

Study on avian diversity of thal desert (district jhang), punjab, pakistan

Shahid Mahboob*^{1,3}, Zaib-U-Nisa², Alkalem Al-Balawi, H. F¹, Fahad Al-Misned¹, Z. Ahmad¹ and S. Sultana³

¹Department of Zoology, College of Science P.O.Box 2455, Riyadh, 11451, Kingdom of Saudi Arabia
Department of Environmental Sciences, GC University Faisalabad, Pakistan.

³Department of Zoology, GC University, Faisalabad, Pakistan
shahidmahboob60@hotmail.com

Abstract: Thal Game Reserve area of district Jhang was surveyed from December, 2008 to November, 2009 on the monthly site visit basis to study the population of wild bird species of the area. The survey method included on site direct observations with the naked eye in the morning and evening. Two transects i.e. one of 10 km in length and 500 m in width for larger birds, whereas second of 10 km in length and 200 m in width for smaller birds were studied. Seventy six plant species belonging to twenty five families were recorded from the area. All these plant species supported the population of avifauna directly or indirectly by providing food, water, shelter, roosting or perching. We recorded 55 bird species belonging to 42 genera from 28 families representing 13 orders from the area. Among these species 13 bird species were migratory and winter visitor, 5 migratory but summer breeder, 1 ordinary migrant and 36 residents which were found throughout the year. A total of 2550219 birds was estimated in the Thal Game Reserve area. The maximum population of birds was estimated during the month of December, 2008 (11.13%) and January, 2009 (10.57%) whereas the minimum population of birds was estimated during April (4.30%), May (5.82%) and June, 2009 (6.7%). The maximum diversity in the avifauna of Thal desert was found during the summer (D=0.11) and autumn (D=0.11) seasons while minimum during spring (D=0.14) season. Illegal hunting, livestock grazing, tree and bush cutting for fuel wood collection, shortage of food and water during summer and vegetation exploitation were recorded the major threats to wild fauna of the area. It was concluded that there is an urgent need to safeguard the very fragile ecosystem and overall biodiversity of Thal desert through management planning of the area.

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1. Introduction

The Thal desert is situated in Punjab, Pakistan. Its total length from north to south is 190 miles, and its maximum breadth is 70 miles while minimum breadth is 20 miles. This region is divided into the districts of Bhakkar, Khushab, Mianwali, Jhang, Layyah and Muzaffargarh. Its part in Jhang is on the left bank of the river Jehlum. The Thal desert lies between the river Indus and Jhelum near the Pothohar Plateau. Geographically, it resembles the deserts of Cholistan and Thar. Sand dunes are a prominent feature of the area which is mainly the result of Aeolian deposition of sand material belonging to Pleistocene and recent times (Mathur and Shankararayan, 1975; Gupta, 1986). This condition of Thal is gradually changing. The barani cultivation is being supplemented by tube-wells. The Rangpur Canal also provides irrigation to the large areas most of which has been leveled by the Thal Development Authority. A large percentage of bird species are sensitive to human habitat transformation. Fragmentation and conversion of desert ecosystems into agricultural and urban areas affect the distribution of species that are highly selective for scrub habitat. Reliable plans for desert bird conservation depend on accurate predictions of

habitat change effects on their distribution and abundance patterns (Ricardo, 2007). In hot desert ecosystems the diversity and development of plant communities depend upon the availability, quality and reliability of resources, mainly water (Evenari et al., 1971). Deserts exhibit higher predation risk than urban habitats (Eyal, 2004). Like the other creatures of the desert, birds come up with interesting ways to survive in the harsh climate. Predictable annual fluctuations in rainfall and resource availability favor a migration strategy more than nomadic movements (Blendinger, 2005).

Thal desert is a very important wintering place for migratory birds such as Houbara bustard and Quails. Houbara bustard is an important game bird for Arab dignitaries, who hunt it through falconry operations in this area. The area has a very good potential for scientific research, conservation, education and sport hunting. Rubin et al. (1998) stressed on the need of accurate knowledge of its spatial distribution for the effective management of a species or population. The present study was thoroughly conducted first time with the objectives to identify and enlist the various bird species visiting and residing in the area and to estimate the population and

bird diversity of the area. Furthermore, the impact of cultivated crops was worked out on population of different bird species in and around the area during different seasons of the year.

2. Materials and Methods

2.1 Study Area:

The Tale Game Reserve area extends up to the district Bakkhar, Khushab, Jhang, Layyah and Muzaffargarh. Thal area of district Jhang falls mostly in Tehsil Jhang and a small part in Tehsil Ahmadpur Sial. Thal area was initially declared a Game Reserve under section 18 of the Punjab Wildlife (Protection, Preservation, Conservation and Management Act, 1974) for a period of five years on 10-7-1978. After the expiry of five years, the area was continuously renotified for the next five years, hence the area still has the status of the Game Reserve. The Thal Game Reserve area of district Jhang comprises approximately 1000 km². The area is bounded by district boundaries of district Khushab, Bakkhar and Layyah in the west whereas in the east it extends up to Athara Hazari, Khushab Road and Rangpur Canal.

2.2: Procedure:

The study was carried out during December, 2008 to November, 2009 covering the whole year so that migratory species of birds could also be studied in addition to local species. A survey was conducted on the monthly visit basis. The survey method included on site direct observations with the naked eye. Binocular standard 10x50 mm was used to identify the bird species following Roberts (1991, 1992) and Ali and Ripley (1983, 1987). Two transects i.e. one of 10 km length and 500 meter width for larger birds whereas second of 10 km in length and 200 meters in width for smaller birds were studied by moving on a 4WD vehicle at a speed of 5 to 8 km/hour and observing outside the vehicle. Flushing distance of the bird was noted in approximate, indirect clues, such as calls, footprints, droppings and signs of feeding were also considered. Random sampling of the area was done and population of important wild birds was estimated by applying Strip Count Method (Tanner, 1978).

Population density/km² of each bird species was worked out and a total population of a bird species was calculated by applying the following equation

$$P = D \times A$$

Where 'P' means total population, 'D' density per km² and 'A' total area in kilometers.

Birds observed were identified up to the species level. Informal discussions and dialogues with local people were also carried out to gather the information about the natural resources of the area. Information from the local community and on site observations were recorded on every visit and accumulated at the end of the study. A study was

carried out with special reference to a diversity of birds. Simpson's diversity index was applied.

Different plant species found in the area were collected during each visit. The collected plant species were identified and impact of cultivated crops in and around the area during different seasons, on population of different species was also taken into account.

3. Results

Flora

The area has well diversified flora of terrestrial ecosystem. Seventy six plant species belonging to twenty five families were recorded from the area. All these plant species supported the population of avifauna directly or indirectly by providing food, water, shelter, roosting or parching. Approximately 15% of the area is irrigated through the canals and tube wells which remain under cultivation throughout the year. Major crops cultivated in the irrigated area are sugarcane *Saccharum officinarum*, wheat *Triticum aestivum*, rice *Oryza sativa*, gram *Cicer arietinum*, maize *Zea mays*, millet *Pennisetum typhoides*, jawar *Sorghum vulgare*, cotton *Gossypium herbaceum*, moong *Phaseolus mungo*, tel *Mollugo cerviana*, mustard *Brassica campestris* and barley *Hordeum vulgare*. The cultivation of non-irrigated area depends totally on rain. In non-irrigated area of the Thal only winter crop of gram *Cicer arietinum* is cultivated whereas during summer the area remained uncultivated. The major species of trees found in the area were *Dalbergia sissoo*, *Prosopis cineraria*, *Acacia nilotica*, *Ziziphus mauritiana*, *Phoenix dactylifera*, *Tamarix aphylla* and *Albizia lebbek*. Major species of natural vegetation found in the area were *Capparis decidua*, *Ziziphus nummularia*, *Calotropis procera*, *Tamarix dioica*, *Haloxylon recurvum*, *H. salicornicum*, *Salsola baryosma*, *Cynodon dactylon*, *Desmostachya bipinnata*, *Pennisetum divisum*, *Calligonum polygonoides*, *Solanum xanthocarpum*, *S. nigrum*, *Calotropis procera*, *Leptadenia pyrotechnica*, *Citrullus colocynthis*, *Carthamus tinctorius*, *Alhagi maurorum*, *Cistanche tuberosa*, *Peganum harmala* and *Tribulus longipetalus*.

Avifauna

Thal area of district Jhang was accommodating a large variety of birds. During study 55 bird species belonging to 42 genera from 28 families representing 13 orders were recorded from the area. These were (1) Ciconiiformes (Family: Ardeidae; *Bubulcus ibis*, *Egretta garzetta*, *Ardeola grayii*), (2) Accipitriformes (Family: Accipitridae; *Elanus caeruleus*, *Milvus migrans*, *Accipiter badius*), (3) Falconiformes (Family: Falconidae; *Falco tinnunculus*, *F. chicquera*, *F. jugger*, *F. peregrinus*), (4) Galliformes (Family: Phasianidae; *Francolinus pondicerianus*, *Coturnix coturnix*), (5) Gruiformes (Family: Otididae;

Chlamydotus undulata macqueeni), (6) Charadriiformes (Family: Charadriidae; Hoplopterus indicus), (7) Columbiformes (Family: Columbidae; Columba livia, Streptopelia decaocto, S.tranquebarica, S. senegalensis), (8) Psittaciformes (Family: Psittacidae; Psittacula krameri), (9) Cuculiformes (Family: Cuculidae; Clamator jacobinus, Centropus sinensis, Eudynamys scolopacea), (10) Strigiformes (Family: Strigidae; Athene brama), (11) Coraciiformes (Family: Alcedinidae; Halcyon smyrnensis, Family: Meropidae; Merops orientalis, M. superciliosus, Family: Coraciidae; Coracias benghalensis, Family: Upupidae; Upupa epops), (12) Piciformes (Family: Picidae; Dinopium benghalense), (13) Passeriformes (Family: Alaudidae; Galerida cristata, Alauda arvensis, Family: Hirundinidae; Hirundo rustica, Family: Motacillidae; Motacilla fálva, M. alba, Family: Pycnonotidae; Pycnonotus cafer, Family: Turdidae; Phoenicurus ochruros, Saxicola caprata, Oenanthe desertii, Family: Sylviidae; Acrocephalus melanopogon, Sylvia nana, Phylloscopus collybita, Family: Timaliidae; Turdoides caudatus, T. earlei, T.striatus, Family: Nectariniidae; Nectarinia asiatica, Family: Lanidae; Lanius excubitor, L. schach, Family: Dicruridae; Dicrurus macrocercus, Family: Corvidae; Corvus splendens, C. corax, Family: Sturnidae; Sturnus vulgaris, S.roseus, Acridotheres tristis, A. ginginianus, Family: Passeridae; Passer domesticus) (Table 1).

Passeriformes was the most dominant order represented by 26 species belonging to 18 genera from 13 families, followed by Coraciiformes which was represented by 5 species belonging to 4 genera from 4 families. Order Falconiformes and Columbiformes were represented by 4 species each belonging to one and two genera respectively from a single family. Order Ciconiiformes, Accipitriformes and Cuculiformes were represented by 3 species belonging to 3 genera from single family each. Order Galliformes was represented by 2 species belonging to 2 genera from a single family. Order Gruiformes, Psittaciformes, Strigiformes, Piciformes were represented by single species each.

Among 55 bird species recorded from the area, thirteen species were migratory and winter visitor, five migratory but summer breeder, one ordinary migrant and 36 residents which were found throughout the year and also bred in the area (Table 1). The most frequently found bird species in the study area were Common myna (22.26%) and House sparrow (21.15%) (Table 2).

During the present study total 2550219 birds were estimated in the Thal Game Reserve area. The maximum population of birds was estimated during the month of December, 2007 (11.13%) and January, 2008 (10.57%) whereas the minimum population of birds was estimated during April (4.30%), May (5.82%) and

June 2008 (6.7%) (Table 2). The population of birds increased up to midwinter due to (i) increase in population of migratory and winter visitor birds especially Common quail (0.42%), Common Starling (1.79%), Rosy Starling (0.27%), Common swallow (0.44%), Desert Warbler (0.48%), Desert Wheatear (0.81%), Black Redstart (0.07%), Houbara bustard (0.03%), mustached warbler (0.10%), Sky lark (0.69%) and Yellow wagtail (0.46%), and (ii) availability of sufficient food. Population of birds decreased gradually after midwinter due to back migration of winter visitor birds, increase in temperature and shortage of food. Change in overall population of birds during different months (Table 2).

The analysis of variance showed that there were statistically significant month-wise and species-wise ($p < 0.01$) variations in the mean estimated population of avifauna at Thal desert (Table 3). The mean number of bird species was found statistically significant maximum during December, 2008 and January, 2009 ($5162.19 \pm 1.770.9$; 4901.73 ± 1583.84 , respectively) and minimum during April, 2009 (1995.64 ± 791.42) (Table 4). During December 43 bird species and during January 45 bird species were recorded whereas, 26-29 species were recorded from April to July. The results of analysis of variance (Table 5) show that there were statistically significant season-wise ($p < 0.01$) and species-wise ($p < 0.01$) variations in the mean estimated population of avifauna at Thal desert. The seasonal variation in estimated population of avifauna of Thal area is shown in Fig. 2 and Table 6. The mean maximum estimated population of avifauna at Thal desert was noted during winter season (14644.82 ± 4801.34) followed by autumn (12637.67 ± 3763.97), summer (10864.07 ± 3280.20) and spring (8221.07 ± 2905.82) seasons (Table 6). Table 7 shows the maximum diversity in the avifauna of Thal desert during summer ($D=0.11$) and autumn ($D=0.11$) seasons followed by winter ($D=0.12$) and spring ($D=0.14$) seasons.

4. Discussion

Thal area is a complex of natural habitat and agricultural fields, therefore, it supports a remarkably diverse group of birds. The bird species are both resident and migratory. The avifauna would, therefore, be supported to belong Oriental and Palearctic zoogeographical regions. The resident species are mainly of the Oriental region. The migratory species during winter season belong to the Palearctic region whereas, the proportion of Oriental species rise during the monsoon season by migrants ((Roberts, 1991).

A total of 55 bird species were recorded. Among them 13 species were winter visitor, five summer breeder, one ordinary migrant and 36 residents. The winter visitor were as Peregrine falcon, Eurasian

kestrel, Houbara bustard, Sky lark, Common swallows, Yellow wagtail, Black Redstart, Desert Wheatear, mustached warbler, Desert warbler, Brown Chiffchaff, Common starling and Rosy starling. These birds breed in western Siberia and comes to Pakistan in winter. Khan (1997) studied the avifauna of Lal Suhanra National Park, Bahawalpur, Pakistan. He recorded 117 species of birds representing 81 genera, 43 families and 16 orders. The density of resident birds was higher as compared to migratory birds. Most of the migratory birds were observed during winter season. Akbar et al. (2003) conducted survey in Thal, Dera Ghazi Khan and Cholistan desert area. They estimated 138 birds of Houbara bustard in Thal through different techniques. During the present study Houbara bustard made only 0.03% of the overall estimated population. Wardman and Warringtonb (1997) studied seasonal changes in abundance of bird species. The density estimates of number of birds were 187 per km in winter (19 species) and 157 per km (15 species) in spring. They recorded *Eremopterix nigriceps*, *Turdoides squamiceps* and *Lanius excubitor* as the most abundant species. In the present study *Lanius excubitor* was a resident species which showed only 0.52% of the overall population.

Azam (2004) studied the avifaunal biodiversity of the National Hingol Park and recorded 105 bird species belonging to 68 genera, 37 families and 14 orders from different habitat types including coast, freshwater wetlands, desert and hills. He noted the abundance of birds belonging to Charadriiformes while larks and shrikes were relatively more numerous in desert areas. Hoopoe was found winter visitor. During the present study Passeriformes was the most dominant order and Hoopoe was found resident in Thal area. Pied crested cuckoo, Koel, Purple Sunbird, Red-turtle dove and Persian bee-eater were summer visitors, which also breed in the area. They come from India and East Africa. Koel is brood parasitic on House crow in Pakistan. Ali and Ripley (1987) and Roberts (1992) also recorded Purple Sunbird in summer. Common Quail was ordinary migrant. Mahboob and Nisa (2009) studied an avifaunal diversity of Trimmu barrage, district Jhang, on monthly basis for a period of nine months. They recorded a total of 9699 birds 89 species belonging to 68 genera, 39 families and 15 orders. Among them 29 species were migratory and winter visitor, four were migratory but summer breeders, four ordinary migrants and 52 were resident. Passeriformes was the most dominant order represented by 36 species belonging to 18 families. The maximum number of bird species were found during midwinter and minimum during summer.

In the present study among resident birds were Cattle egret, Little egret, Indian pond heron, Black winged kite, Pariah kite, Indian sparrow hawk, Red-headed merlin, Laggar falcon, Grey partridge,

Red-wattled lapwing, Rock pigeon, Ring dove, Red turtle dove, Little brown dove, Rose-ringed parakeet, Pied crested cuckoo, Crow pheasant, Spotted little owl, White-throated kingfisher, Little green bee-eater, Indian roller, Hoopoe, Golden-backed woodpecker, White wagtail, Pied bush chat, Striated babbler, Jungle babbler, Common babbler, Great grey shrike, Rufous backed Shrike, Black drongo, House crow, Raven, Common myna, Bank myna and House sparrow.

Food plays an important role in the density of various birds. Different birds show more or less preference for a particular kind of food. The fruits of *Ziziphus* species provide rich supply of food and attract mynas, babblers, bulbuls and parakeets. Fruits of *Capparis decidua* attract wintering population of Houbara bustard. Cultivated grams also provide food and shelter to Houbara bustard (Photograph 1. Footprints of Houbara bustard in grams). Chaudhry et al. (1997) studied the avifauna of Cholistan. They identified 58-bird species representing 42 genera, 26 families and 12 orders, including *Chlamydotis undulate*, *Pterocles orientalis*, *Elanus caeruleus*, *Accipiter badius*, *Cursorius coromandilicus*, *Eremopterix alaudips* and *Lanius excubitor*. Presence of vultures and birds of prey was a special feature of the study area. During winter the whole Thal area was lush green due to cultivated gram crop. No insecticide was applied to this crop therefore huge numbers of insects were available to insectivorous birds such as Cattle egret, Little green bee-eater, Persian bee-eater, Indian roller, Hoopoe, Golden backed-woodpecker, Black Drongo, Common starling, Rosy starling, Common myna and Bank myna. The cultivated crops such as rice, wheat, millet, maize, bean and gram provided a good source of food to the granivorous birds such as Grey partridge, Common quail, Rock pigeon, Ring dove, Little brown dove, Crested lark, Sky lark, Common babbler, Striated babbler, Jungle babbler, Common myna and house sparrow. Birds of terrestrial habitat take a mixed diet such as wagtails and partridges. Many birds such as Swallows, Bee-eaters and Black Drongo take their food in flight. Woodpeckers feed on insects and larvae by excavating the tunnels in wood. Black winged kite, Pariah kite, Indian sparrow hawk, Eurasian kestrel, redheaded merlin, Laggar falcon and Peregrine falcon are birds of prey which feed on rodents, lizards and small birds. The population of birds decreased in summer due to shortage of food and water in non-irrigated area of Thal and increased in irrigated area due to local shifting of birds. Purple Sunbird was observed from April to July in the study area. Roberts (1992) described that it is a winter migratory bird in desert from high mountain areas. Great grey shrike was observed throughout the year in the study area. It is particularly noticeable in Thal desert, in the Chagai desert and Makran coast (Roberts, 1992). Jackals,

Desert fox and Indian mongoose were recorded as natural enemies of Houbara bustards, Partridges, Rock pigeons, Doves and other grainivorous birds in the study area.

Table 1. Systematic List of Avifauna Observed at Thal Desert, District Jhang

Order	Family	Scientific Name	Common Name	Status*
Ciconiiformes	Ardeidae	Bubulcus ibis(LINNAEUS, 1758)	Cattle egret	R
		Egretta garzetta (LINNAEUS, 1766)	Little egret	R
		Ardeola grayii (SYKES, 1832)	Indian pond heron	R
Accipitriformes	Accipitridae	Elanus caeruleus(LATHAM, 1790)	Black winged kite	R
		Milvus migrans(SYKES, 1832)	Common Pariah kite	R
		Accipiter badius (TEMMINCK, 1824)	Indian sparrow hawk	R
Falconiformes	Falconidae	Falco tinnunculus (LINNAEUS, 1758)	Eurasian kestrel	WV
		Falco chicquera (DAUIN, 1800)	Red-headed merlin	R
		F. jugger (J. E. GREY, 1834)	Laggar falcon	R
		F. peregrinus (SUNDEVALL, 1837)	Peregrine falcon	WV
Galliformes	Phasianidae	Francolinus pondicerianus (GMELIN, 1789)	Grey partridge	R
		Coturnix coturnix (LINNAEUS, 1758)	Common Quail	OM
		Chlamydotus undulata macqueenii (J. E. GREY, 1832)	Houbara bustard	WV
Charadriiformes	Charadriidae	Hoplopterus indicus (BODDAERT, 1783)	Red-wattled lapwing	R
Columbiformes	Columbidae	Columba livia (STICKLAND, 1844)	Rock pigeon	R
		Streptopelia decaocto (FRIVALDSZKY, 1838)	Ring dove	R
		S. tranquebarica (HARMANN, 1804)	Red turtle dove	SB
		S. senegalensis (GMELIN, 1789)	Little brown dove	R
Psittaciformes	Psittacidae	Psittacula krameri (NEUMANN, 1915)	Rose-ringed parakeet	R
Cuculiformes	Cuculidae	Clamator jacobinus (SPARRMAN, 1786)	Pied crested cuckoo	SB
		Centropus sinensis (STRESEMANN, 1913)	Crow pheasant	R
		Eudynamis scolopacea (LINNAEUS, 1758)	Koel	SB
Strigiformes	Strigidae	Athene brama (TEMMINCK, 1825)	Spotted little owl	R
			White-throated kingfisher	R
Coraciiformes	Alcedinidae	Halcyon smyrnensis (LINNAEUS, 1758)		R
	Meropidae	Merops orientalis (NEUMANN, 1910)	Little green bee-eater	R
		M. supercilliosus (PALLAS, 1773)	Persian bee-eater	SB
	Coraciidae	Coracias benghalensis (LINNAEUS, 1758)	Indian roller	R
	Upupidae	Upupa epops (LINNAEUS, 1758)	Hoopoe	R
Piciformes	Picidae	Dinopium benghalense (BLYTH, 1849)	Golden-backed woodpecker	R
Passeriformes	Alaudidae	Galerida cristata (FRANKLIN, 1831)	Crested lark	R
		Alauda arvensis (LINNAEUS, 1758)	Sky lark	WV
	Hirundinidae	Hirundo rustica (LINNAEUS, 1758)	Common swallow	WV
	Motacillidae	Motacilla flava (PRZEVALSKI, 1887)	Yellow wagtail	WV
		M. alba (SYKES, 1832)	White wagtail	R
	Pycnonotidae	Pycnonotus cafer (LINNAEUS, 1766)	Red-vented bulbul	R
	Turdidae	Phoenicurus ochrurus (MOORE, 1854)	Black redstart	WV
		Saxicola caprata (SYKES, 1832)	Pied bush-chat	R
		Oenanthe desertii (TEMMINCK, 1825)	Desert wheatear	WV
	Sylviidae	Acrocephalus melanopogon (TEMMINCK, 1825)	Moustached warbler	WV
		Sylvia nana (HEMPRICH & EHRENBERG, 1833)	Desert warbler	WV
		Phylloscopus collybita (BLYTH, 1843)	Brown chiffchaff	WV
	Timaliidae	Turdoides caudatus (DUMONT, 1823)	Common babbler	R
T. earlei (BLYTH, 1844)		Striated babbler	R	
T. striatus(TIGEHURST, 1920)		Jungle babbler	R	
Nectariniidae	Nectarinia asiatica (LATHAM, 1790)	Purple-sunbird	SB	
Lanidae	Lanius excubitor (SYKES, 1832)	Great grey shrike	R	
	L. schach (VIGORS, 1831)	Rufous backed shrike	R	
Dicruridae	Dicrurus macrocercus (KOELZ, 1954)	Black drongo	R	
Corvidae	Corvus splendens (VIELLOT, 1817)	House crow	R	
	C. corax (LINNAEUS, 1758)	Raven	R	
Sturnidae	Sturnus vulgaris (VIELLOT, 1878)	Common starling	WV	
	S. roseus (LINNAEUS, 1758)	Rosy starling	WV	
	Acridotheres tristis (LINNAEUS, 1766)	Common myna	R	
	A. ginginianus (LATHAM, 1790)	Bank myna	R	
Passeridae	Passer domesticus (JARDINE & SELBY, 1835)	House sparrow	R	

* R= Resident, WV= Winter visitor, OM=Ordinary migrant and SB= Summer breeder

Table- 2 Month-wise Estimated Population of Avifauna of Thal Area Of District Jhang

Sr	Name of Species	December 2007	January 2008	February 2008	March 2008	April 2008	May 2008	June 2008	July 2008	August 2008	September 2008	October 2008	November 2008	Total	%
1	Bank Myna	15630	14940	12650	3320	4420	13494	14259	15794	12972	11835	11697	13512	144523	5.67
2	Black drango	5460	5850	4610	7644	8090	3037	6988	3867	8064	8316	14350	12100	88376	3.47
3	Black red start	273	276	0	0	0	0	0	0	0	0	608	664	1821	0.07
4	Black winged kite	0	0	0	124	0	0	0	0	498	456	452	207	1737	0.07
5	Brown chuffchaff	498	830	550	0	0	0	0	0	0	249	3320	0	5447	0.21
6	Cattle egret	14380	11130	11750	1853	1459	10560	13030	15491	12369	11694	9270	7843	120829	4.74
7	Common babbler	3589	4042	3237	2763	3596	8430	8786	10922	6083	10507	12890	6640	81485	3.20
8	Common myna	64920	77585	78680	52976	14660	22890	35233	38670	42388	42595	48450	48650	567697	22.26
9	Common pariah kite	577	312	958	0	0	0	0	240	0	138	228	166	2619	0.10
10	Common quail	996	1023	913	0	0	0	0	0	166	6847	435	332	10712	0.42
11	Common starling	11827	11412	17720	0	2697	0	0	0	0	0	0	2080	45736	1.79
12	Common Swallow	2490	954	7710	0	0	0	0	0	0	0	0	0	11154	0.44
13	Crested lark	13165	22484	12050	17629	2490	0	0	0	9037	13935	13695	12790	117275	4.60
14	Crow pheasant	830	830	830	415	0	0	1660	373	1037	375	207	6557	226	0.26
15	Desert warbler	1626	3071	4630	2971	0	0	0	0	0	0	0	0	12298	0.48
16	Desert wheater	1245	2213	1520	747	0	0	0	0	1214	4274	5350	4005	20568	0.81
17	Eurasian Kestrel	41	133	166	0	0	0	0	0	0	0	0	0	340	0.01
18	Golden-backed woodpecker	0	166	0	415	0	175	580	0	304	0	649	691.6	2980.6	0.12
19	Grey partridge	166	166	173	352	320	0	207	0	41	298	41	83	1847	0.07
20	Great Grey shrike	1106	415	0	788	2900	0	0	5835	484	0	1106	691	13325	0.52
21	Houbara bustard	193	373	129	0	0	0	0	0	0	0	41	96.7	832.7	0.03
22	Hoopoe	484	854	608	0	1660	830	0	415	1964	2490	2766	2627	14698	0.58
23	House crow	15140	13141	11750	4119	8520	1585	3923	12483	12284	17396	10270	17190	127801	5.01
24	House sparrow	71540	33855	30020	50331	40047	42280	41997	52862	34310	49567	37075	55361	539245	21.15
25	Indian roller	4191	9142	5450	3690	3330	3759	5778	3461	10694	5830	4879	6526	66730	2.62
26	Indian Sparrow hawk	581	373	608	415	41	0	146	138	0	166	276	207	2951	0.12
27	Jungle babbler	2489	3043	0	1037	968	990	0	0	15449	2490	0	0	26466	1.04
28	Koel	0	0	0	0	444	442	332	0	0	0	0	0	1218	0.05
29	Laggar falcon	33	0	36	0	0	0	0	83	34	41	36	0	263	0.01
30	Little brown dove	691	498	691	466	0	550	0	1245	1186	622	0	670	6619	0.26
31	Little egret	0	0	0	0	0	2250	2600	1734	6641	2672	474	0	16371	0.64
32	Little green bee-eater	2950	2348	4287	8134	6200	8723	10242	11786	3229	5229	2805	4412	70345	2.76
33	Moustached warbler	1383	553	0	0	0	0	0	0	0	0	622	0	2558	0.10
34	Peregrine Falcon	33	36	67	0	0	0	0	0	0	0	0	0	136	0.01
35	Persian bee-eater	0	0	0	0	0	3560	5429	4913	7967	2041	0	0	23910	0.94
36	Pied bush chat	1576	3490	1190	7677	0	481	0	0	1383	830	1245	2213	20085	0.79
37	Pied crested cuckoo	0	0	0	0	0	830	1660	0	415	207	0	0	3112	0.12
38	Pond heron	0	0	0	0	0	2075	3808	4697	2102	2955	1100	0	16737	0.66
39	Purple sunbird	0	0	0	1660	830	1660	1106	0	0	0	0	0	5256	0.21
40	Raven	408	0	0	688	166	0	124	0	0	415	421	332	2554	0.10
41	Red-headed merlin	33	37	0	42	0	0	269	0	554	257	0	0	1192	0.05
42	Red turtle dove	0	0	0	2420	0	435	0	340	373	0	0	0	3568	0.14
43	Red vented bulbul	2540	3527	1548	2213	276	3253	2656	5685	691	830	829	2210	26258	1.03
44	Red wattled lapwing	9660	8109	4789	3959	1419	8220	8158	6922	8490	8947	7557	7347	83577	3.28
45	Ring dove	3314	1880	1253	456	2628	1058	433	6117	7660	6274	6440	6596	44109	1.73
46	Rock pigeon	4482	2822	3650	0	539	1010	0	0	175	581	645	68.7	13972.7	0.55
47	Rose ringed parakeet	2317	1779	1692	350	341	206	0	276	0	1660	581	1079	10281	0.40
48	Rosy starling	1490	2766	0	1660	0	0	0	0	0	0	1037	0	6953	0.27
49	Rufous backed shrike	415	581	0	1245	0	207	747	415	0	755	0	0	4365	0.17
50	Sky lark	2697	4150	2900	0	0	0	0	0	2163	1660	1715	2268	17553	0.69
51	Spotted owl	0	553	830	0	474	0	830	0	0	0	830	0	3517	0.14
52	Striated babbler	0	1660	2320	1933	0	3730	0	2490	0	0	664	691.6	13488.6	0.53
53	White breasted kingfisher	0	402	0	4980	415	0	0	1477	2489	688	166	415	11032	0.43
54	White Wagtail	14410	11365	19990	6249	0	2448	968	1311	0	4664	18716	13270	93391	3.66
55	yellow wagtail	2046	4426	0	0	0	0	0	0	0	0	2665	2610	11747	0.46
Total Estimated Population		283915	269595	251955	194061	109760	148338	170843	212435	214246	231448	226771	236852	2550219	
%		11.13	10.57	9.88	7.61	4.30	5.82	6.70	8.33	8.40	9.08	8.89	9		100
Total Species															

Table 3. Month-wise comparison of means of estimated population of avifauna of Thal Desert

Months	Mean±SE
December, 2008	5162.09±1770.79 A
January, 2009	4901.73±1583.84 A
February, 2009	4581.00±1584.70 AB
March, 2009	3528.38±1337.49 ABCD
April, 2009	1995.64±791.42 D
May, 2009	2697.05± 918.28 CD
June, 2009	3106.24±1047.69 BCD
July, 2009	3862.45±1246.78 ABC
August, 2009	3895.38±1073.53 ABC
September, 2009	4208.15±1239.22 ABC
October, 2009	4123.11±1192.37 ABC
November, 2009	4306.39±1384.63 ABC

Table 4. Seasonal and species-wise One factor Randomized Complete Block Design analysis of estimated population of Avifauna of Thal Desert

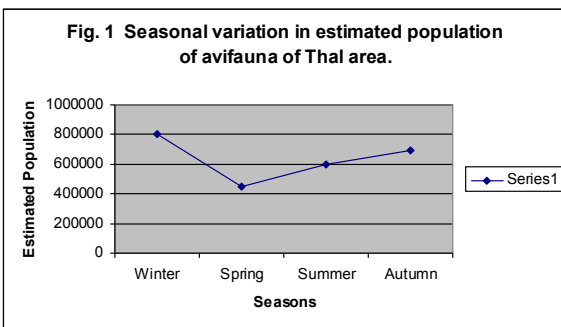
Source	Degree of Freedom	Mean Square	F Value	Prob
Season	3	408946249.491	4.3542	0.0056
Species	54	2821548627.642	30.0417	0.0000
Error	162	93921002.192		

Table 5. Comparison of means by DMR-test for seasonal variations for the estimated population of avifauna of Thal Desert

Seasons	Mean \pm SE
Winter	14644.82 \pm 4801.34 A
Spring	8221.07 \pm 2905.82 B
Summer	10864.07 \pm 3280.20 AB
Autumn	12637.67 \pm 3763.97 A

Table 6. Simpson's Diversity Index Showing seasonal values for avifauna of Thal Desert

Simpson's diversity index	Winter	Spring	Summer	Autumn
(D)	0.12	0.14	0.11	0.11
(1-D)	0.88	0.86	0.89	0.89



Conclusion and suggestion for management

It was concluded that the population of avifauna of the area is drastically decreasing due to illegal hunting carried out mostly by wealthier people, who live within the vicinity, high ranked officers and who have sufficient influence to escape retribution. Houbara bustard is hunted by Arab Dignitaries under special permits issued by the Federal Government of Pakistan. Illegal netting of Quails, Common Mynas, Bank Mynas, Babblers, Common Starling, Rosy Starling, Grey Partridges, Doves and Parakeets is carried out in the area on a large scale. The birds are caught from the wild both as adults and chicks. The caught birds are sold in the markets of the big cities. The netting of these birds is highly paying because many of these species have entered the food dishes. High demand, good price and quick disposal of catch are the biggest incentives which add to the illegal hunting practices. Tree and bush cutting for fuel wood is a very common practice in the area due to which vegetation is being seriously exploited by local people. The area is also facing a shortage of protection staff. A few wildlife watchers without any weapons, which are insufficient for the huge area and unable to control illegal hunting, netting and poaching of wildlife.

In order to protect and conserve the avifauna and flora, it is suggested that illegal hunting and netting should be strictly controlled through deployment of

reasonable number of well equipped and communicated staff along with transport facility. The Punjab Wildlife (Protection, Preservation, Conservation and Management) Act 1974 must be enforced strictly and illegal hunters / netters should be punished very strictly by the court. There should be a complete ban on hunting of Houbara bustard for at least five years. Conservation issues of a long-distance migrant species like Houbara bustard should be addressed at a broader scale through an international collaboration between Central Asian countries, from the breeding grounds of China to the wintering grounds of the Pak-Indo subcontinent. Information boards of the Game Reserve indicating boundaries, warning against hunting / netting of wildlife should be fixed at the entry points and in the Game Reserve area. Habitat of the area should be protected by controlling vegetation exploitation. The natural habitat of the area should be improved through reseedling of natural vegetation and rising of the plantation. Public awareness about the local environmental problems should be promoted through publicity campaigns, brochures, boards, etc. at the local level. Community based organizations should be involved in the management of the area.

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