them (Ali, 2003).

4.1.2.25. BLACK- RUMPED FLAMEBACK (*Dinopium benghalense)*

The Black-rumped flameback (*Dinopium benghalense*), also known as the lesser golden-backed woodpecker or lesser golden back, is a woodpecker found widely distributed in the Indian subcontinent (Plate 25). It is one of the few woodpeckers that are seen in urban areas. It has a characteristic rattling-whinnying call and an undulating flight. It is the only golden-backed woodpecker with a black throat and black rump. The Blackrumped flameback is a large species at 26–29 cm in length. It has a typical woodpecker shape, and the golden yellow wing coverts are distinctive. The rump is black and not red as in the greater rumped flameback. The underparts are white with dark chevron markings. The black throat finely marked with white immediately separates it from other golden backed woodpeckers in the Indian region. The head is whitish with a black nape and throat, and there is a greyish eye patch. Unlike the greater rumped flameback it has no dark moustachial stripes. The adult male has a red crown and crest. Females have a black fore crown spotted with white, with red only on the rear crest. Young birds are like the female, but duller (Ali, 2003).

4.1.2.26. PADDY FIELD PIPIT (*Anthus rufulus*)

The species is sighted in the grassland near the runway is a resident species usually sighted in short grasslands and cultivation (Plate 26). Usually seen in open country grazing land and feeds on weevils and other small insects. Sexes alike seen in pairs or loose parties and considerable experience needed to differentiate the species in the field.

4.1.2.27. BLUE-TAILED BEE EATER (*Merops philippinus*)

It is a migratory species coming to Kerala during the winter period usually seen in wooded country. The species was recorded as siting on the runway during the survey (Plate 27). Usually seen near the streams and in coastal areas in colonies.

4.1.2.28. BARN SWALLOW (*Hirundo rustica*)

The barn swallow (*Hirundo rustica*) is the most widespread species of swallow in the world (Plate 28). It is a distinctive passerine bird with blue upper parts, a long, deeply forked tail and curved, pointed wings. The barn swallow is a bird of open country that normally uses man-made structures to breed and consequently has spread with human expansion. It builds a cup nest from mud pellets in barns or similar structures and feeds on insects caught in flight. This species lives in close association with humans, and its insect-eating habits mean that it is tolerated by humans, this acceptance was reinforced in the past by superstitions regarding the bird and its nest. There are frequent cultural references to the barn swallow in literary and religious works due to both its living in close proximity to humans and its annual migration.

4.1.2.29. ASIAN OPEN BILL STORK (*Anastomus oscitans*)

The Asian openbill or Asian openbill stork (*Anastomus oscitans*) is a large wading bird in the stork family Ciconiidae (Plate 29). This distinctive stork is found mainly in the Indian subcontinent and Southeast Asia. It is greyish or white with glossy black wings and tail and the adults have a gap between the arched upper mandible and recurved lower mandible. Young birds are born without this gap which is thought to be an adaptation that aids in the handling of snails, their main prey. Although resident within their range, they make long distance movements in response to weather and food availability. The Asian openbill stork is predominantly greyish (non-breeding season) or white (breeding season) with glossy black wings and tail that have a green or purple sheen. The name is derived from the distinctive gap formed between the recurved lower and arched upper mandible of the beak in adult birds. Young birds do not have this gap. The cutting edges of the mandible have a fine brush like structure that is thought to give them better grip on the shells of snails The tail consists of twelve feathers and the preen gland has a tuft. The mantle is black and the bill is horn-grey. At a distance, they can appear somewhat like a white stork or Oriental stork. The short legs are pinkish to grey, reddish prior to breeding. Non-breeding birds have a smoky grey wings and

back instead of white. Young birds are brownish-grey and have a brownish mantle. Like other storks, the Asian openbill is a broad-winged soaring bird, which relies on moving between thermals of hot air for sustained flight. They are usually found in flocks but single birds are not uncommon. Like all storks, it flies with its neck outstretched. It is relatively small for a stork and stands at 68 cm height (81 cm long).

4.1.2.30. ORIENTAL DARTER (*Anhinga melanogaster*)

The Oriental darter or Indian darter (*Anhinga melanogaster*) is a waterbird of tropical South Asia and Southeast Asia (Plate 30). It has a long and slender neck with a straight, pointed bill and like the cormorant, it hunts for fish while its body is submerged in water. It spears a fish underwater, bringing it above the surface, tossing and juggling it before swallowing the fish head first. The body remains submerged as it swims, and the slender neck alone is visible above the water, which accounts for the colloquial name of snakebird. Like the cormorants, it has wettable feathers and it is often found perched on a rock or branch with its wings held open to dry. The Oriental darter is like all other anhingas, a cormorant-like species that has a very long neck. The structure of the neck is as in other species of darter with strongly developed muscles about a kink in the neck at the 8th and 9th vertebrae that allows it to be flexed and darted forward with rapid force to stab fish underwater. The edges of the commissures of the mandible tips have minute inward pointing serrations that hold impaled fish.

4.1.2.31. BLACK-CROWNED NIGHT HERON (*Nycticorax nycticorax*)

The Black-crowned night herons are medium-sized herons, 58–65 cm, in the genera Nycticorax, Nyctanassa and Gorsachius (Plate 31). The genus name Nycticorax derives from the Greek for “night raven” and refers to the largely nocturnal feeding habits of this group of birds, and the croaking crow-like call of the best known species, the black-crowned Black-crowned night heron. Adults are short-necked, short-legged, and stout herons with a primarily brown or grey plumage, and, in most, a black crown. Young birds are brown, flecked with white. At least some of the extinct Mascarenes taxa appear to have retained this juvenile plumage in adult birds. Black-crowned night herons nest alone or in colonies, on platforms of sticks in a group of trees, or on the ground in protected locations such as islands or reedbeds. 3-8 eggs are laid. Black-crowned night herons stand still at the water's edge, and wait to ambush prey, mainly at night. They primarily eat small fish, crustaceans, frogs, aquatic insects, and small mammals. During the day, they rest in trees or bushes.

4.1.2.32. GREATER RACKET-TAILED DRONGO (*Dicrurus paradiseus*)

The Greater racket-tailed drongo (*Dicrurus paradiseus*) is a medium-sized Asian bird which is distinctive in having elongated outer tail feathers with webbing restricted to the tips (Plate 32). They are placed along with other drongos in the family Dicruridae. They are conspicuous in the forest habitats often perching in the open and by attracting attention with a wide range of loud calls that include perfect imitations of many other birds. In most of its range in Asia, this is the largest of the drongo species and is readily identifiable by the distinctive tail rackets and the crest of curled feather that begin in front of the face above the beak and along the crown to varying extents according to the subspecies. The tail with twirled rackets is distinctive and in flight it can appear as if two large bees were chasing a black bird. In the eastern Himalayas the species can be confused with the lesser racket-tailed drongo, however the latter has flat rackets with the crest nearly absent.

4.1.2.33. SCALY-BREASTED MUNIA (*Lonchura punctulata*)

The scaly-breasted munia or spotted munia (*Lonchura punctulata*), known in the pet trade as nutmeg mannikin or spice finch, is a sparrow-sized estrildid finch native to tropical Asia (Plate 33). A species of the genus Lonchura, it was formally described and named by Carl Linnaeus in 1758. Its name is based on the distinct scale-like feather markings on the breast and belly. The adult is brown above and has a dark conical bill. The species has 11 subspecies across their range and differ slightly in size and colour. This munia eats mainly grass seeds apart from berries and small insects. They forage in flocks and communicate with soft calls and whistles. The species is highly social and may sometimes roost with other species of munias. This species is found in tropical plains and grasslands. Breeding pairs construct dome-shaped nests using grass or bamboo leaves.

4.1.2.34. JUNGLE CROW (*Corvus macrorhynchos*)

The jungle crow (*Corvus macrorhynchos*) is a species of crow found across the Indian Subcontinent south of the Himalayas (Plate 34). It is very common and readily distinguished from the house crow which has a grey neck. It differs in its voice from the large-billed crow found in the higher elevations of the Himalayas and the eastern jungle crow (*Corvus levaillantii*) overlaps in the eastern part of its range. In appearance it can be difficult to

distinguish from either of these species although the plumage tends to be more uniformly glossed in purple and has a longer bill with a fine tip and an arched culmen. The Himalayan species has a slightly wedge-shaped tail unlike the rounded tail of the Indian jungle crow and tends to glide a lot. This glossy all-black crow has a heavy black bill with an arching culmen (upper edge of the mandible) and has a fine tip. The feathers have a purple gloss throughout. The tail of the Indian jungle crow is rounded and the legs and feet are stout.

4.1.2.35. INDIAN SWIFTLET (*Aerodramus unicolor*)

The Indian swiftlet, or Indian edible-nest swiftlet, (*Aerodramus unicolor*) is a small swift. It is a common resident colonial breeder in the hills of Sri Lanka and south west India (Plate 35). The half-cup nest is built on a vertical surface, often in a cave. The male swift uses thick saliva to construct the white, shiny nest into which two eggs are laid. The relatively tasteless nests are harvested, and mixed with chicken, spices, and other flavors as bird's nest soup, a supposed aphrodisiac. This 12 cm long species is mainly dark brown above and paler brown below. It has swept-back wings that resemble a crescent or a boomerang. The body is slender, and the tail is short and only slightly indented. Both sexes and young birds are similar. Indian swiftlet has very short legs which it uses only for clinging to vertical surfaces, since swifts never settle voluntarily on the ground. These swifts spend most of their lives in the air, living on the insects they catch in their bills, and they drink on the wing.

4.1.2.36. WHITE-BREASTED WATERHEN (*Amaurornis phoenicurus*)

The white-breasted waterhen (*Amaurornis phoenicurus*) is a water bird of the rail and crake family, Rallidae, that is widely distributed across Southeast Asia and the Indian Subcontinent (Plate 36). They are dark slaty birds with a clean white face, breast and belly. They are somewhat bolder than most other rails and are often seen stepping slowly with their tail cocked upright in open marshes or even drains near busy roads. They are largely crepuscular in activity and during the breeding season, just after the first rains, make loud and repetitive croaking calls. Adult white-breasted water hens have mainly dark grey upper parts and flanks, and a white face, neck and breast. The lower belly and under tail are cinnamon coloured. The body is flattened laterally to allow easier passage through the reeds or undergrowth. They have long toes, a short tail and a yellow bill and legs. Sexes are similar but females measure slightly smaller. Immature birds are much duller versions of the adults. The downy chicks are black, as with all rails.

4.1.2.37. RUFOUS TREEPIE (*Dendrocitta vagabunda*)

The rufous treepie (*Dendrocitta vagabunda*) is a treepie, native to the Indian Subcontinent and adjoining parts of Southeast Asia (Plate 37). It is a member of the crow family, Corvidae. It is long tailed and has loud musical calls making it very conspicuous. It is found commonly in open scrub, agricultural areas, forests as well as urban gardens. Like other corvids it is very adaptable, omnivorous and opportunistic in feeding. The sexes are alike and the main colour of the body is cinnamon with a black head and the long graduated tail is bluish grey and is tipped in black. The wing has a white patch. The only confusable species is the grey treepie which however lacks the bright rufous mantle. The bill is stout with a hooked tip. The underparts and lower back are a warm tawny-brown to orange-brown in colour with white wing coverts and black primaries. The bill, legs and feet are black.

4.1.2.38. LESSER SAND PLOVER (*Charadrius mongolus*)

The lesser sand plover (*Charadrius mongolus*) is a small wader in the plover family of birds (Plate 38). It breeds above the tree line in the Himalayas and discontinuously across to bare coastal plains in north-eastern Siberia, with the Mongolian plover in the eastern part of the range; it also breed in Alaska. It nests in a bare ground scrape, laying three eggs. This species is strongly migratory, wintering on sandy beaches in east Africa, south Asia and Australasia. This chunky plover is long-legged and long-billed. Breeding males have grey backs and white underparts. The breast, forehead and nape are chestnut, and there is a black eye mask. The female is duller, and winter and juvenile birds lack the chestnut, apart from a hint of rufous on the head. Legs are dark and the bill black. In all plumages, this species is very similar to the greater sand plover, *Charadrius leschenaultii*. Separating the species may be straightforward in mixed wintering flocks on an Indian beach, where the difference in size and structure is obvious; it is more difficult to identify a lone vagrant to Western Europe, where both species are very rare. The problem is compounded in that the Middle Eastern race of greater sand plover is the most similar to the lesser. The lesser usually has darker legs, a white forehead, and a more even white wing bar than the greater.

4.1.2.39. INDIAN FRUIT BAT (*Pteropus giganteus*)

The Indian flying fox (*Pteropus giganteus*), also known as the greater Indian fruit bat, is a species of flying fox found in South Asia (Plate 39). It is one of the largest bats in the world. It is of interest as a disease vector, as it is capable of transmitting several viruses to humans. It is nocturnal and feeds mainly on ripe fruits, such as mangoes and bananas, and

nectar. The bat is often regarded as vermin due to its destructive tendencies towards fruit farms, but the benefits of its pollination and seed propagation often outweigh the impacts of its fruit consumption. The Indian flying fox is India's largest bat, weighing up to 1.6 kg. Its body mass ranges from 0.6–1.6 kg, and males are generally larger than females. The wing span of the bat ranges from 1.2–1.5 m and body length averages 15.5–22.0 cm. The wings of the bat rise from the side of the dorsum and from the back of the second toe, and the index finger of the bat has a powerful claw. The bat has claws on only its first two digits of its wings, with the index possessing the more powerful claw, and has claws on all five digits of its leg. The bat lacks a tail.

4.2. Plant species identified from INS Garuda

Plant species identified from the INS Garuda is given in the Table 27. Many fruiting trees like mango, Jack fruit, Anjili, Guava and Ficus were recorded from the INS Garuda. These species of trees will attract frugivorous birds, in future planting of fruiting trees in the immediate premises of runway should be avoided. Planting of trees near the runway should be avoided.

Table 27. Plants identified from INS Garuda

Sl.no.	Scientific name	Common name
1.	*Gliricidia sepium* (Jacq.) Kunth ex Walp	Spotted Gliricidia
2.	*Rhapis excelsa* (Thunb.) Henry	Fan palm
3.	*Mangifera indica* L.	Mango
4.	*Artocarpus heterophyllus* Lam.	Jack fruit
5.	*Artocarpus hirsutus* Lam.	Anjili
6.	*Psidium guajava* L.	Guava
7.	*Trema orientalis* (L.) Blume	Oriental trema
8.	*Bambusa tuldoides* Munro	Bamboo
9.	*Averrhoa bilimbi* L.	Bilimbi
10.	*Ficus benghalensis* L.	Ficus
11.	*Bambusa bambos* (L.) Voss	Thorny bamboo
12.	*Citrus* sp.	Citrus

13.	*Areca triandra* Roxb.	Betal nut palm
14.	*Bougainvillea spectabilis* Willd.	Bougainvilla
15.	*Asclepias curassavica* L.	Tropical milkweed
16.	*Musa paradisiaca* L.	Banana
17.	*Ipomoea mauritiana* Jacq.	Giant potato
18.	*Racosperma auriculiforme* (Benth.) Pedley	Darwin Black wattle
19.	*Tamarindus indica* L.	Tamarind
20.	*Homonoia riparia* Lour.	Willow leaved water croton
21.	*Ficus religiosa* L.	Sacred fig
22.	*Pueraria phaseoloides* (Roxb.) Benth.	Pea Sp.
23.	*Cyperus cyperinus* (Retz.) Sur.	
24.	*Caryota urens* L.	Toddy palm
25.	*Vanda testacea* (Lindl.) Rchb.f.	Orchid Sp.
26.	*Chromolaena odorata* (L.) King & Robins.	Siam weed
27.	*Mimosa pudica* L.	Touch me not
28.	*Colocasia esculenta* (L.) Schott	Taro
29.	*Morinda pubescens* J. E. Smith	Morinda tree
30.	*Phyllanthus virgatus* G. Forst.	
31.	*Azadirachta indica* A. Juss.	Neem
32.	*Syzygium cumini* (L.) Skeels	Black plum
33.	*Euphorbia milii* Desmoul	Christ plant
34.	*Dalbergia latifolia* Roxb.	Indian rosewood
35.	*Tectona grandis* L.	Teak
36.	*Ixora coccinea* L.	Jungle flame

37.	*Swietenia mahagoni* (L.) Jacq.	American mahogany
38.	*Delonix elata* (L.) Gamble	Gulmohar
39.	*Bauhinia acuminata* L.	White orchid tree
40.	*Cyrtostachys renda* Blume	Lip stick palm
41.	*Bambusa vulgaris* Schrad.	Bamboo
42.	*Casuarina equisetifolia* L.	Australian pine tree
43.	*Rhopaloblaste* sp.	Ornamental palm
44.	*Phoenix roebelenii* O'Brien	Pygmy date palm
45.	*Spathodea campanulata* P. Beauv.	African tulip tree
46.	*Carica papaya L.*	Papaya

4.3. Bird strikes during the period

Eighteen birdstrike were reported during the period and out of which three each occurred during February, May and June 2016. Four birdstrike were due to Red-wattled Lapwing, two by Blue rock pigeon and three by Black Kite (Table 28). In the month of November one Sand plover was involved in a bird strike. All the birdstrike were not serious and no damage has been reported. To know more about the occurrence of birdstrike this has to be compared with the number of landings and takeoffs from the air field during the same period. During the second year of study *ie* in 2017, the birdstrike were reduced to seven (Table 29).

Table 28. Recorded birdstrike during the study period in INS Garuda (2016).

Sl.no.	Date	Time	A/C Type	Type of Bird	Stage of Flight	Details of Damage
1	03 February 2016	0830	DO 245	Black kite	During BFS	Nil
2	10 February 2016	1940	DO 229	Red-wattled Lapwing	Post Flight External Checks	Nil
3	16 February 2016	1920	DO 229	Blue Rock Pigeon	Post Take Off	Nil
4	19 May 2016	2115	DO 229	Red-wattled Lapwing	Flying	Nil

5	19 May 2016	2130	DO 226	Black kite	Flying	Nil
6	24 May 2016	1940	DO 246	Not Known	Landing	Nil
7	01 June 16	1340	DO 229	Red-wattled Lapwing	Flying	Nil
8	03 June 2016	1740	DO 245	Black kite	Landing	Nil
9	29 June 2016	2015	DO 246	Red-wattled Lapwing	Landing	Nil
10	10 November 2016	2245	DO 244	Sand Plover	Circuit and Landing Sortie	Nil
11	27 December 2016	1355	DO 771	Blue Rock Pigeon	During Take Off Outside Airfield	Nil

Table 29. Recorded birdstrikes during the study period in INS Garuda (2017)

Sl.no	Date	Time	A/C Type	Type of bird	Stage of flight	Details of damage
1	08 February 2017	2010	CH 407	Not Known	Flying	NIL
2	09 February 2017	2200	DO229	Owl	Not Known, seen during AFS	NIL
3	20 April 2017	2200	CG785	Black-crowned night heron	Not Known, seen during AFS	NIL
4	20 September 2017	1020	CG764	Black kite	Landing	NIL
5	03 November 2017	1801	SK530	Not Known	10NM into the sea on transit to ship	NIL
6	06 November 2017	1500	DO227	Brahminy kite	Circuit	NIL
7	24 January 2018	1520	DO227	Not Known	Circuit	NIL

5. DISCUSSION

INS Garuda of Cochin Naval Base has recorded eleven bird strikes in the year of 2016. Bird population of INS Garuda showed an increase during July and August and lowest number of birds were recorded during the June. Maximum of bird strikes were recorded during February, May and June. Red-wattled Lapwing were involved in four bird strikes, during the year 2016, and Black kites in three incidents and Blue rock pigeon in two incidents during the year. The population of Black kites and Red-wattled Lapwing was highest during the months of July and August (Fig.06 and Fig.10). No relationship could be obtained between the population dynamics of Blue rock pigeon and bird strikes. This is because the Blue rock pigeon is not staying in the INS Garuda area, but they were involved in bird strike when they fly over the INS Garuda air strip for their journey from FCI stockyard and other areas. All other species has not involved in any bird strike during the period except a sand plover. They are migratory birds and the one hit occurred during November which is the normal migratory period of the species.

In the year 2017 the number of bird strikes reduced to seven out of the seven bird strike, the species of bird could not be identified in three incidents in the year 2017 an Owl was involved in bird strikes (Table 29).

The main species of birds involved in bird strike were Red wattled Lapwing, Blue rock Pigeon and Black kite. After initiating the study in March many suggestions were given in each month after the field visit and most of them were implemented in time. The suggestion to cover the channels on the northern side and spraying the tobacco decoction to control the Giant African Snail were not executed. Out of the three species causing bird strikes in the INS Garuda only one species, Red wattled Lapwing can be controlled from inside of INS Garuda. The control of other two species can be carried out only through the cooperation of civil authorities and local people (Blue Rock Pigeon and Black Kite).

Godin and Alfred (1994) reported that birds have been a hazard to aircraft from the first powered flight. During the early days of aviation, when aircraft flew at slow speeds, birds had little difficulty in getting out of the way. Bird strikes were infrequent and damage was mainly confined to cracked windshields. The likelihood of the loss of aircraft and/or human lives was remote. With the development and introduction of jet aircraft, bird strikes became a serious hazard and costly problem. Faster speeds mean birds have less time to react to approaching aircraft. The force generated by bird impact with a fast-moving aircraft is tremendous. The

newer turbine engines use light-weight, high speed mechanical parts which are vulnerable to bird strike damage.

All birds are protected under Indian wildlife protection Act (1972). These laws make it unlawful to pursue, capture, take, kill, or possess migratory birds or endangered and threatened species, except as permitted by regulations. No two airports are exactly alike. Accordingly, bird hazards vary from airport to airport, even when the same species are involved. The occurrence of birds at airports varies according to habitat availability, weather, season of year and time of day. Airports provide a wide variety of natural and human-made habitats that offer food, water, and cover. INS Garuda is on the migratory path way going through India *i.e.* Central Asian Indian fly way, where migratory birds from Siberia, Magnolia, China and North India fly to Sri Lanka and up to Seychelles and they return through the same way back in March and April.

One of the first steps in reducing bird hazards is to recognize these attractants. Usually, several attractants acting in combination are responsible for the presence of birds and their behaviour at an airport.

Food: Birds require relatively large amounts of food. Most airports support an abundance and variety of foods such as seeds, berries, grass, insects, grubs, earthworms, small birds, and small mammals. Seeds and berries are sought by several migratory and resident birds such as sparrows, finches, starlings, blackbirds, mourning doves, common pigeons, and waterfowl. Geese are attracted to open expanses of grasses. Gulls, starlings, robins, and crows often feed on earthworms on the surface of the ground following a rain. Raptors are attracted to airports because of rodents, birds, and other small animals that harboured by tall, poorly maintained grass stands and borders. Occasionally, food becomes available through careless waste disposal practices by restaurants and airline flight kitchens. Airport personnel have been known to feed birds during their lunch breaks. Many airports have inadequate garbage disposal systems that permit access to various food items. Nearby landfills or sewage outlets may also provide food for birds and other wildlife. Landfills are often located on or near airports because both are often built on publicly owned lands. In these circumstances, landfills contribute to bird strike hazards by providing food sources and loafing areas that attract and support thousands of gulls, starlings, pigeons, and other species. The waste dump on the southern border of the INS Garuda is an example for this sort of availability of food.

Water: Birds of all types are drawn to open water for drinking, bathing, feeding, loafing, roosting, and protection. Rainy periods provide temporary water pools at many airports. Many airports have permanent bodies of water near or between runways for landscaping, flood control, or wastewater purposes. These permanent sources of water provide a variety of bird foods, including small fish, tadpoles, frogs, insect larvae, other invertebrates, and edible aquatic plants. Temporary and permanent waters, including ponds, borrow pits, sumps, swamps, and lakes, attract gulls, waterfowl, shorebirds, and marsh birds. Fresh water is especially attractive in coastal areas. Birds need cover for resting, loafing, roosting, and nesting. Trees, brushy areas, weed patches, shrubs, and airport structures often provide suitable habitat to meet these requirements. Almost any area that is free from human disturbance may provide a suitable roosting site for one or more species of birds. Starlings, pigeons, house sparrows and swallows often roost or nest in large numbers in airport buildings or nearby trees, shrubs, or hedges.

Local Movements: Shorebirds, waterfowl, gulls, and other birds often make daily flights across airports from their feeding, roosting, nesting and loafing areas. Airports near cities may experience early morning and late afternoon roosting or feeding flights of thousands of starlings.

Damage Prevention and Control Methods: Bird strike hazards reoccur regularly at many airports and require constant attention. Before attempting to reduce bird hazards at an airport, it is important to assess the problem, identify contributing factors, and analyze the threat to aircraft and human safety. A wildlife hazard management plan should be implemented to make the airport unattractive to birds. Scaring or dispersing birds away from airports is usually difficult because birds are tenaciously attracted to available food, water, and cover. As long as these attractants exist, birds will be a problem.

Habitat Modification: Several habitat management practices can make an airport less attractive to birds. These include eliminating standing water, removing or thinning trees, removing brush and managing grass height. Buildings can be modified to reduce or eliminate roosting or nesting sites.

Frightening: This is a reliable and expeditious means of repelling birds. Frightening programs, however, provide only temporary relief and require constant monitoring. An early priority in reducing bird hazards is to establish a bird dispersal patrol team to harass and scare birds and provide immediate protection for aircraft within the airport perimeter. The patrol team must

consist of highly motivated and knowledgeable personnel with adequate equipment, such as radio-equipped vehicles, shotguns, and frightening devices consisting of bird distress calls, live ammunition, and pyrotechnic devices (automatic gas exploders, shell crackers, and racket bombs). Patrol personnel must be trained in bird identification and dispersal methods. Clear communication between the patrol team and the control tower is essential. Birds react to unfamiliar sounds and objects. They learn, however, to ignore sounds and objects that have proven harmless, especially if they are used often and for long periods of time. Birds should not be allowed to acclimate to a scare device through repeated exposure without an associated adverse effect. The use of shooting to reinforce frightening techniques can be effective and should occur simultaneously with the scare devices often enough to maintain fear in the birds. In most cases, an integrated approach that incorporates several frightening devices will produce the best results. The shell cracker fires a projectile from a 12-gauge shotgun. It travels up to 90 m and explodes with a loud noise and a flash. Noise bombs are similar and can supplement shell crackers, but their range is much shorter. Racket bombs are propelled by a special pistol and travel approximately 90 m; they do not explode. Shell crackers and racket bombs may lose their effectiveness when used frequently. Distress calls are sounds emitted by birds under conditions of stress. The calls can be recorded on tape cassettes and played through a loudspeaker located on the patrol vehicle. Distress calls supplement shell crackers and noise bombs. Automatic exploders or gas cannons, operated by acetylene, propane, or LP gas, produce a noise louder than a shotgun blast. Exploders can be set up and left to operate continuously, but for best results, the exploders should be operated for limited periods of time only, unless birds are moving into the airport. Exploders should be moved periodically so that the birds do not become accustomed to the blasts. Repellents Research has been conducted on the efficacy of methyl anthranilate for repelling gulls and waterfowl from standing pools of water on airport runways. Methyl anthranilate is a grape-flavoured food additive.

Shooting: Shooting birds with shotguns or rifles can be a highly selective and useful form of hazard control under certain conditions. Shooting has been used to reduce hazards caused by birds that habitually fly over airport runways. Caution must be used so that shooting does not disturb no target species. Shooting is not practical or desirable as a method for reducing large numbers of birds.

Management of problem wildlife within the airfield environment is a difficult job Klope *et al.* (2009). Today's Bird–Animal Aircraft Strike Hazard (BASH) program managers require as much information as possible to accomplish their tasks. Bird censuses and actual

bird-strike events in and around the air operations area are used to make airfield management decisions and to assess the risk of bird hazards to aircraft. Both types of information are sampled rather sparsely. In some air fields Avian radar is now being used as a new tool to provide continuous sampling of bird activity that significantly supplements visual censuses. The measure of risk used today is commonly expressed as the ratio of the number of bird strikes per 100,000 flying hours. While important, this measure of risk is relatively insensitive to improvements in safety measures that do not result in dramatically fewer bird strikes. Stated differently, a reduction in safety or an increase in risk (which reflects an increased likelihood of bird strikes occurring) is not anticipated, but, rather, it is calculated after the fact when increases in bird strikes have been experienced. As a result, BASH managers are at a disadvantage because they can respond only after bird strikes occur. To address this deficiency, they introduced a new method for assessing risk that is based on near-miss events that complements risk calculations based on reported bird strikes. Recent advances in commercially available, digital avian tracking radars enabled biologists to automatically monitor and assess near-miss events. Near-miss events occur much more frequently than bird strikes. A combined dataset of bird strikes and near-misses provides BASH managers with a more responsive metric to evaluate the success of their program over time than by using only the bird-strike dataset.

6. GENERAL SUGGESTIONS

Based on our field work, following suggestions are given for implementation in the INS Garuda and the surrounding area of INS Garuda.

1. Population of Red-wattled lapwings have increased in the months of June to September and many eggs were recorded. To reduce the population growth, eggs have to be pricked. A way to reduce the population growth is by habitat alteration, to achieve this planting of local species of grass in the areas where pebbles are found and in the open areas is recommended. Such open areas have to be planted with grass after removing the pebbles and filling the area with sufficient quantity of soil. By growing grass in open areas the Red-wattled lapwing will not be breeding in the air field.

2. Metallic posts functioning as perches for birds like Black drongo has to be removed.

3. Urgent steps should be initiated to cover the canal with metallic frames or RCC slabs, so that diving birds will not make use of the canals in monsoon.

4. The marshes near the south-eastern side are a good heaven for wetland birds. Proper drainage may be made to drain the water from these marshes, so that the wetland birds will not come to inhabit this area.

5. West-south side of ATC has to be cleared of bushes. The area allotted to Indian Oil Corporation has to be maintained without heavy grass and bushes, for this discussion have to be initiated with the IOC.

6. Awareness programme to surrounding local people for not leaving the waste without proper processing.

7. African snail population has to be controlled during the months of May to September to stop attracting the birds feeding on the snail. A simple and effective method is by luring the African snail to the bait (Papaya leaves or cabbage), which can be mixed with rum or beer (Because they get attracted to the fermented items) collected snails can be killed by putting salt over it. The bait has to be put at 7 pm and collected at 8 pm and the collected snails destroyed immediately.

8. Waste dump near the southern side of the INS Garuda opposite the road has to be cleaned and waste dumping stopped immediately.

9. FCI warehouse has to be cleaned periodically and spillage of grains stopped. Open areas in the warehouse covered with wire mesh to stop the breeding of Blue Rock Pigeon. For the above purpose FCI authorities has to be contacted.

Month wise actions to be carried out in each month are given below in the Table 30.

Table 30. List of actions to be carried out in INS Garuda in each month.

Sl. no.	Recommendations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Grass growing outside the runway has to be	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	trimmed to 10-12 cm height.												
2	Rats have to be controlled to stop predatory owls, which may come at night	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Dry branches, bushes and unnecessary wooden pieces to be removed	No	No	No	No	Yes	Yes	No	No	No	No	No	No
4	The nest building process of Red-wattled Lapwing should be stopped by continuously scaring them.	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
5	Prick the eggs of Red-wattled Lapwing with pins so that the eggs will not be hatched successfully.	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
6	Removal of African snails by attracting them and destroying them	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No
7	Precaution towards wetland birds (Draining water from the airfield and canals)	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
8	Arrival of migratory birds (High precaution is required while flying)	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
9	Scaring of birds from the runway (Black kite, Red-wattled lapwing, Blue rock pigeon) By using crackers and shooting.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

7. ACKNOWLEDGMENTS

We heartily express our thanks to INDIAN NAVY for sponsoring this study. Commodore R. R. Ayyar, Commanding Officer INS Garuda, and Capt. Venkatesh R. Iyer gave tremendous encouragement and all facilities for the study. Many SFSO's interest realised in executing the current project, namely Cdr. Sanjay Awasthi, Cdr. U. Dutta, Cdr. Paul Mathew, and the present SFSO Cdr.Vinod Sivadasan. We thank all the officers and JCO s for facilitating the study. S. K.Yadav MCELAR II, U.B Yadav MCELAR II, Deepak Pandey LAH, B.B Baruah LAH, and Gaurav Sharma LAH assisted the work in many ways.

We thank Dr. S. Pradeep Kumar, Director, Kerala Forest Research Institute and all the officers of KFRI for encouraging us while doing this work. Dr. V. B. Sreekumar, Scientist, Department of Botany is thanked for contributing to the study by identifying the plants in INS Garuda. Ms. Greeshma, provided us many suggestions for the improvement of the manuscript for which she is thanked. Shri E. G. Shonith and Ms. K. Arathi, Dept. of Wildlife helped in preparing the Report.

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Plate 01. Indian pond heron (*Ardeola grayii*)

Plate 02. Black drongo (*Dicrurus macrocercus*)

Plate 03. Red-Wattled Lapwing (*Vanellus Indicus*)

Plate 04. Common Myna (*Acridotheres Tristis*)

Plate 05. Black Kite (*Milvus Migrans*)

Plate 06. Brahminy Kite (*Haliastur Indus*)

Plate 07. House Crow (*Corvus Splendens*)

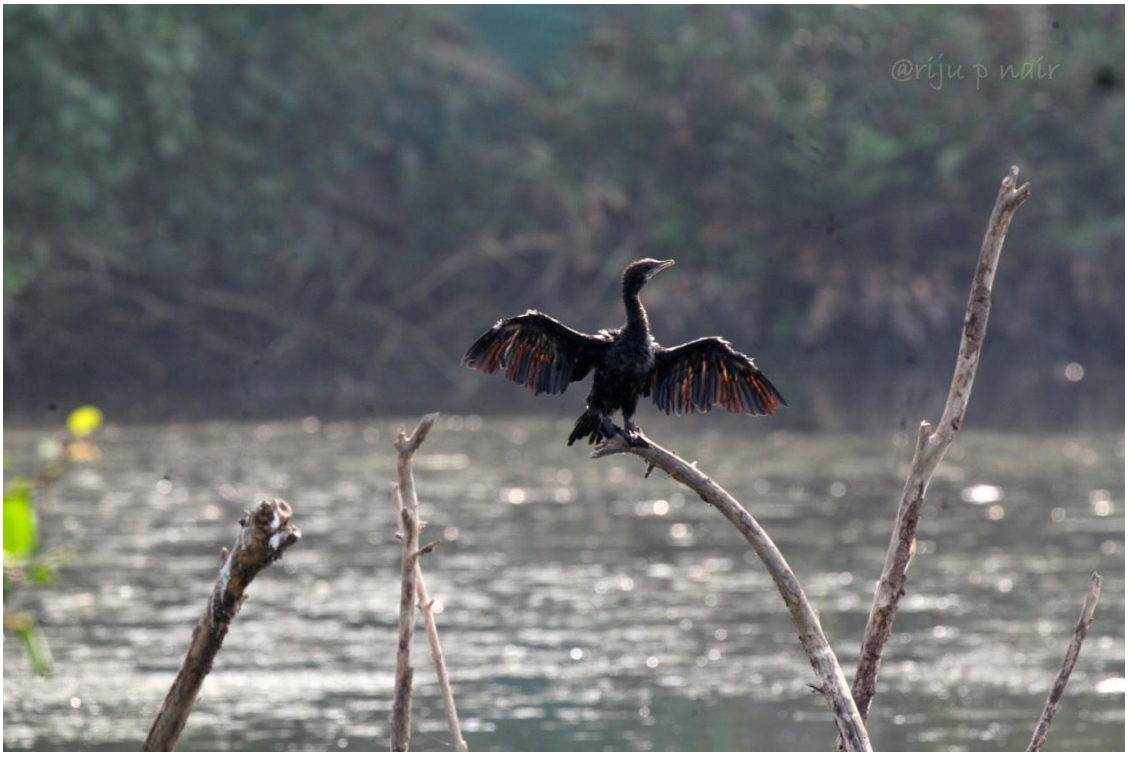

Plate 08. Little Cormorant (*Microcarbo Niger*)

Plate 09. Large Egret (*Ardea alba)*

Plate 10. Purple Heron (*Ardea purpurea)*

Plate 11. Little Egret (*Egretta garzetta)*

Plate 12. Blue Rock Pigeon (*Columba livia*)

Plate 13. Indian Roller (*Coracias benghalensis)*

Plate 14. Pied Wagtail (*Motacilla alba*)

Plate 15. Median Egret (*Ardea alba)*

Plate 16. Shikra *(Accipiter badius)*

Plate 17. Greater Coucal (*Centropus sinensis*)

Plate 18. Whitecheeked Barbet (*Psilopogen zeylanicus)*

Plate 19. Asian Koel (*Eudynamys scolopaceus)*

Plate 20. Redvented Bulbul (*Pycnonotus cafer)*

Plate 21. Oriental Magpie Robin (*Copsychus saularis*)

Plate 22. Purplerumped Sunbird (*Leptocomoa zeylonica)*

Plate 23. House Sparrow (*Passer domesticus)*

Plate 24. Cattle Egret (*Bubulcus ibis)*

Plate 25. Blackrumped Flameback (*Dinopium benghalense)*

Plate 26. Oriental pipit (*Anthus rufulus*) in grassland near the runway

Plate 27. Bluetailed bee-eater (*Merops philippinus*) in the runway

Plate 28. Barn swallow (*Hirundo rustica*)

Plate 29. Asian openbill stork (*Anastomus oscitans*)

Plate 30. Oriental darter (*Anhinga melanogaster*)

Plate 31. Night heron (*Nycticorax nycticorax*)

Plate 32. Greater racket-tailed drongo (*Dicrurus paradiseus*)

Plate 33. Scalybreasted munia (*Lonchura punctulata*)

Plate 34. Jungle crow (*Corvus culminatus*)

Plate 35. Indian edible-nest swiftlet (*Aerodramus unicolor*)

Plate 36. Whitebreasted waterhen (*Amaurornis phoenicurus*)

Plate 37. Rufous treepie (*Dendrocitta vagabunda*)

Plate 38. Lesser sand plover (*Charadrius mongolus*)

Plate 39. Indian flying fox (*Pteropus giganteus*)

Plate 40. Flock of Blue rock Pigeon in FCI warehouse, near INS Garuda

Plate 41. Flock of Blue rock Pigeon foraging in front of FCI warehouse where they roost and breed also

Plate 42. Waste dump near INS Garuda which attracts Black kites

Plate 43. Fishing Harbour near INS Garuda which attracts kites to feed on waste fish