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Avifaunal Diversity And Anthropogenic Threats To Wetland Gamela Pond, Sagwara, Dungarpur, Rajasthan.

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Abstract

The present research was conducted to assess the anthropogenic impacts on avian diversity around the wetland of Gamela pond, Sagwara, Rajasthan. A total of 94 bird species belonging to 40 families and 15 orders were documented from the wetland of Gamela pond using the point count method, transect method, and linear method, with the Shannon-Wiener index of 2.84, species richness of 5.07, and evenness of 0.77. RDi for Ardeidae and Phasianidae were 7.44, indicating that these were dominant families. Birds use wetlands for breeding, roosting, nesting and foraging. Order Passeriformes had the highest number of families, while order Pelecaniformes showed the highest count of birds. 88 species recorded from the study areas were in the least Concern (LC) category (94%), four species (4%) were Near Threatened (NT), and 2 species were Vulnerable. The four Near Threatened species were Black-headed Ibis, Oriental Darter, Black-tailed godwit, and Painted Stork, while Woolly-necked stork and River tern were vulnerable species.

Keywords: - Wetland Gamela pond, Avian diversity, Shannon-Wiener, Anthropogenic threat.

Introduction

Wetlands are defined as a bridge between aquatic and terrestrial ecosystems, where the water table generally at or near the land's surface is encompassed by shallow water (Mitsch and Gosselink, 1986). Wetlands are highly productive and biologically unique in the world but have very delicate ecosystems. India has around 67,429 wetlands, covering an area of about 4.1 million hectares. Out of these, 2,175 are natural, and 65,254 are human-made. Wetlands in India (excluding rivers)

account for 18.4% of the country's geographic area, of which 70% is under paddy cultivation (MoEF, 1990; Parekh and Gadhvi, 2013). Wetlands furnish a home for a considerable diversification of wildlife such as mammals, fish, birds, insects, frogs, and plants (Buckton, 2007).

Wetland degradation, deprivation, and interference affect wetland-dependent animal and plant species (Woldemariam *et al.*, 2018). Wetlands give economic and ecological services like food and water source for domestic animals, water supply and purification, fish supply, climate change regulation, leisure values, and medicinal plants (Houlahan *et al.,* 2006; Asefa *et al.,* 2015). Wetlands and water birds are inseparable elements, and they form a wealthy arrangement of waterbird communities (Grimmett and Inskipp, 2007).

Waterbirds are closely related to the freshwater and marine environment and play a significant role in ecosystem health (Ogden *et al.*, 2014) and work as a source of amusement proceeds (Carver, 2009). Bird species composition and diversity change with wetland habitat structures, area, and adjacent land use alteration. Information on bird and plant species of a particular wetland is beneficial to understand the habitat condition and design suitable conservation strategies for sustainable biodiversity conservation. Wetlands are one of the most fertile ecosystems in the world (Kumar and Gupta, 2009). They give significant flood control functions, erosion control, nutrient absorption, and aquifer recharge (Kumar and Gupta, 2009). They also provide habitats for a considerable number of flora and fauna (Buckton, 2007). The large numbers of invertebrates present in the mud provide food for many migratory waterbirds (www.Ramsar.org).

Birds are the best indicators of any ecosystem's environmental quality; several ecological factors directly influence the birds' population. Availability of food, detestability, capture, location of nesting sites, availability of nesting materials, presence of predators, and competitors are the major factors influencing the foraging and breeding of birds and their population (Ali and Ripley, 1983).

Numerous studies related to avifaunal diversity and its status have been conducted in different wetlands, Rajasthan but few studies have been carried out on distribution diversity and status of birdlife in this area (Koli *et al*., 2011; Thapa and Saund, 2012; Koli *et al*., 2013; Koli, 2014, Bhatnagar and Shekhawat, 2014 and Viehberg and Pienitz, 2017).

Fig.1 – Study area.

Materials And Methods

Study Area

The Gamela pond is located between 23°40'5N - 23°68'N latitude and 74°1'28' E - 74°024'E longitude. The pond is about 8.9667 ha, situated near Gamerashwar Temple and beside National highway 927A (Ratlam-Swaroopganj). This wetland provides water for irrigation to the surrounding agricultural fields of Patelwara Sagwara, washing clothes, culturing fish, and drinking water to cattle from the nearby area (Fig. 1).

Methods

Fieldwork was conducted on foot from February 2019 to February 2020 across the Gamela pond (Simpson 1949; Burnham *et al.,* 1980). The data on the diversity of various avian species were collected through the point count method, transect method and linear method. A total of 24 field visits (2 visits per month) were conducted to observe birds' status and diversity during this period. Birds were observed in the morning from 06:00 to 11:00 AM and in the evening from 16:00 to 19:00 PM. These birds were identified using Olympus binoculars (10x50) and field guides (Ali & Ripley 1983; Grimmett *et al.,* 2001), and standardized common and scientific names are as per Pande *et al*. 2016 and Praveen *et al.* 2016. The birds are grouped under three categories, namely LM - Local migrants, WM - winter migrants, and R- Residents, depending on their timing and duration of occurrence (Table 1).

Results And Discussion

A total of 94 bird species from 40 families and 15 orders were identified in the study. Breeding,

Table-1: Avian order, family, common and scientific names, bird count and IUCN status is shown of Gamela pond.

FAMILY	COMMON NAME	SCIENTIFIC NAME	No. OF BIRDS FOUND	Status
Accipitridae	Shikra	*Accipiter badius*	6	LC, R
	Kite	*Milvus migrans*	3	LC, R
Acridotheres	Common myna	*Acridotheres*	21	LC, R
Alcedinidae	Common Kingfisher	*Alcedo atthis*	5	LC, R
Anatidae	Lesser Whistling-Duck	*Dendrocygna javanica*	178	LC, R
	Indian Spot-billed Duck	*Anas poecilorhyncha*	7	LC, WM
	Garganey	*Spatula querquedula*	9	LC, WM
	Knob-billed Duck	*Sarkidiornis melanotos*	4	LC, LM
	Common Pochard	*Aythya ferina*	16	LC, WM
	Greylag goose	*Anser anser*	10	LC, WM
Anhingidae	Oriental Darter	*Anhinga melanogaster*	9	NT, M
Apodidae	House swift	*Apus nipalensis*	39	LC, R
Ardeidae	Gray Heron	*Ardea cinerea*	8	LC, R
	Purple Heron	*Ardea purpurea*	8	LC, LM
	Great Egret	*Ardea alba*	27	LC, R
	Intermediate Egret	*Ardea intermedia*	12	LC, R
	Little Egret	*Egretta garzetta*	128	LC, R
	Cattle Egret	*Bubulcus ibis*	278	LC, R
	Indian Pond-Heron	*Ardeola grayii*	18	LC, R
Charadriidae	Lapwing	*Vanellinae*	12	LC, R
	Little-ringed Plover	*Charadrius dubius*	19	LC, R
Ciconiidae	Asian Openbill	*Anastomus oscitans*	8	LC, R
	Painted Stork	*Mycteria leucocephala*	200	NT, R
	Woolly-necked stork	*Ciconia episcopus*	6	VU, LM
Cisticolidae	Common tailorbird	*Orthotomus sutorius*	6	LC, R
	Ashy prinia	*Prinia socialis*	24	LC, R
	Grey-breasted Prinia	*Prinia hodgsonii*	8	LC, R
Columbidae	Rock Pigeon	*Columba livia*	12	LC, R
Coraciidae	Indian Roller	*Coracias benghalensis*	7	LC, R
Corvidae	House crow	*Corvus splendens*	5	LC, R
	Large billed crow	*Corvus macrorhynchos*	3	LC, R
Cuculidae	Greater Coucal	*Centropus sinensis*	8	LC, R
	Pied Cuckoo	*Clamator jacobinus*	3	LC, R
	Common cuckoo	*Cuculus canorus*	4	LC, R

FAMILY	COMMON NAME	SCIENTIFIC NAME	No. OF BIRDS FOUND	Status
	Common Hawk-cuckoo	*Hierococcyx varius*	3	LC, R
	Asian koel	*Eudynamys scolopaceus*	5	LC, R
Dicruridae	Black Drongo	*Dicrurus macrocercus*	25	LC, R
	White drongo	*Dicrurus caerulescens*	8	LC, R
Emberizidae	Grey-necked Bunting	*Emberiza buchanani*	9	LC, LM
	House Bunting	*Emberiza sahari*	15	LC, M
Estrildidae	Indian Silverbill	*Euodice malabarica*	34	LC, R
	Scaly-breasted munia	*Lonchura punctulata*	4	LC, R
Hirundinidae	Dusky crag martin	*Ptyonoprogne concolor*	17	LC, R
	Wire-tailed swallow	*Hirundo smithii*	7	LC, R
	Streak-throated swallow	*Petrochelidon fluvicola*	5	LC, R
Jacanidae	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	13	LC, R
	Bronze-winged Jacana	*Metopidius indicus*	30	LC, R
Laniidae	Bay-backed Shrike	*Lanius vittatus*	5	LC, R
	Long-tailed Shrike	*Lanius schach*	4	LC, R
	Great Gray Shrike	*Lanius excubitor*	7	LC, R
	Isabelline Shrike	*Lanius isabellinus*	19	LC, M
Laridae	River Tern	*Sterna aurantia*	8	VU, R
Leiothrichidae	Jungle Babbler	*Turdoides striata*	29	LC, R
	Large grey babbler	*Turdoides malcolmi*	28	LC, R
Meropidae	Green Bee-eater	*Merops orientalis*	2	LC, R
	Bee-eater	*Meropogon forsteni*	12	LC, R
Motacillidae	White-browed wagtail	*Motacilla maderaspatensis*	8	LC, R
	Western yellow wagtail	*Motacilla flava*	5	LC, WM
	Citrine wagtail	*Motacilla citreola*	7	LC, WM
	Tree pipit	*Anthus trivialis*	8	LC, R
Nectariniidae	Purple sunbird	*Cinnyris asiaticus*	5	LC, R
	Purple rumped sunbird	*Leptocoma Zeylonica*	8	LC, R
Passeridae	House sparrow	*Passer domesticus*	18	LC, R
	Rock sparrow	*Petronia*	7	LC, R
Phalacrocoracidae	Little Cormorant	*Microcarbo niger*	200	LC, R
	Great Cormorant	*Phalacrocorax carbo*	10	LC, LM
	Indian cormorant	*Phalacrocorax fuscicollis*	42	LC, R
Phasianidae	Common Quail	*Coturnix coturnix*	13	LC, R
	Rain Quail	*Coturnix coromandelica*	9	LC, R

FAMILY	COMMON NAME	SCIENTIFIC NAME	No. OF BIRDS FOUND	Status
	Black Francolin	*Francolinus francolinus*	3	LC, R
	Painted Francolin	*Francolinus pictus*	3	LC, R
	Gray Francolin	*Francolinus pondicerianus*	5	LC, R
	Gray Junglefowl	*Gallus sonneratii*	2	LC, R
	Indian Peafowl	*Pavo cristatus*	16	LC, R
Ploceus	Baya weaver bird	*Ploceus philippinus*	3	LC, R
Podicipedidae	Little grebe	*Tachybaptus rufficollis*	9	LC, LM
Rallidae	Purple Moorhen	*Porphyrio porphyrio*	24	LC, R
	Common moorhen	*Gallinula chloropus*	21	LC, R
	Eurasian Coot	*Fulica atra*	27	LC, M
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	4	LC, R
Rhipiduridae	White-browed fantail	*Rhipidura aureola*	6	LC, LM
Scolopacidae	Ruff	*Calidris pugnax*	5	LC, R
	Common Sandpiper	*Actitis hypoleucos*	19	LC, R
	Sandpiper	*Scolopacidae*	13	LC, R
	Black-tailed godwit	*Limosa limosa*	12	NT, WM
Sturnidae	Pied myna	*Gracupica contra*	11	LC, R
	Brahminy myna	*Sturnia pagodarum*	9	LC, R
Sylviidae	Lesser whitethroat	*Curruca curruca*	7	LC, R
Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	178	LC, R
	Black-headed Ibis	*Threskiornis melanocephalus*	43	NT, R
	Eurasian Spoonbill	*Platalea leucorodia*	8	LC, R
Upupidae	Eurasian Hoopoe	*Upupa epops*	3	LC, R
Vangidae	Common woodshrike	*Tephrodornis pondicerianus*	14	LC, R
Zosteropidae	Oriental white eye	*Zosterops palpebrosus*	4	LC, R

(Abbreviations – R = resident, M = migratory, LW = local migratory and WM = winter migratory)

roosting, nesting, and foraging were all done in wetlands by birds.

Among the 94 species, 88 species recorded from the study were of Least Concern (LC) (94%), four species (4%) were Near Threatened (NT), and 2 species were Vulnerable (V). The four Near Threatened species were Black-headed ibis, Oriental darter, Black-tailed godwit, and Painted Stork, while Woolly-necked stork and River tern were vulnerable species. Shannon-Wiener index was 2.84, species richness was 5.07, and evenness was 0.77. RDi showed that Ardeidae and Phasianidae were 7.44 (Fig. 3). Order Passeriformes had the highest number of families, while order Pelecaniformes showed the highest count of birds (Fig. 2).

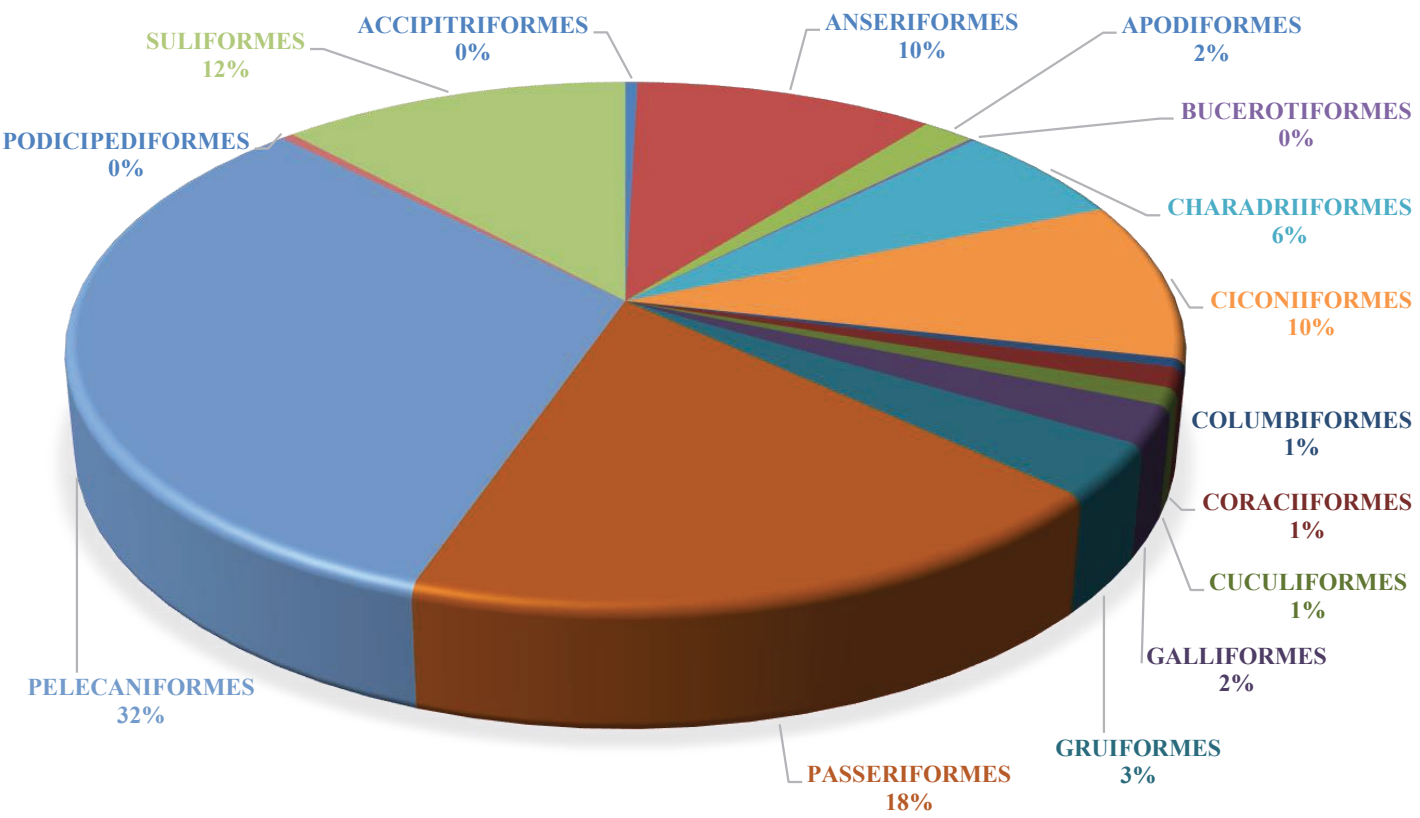

Fig. 2 - Shows avian diversity of various order.

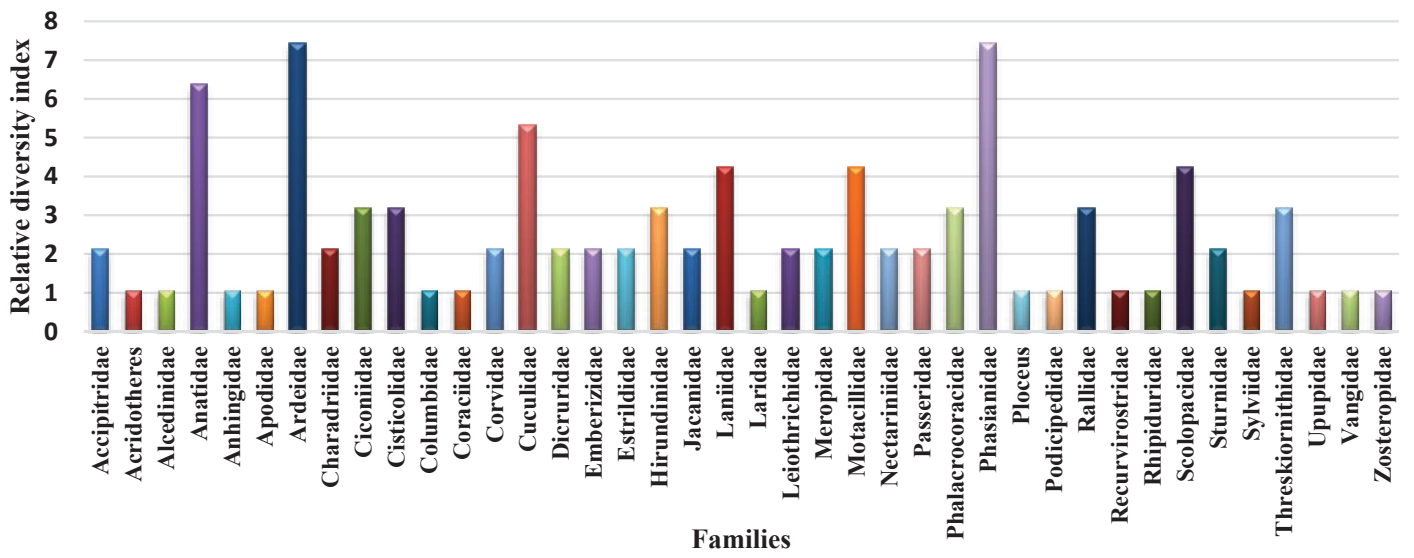

Fig. 3 - Relative Diversity (RDi) of various aviafunal families.

Wetland birds are diverse in their feeding habits (Ali & Ripley 1987). These water birds consume different wetland habitats and extensively depend on a mixture of microhabitats for their continued existence. In the present study, irrigated agricultural fields surrounding the pond and small island provided shelter and suitable foraging grounds, nesting and roosting on the developing and fringed undergrowth for the wetland bird.

A total of 133 avifauna species were identified, including 80 residents and 53 migratory species in Kopra wetland, Chhattisgarh. (Vishwakarma *et al.,* 2021). During the study, 124 species from 52 families were identified, including 69 non-passerine species and 55 passerine species (Khan *et al.,* 2021). This pond is a leading water source for recharging the surrounding bore-wells and agricultural fields. Migratory species were observed during the research. Throughout the year, resident birds were spotted. The majority of the winter migrants arrived between October and November and lasted until March. Anthropogenic activities such as cattle grazing, deforestation (for timber, fiberwood, and urbanization), washing clothes, lighting, noise production, and fishing had a negative impact on the bird population (McLellan and Shackleton, 1988; Anderson *et al.*, 1990). Unchecked foraging, increasing nest predation, and decreasing wildlife densities are common anthropogenic threats (Burger, 1981, 1986; Evington and Evington, 1986; Skagen *et al.*, 1991; Strang, 1980; Safina and Burger, 1983; Piatt *et al.,* 1990; Werschkul *et al.*, 1986; Ervin, 1980; Madsen, 1985). These anthropogenic threats were also observed in the area of the Gamela pond wetland. Anthropogenic disturbances also act in other ways, increasing nesting failures (Boeker and Ray, 1981) and reducing the viability of fledglings (Korpimaki and Lagerstrom, 1988).

As this wetland is located adjacent to the national highway (Swaroopganj-Ratlam), heavy vehicle movement is one of the primary disturbances to the birds. Frequent cleaning of vehicles, cattle bathing, and grazing disturb the avifauna. Habitat degradation due to agricultural land expansion, lower water retention for an extended period, and less availability of food resulted in reduced avifaunal diversity of the wetland area. The highest species richness and density were recorded during the winter months when there were fewer anthropogenic activities

The present bird checklist comprises 94 species from 15 orders, 40 families. The total count of birds was 2189; out of these 2001 are residents (Shannon-Wiener index was 3.36, species richness was 9.867 and evenness was 0.77), 70 are migratory (Shannon-Wiener index was 1.32, species richness was 0.70, and evenness was 0.94), 52 are local migrants (Shannon-Wiener index was 1.90, species richness was 1.52 and evenness was 0.98) and 66 are winter migratory (Shannon-Wiener index was 1.88, species richness was 1.43 and evenness was 0.96).

Conclusion

The present bird checklist comprises 94 species from 15 orders and 40 families. 88 species recorded from the study were of Least Concern (LC), 4 species were Near Threatened (NT), and 2 species were Vulnerable (V). The four Near Threatened species were Black-headed ibis, Oriental Darter, Black-tailed Godwit, and Painted Stork, while Woolly-necked Stork and River Rern were vulnerable species. Shannon-Wiener index was 2.84, species richness was 5.07, and evenness was 0.77. The total count of birds was 2189; out of these, 2001 are residents, 70 are migratory, 52 are local migrants, and 66 are winter migratory.

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Ephippiorhynchus asiaticus

Porphyrio poliocephalus

Himantopus himamtopus

Ardea purpurea

Anastomus oscitans

Grus antigone

Halcyon smyrnensis

Merops orientalis

Plate – 1

Wintering Piscivorous birds of Porbandar district, Gujarat face pesticide threat

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Abstract
Pesticide poisoning is a growing threat to waterbirds, notably piscivorous birds. Fishes are indicators of environmental contamination because they concentrate pollutants in their tissues. Wintering populations of piscivorous birds were studied in 23 wetlands in the Porbandar area of Gujarat, India, from 2015 to 2021, using standard waterbird counting procedures. Pesticide residue analysis was also performed in the liver tissues of piscivorous birds found dead from kite flying injury, and also from fish species captured from the Mokarsagar Wetland Complex in Porbandar. There were 45 species of piscivorous waterbirds from a total of 145 waterbird species recorded. Of the 45 species, 13 had more than 1% biogeographic population at least once in seven years. In the LC-MS/MS, all bird and fish samples were analysed for 230 pesticides. Indoxacarb (0.012 ppm) was found in Great Egret, while Oxadiazon (0.0233 ppm) and Indoxacarb (0.015 ppm) were found in Indian Pond Heron. Indoxacarb and Oxadiazon were found in five fish species, whereas Amectotradin was found in four fish species and Imidacloprid was found in one fish species. *Sardonella longiceps* had the highest concentration of Oxadiazon (0.298 ppm) which is higher than ARfD of Oxadiazon to pose a health risk to human consumers and birds. It is recommended that pesticides other than HCH, OCP, and DDT derivatives should be monitored in future studies and strict control should be exercised through policy changes on indiscriminate use of pesticides.

Keywords
Fish; fish-eating birds; Mokarsagar; Indoxacarb, Oxadiazon; Amectotradin; Imidacloprid; *Sardonella longiceps*; feeding guild

Introduction

Waterbirds in Asia include increasing number of threatened species, many of which are on the verge of extinction. Conservation of these species and their habitats needs to be based on current information on their distribution and trends (Mundkur et al. 2017).

Pesticides and insecticides (organophosphorus and carbamate) are a well-known direct threat to bird species, and they can also affect their diet and habitat indirectly (Gupta 2004). Due to long half-life and slow decomposition rate, pesticides remain in the ecosystem including as sediments of the wetland basins and retain their hazardous effects for very long time which may severely harm the wildlife and other forms of biodiversity (Muralidharan 2000). To take advantage of easy water availability, many agricultural fields are located near fresh water inland wetlands. Due to heavy use of pesticides, their agricultural runoff caries pesticide residues into the wetland.

Waterbirds including piscivorous birds are under growing threat of pesticide toxicity. There are recent records of mortality of these birds due to phosphamidon poisoning at Anna Zoological Park, Chennai; and Sitarganj Forest Range, Uttarakhand due to Chorpyrifos poisoning. Moreover, intentional pesticide poisoning of herons using carbofuran pesticides has been recorded at Virundunagar, Tamil Nadu (Muralidharan et al. 2014). Pesticides are also traced from the eggshells of colonial piscivorous birds of Keoladeo National Park wetland complex (a Ramsar Site from Rajasthan, India), and Dialdrin was found in higher concentration in eggs of cormorants, herons, egrets and storks in various levels (1.52 to 5.95 ppm) (Dhananjayan and Ravichandran 2014).

During the breeding season, wetlands provide breeding and feeding opportunities for a large number of piscivorous birds. Unfortunately, pesticides accumulate in these habitats, posing a threat to reproduction and species survival, because fish concentrate pesticides in their tissues directly from the water; hence, fish can be used as sentinels and best indicators of environmental contamination (Samidurai et al. 2019).

The Sowing window of major Rabi crops like wheat and gram is between October to November of any year. This is the time when many of the migratory waterbirds visit the wetlands of Porbandar. To preserve the seeds from termites and other insects, many times farmers treat the seeds with pesticides prior to sowing day as seed treatment (Vargiya et al. 2016). Despite the fact that pesticide regulations exist in India, Indian wetlands and other habitats are already contaminated with pesticides and major work is yet to be done on this aspect (Muralidharan 1993; (Muralidharan 2000; (Muralidharan et al. 2004; (Muralidharan et al. 2008; (Muralidharan et al. 2009). Wetlands around Porbandar are good waterbird habitats but agriculture is practiced in during winter to summer when water levels dip, posing a major threat to waterbirds and wetlands from pesticide concentration (Vargiya et al. 2016).

Publications often focus on wintering population of waterbirds, pesticide residual analysis in fish and pesticide residual analysis in waterbirds separately. An attempt has been made in this paper to combine these three important research aspects in a single publication.

Methodology

During the months of January and February every year, from 2015 to 2021 wintering population of the piscivorous birds was studied in 23 wetlands of Porbandar district of Gujarat state of India. The study area has been already described (Varagiya and Chakraborty 2019). Standard waterbird counting techniques and counting period were followed for the determination of the wintering population (Wetlands International 2018; (Wetlands International South Asia 2020). The 1% biogeographic population was accessed from (Wetlands International 2012) while IUCN status was accessed from (IUCN 2021). The fish as a food preference of a waterbird was confirmed from (Ali and Ripley 1974). The status and distribution of the species in Gujarat is from (Ganpule 2016).

The Gujarat Forest Department granted the necessary permission prior to the sample collection. Many piscivorous birds become entangled in kite flying threads on January 14, each year, a kite flying day. The injury was made worse by the use of powdered glass to polish the threads. Various NGOs as well as individuals rescued injured piscivorous birds, and a veterinary doctor provided the veterinary care to the rescued birds. The study included liver tissues of the piscivorous

birds that died as a result of the injury. As the fish is the main diet of the piscivorous birds, fishes were caught with the help of a local fisherman from Karly area of Mokarsagar Wetland Complex, Porbandar and the edible muscle tissues were isolated for the pesticide residual analysis. Three samples each of six species of wetland fishes were analysed for pesticide residual analysis. The samples were wrapped in an aluminium foil and refrigerated at -8°C till the analysis. All bird and fish samples were screened for 230 pesticides in the LC-MS/MS (with minimum level of quantification of 0.01 ppm) using a method described by (Wang et al. 2010) for pesticide residual analysis.

Results and Discussion

1. Wintering Population of piscivorous birds

During 2015-2021, a total of 145 species of waterbirds were recorded out of which 45 species were of piscivorous waterbirds. A mean wintering population data (2015-2021) of piscivorous waterbirds is presented in Table 1 with species' 1% biogeographic population, and IUCN status.

Table 1. Wintering population of 45 piscivorous waterbirds recorded in Porbandar wetlands.

#	Species	1%	IUCN Status	Mean population (2015-2021)
1	Little Grebe (*Tachybaptus ruficollis*)	10000	LC	453
2	Great Crested Grebe (*Podiceps cristatus*)	250	LC	43.29
3	Slender-billed Gull (*Chroicocephalus genei*)	**1500**	LC	853.71
4	Black-headed Gull (*Chroicocephalus ridibundus*)	10000	LC	4927.57
5	Brown-headed Gull (*Chroicocephalus brunnicephalus*)	**1400**	LC	4786.86
6	Pallas's Gull (*Ichthyaetus ichthyaetus*)	10000	LC	739.14
7	Caspian Gull (*Larus cachinnans*)	-	LC	0.14
8	Heuglin's Gull (*Larus fuscus heuglini*)	-	LC	164.57
9	Steppe Gull (*Larus fuscus barabensis*)	-	LC	119.71
10	Little Tern (*Sternula albifrons*)	710	LC	14.14
11	Gull-billed Tern (*Gelochelidon nilotica*)	770	LC	185
12	Caspian Tern (*Hydroprogne caspia*)	710	LC	49
13	Whiskered Tern (*Chlidonias hybrida*)	1000	LC	455.86
14	Common Tern (*Sterna hirundo*)	-	LC	3
15	Indian River Tern (*Sterna aurantia*)	**710**	VU	516.29
16	Sandwich Tern (*Thalasseus sandvicensis*)	1100	LC	11.43
17	Lesser Crested Tern (*Thalasseus bengalensis*)	1600	LC	27.14
18	Indian Skimmer (*Rynchops albicollis*)	75	EN	3.29
19	Black Stork (*Ciconia nigra*)	100	LC	0.43
20	Woolly-necked Stork (*Ciconia episcopus*)	250	NT	9.14
21	White Stork (*Ciconia ciconia*)	25	LC	1
22	Painted Stork (*Mycteria leucocephala*)	**250**	NT	711.43
23	Oriental Darter (*Anhinga melanogaster*)	40	NT	24.14
24	Little Cormorant (*Microcarbo niger*)	**2500**	LC	1371.57
25	Great Cormorant (*Phalacrocorax carbo*)	1000	LC	86
26	Indian Cormorant (*Phalacrocorax fuscicollis*)	**300**	LC	424.71
27	Great White Pelican (*Pelecanus onocrotalus*)	**210**	LC	2547
28	Dalmatian Pelican (*Pelecanus crispus*)	**75**	NT	169.86
29	Great Bittern (*Botaurus stellaris*)	-	LC	0.71
30	Yellow Bittern (*Ixobrychus sinensis*)	-	LC	0.14
31	Grey Heron (*Ardea cinerea*)	1000	LC	102.71

32	Purple Heron (*Ardea purpurea*)	250	LC	53.86
33	Great Egret (*Ardea alba*)	**1000**	LC	1573.57
34	Intermediate Egret (*Ardea intermedia*)	1000	LC	91.29
35	Little Egret (*Egretta garzetta*)	1400	LC	524
36	Western Reef-Heron (*Egretta gularis*)	**170**	LC	277.43
37	Indian Pond-Heron (*Ardeola grayii*)	10000	LC	364.86
38	Striated Heron (*Butorides striata*)	250	LC	0.86
39	Black-crowned Night-Heron (*Nycticorax nycticorax*)	1200	LC	2
40	Black-headed Ibis (*Threskiornis melanocephalus*)	**250**	NT	529.29
41	Red-naped Ibis (*Pseudibis papillosa*)	**100**	LC	120.71
42	Eurasian Spoonbill (*Platalea leucorodia*)	**230**	LC	994
43	Common Kingfisher (*Alcedo atthis*)	-	LC	13.14
44	White-throated Kingfisher (*Halcyon smyrnensis*)	-	LC	35.29
45	Pied Kingfisher (*Ceryle rudis*)	-	LC	11.14

Where LC= Least Concern; NT= Near Threatened; VU= Vulnerable; EN= Endangered; and 1% population mentioned in bold denotes the species being recorded above that particular population at least once during 2015 to 2021. 1% biogeographic population of the species from Wetlands International 2012 is mentioned.

Out of 45 recorded waterbird species, 38 belonged to least concerned, five near-threatened (Woolly-necked Stork, Painted Stork, Oriental Darter, Dalmatian Pelican, and Black-headed Ibis), one vulnerable (Indian River Tern), and one endangered (Indian Skimmer) as per IUCN red-list category. A total of 13 piscivorous species (Slender-billed Gull, Brown-headed Gull, Indian River Tern, Painted Stork, Little Cormorant, Indian Cormorant, Great White Pelican, Dalmatian Pelican, Great Egret, Western Reef-Heron, Black-headed Ibis, Red-naped Ibis, and Eurasian Spoonbill) were recorded with more than 1% biogeographic population of the species at least at one wetland. The wintering population of these 13 species has been discussed below.

Slender-billed Gull is a common resident and winter migrant to Gujarat. The maximum count recorded in the present study was in 2019, at Javar wetland where 3000 birds were observed. These gulls were observed feeding on waste materials of the fish processing plants with other species of gulls, terns, and egrets. Gulls have been reported to scavenge on fish waste in large numbers (Yorio and Caille 2004). Charakla Saltworks, Gujarat; Lakhota Lake, Gujarat; and Point Calimere Sanctuary (Vedaranyam Swamp); Tamil Nadu supported 1% bio-geographic population of the species during AWC 2006-2015 in India (Wetlands International South Asia 2020). In fact, 2000 individuals were also reported in AWC from Great Rann of Kachchh (Flamingo City), Gujarat in the year of 1991 (Li et al. 2009).

Brown-headed Gull is a common winter visitor seen all over the Gujarat state. The highest number of this species in the present study was reported from Mokarsagar wetland in the year of 2019 where 5700 birds were observed. Mokarsagar and Javar supported 1% population three times each while Mendha Creek and Subhashnagar wetlands supported once each. During AWC 2006-2015 in India, 15 wetlands across India supported 1% bio-geographic population of the species (Wetlands International South Asia 2020). Chapora Estuary, Goa, India alone recorded 34,000 individuals in 2007 and Chilika Lake, Orissa supported 19,281 birds in 1996 (Li et al. 2009).

Indian River Tern is a common resident of Gujarat. The species is widely distributed in India but, population has been declining since last two decades (SoIB 2020). The peak count was 1490 individuals in 2016 at Mokarsagar. Pong Dam Bird Sanctuary, Himachal Pradesh and Chilika Lake, Odisha are the only sites where the species has been supported with 1% population during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Painted Stork is an uncommon to locally common resident of Gujarat. The 1% population was supported thrice at Mokarsagar (the highest count of 1643 at Mokarsagar in 2016) and once at Javar and Subhashnagar each. The species has very large

distribution range across India and the numbers are rising since last few years. It has been supported at 21 sites with 1% population during AWC 2006-2015 in India (SoIB 2020; (Wetlands International South Asia 2020).

Little Cormorant is a fairly common resident bird throughout Gujarat. In fact, the species is restricted to South and Southeast Asia. The 1% population was supported once at Mokarsagar in 2016 when 4058 individuals were recorded. During AWC 2006-2015 in India, the species has been recorded above 1% population at seven sites (Wetlands International South Asia 2020).

Indian Cormorant is a common resident in entire Gujarat. The 1% population has been supported twice at Mokarsagar (maximum count was 1188 in 2015) and once at Kuchhdi wetland. A total of 16 sites supported over 1% population of the species during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Great White Pelican is a common winter visitor to Gujarat. The 1% biogeographic population of the species has been reduced from 230 to 210 for South Asia (Li et al. 2009; (Wetlands International 2012). The species has been recorded with more than 1% population at five sites viz. Mokarsagar, Medha Creek, Amipur, and Bardasagar (maximum count 3704 in 2017) and Kuchhadi. Mokarsagar wetland supported 1% population in all seven years of study where mean population of 1355 and maximum count recorded was 2568 in 2020. Mendha Creek supported 1% population four times and Amipur three times. The species has been recorded above 1% population at 36 sites during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Dalmatian Pelican is a common to uncommon winter visitor to Gujarat. Mokarsagar and Bardasagar met 1% criterion where maximum numbers 222 were at Mokarsagar in 2016. In fact 500 individuals were recorded at Amipur, Porbandar in 2004 (Li et al. 2009). Only four sites met 1% criterion during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Great Egret is fairly common in Gujarat state. Mokarsagar and Javar met 1% population criterion twice each when maximum count of 2314 was recorded at Mokarsagar in 2016. Nine sites met 1% criterion during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Western Reef Heron is a common resident and winter visitor to Gujarat. Mokarsagar and Javar each met 1% criterion once during 2015 when highest count of 400 was recorded at Javar. During 2006-2015, 10 sites met 1% criterion in India (Wetlands International South Asia 2020).

Black-headed Ibis is a common resident of Gujarat. Mokarsagar has met 1% criterion three times (maximum of 1376 in the year of 2016) and Javar has met once. A total of 23 sites have met 1% criterion during AWC 2006-2015 in India (Wetlands International South Asia 2020).

Red-naped Ibis is a common resident bird of Gujarat. Mokarsagar, Fodara and Ranasar have met 1% criterion in which maximum count of 347 was at Fodara in 2016. During AWC 2006-2015, 22 sites have met 1% criterion (Wetlands International South Asia 2020).

Eurasian Spoonbill is a common resident and local migrant of Gujarat. Mokarsagar has met 1% criterion five times in seven years and Amipur has met once. The mean value of Eurasian Spoonbill at Mokarsagar was 995 and maximum count was 3411 in 2016. In fact, 1450 individuals were recorded at Amipur in 2004 (Li et al. 2009). A total of 15 sites have met 1% population criterion during AWC 2006-2015 in India and the all national wetlands-combined population of the species was 4404 in 2008 (Wetlands International South Asia 2020). A total of 23000 Spoonbills were recorded at three sites of a Nadabet wetland, Greater Rann of Kachchh, Gujarat in 2016 (Jethva et al. 2016).

2. Pesticide residual analysis of piscivorous birds

Out of several samples of waterbirds analysed for presence of 230 pesticides, two piscivorous waterbirds were found to have pesticides residues viz. Great Egret and Indian Pond Heron. The insecticide, Indoxacarb was detected in Great Egret at the concentration of 0.012 ppm. Herbicides, Indoxacarb (0.015 ppm) and Oxadiazon, (0.233 ppm) were also detected in Indian Pond Heron.

On an acute oral basis and subacute dietary basis, Indoxacarb is moderately toxic to avian species (EPA 2010). Oxadiazon is classified as a light-dependent peroxidizing herbicide (LDPH), which means that its toxicity increases when exposed to light. Oxadiazon residues can build in sediments at the bottom of water bodies because this stable chemical can bind to particle

Table 2. Mean ± SD and residual range (lower to higher) in ppm of four detected pesticides in various fish species.

#	Fish Species	Indoxacarb	Imidacloprid	Oxadiazon	Amectotradin
1	*Oreochromis mossambicus*	0.035 ± 0.038			
		0.01-0.08	BLQ	BLQ	BLQ
2	*Cirrhinus mrigala*	0.003 ± 0.006		0.071 ± 0.016	0.018 ± 0.008
		BLQ -0.01	BLQ	0.05-0.088	0.011-0.027
3	*Channa mircopeltes*			0.065 ± 0.01	0.015 ± 0.004
		BLQ	BLQ	0.055-0.074	0.011-0.019
4	*Puntius sophore*	0.008 ± 0.008		0.066 ± 0.018	0.014 ± 0.005
		0.01-0.015	BLQ	0.047-0.082	0.01-0.019
5	*Sardonella longiceps*	0.037 ± 0.009	0.014 ± 0.013	0.256 ± 0.037	
		0.028-0.045	0.018-0.025	0.228-0.298	BLQ
6	*Labeo bata*	0.013 ± 0.002		0.156 ± 0.01	0.019 ± 0.006
		0.011-0.015	BLQ	0.147-0.167	0.014-0.025

BLQ= Below Level of Quantification

Table 3. ADI and ARfD of the detected pesticides

Pesticide	Category	ADI (ppm)	ARfD (ppm)
Indoxacarb	Insecticide	0–0.01	0.1
Imidacioprid	Insecticide	0–0.06	0.4
Oxadiazon	Herbicide	0.0036	0.12
Amectotradin	Fungicide	10	Not necessary

and organic debris (EPA 2008). Hexachlorocyclohexane (HCH), DDT, and Polychlorinated biphenyls (PCB) have been reported previously in Great Egret and Indian Pond Heron (Ramesh et al. 1992; (Tanabe et al. 1998; (Senthilkumar et al. 2001; (Kunisue et al. 2003; (Sethuraman and Subramanian 2003; (Malik et al. 2018).

3. Pesticide residual analysis of fishes

Three samples each of six species of wetland fishes were analysed for pesticide residual analysis. Indoxacarb and Oxadiazon were detected in five species each, Amectotradin in four species, and Imidacloprid in one species. Mean value and the residual range has been shown in the Table 2. The highest level of Oxadiazon (0.298 ppm) was detected in *Sardonella longiceps*. The study suggests that each fish species has been contaminated by at least one pesticide.

Various metabolites of HCH and DDT along with other pesticides were previously detected in some of above mentioned species from the Gujarat state (Dhananjayan et al. 2012), Karnataka state (Dhananjayan and Muralidharan 2010), and Tamil Nadu (Samidurai et al. 2019). But, the pesticides detected under the present study are being reported for the first time among these species. Freshwater and estuarine/marine fish are moderately to very highly acutely toxic to Indoxacarb and its metabolites, and freshwater and estuarine/marine invertebrates are moderately to very highly acutely toxic to Indoxacarb and its metabolites (EPA 2010).

Acceptable Daily Intake for humans (ADI) and Acute reference dose (ARfD) that can be ingested over a short period of time, usually during one meal or one day, without appreciable health risk were accessed from (FAO 2020) and shown in Table 3. It has been found that ARfD of Oxadiazon in *Sardonella longiceps* is high enough to produce health risks in human consumers.

Conclusion

All of the six fish species investigated showed the presence of at least one pesticide which is the main diet

of piscivorous birds. Presently, they do not appear to be dangerous to humans except for Oxadiazon in *Sardonella longiceps*, but future monitoring is recommended. In India, investigations on the levels of pesticides in fish are usually conducted on an irregular and random basis and HCH, OCP and DDT metabolites are targeted. It is recommended that other pesticides that may be present in high level should also be investigated.

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Authors' contributions

Dhavalkumar Varagiya: Original Idea, Design of the study, Survey and Data collection, Laboratory Experimental work, Data analysis, Funding acquisition, and Manuscript Preparation

Bharat Jethva: Manuscript Preparation, and Supervision

Devang Pandya: Manuscript Preparation, and Supervision

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Diversity of birds in and around Dharmaveer Sambhaji Lake, Dist. Solapur (Maharashtra)

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Abstract

The present article deals with diversity of birds of Dharmaveer Sambhaji Lake (17^0 38'55" and 75^0 54'14") in Solapur city, Maharashtra. The lake is a perennial reservoir having catchment area of about 2500 acres. The study was carried out from March, 2019 to February, 2020. Total 45 bird species (28 resident, 11 winter migratory and 6 local migratory) belonging to 25 families were recorded.

Keywords: Birds; Perennial; Local migratory; Migratory; Strategy; Dharmaveer Samabhaji Lake.

Introduction

Birds are one of the most extensively studied organisms on the planet and serve as important bio-indicators, control crop pests, are good pollinators in agricultural crops. And an important link in the food chain. Around 1349 species are known in India. Solapur city is located in the south-western region of the Maharashtra state and lies in the Bhima-Sina-Man basins. Dharmaveer Sambhaji Lake supports rich diversity of flora and fauna and is unique ecosystem. The water spread area of the lake approximate 42 acres with mean annual rainfall 545mm. The bank of lake at east side is lined by woody vegetation, herbs and shrubs while the west side by Solapur-Chitradurg national highway. The water of lake is rich in aquatic vegetation. Bagale and Rokade (2015) studied avian diversity of this water body. Kumbhar *et al.,* (2009) studied ecology of Purple Moorhen at Dharmaveer Sambhaji Lake. The present study is not carried out only to prepare the diversity of birds, but to create awareness for their conservation.

Materials and Methods:

Materials:

The present study is restricted to the Dharmaveer Sambhaji Lake1 (7^0 38' 55" N $75^0$54'14" E.) which was earlier known as Kambar Talav and was in the outskirts of Solapur city but is now in its central part due to extensive urbanization.

Methods:

Avifauna was studied from March, 2019 to February, 2020. Observations were carried out using binoculars. Photographic documentation was done with the help of Nikon D-5300 camera with zoom lens of 55mm to 200mm. The identification of bird species was done by referring pictorial guides Grimmett *et al.,* (2015) and Pande *et al.,* (2013).

Results and Discussion:

Total 45 species of birds (28 resident, 11 winter migrants and 6 local migrants) from 25 families were recorded from the study site from March, 2019 to February, 2020 (Table 1). This lake is seen to be disturbed by anthropological activities and pollution from garbage. Major part of the water surface is occupied by water weed eichornia and the avifaunal habitat is presently threatened. This water body needs protection by reducing or removing human interferance and should be keept free from pollution.

Study site : Dharmaveer Sambhaji Lake (www.googlemaps.com)

Table:1 Checklist of birds in and around Dharmaveer Sambhaji lake.

Sr. No.	Common Name	Scientific Name	Family	Status
1	Black Kite	*Milvus migrans*	Accipitridae	R
2	Brahminy Kite	*Haliastur indus*		LM
3	Small Blue Kingfisher	*Alcedo atthis*	Alcedinidae	LM
4	White-Throated Kingfisher	*Halcyon smyrnensis*		R
5	Northern Shoveller	*Anas clypeata*	Anatidae	WM
6	Spotbill Duck	*Anas poecilorhyncha*		LM
7	Common Teal	*Anas actuta*		M
8	Garganey	*Querquedula querquedula*		M
9	Red rumped swallow	*Cecropis daurica*		R
10	Pond Heron	Ardeola grayii	Ardeidae	R
11	Little Egret	*Egretta garzetta*		R
12	Cattle Egret	*Bubulcus ibis*		R
13	Purple Heron	*Ardea purpurea*		LM
14	Red-wattled Lapwing	*Vanellus indicus*	Charadriidae	R
15	Ashy Prinia	*Prinia socialis*	Cisticolidae	R
16	House Crow	*Corvus splendens vieillot*	Corvidae	R
17	Indian Jungle Crow	*Corvus culminaatus*		R
18	Greater Coucal	*Centropus sinensis*	Cuculidae	R
19	Black Drongo	*Dicrurus adsimilis*	Dicruridae	LM
20	White-tailed Swallow	*Hirundo smithii*	Hirudinidae	R
21	Barn Swallow	*Hirundo rustica*		M
22	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	Jacanidae	R
23	Bronze winged Jacana	*Metopidius indicus*		R
24	River Tern	*Sterna aurantia*	Laridae	M
25	Green Bee-eater	*Merops orientalis*	Meropidae	LM
26	Yellow Wagtail	*Motacilla citreola pallas*	Motacillidae	WM
27	White Wagtail	*Motacilla alba*		WM
28	Grey Wagtail	*Motacilla cinerea*		WM
29	Pied Bushchat	*Saxicola caprata*	Muscicapidae	R
30	Indian Robin	*Saxicoloides fulicatus*		R
31	Purple-Rumped Sunbird	*Aethopyga siparaja*	Nectarinidae	R
32	Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	R

33	House Sparrow	*Passer domesticus*	Ploceidae	R
34	Little Grebe	*Tachybaptus ruficollis*	Podicipedidae	R
35	Little Cormorant	*Phalacrocorax niger*	Racidae	R
36	Purple Moorhen	*Porphyrio porphyrio*	Rallidae	R
37	White-Breasted Waterhen	*Amaurornis phoenicurus*		R
38	Indian Moorhen	*Gallinula chloropus*		R
39	Coot	*Fulica atra*		R
40	Black-Winged Stilt	*Himantopus himantopus*	Recurvirostridae	R
41	Little Stint	*Ereunetes minuta*	Scolopacidae	WM
42	Wood Sandpiper	*Tringa glareola*		WM
43	Commom Sandpiper	*Actitis hypoleucos*		WM
44	Indian Myna	*Idotheres tristis*	Sturnidae	R
45	Black Ibis	*Pseudibis papillosa*	Threskiornithidae	R
Total	Species = 45		Families = 25	R=28 WM=11 LM=06

R : Resident, WM : Winter Migratory, LM : Local Migratory

Author's Contributions

Designing, survey and mansuscript prepartation – Mahesh Nilange. Data collection – Savita Nilange, Data analysis – Arvind Kumbhar.

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Birds belonging to orders Gruiformes, Psittasiformes and Columbiformes in Ratlam, Madhya Pradesh

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Abstract

The avian diversity from orders Gruiformes, Psittasiformes and Columbiformes found in Ratlam, Madhya Pradesh was studied by distant count method from June, 2015 to June, 2019. A total of 18 species of birds belonging to three orders four families comprising of 9 genera were recorded. Order Gruiformes exhibited 5 species from four genera and two families Rallidae and Gruidae, order Psittasiformes exhibited 4 species belonging to a single genus Psittacula of family Psittaculidae whereas order Columbiformes represented 8 species belonging to three genera of family Columbidae.

Keywords: Gruiformes, Psittasiformes, Columbiformes

Introduction

Ratlam (23°19′0″N 75°04′0″E) is a city situated in the northwestern part of the Malwa region in Madhya Pradesh. It has humid subtropical climate. The average rain fall is 37 inches. More than ten thousand bird species are found worldwide (Gill et. al.2020). Almost half of them are Passerine or perching birds. Birds are excellent models for understanding the key issues in ecology, animal behavior, evolution and conservation (Urfi, 2011). Diversity of birds is one of the most important ecological indicator to evaluate the quality of habitats. The diversity of birds however is decreasing day by day due to destruction of habitat and human intervention (Bhadja and Vaghela, 2013). Their abundance indicates healthy status of environment and food sources (Joshi, 2012). Some reports from Madhya Pradesh are available on birds (Pasha and Sankar 1996, Pasha 1998), Milind Dange and Pradip Kumar 2013, 2019a.b.

India being a mega diversity centre harbors 1334 species of birds which contributes to more than 13 percent of the world avian species (Praveen J., Jayapal, R., & Pittie, A., 2016). The study will serve the purpose of awareness generation among society and students and will urge a feeling of conservation of these avian fauna.

Material and Methods

Identification of birds was done using Ali 1941. The area was regularly surveyed for birds by direct observation with the help of Olympus 10X50 DPS I field binoculars. Birds seen were identified and recorded along with habitat type and status (resident or winter visitor). On the basis of the frequency of sighting, the bird species were assigned categories of abundance (uncommon and common). Observations were carried out, using distance count method. Photographs were taken with Nikon Coolpix p900 camera.

Table 1: Checklist of Birds from Gruiformes, Psittasiformes and Columbiformes orders in Ratlam, MP

S. No.	Common Name	Scientific Name	Frequency	Number of birds	Number of Visits	IUCN status	Residential status
Order: Gruiformes							
Family: Rallidae							
1	White-breasted Waterhen	*Amaurornis phoenicurus*	U	5	16	LC	R
2	White-browed Crake	*Amaurornis cinerea*	R	1	5	LC	W
3	Purple Swamphen	*Porphyrio porphyrio*	C	15	35	LC	R
4	Common Moorhen	*Gallinula chloropus*	C	25	40	LC	R
5	Common Coot	*Fulica atra*	C	30	30	LC	R
Family: Gruidae							
6	Sarus Crane	*Antigone antigone*	O	2	2	V	W
Order: Psittaciformes							
Family: Psittaculidae							
7	Slaty-headed Parakeet	*Psittacula himalayana*	O	2	4	LC	R
8	Plum-headed Parakeet	*Psittacula cyanocephala*	O	1	1	LC	W
9	Alexandrine Parakeet	*Psittacula eupatria*	U	2	6	NT	R
10	Rose-ringed Parakeet	*Psittacula krameri*	C	105	28	LC	R
Order: Columbiformes							

Family: Columbidae							
11	Rock Pigeon	*Columba livia*	C	50	50	LC	R
12	Pale-capped Pigeon	*Columba punicea*	R	2	5	V	W
13	Oriental Turtle Dove	*Streptopelia orientalis*	U	3	8	LC	R
14	Eurasian Collared Dove	*Streptopelia decaocto*	R	1	2	LC	R
15	Red Collared Dove	*Streptopelia tranquebarica*	C	6	12	LC	R
16	Spotted Dove	*Streptopelia chinensis*	U	2	4	LC	R
17	Laughing Dove	*Streptopelia senegalensis*	U	2	6	LC	R
18	Yellow-legged Green Pigeon	*Treron phoenicopterus*	R	1	1	LC	W

V=Vulnerable, LC= Least Concerned, NT= Near Threatened

R= Rare, O=Occasional, U=Uncommon, C=Common, W=Winter Migrant, R=Resident

Results and discussion

During the study period 18 species of birds belonging to 9 genera and four families were observed. A checklist of the birds along with residential status is given in Table 1. As far as residential status is concerned, out of the 18 species of birds, 6 species were Winter visitors (W) while 12 species were residents (R).

Sarus Crane *Antigone antigone* and Pale-capped Pigeon *Columba punicea* are Vulnerable. Alexandrine Parakeet *Psittacula eupatria* is near threatened whereas the rest are least concerned as per IUCN list. (BirdLife International (2017) Gruiformes is the order of medium to large size birds which comprises 145 species. They live near water and usually eat insects and other invertebrates. These include mainly cranes, coots, crakes and moorhens. Psittasiformes is the order of medium sized and vividly colored birds which comprises 393 species belonging to 92 genera. These are parrot like birds with a strong, curved bill, an upright stance and their diet includes seeds, nuts, fruit, buds, and other plant material. Some of the species have the ability to imitate human speech. Columbiformes is the order of stoutly build birds with short neck and short slender bill. It comprises a single family Columbidae which contains 344 species divided into 50 genera.

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White-breasted Waterhen Amaurornis phoenicurus

Purple Swamphen Porphyrio porphyrio

Common Moorhen Gallinula chloropus

Common Coot Fulica atra

Slaty-headed Parakeet Psittacula himalayana

Plum-headed Parakeet Psittacula cyanocephala

Rose-ringed Parakeet Psittacula krameri

Rock Pigeon Columba livia

Eurasian Collared Dove Streptopelia decaocto

Spotted Dove Streptopelia chinensis

Laughing Dove Streptopelia senegalensis

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A checklist of avifauna of Kombai, Tamil Nadu, India, including diversity, abundance, and richness

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Abstract

The present study documents the population, distribution, diversity, richness, and abundance of avifauna of Kombai, a town situated at the foothills of Western Ghats for the first time, including the migratory status and feeding habits. A total of 1008 birds belonging to 61 species, 34 families and 15 orders were recorded by direct count method. The most dominant order was Passeriformes (55%) with a total of 33 species followed by Columbiformes and Pelecaniformes (6.55%) with four species each. Accipitriformes, Coraciformes and Cuculiformes (5%) each with three species were the next in line followed by Charadriiformes and Galliformes (3.27%) each with two species. The remaining orders, *viz*., Anseriformes, Gruiformes, Piciformes, Podicipedoformes, Psittaciformes, Strigiformes and Suliformes were equally distributed with one species each (1.6%). All species surveyed were found to be residents (93%), except for Common Sandpiper, Ashy Drongo and Brown Shrike which were migrants (5%), and Black-shouldered Kite a local migrant (2%). Among the 61 species, 43% were common as they were observed >10 times; 37% were uncommon, observed <10 times; and 20% were rare, observed once/twice during the study period. Shannon's diversity index ranged from 0.04 to 0.36 and its overall index was 2.18. Eight types of feeding guilds/habits were observed during the study. Twenty three species (37.7%) of insectivores, followed

by 10 species of omnivores (16.39%), eight species of granivores (13.11%), seven species of frugivores (11.47%), five species of carnivores (8.19%), four species of piscivores (6.55%), three species of nectarivores (4.91%) and a single species of herbivore (1.60%) were recorded.

Keywords: Avifauna; Kombai; species composition; diversity indices; feeding guilds

Introduction

Birds are common denizens of the ecosystem, and the most prominent species of earth's biodiversity (Rahul et al. 2014) considered as biological indicator species of inhabited areas (Blair 1999; Pradhan et al. 2013) since they are sensitive to environmental change (Canterbury et al. 2000) and maintain the ecological balance and health of a habitat (Aggarwal et al. 2015). Birds enact a significant role in flower pollination, seed dispersal, source of food chain, and as dispersal agents in transporting nutrients and spores from one place to another via migration/local movements (Niemi 1985; Nason 1992). Assessment of bird community has become a central tool in biodiversity conservation and conservation planning in regions of excessive human pressure (Jayson and Mathew 2000; Ramesh et al. 2011; Meeran et al. 2021), and an up-to-date documentation of avian species is mandatory for prospective conservation and monitoring (Rahmani and Islam 2004).

Diversity of avifauna is one of the vital ecological indicators to evaluate the quality of habitats (Scott 2010; Manjunath and Joshi 2012). Study of avifaunal diversity is a necessary crucial ecological tool which acts as a critical indicator to assess diverse habitats qualitatively and quantitatively (Bibby et al. 1992). In general, the global avian diversity is declining due to climate change and anthropogenic conflicts (Collias 1952). India, a mega biodiversity region, houses about 1301 avian species that amounts to 13% of the world's total avian fauna (Ali 2002). Ostensibly, avian populace of India has been deteriorating owing to direct and oblique influence from growing human population, loss of habitat, disintegration, and intense biotic pressure, requiring documentation of the current bird species status towards prospective conservation and monitoring (Balasubramanian and Maheswaran 2003; Rahmani and Islam 2004; Balachandran et al. 2005).

Studies on the structure of bird communities have gained considerable attention over the past five decades (Cody 1974; Wiens 1989). Several reviews of the vast literature on ecology of bird communities are available (Cody 1974; Perrins and Birkhead 1983; Keast 1990). The avifauna of India was studied by Ali and Ripley (1987), and systematic studies on birds of Indian sub-continent dates back to the 19th century and most of these studies were concerning taxonomy, distribution and natural history (Ali and Ripley 2001). However, no published literature is available on the avian diversity of Kombai, Tamil Nadu, India so far. Therefore, a thorough survey of avian fauna and its population was essential to revive its population status. Hence, the present study was taken up to determine the population and distribution of avian community, and the present investigation will document its first research on the distribution, diversity, richness, and abundance, and the comprehensive checklist includes migratory status and feeding habits of avifauna of Kombai.

Materials and Methods

Study area

Kombai (9.8517° N, 77.2939° E) with an average elevation from the sea level of 399m (1309ft) is located at the foothills of Western Ghats (Figure 1), and is surrounded by mountains, with Western Ghats on the west, and Silamalai on the east. The land size of this study area is 48.1Km^2. In Kombai, the wet and dry seasons are oppressive and overcast, and muggy and partly cloudy, respectively. Temperature ranges from 18.3 to 34.4°C, and rarely falls below 16.1°C or rises above 37.2°C. The study area was divided into ten major sites, *viz*., Valaikombai, Panayadi, Ranganathar kovil, Kuppugundu foothill, Pigface foothill, urbanized village, Puthukulam, Silamalai foothill, 18th canal shore and roadsides, of which the first five sites are housed under the foothills of Western Ghats. The survey was conducted on the habitats like foothills, wetlands, agricultural lands and grasslands. Kombai is an agrobased region encircled by hills and mountains with natural water bodies, which attracts birds.

Study Period and Design

The survey was carried from June 2020 to March 2021. An initial survey was undertaken on foot so as to understand the topography and nature of study area and a systematic survey was undertaken by walk

along the fixed paths/trails for documentation of bird species. Direct count method (Bibby et al. 1992, 2000) was employed for the survey, which embroils search through a fixed area for a set amount of time and to record the number of birds observed. In this technique, an opposite vantage point was designated and all the visible birds were counted. The species of birds were visually observed randomly in the study sites and the adjacent areas, and observations recorded. Each study site was surveyed twice a day from 06:00am to 10:00am, and from 04:00pm to 06:00pm owing to the peak activity of birds. Care was taken to avoid double count by watching the bird's direction of flight and landing in case they are disturbed by predators or people. No census was done on days with unfavourable climatic conditions such as rainy or windy days. The identity, ecology, behaviour and calls of the birds were carefully observed and recorded. Care was taken, not to disturb the activity or nest of any avian species.

Nikon (12x50 mm) binoculars were used and Nikon 3100D 18x55 mm zoom lens digital camera was used to photograph the birds during the survey. Photographs were taken to identify the birds whenever possible and the bird's identification was confirmed using standard field guides (Ali and Ripley 1977, 1983, 1987, 1996; King et al. 1991; Grimmet et al. 1998, 2009, 2011, 2014; Grimmett and Inskipp 1999, 2007; Ali 2002; Ratnam 2002, 2004). Calls of invisible birds were recorded using a recorder and identified later with the help of bird experts, internet and android apps like 'bird sounds' and 'Indian birds'.

Data analysis

Field notes about the species and its activity such as feeding, calling, bathing and preening, roosting, and other behaviour were noted down. The collected data was analysed and tabulated. The data collected from the surveys were used to estimate diversity and status of bird species. The check list was prepared using standardized common and scientific names and were arranged order and family wise following Manakadan and Pittie (2001) and for vernacular name by Ratnam (1998). For taxonomy and nomenclature of birds, Inskipp et al. (2001) and Manakadan and Pittie (2001) was consulted and for classification, Kazmierczak and van Perlo (2000) and Banerjee (2008) were followed. Based on the frequency of field observation, the status and abundance of each bird was categorized a resident, migrant and local migrant after Ali (2002). Birds were categorized into carnivore, frugivore, granivore, herbivore, insectivore, nectivore, omnivore and piscivore following Ali and Ripley (1987). The abundance of bird species was categorized as common (species observed >10 times), uncommon (species observed <10 times) and rare (species observed once/twice) (Saikia and Saikia 2000).

Diversity indices

The indices for richness were represented by Hill's species (Hill 1973), Margalef's (Margalef 1958), and Menhinick's (Menhinick 1964); for diversity by Brillouin's, Hill's (Hill 1973), Shannon's (Shannon and Weiner 1948, 1949, 1964), Simpson's dominance (Simpson 1949), and species diversity; and for evenness, Alatalo's (Alatalo 1981), Heip's (Heip 1974; Heip and Engels 1974), Pielou's (Pielou 1966), Shannon's (Shannon and Weiner 1948, 1949, 1964) and Sheldon's (Sheldon 1969) indices. Other diversity indices according to Ludwig and Reynolds (1988), include Berger-Parker's dominance (Berger and Parker 1970), community dominance index, Hill's number abundance (Hill 1973), relative dominance, and relative frequency.

Results

A total of 1008 birds belonging to 61 species, 34 families and 15 orders were recorded (Table 1). Accipitriformes, Anseriformes, Charadriiformes, Columbiformes, Coraciformes, Cuculiformes, Galliformes, Gruiformes, Passeriformes, Pelecaniformes, Piciformes, Podicipedoformes, Psittaciformes, Strigiformes and Suliformes were the orders observed and recorded in the study area (Figure 2). The most dominant order was Passeriformes (55%) with 33 species, followed by Columbiformes and Pelecaniformes (6.55%) with four species each. Accipitriformes, Coraciformes and Cuculiformes (5%) each with three species was the next in line followed by Charadriiformes and Galliformes (3.27%) each with two species. The remaining orders, *viz*., Anseriformes, Gruiformes, Piciformes, Podicipedoformes, Psittaciformes, Strigiformes and Suliformes were equally distributed with one species each (1.6%).

All species surveyed were found to be residents (93%), except for Common Sandpiper, Ashy Drongo and Brown Shrike which were migrants (5%), and

Black-shouldered Kite a local migrant (2%). Among the 61 species, 43% were common (Singing Bush Lark, House Crow, Jungle Crow, Black-throated Munia, Yellow-billed Babbler, Jungle Babbler, House Sparrow, Common Myna, Intermediate Egret, Rose-ringed Parakeet (observed in flocks), Rock Pigeon, Spotted Dove, White-throated Kingfisher, Indian Roller, Green Bee Eater, Greater Coucal, Grey Francolin, Indian Peafowl, Blyth's Reed Warbler, Grey-breasted Prinia, Black Drongo, Indian Robin, Oriental Magpie Robin, Cattle Egret, Indian Pond Heron, Little Cormorant); 37% were uncommon (Indian Spot Billed Duck, Red Wattled Lapwing, Common Sandpiper, Eurasian Collared Dove, Laughing Dove, Blue Faced Malkoha, White-breasted Waterhen, Common Iora, Common Tailor Bird, Rufous Treepie, Scaly-breasted Munia, Indian Silverbill, Brown Shrike, Indian Paradise Flycatcher, Loten's Sunbird, Purple Sunbird, Purple-rumped Sunbird, Red-vented Bulbul, Jungle Myna, Little Egret, Lesser Golden-backed Woodpecker, Little Grebe, Spotted Owlet); and 20% were rare (Oriental Honey Buzzard, Black-shouldered Kite, Crested Serpent Eagle, Common Hawk Cuckoo, Jerdon's Bush Lark, Jungle Prinia, Tickell's Flower Pecker, Greater Racket-tailed Drongo, Ashy Drongo, Red-whiskered Bulbul, White Browed Bulbul, Brahminy Starling) (Figure 3).

Eight types of feeding guilds/habits were observed during the study. Twenty three species (37.7%) were insectivores followed by 10 species of omnivores (16.39%), eight species granivores (13.11%), seven species frugivores (11.47%), five species carnivores (8.19%), four species piscivores (6.55%), three species nectarivores (4.91%) and a single species herbivores (1.60%) (Figure 4).

The richness indices represented by Hill's species, Margalef's and Menhinick's are presented in Table 2. The diversity indices were denoted by Brillouin's, Hill's, Shannon's, Simpson's, and species diversity (Table 3). The overall Shannon's diversity index was 2.18. Alatalo's, Heip's, Pielou's, Shannon's and Sheldon's epitomized the evenness indices for the present study (Table 4). Other indices signified Berger-Parker dominance, community dominance index, Hill's number abundance, relative dominance, and relative frequency (Table 5).

Discussion

Birds are usually utilized as surrogates of biodiversity due to the comprehensive availability of relevant data on their status and distribution (Gregory et al. 2003; Gregory 2006; Eglington et al. 2012). Documenting and monitoring of the birds offer information on the ecological health and status. Avifauna acts as indicators of ecological quality, and factors for evaluating restoration success and regional biodiversity (Kumar and Gupta 2009).

No single survey can provide all data to answer every research question (Turner 2003) because birds differ in terms of their size, behavioural traits and habitat preferences (Urfi et al. 2005). Based on the experience in the field considering the habitat status, and area of the study site, direct count method surveys were conducted to the entire study area by randomized walking (Crump and Scott 1994). Kombai recorded 57 resident, three migrant and a local migrant species. Migrants observed in the survey may be generally due to seasonal movement, include those made in response to changes in food availability, habitat, or weather. The dominance of insectivorous birds in the present study might be due to the flowering and fruiting season of angiosperms and greater insect population. Similar domination of insectivorous bird populace has been reported in dry deciduous forest of Sangili district (Kumbar and Ghadage 2014) and Amaravati district covered with evergreen, semi-evergreen and deciduous forests (Wadatkar and Kasambe 2002; Kulkarni et al. 2005).

The significant parameters in a bird study include species richness, density and diversity (Nilsson and Nilsson 1978). Shannon-Weiner diversity index states the proportional existence of numerous species, to associate abundance and relative richness amongst species (Whittaker 1977). High value of diversity indices and species richness and Simpson's index indicates a conducive environment. Species richness declines with increasing elevation (Begon et al. 1996) since avian abundance and distribution differs with habitat (Jayapal et al. 2007; Ramesh et al. 2011), climatic condition, food resource and evolutionary history of the region (Jayson 1994). The community composition and bird populace density might indicate spatial and temporal difference owed to availability of food resources (Pyke 1985; Levey 1988; Innes 1989; Koen 1992; Poulin et al. 1994). Further, climatic factors might

perhaps be accountable for difference in composition of avian species (Price 1979; Vijayan 1984) together with time and space (Karr 1971; Greenberg 1981; Loiselle 1988). Seasonal variation in the richness of a species is an adaptive occurrence (Koen, 1992). In the present study, the richness indices represented by Hill, Margalef and Menhinick were higher in Passeriformes and lower in Anseriformes, Gruiformes, Piciformes, Podicipedoformes, Psittaciformes, Strigiformes and Suliformes. Shannon's index of diversity is considered to be a good measure of diversity, for it takes into account both the number of species and the abundance of each species. In the present study at Kombai, the values ranged from 0.04 in Psittaciformes to 0.36 in Gruiformes and the overall was 2.18. Similar reports were revealed by Usha and John (2015) at Wadakkanchery, Thrissur, Kerala, India. The present study reports a high value of diversity indices and species richness indicating Kombai to be a conducive environment for avifauna. Five indices were used to represent the evenness indices for the present study, of which Shannon's evenness and Alatalo's indices was high in Gruiformes and low in Passeriformes. Further, Sheldon's index reported higher and lower values in Anseriformes and Passeriformes respectively. Pielou's index was high in Gruiformes and low in Psittaciformes.

The quantity of various species inside a geographical region relies upon migration and adaptation to environmental conditions and how they in turn modify the environment (Groombridge and Jenkins 2002). The study area Kombai is an agrobased region and high number of avian species in agriculture habitat might be due to variety of agricultural crops, vegetation densities, and availability of bushes and herbs and shrubs for foraging and nesting. Higher abundance of birds could also be due to the composition of the vegetation that forms a main element of their habitat (Lee and Rotenberry 2005; Chapman and Reich 2007; Salah and Idris 2013), and vegetation cover has been reported to have a strong influence on avifauna diversity (Scott et al. 1989; Radford et al. 2005). Further, presence of insects, low grass cover, and less human disturbances would have been responsible for the high density of avian species. Secondly, Kombai is enriched with many water bodies making it as one of the major feeding ground for many species of birds. During summer, these water bodies may get dried up without water which can make the birds to ignore ponds during summer. Similar studies have been reported stating water as a major driven factor that affected aquatic vegetation composition and food resources that influenced bird density, diversity and distribution (Colwell and Taft 2000; Mohanraj and Pandiyan 2015).

Birds are biological indicators and serve as suitable models to analyse a range of environmental problems, therefore the state of local landscape needs to be studied to ascertain crucial determinants of bird community structure for avian conservation (Newton 1995; Kattan and Franco 2004; Li and Mundkur 2007). Description and explanation of spatial patterns in species diversity are vital steps in conserving global biodiversity (Lee et al. 2004), as the number of bird species occupying different life sectors, rely on climatic changes convoyed by corresponding vegetation changes (Ali 1949). Studies on species distribution alongside elevation gradients are crucial to comprehend doctrines of community organisation and species conservation. Birds adapt to regions with suitable habitation which offers nesting site/material, food and protection from other species (Cody 1980). Further, it is to be noted that inside geographical regions, species are not uniformly spread through all accessible habitations, nonetheless inclines to habit some habitats more than others. Thus, a species with supreme frequency and abundance to its habitat is best adapted, yet, these preferences might alternate across geographical regions and over seasons.

Conclusion

Avifauna composition of the present study might be based on factors like avifaunal habitat, vegetation composition, and interactions between species. Moreover, the activities of each avifaunal species could have been related to the adaptation response of other bird species, and the interactions among species like association, predation, and competition.

Figure 1. Map of the study area

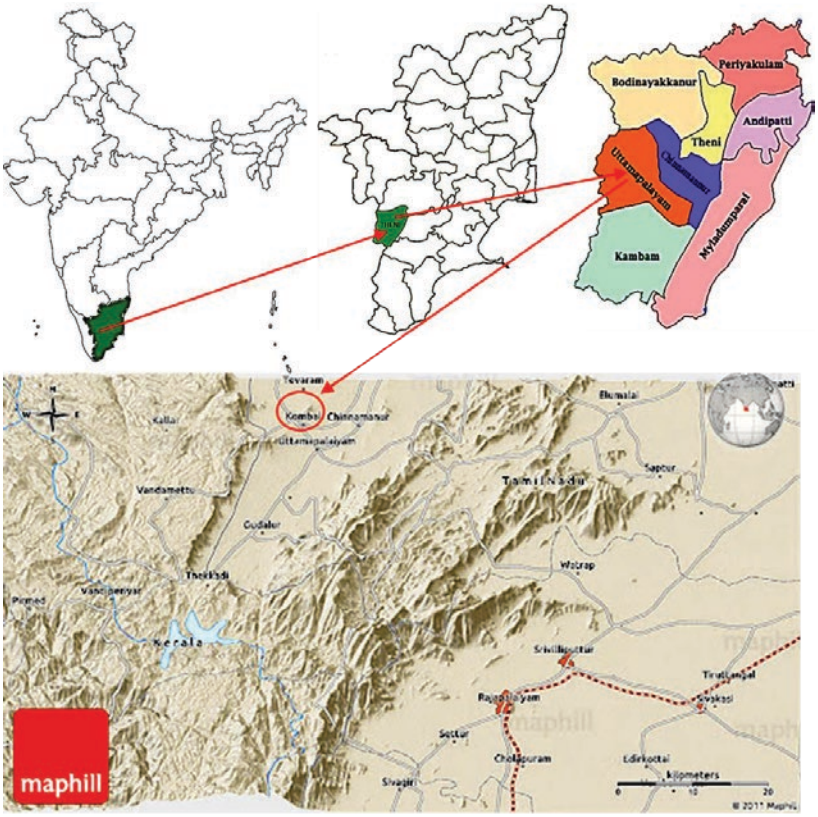

Figure 2. Total number of birds recorded under each order

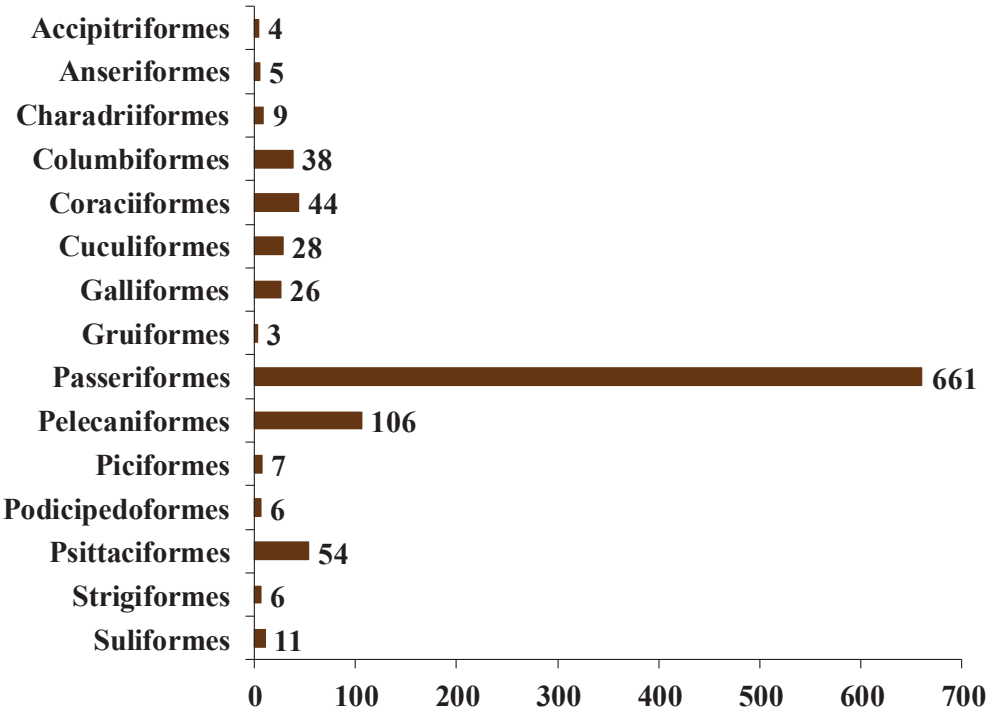

Figure 3. Total number of species recorded in each order

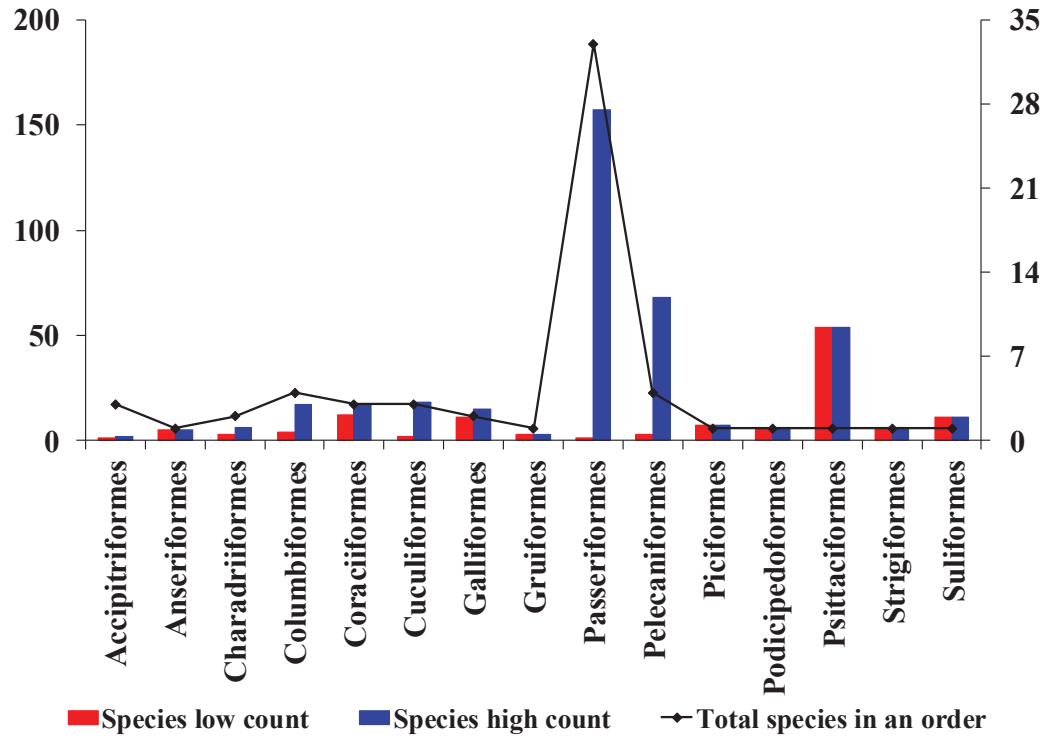

Figure 4. Feeding guild of birds at the study area

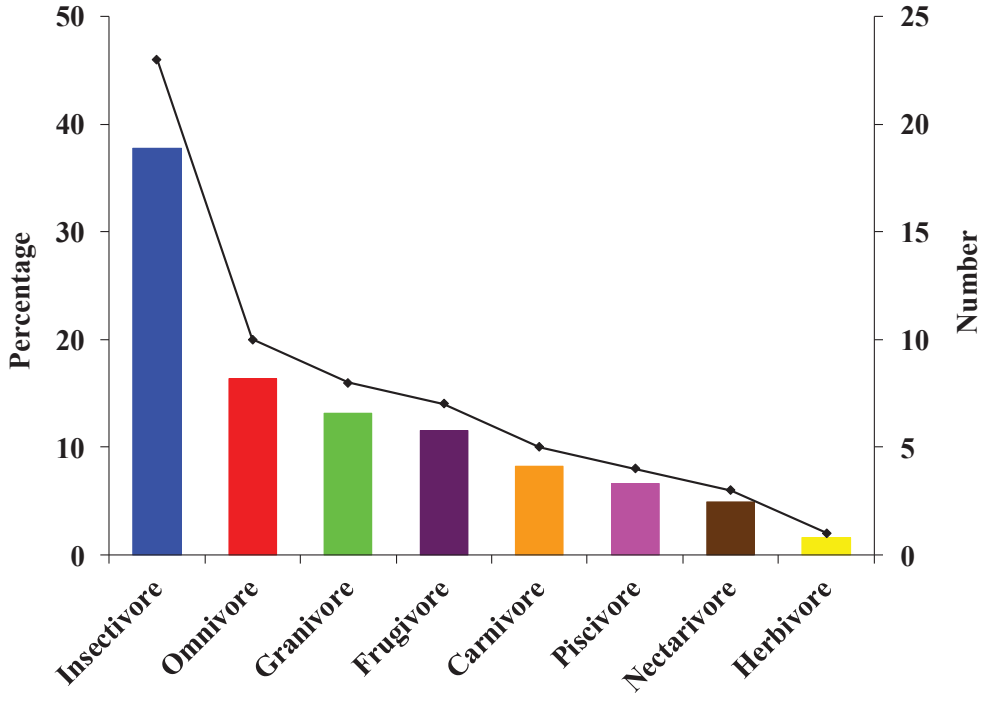

Table 1. Checklist of birds surveyed at the study area

S. No.	Common name	Scientific name (Author citation, year)	Family	Vernacular name (Tamil)	Observed (Feeding habit)
Accipitriformes					
1	Oriental Honey Buzzard	*Pernis ptilorhynchus* (Temminck, 1821)	Accipitridae	Thaen parundhu	1 (I)
2	Black-shouldered Kite	*Elanus caeruleus* (Desfontaines, 1789)	Accipitridae	Karundhol parundhu	2 (C)
3	Crested Serpent Eagle	*Spilornis cheela* (Latham, 1790)	Accipitridae	Koṇdai pampuṇṇik kazhgu	1 (C)
Anseriformes					
4	Indian Spot Billed Duck	*Anas poecilorhyncha* (Forster, 1781)	Anatidae	Pulli mookku vathu	5 (H)
Charadriiformes					
5	Red Wattled Lapwing	*Vanellus indicus* (Boddaert, 1783)	Charadriidae	Sivappu mookku aalkaatti	3 (I)
6	Common Sandpiper	*Actitis hypoleucos* (Linnaeus, 1758)	Scolopacidae	Ullan	6 (I)
Columbiformes					
7	Rock Pigeon	*Columba livia* (Gmelin, 1789)	Columbidae	Maada pura	17 (G)
8	Eurasian Collared Dove	*Streptopelia decaocto* (Frivaldszky, 1838)	Columbidae	Saambal pura	4 (G)
9	Laughing Dove	*Streptopelia senegalensis* (Linnaeus, 1766)	Columbidae	Chinna thavittu pura	6 (G)
10	Spotted Dove	*Streptopelia chinensis* (Scopoli, 1768)	Columbidae	Mani pura	11 (G)
Coraciiformes					
11	White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	Alcedinidae	Venmaarbu meenkothi	12 (P)
12	Indian Roller	*Coracias benghalensis* (Linnaeus, 1758)	Coraciidae	Panangadai	17 (I)
13	Green Bee Eater	*Merops orientalis* (Latham, 1801)	Meropidae	Pachai panjuruttaan	15 (I)
Cuculiformes					
14	Common Hawk Cuckoo	*Hierococcyx varius* (Vahl, 1797)	Cuculidae	Akka kuyil	2 (F)
15	Greater Coucal	*Centropus sinensis* (Stephens, 1815)	Cuculidae	Shenbagam	18 (F)
16	Blue Faced Malkoha	*Phaenicophaeus viridirostris* (Jerdon, 1840)	Cuculidae	Neelamuga poonguyil	8 (I)
Galliformes					
17	Grey Francolin	*Francolinus pondicerianus* (Gmelin, 1789)	Phasianidae	Kowdhari	15 (G)
18	Indian Peafowl	*Pavo cristatus* (Linnaeus, 1758)	Phasianidae	Neela mayil	11 (O)
Gruiformes					
19	White-breasted Waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	Rallidae	Venmarbu kaanankozhi	3 (O)
Passeriformes					
20	Common Iora	*Aegithina tiphia* (Linnaeus, 1758)	Aegithinidae	Mampazha chittu	6 (I)
21	Blyth's Reed Warbler	*Acrocephalus dumetorum* (Blyth, 1849)	Acrocephalidae	Blyth naanal kadhir kuruvi	18 (I)
22	Singing Bush Lark	*Mirafra cantillans* (Blyth, 1845)	Alaudidae	Paadum Vaanambadi	13 (I)
23	Jerdon's Bush Lark	*Mirafra affinis* (Blyth, 1845)	Alaudidae	Pudhar Vaanambadi	2 (I)
24	Jungle Prinia	*Prinia sylvatica* (Jerdon, 1840)	Cisticolidae	Kaattu kadhir kuruvi	2 (I)
25	Grey-breasted Prinia	*Prinia hodgsonii* (Blyth, 1844)	Cisticolidae	Ven sambal kadhir kuruvi	12 (I)
26	Common Tailor Bird	*Orthotomus sutorius* (Pennant, 1769)	Cisticolidae	Thaiyal kuruvi	4 (I)
27	House Crow	*Corvus splendens* (Vieillot, 1817)	Corvidae	Kaakkai	157 (O)
28	Jungle Cow	*Corvus macrorhynchos* (Wagler, 1827)	Corvidae	Andang kaakkai	78 (O)
29	Rufous Treepie	*Dendrocitta vagabunda* (Latham, 1790)	Corvidae	Vaal kaakkai	8 (O)
30	Tickell's Flower Pecker	*Dicaeum erythrorhynchos* (Latham, 1790)	Dicaeidae	Tickall malar kothi	2 (F)
31	Black Drongo	*Dicrurus macrocercus* (Vieillot, 1817)	Dicruridae	Rettaivaal kuruvi	12 (I)
32	Greater Racket Tailed Drongo	*Dicrurus paradiseus* (Linnaeus, 1766)	Dicruridae	Thuduppu vaal karichaan	1 (I)
33	Ashy Drongo	*Dicrurus leucophaeus* (Vieillot, 1817)	Dicruridae	Karichaan	2 (I)
34	Black Throated Munia	*Lonchura kelaarti* (Jerdon, 1863)	Estrildidae	Karun thondai chillai	18 (G)
35	Scaly-breasted Munia	*Lonchura punctulata* (Linnaeus, 1758)	Estrildidae	Pulli chillai	3 (G)
36	Indian Silverbill	*Euodice malabarica* (Linnaeus, 1758)	Estrildidae	Venthondai chillai	6 (I)
37	Brown Shrike	*Lanius cristatus* (Linnaeus, 1758)	Laniidae	Pazhuppu keechaan	4 (I)
38	Yellow Billed Babbler	*Turdoides affinis* (Jerdon, 1845)	Leiothrichidae	Venthalai silamban	27 (O)
39	Jungle Babbler	*Turdoides striata* (Dumont, 1823)	Leiothrichidae	Kaattu silamban	47 (O)
40	Indian Paradise Flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	Monarchidae	Arasavaal eeppidippaan	5 (I)
41	Indian Robin	*Saxicoloides fulicata* (Linnaeus, 1766)	Muscicapidae	Karunchittu	16 (I)
42	Oriental Magpie Robin	*Copsychus saularis* (Linnaeus, 1758)	Muscicapidae	Vannaathi kuruvi	12 (I)
43	Loten's Sunbird	*Cinnyris lotenius* (Linnaeus, 1766)	Nectariniidae	Oodha thaenchiittu	5 (N)
44	Purple Sunbird	*Leptocoma asiatica* (Latham, 1790)	Nectariniidae	Oodha thaenchittu	5 (N)
45	Purple-rumped Sunbird	*Leptocoma zeylonica* Linnaeus, 1766)	Nectariniidae	Oodha pitta thaenchittu	7 (N)
46	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	Passeridae	Chittu kuruvi	39 (G)
47	Red Vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	Pycnonotidae	Chinnaan	4 (F)
48	Red Whiskered Bulbul	*Pycnonotus jocosus* Linnaeus, 1758)	Pycnonotidae	Sivappu meesai chinnaan	2 (F)

S. No.	Common name	Scientific name (Author citation, year)	Family	Vernacular name (Tamil)	Observed (Feeding habit)
49	White Browed Bulbul	*Pycnonotus luteolus* (Lesson, 1841)	Pycnonotidae	Ven paruva chinnan	1 (F)
50	Brahminy Starling	*Sturnia pagodarum* (Gmelin, 1789)	Sturnidae	Karungondai naaganavaai	2 (O)
51	Jungle Myna	*Acridotheres fuscus* (Wagler 1827)	Sturnidae	Kaattu naaganavaai	5 (O)
52	Common Myna	*Acridotheres tristis* (Linnaeus 1766)	Sturnidae	Naaganavaai	136 (O)
Pelecaniformes					
53	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	Ardeidae	Chinna kokku	3 (C)
54	Intermediate Egret	*Ardea intermedia* (Wagler, 1827)	Ardeidae	Ven kokku	68 (P)
55	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	Ardeidae	Unni kokku	12 (C)
56	Indian Pond Heron	*Ardeola grayii* (Sykes, 1832)	Ardeidae	Madayaan	23 (C)
Piciformes					
57	Lesser Golden Backed Woodpecker	*Dinopium benghalense* (Linnaeus, 1758)	Picidae	Ponmudhugu maramkothi	7 (I)
Podicipedoformes					
58	Little Grebe	*Tachybaptus ruficollis* (Pallas, 1764)	Podicipedidae	Mukkulippan	6 (P)
Psittaciformes					
59	Rose Ringed Parakeet	*Psittacula krameri* (Scopoli, 1769)	Psittaculidae	Sivappu pynkili	54 (F)
Strigiformes					
60	Spotted Owlet	*Athene brama* (Temminck, 1821)	Strigidae	Pulli aandhai	6 (I)
Suliformes					
61	Little Cormorant	*Microcarbo niger* (Vieillot, 1817)	Phalacrocoracidiae	Chinna neerkagam	11 (P)

Species observed >10 times were common; <10 times were uncommon; and those observed once/twice were rare
C: Carnivore; F: Frugivore; G: Granivore; H: Herbivore; I: Insectivore; N: Nectarivore; O: Omnivore; P: Piscivore

Table 2. Richness indices for the present study

Order	Hill's species index	Margalef's index	Menhinick's index
Accipitriformes	3	0.66	0.09
Anseriformes	1	0.00	0.03
Charadriiformes	2	0.33	0.06
Columbiformes	4	1.00	0.12
Coraciiformes	3	0.66	0.09
Cuculiformes	3	0.66	0.09
Galliformes	2	0.33	0.06
Gruiformes	1	0.00	0.03
Passeriformes	33	10.66	1.03
Pelecaniformes	4	1.00	0.12
Piciformes	1	0.00	0.03
Podicipedoformes	1	0.00	0.03
Psittaciformes	1	0.00	0.03
Strigiformes	1	0.00	0.03
Suliformes	1	0.00	0.03

Table 3. Diversity indices for the present study

Order	Brillouin's index	Hill's index	Shannon's index	Simpson's dominance index	Species index
Accipitriformes	0.0023	0.0014	0.21	0.00001	0.0029
Anseriformes	0.0022	0.0017	0.32	0.00001	0.0009
Charadriiformes	0.0020	0.0047	0.33	0.00007	0.0019
Columbiformes	0.0014	0.0172	0.23	0.0013	0.0039
Coraciiformes	0.0013	0.0169	0.16	0.0018	0.0029
Cuculiformes	0.0015	0.0126	0.23	0.0007	0.0029
Galliformes	0.0015	0.0103	0.18	0.0006	0.0019
Gruiformes	0.0025	0.0042	0.36	0.00005	0.0009
Passeriformes	0.0001	0.2268	0.12	0.429	0.0327
Pelecaniformes	0.0009	0.0330	0.10	0.0109	0.0039
Piciformes	0.0021	0.0032	0.27	0.00004	0.0009
Podicipedoformes	0.0022	0.0024	0.29	0.00002	0.0009
Psittaciformes	0.0012	0.0105	0.04	0.0028	0.0009
Strigiformes	0.0022	0.0024	0.29	0.00002	0.0009
Suliformes	0.0019	0.0045	0.21	0.0001	0.0009

Table 4. Evenness indices for the present study

Order	Alatalo's index	Heip's index	Pielou's index	Shannon's index	Sheldon's index
Accipitriformes	0.458	0.61	0.25	1.57	0.41
Anseriformes	0.565	0.00	0.43	1.36	1.37
Charadriiformes	0.574	1.39	0.45	0.99	0.69
Columbiformes	0.479	0.41	0.27	0.60	0.31
Coraciiformes	0.399	0.58	0.18	0.57	0.39
Cuculiformes	0.479	0.62	0.27	0.65	0.41
Galliformes	0.424	1.19	0.20	0.67	0.59
Gruiformes	0.599	0.00	0.51	2.00	1.43
Passeriformes	0.261	0.03	0.30	0.33	0.03
Pelecaniformes	0.314	0.36	0.10	0.46	0.27
Piciformes	0.519	0.00	0.34	1.12	1.30
Podicipedoformes	0.538	0.00	0.37	1.21	1.33
Psittaciformes	0.199	0.00	0.04	0.54	1.04
Strigiformes	0.538	0.00	0.37	1.21	1.33
Suliformes	0.458	0.00	0.25	0.91	1.23

Table 5. Other indices for the present study

Order	Berger-Parker dominance (%)	Community dominance index	Hill's number abundance (%)	Relative dominance (%)	Relative frequency
Accipitriformes	0.39	0.019	1.23	4.91	0.005
Anseriformes	0.49	0.031	1.37	1.63	0.012
Charadriiformes	0.89	0.057	1.39	3.27	0.015
Columbiformes	3.37	0.178	1.25	6.55	0.043
Coraciiformes	4.36	0.203	1.73	4.91	0.043
Cuculiformes	2.77	0.165	1.25	4.91	0.045
Galliformes	2.57	0.165	1.19	3.27	0.038
Gruiformes	0.29	0.019	1.43	1.63	0.007
Passeriformes	65.57	1.866	1.12	54.09	0.400
Pelecaniformes	10.41	0.579	1.10	6.55	0.173
Piciformes	0.69	0.044	1.30	1.63	0.017
Podicipedoformes	0.59	0.038	1.33	1.63	0.015
Psittaciformes	5.35	0.343	1.04	1.63	0.137
Strigiformes	0.59	0.044	1.33	1.63	0.015
Suliformes	1.09	0.070	1.23	1.63	0.028

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An annotated checklist of butterflies from Anjaneri conservation reserve, Northern Western Ghats, India

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Abstract

The destruction of habitats and urbanization pose a potential threat to butterfly diversity. Conservation reserves provide suitable habitats for flora and fauna. Butterflies are one of the most important and useful insects in the ecosystem. A total of 62 butterfly species from 46 genera and five families were documented Anjaneri conservation reserve located in India's Northern Western Ghats. The richest family was Nymphalidae (24 species), followed by the Lycaenidae (18 species), Pieridae (11 species), Papilionidae (6 species), and Hesperiidae (3 species). Among the 62 species, six species are protected under the Indian Wildlife (Protection) Act of 1972. This study emphasizes the importance of conservation reserves and focuses on the diversity of India's Northern Western Ghats.

Keywords: Anjaneri; Northern Western Ghats; Diversity; Butterflies.

Introduction

The Western Ghats can be divided into three parts the Southern Western Ghats, Central Western Ghats and Northern Western Ghats (NWGs) (Gaonkar, 1996). The NWGs run north to south along western Maharashtra from south of Gujarat to Goa. The NWGs includes a wide variety of habitats (Dethe and Medhe, 2020) and are home to rare and unique biodiversity. Due to a lack of proper management and study, NWG's biodiversity only remains in the reserved forests and they have received less conservation attention (Watve, 2008). Surveys in NWG's protected areas are needed to understand the true status and diversity of butterflies. (Padhye et al., 2013)

Butterflies are members of the order Lepidoptera and play an important role in ecosystems. Butterflies are significant in areas like genetics, ecology, embryology, and pest control. Butterflies are efficient pollinators and indicators of ecological health, anthropogenic disturbance and habitat quality (Kocher and Williams, 2008). Numerous species serve as biological indicators of environmental health and change (Thomas, 2005; Posha & Sodhi 2006; Koh, 2007). Butterflies are effective flagship species due to their attractiveness on the global level. (Barua et al., 2012). Therefore, studying butterflies is critical for conservation policies and environmental monitoring. (Sidat & Bhatt, 2020).

In 2017, the Anjaneri hill, which is located in the NWGs, was designated as a Conservation Reserve under Section 36A of the Wild Life Protection Act, 1972. The Anjaneri reserve is home to 385 different plant species, these plants are distributed into 68 different families (Auti et al., 2020) The area's rich floristic diversity and riparian patches attracts a wide range of insects and birds (Dethe and Medhe, 2020), amphibians, and reptiles. The Anjaneri is one of the most prominent hill forts in Nasik's Trymabkeshwar mountain range, because of its unique biodiversity; the forest department has designated this hill as a conservation reserve. Despite the floral and faunal importance, the area has been poorly documented in terms of faunal community, leaving data gaps. This study was done to document the baseline butterfly diversity in Anjeneri conservation reserve.

Material and Method

Anjaneri conservation reserve (Fig.1) is located at 20 km from Nashik (19 55'11.14"N 73 34'18.0"E) and has a total area of 8.0312 sq. kms, of which 5.69 sq. kms is designated as conservation reserve by forest department in 2017. It is surrounded by human habitation and agricultural land. There are three main plateaus at elevation 800MSL, 1100 MSL and 1280-1300 MSL respectively. Field data (02/01/ 2017 to 01/12/2019) was collected through a random survey when the majority of the butterflies were active (Morning 9 to 11 AM and evening 4 to 5 PM). Butterflies were identified in the field using field guides (Kunte, 2000; Kehimkar, 2016). The collection of specimens was not dome.

Climatic condition

There are three distinct seasons in the study area: Summer (March to May) with maximum temperatures ranging from 38 to 42°C, Monsoon (June to October) with average rainfall of 1500-2000mm, and winter (November to February) with temperatures ranging from 7-10°C.

Vegetation

The species composition on all three elevations varies. S*trobilanthes callosa, Chlorophytum glaucum, Pimpinella wallichiana, Lepidagathis cuspidata, Gynura bicolor, Alysicarpus bupleurifolius, Desmodiastrum racemosum var. rotundifolium, Smithia species* are present on middle and upper slope of hills, while middle slope has various herbaceous plants like *Commelina species, Neanotis foetida, Neanotis montholonii, Cynarospermum,* and *Canscora diffusa.* (Auti et al., 2020), the seasonal flowering plants like *Smithia, Senecio, Blumea*, *Celosia* are also present.

Results

Total 62 species belonging to five families were recorded during the study. Nymphalidae (24 species, 38.70%) was the richest family followed by Lycaenidae Family (17 species, 27.41%), Pieridae (11 species, 17.74%), Papilionidae (6 species, 9.67 %) and Hesperiidae (3 species, 5%). Among 60 species six species, *Pachliopta hector* (Linnaeus, 1758), *Anthene lycaenina* (R. Felder, 1868) *Hypolimnas misippus* (Linnaeus, 1764), *Cepora nerissa* (Fabricius, 1775), *Castalius rosimon* (Fabricius, 1775) and *Euchrysops cnejus* (Fabricius, 1798) were included in Indian Wildlife (Protection) Act 1972. *Junonia* were the most species-rich genera with five species (Fig.2). The checklist of butterfly is given below (Table.1) (Kasambe, 2016), along with photographs (Fig.3).

Discussion

According to IUCN (1994), protected area is an "area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means". Therefore, the main role of protected area is to conserve the diversity at population and genetic level, also protected area can contribute to save habitat and biogeographical zone. (Naro-Maciel et al., 2009). The primary goal of this research is to create an annotated checklist of the butterflies found in the Anjeneri conservation reserve; butterflies can serve as a flagship and umbrella species, and can contribute to protect ecosystems and other

Table 1. The checklist of butterfly form Anjaneri conservation reserve, Northern Western Ghats, India

	Species name	Common name
Sr. No	**Family Papilionidae**	
1	*Pachliopta aristolochiae* (Fabricius, 1775)	Common Rose
2	*Pachliopta hector (Linnaeus, 1758)* –	Crimson Rose
3	*Graphium agamemnon* (Linnaeus, 1758) –	Tailed Jay
4	*Graphium doson* (C. & R. Felder, 1864) –	Common Jay
5	*Papilio polymnestor* (Cramer, [1775]) –	Blue Mormon
6	*Papilio demoleus* Linnaeus, 1758 –	Lime Swallowtail
	Family Pieridae	
7	*Eurema hecabe/balda* (Linnaeus, 1758)	Common Grass Yellow
8	*Catopsilia pomona* (Fabricius, 1775) –	Common Emigrant
9	*Catopsilia pyranthe* (Linnaeus, 1758) –	Mottled Emigrant
10	*Delias eucharis* (Drury, 1773) –	Indian Jezebel
11	*Leptosia nina* (Fabricius, 1793) –	Psyche
12	*Cepora nerissa* (Fabricius, 1775) –	Common Gull (Schedule II - Part II)
13	*Ixias marianne (Cramer, [1779])*	White Orange-tip
14	*Ixias pyrene* (Linnaeus, 1764) –	Yellow Orange Tip
15	*Pareronia hippia* (Fabricius, 1787*)* –	Indian Wanderer
16	*Belenois aurota* (Fabricius, 1793) –	Pioneer
17	*Appias albina* (Boisduval, 1836) –	Common Albatross
	Family Nymphalidae	
18	*Melanitis leda (Linnaeus, 1758)* –	Common Evening Brown
19	*Melanitis phedima* (Cramer, 1780) –	Dark Evening Brown
20	*Ypthima baldus* (Fabricius, 1775) –	Common Five-ring
21	*Ypthima asterope* (Klug, 1832) –	Common Three-ring
22	*Ypthima huebneri Kirby, 1871* –	Common Four-ring
23	*Ariadne merione* (Cramer, [1777]) –	Common Castor
24	*Phalanta phalantha* (Drury, [1773]) –	Common Leopard
25	*Euthalia aconthea* (Cramer, [1777]) –	Common Baron
26	*Junonia lemonias* (Linnaeus, 1758) –	Lemon Pansy
27	*Symphaedra nais* (Forster, 1771) –	Baronet
28	*Junonia atlites* (Linnaeus, 1763) –	Grey Pansy
29	*Junonia hierta* (Fabricius, 1798) –	Yellow Pansy
30	*Junonia iphita* (Cramer, 1779) –	Chocolate Pansy
31	*Junonia orithya* (Linnaeus, 1758) –	Blue Pansy
32	*Vanessa cardui* (Linnaeus, 1758) –	Painted Lady
33	*Hypolimnas misippus* (Linnaeus, 1764) –	Danaid Eggfly (Schedule II- Part II)
34	*Hypolimnas bolina* (Linnaeus, 1758) –	Great Eggfly

35	*Tirumala limniace* (Cramer, [1775]) –	Blue Tiger
36	*Danaus chrysippus* (Linnaeus, 1758) –	Plain Tiger
37	*Danaus genutia* (Cramer, [1779]) –	Striped Tiger
38	*Euploea core* (Cramer, [1780]) –	Common Crow
39	*Parantica aglea* (Stoll, [1782]) –	Glassy Tiger
40	*Byblia ilithyia* (Drury, [1773]) –	Joker
41	*Neptis hylas (Linnaeus, 1758)* –	Common Sailer
	Family Lycaenidae	
42	*Castalius rosimon* (Fabricius, 1775) –	Common Pierrot (Schedule I - Part IV)
43	*Caleta decidia* (Hewitson, 1876) –	Angled Pierrot
44	*Talicada nyseus* (Guérin-Méneville, 1843) –	Red Pierrot
45	*Jamides celeno* (Cramer, [1775]) –	Common Cerulean
46	*Jamides bochus* (Stoll, [1782]) –	Dark Cerulean
47	*Zizeeria karsandra* (Moore, 1865*),* –	Dark Grass Blue
48	*Anthene lycaenina* (R. Felder, 1868)	Pointed Ciliate Blue ((Schedule II - Part II))
49	*Euchrysops cnejus* (Fabricius, 1798) –	Gram Blue (Schedule II - Part II)
50	*Abisara bifasciata* (Moore, 1877),	Double-banded Judy
51	*Curetis thetis* (Drury, 1773),	Indian Sunbeam
52	*Spindasis vulcanus* (Fabricius, 1775),	Common Silverline
53	*Chilades pandava* (Horsfield, [1829]) –	Plains Cupid
54	*Rathinda amor* (Fabricius, 1775) –	Monkey Puzzle.
55	*Chilades lajus* (Stoll, [1780]) –	Lime Blue
56	*Freyeria putli* (Kollar, [1844]) –	Black-spotted Grass Jewel
57	*Iraota timoleon* (Stoll, [1790]) –	Silverstreak Blue
58	*Zizina otis (Fabricius, 1787)* –	Lesser Grass Blue
59	*Acytolepis puspa (Horsfield, [1828])* –	Common Hedge Blue
	Family Hesperiidae.	
60	*Sarangesa dasahara* (Moore, [1866]) –	Common Small Flat
61	*Pelopidas conjuncta* (Herrich-Schäffer, 1869) –	Conjoined Swift
62	*Taractrocera ceramas* (Hewitson, 1868)	Tawny-spotted Grass Dart

organisms (Spitzer et al., 2009). During this study, we discovered that Nymphalidae is a species-rich family, with 15 genera of 24 species and this concurs with other studies (Tiple and Khurad, 2009; Kumar et al., 2016). Anjeneri reserve is butterfly rich area, which includes six species listed under Indian Wildlife Protection Act.1972. Many butterfly species have been observed in the post-monsoon season, which correlates with the flowering season. (Harsh et al., 2015).

Butterfly diversity is primarily determined by floral and larval host plant diversity. (Murphy and Wilcox, 1986). This rich diversity demonstrates that this reserve is a thriving habitat for butterflies, which can be attributed to the reserve's floral diversity. (Silambarasan, K et al., 2016). The high butterfly diversity of this area is due to favorable temperature, precipitation and diverse habitat. Butterflies favor specific habitats (Sreekumar and Balakrishna, 2001).

Fig.1. Study site Anjaneri conservation reserve.

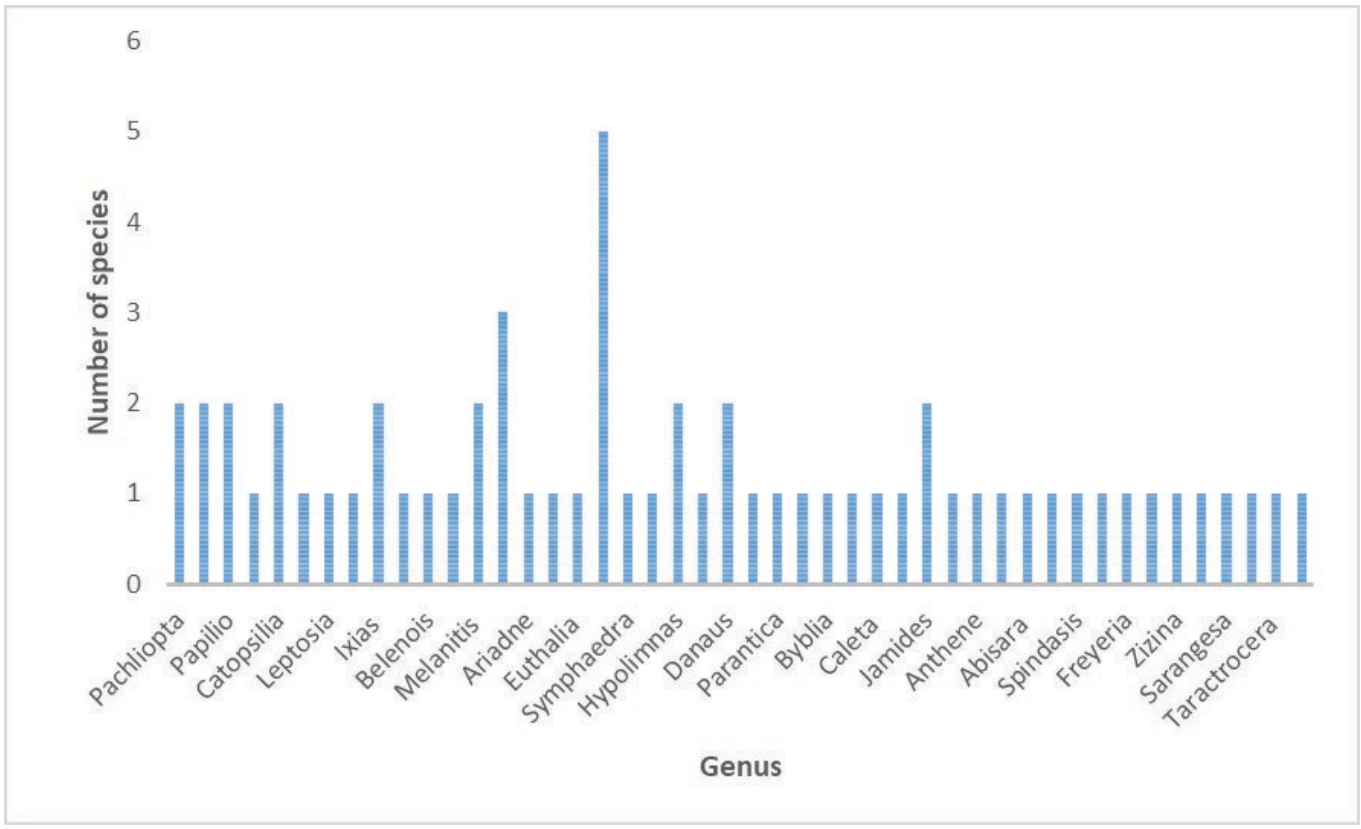
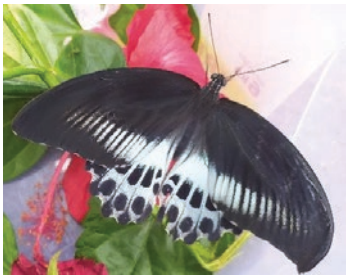


Fig.2. The number of butterflies in each genus in the Anjaneri conservation Reserve.

Fig.3. Butterflies of Anjaneri conservation reserve.



Papilio polymnestor

Papilio demoleus

Graphium doson

Graphium agamemnon

Eurema blanda

Catopsilia pomona

Leptosia nina

Cepora nerissa

Ixias marianne

Pareronia hippia

Belenois aurota

Melanitis leda

Ypthima asterope

Ypthima huebneri

Ariadne merione

Fig.3. Butterflies of Anjaneri conservation reserve.

Phalanta phalantha

Euthalia aconthea

Junonia lemonias

Junonia atlites

Vanessa cardui

Hypolimnas bolina (Male)

Tirumala limniace

Danaus chrysippus

Hypolimnas bolina (Female)

Neptis hylas

Castalius rosimon

Talicada nyseus

Fig.3. Butterflies of Anjaneri conservation reserve.

Jamides bochus

Chilades pandava

Zizina otis

Acytolepis puspa

Freyeria putli

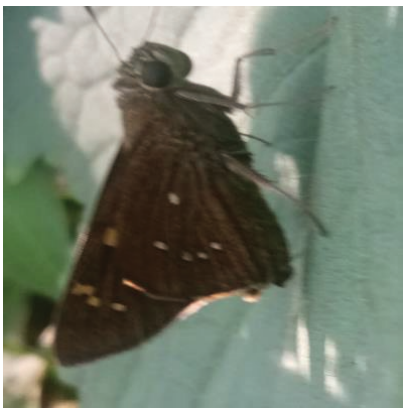
Abisara bifasciata

Rathinda amor

Spindasis vulcanus

Iraota timoleon

Sarangesa dasahara



Pelopidas conjuncta

Taractrocera ceramas

The diversity of herb, shrub, and tree species found in the Anjaneri conservation reserve, as well as the existence of riparian sections, hills, and lowlands, provide appropriate breeding and feeding grounds for butterfly species. Butterflies serve a crucial role in pollination and ecological maintenance. The rich diversity of butterflies in an area is a sign of a healthy and productive environment. The periodic survey, population and conservation study of butterflies is needed in Anjaneri conservation reserve.

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The status of raptors in steppe area around Solapur city, Maharashtra

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ABSTRACT

Grassland ecosystem in scrubs and plateau area around Solapur city, Maharashtra was surveyed by line transect and point count method. Existing tar roads were used to reach the villages around the Solapur city, Maharashtra. In all 22 species of raptors were recorded. 50% of the species found were winter visitors (n=11). Greater Spotted Eagle *Aquila clanga* and Lesser Kestrel *Falco naumanni* were globally threatened winter migrant and passage migrants. A ringed and antenna tagged individual of Montagu's Harrier *Circus pygargus* was recorded in the region. Grasshoppers were taken as food by most raptors while other food items were geckos and snakes (Common Rat Snake *Ptyas mucosa* , Saw-scaled Viper *Echis carinatus* and Common Indian Spectacled Cobra *Naja naja* . Other birds (N= 35), reptiles (n= 5) and mammals (n= 6) were also recorded. This report can be useful to plan raptor conservation and habitat protection in the region.

Key Words: Raptors, Solapur, Grasslands, Steppe, Migration, Accipiter, Harriers, Eagles, Falcon.

Introduction-

There are 557 species of raptors in the world (Christopher *et al.,* 2018), including Orders like Accipitriformes (Hawks and Eagles excluding old world vultures), Cathartiformes (Old world vultures and new world vultures), Falconiformes (Falcons)

and Strigiformes (Owls as per IUCN standards and petitions subcommittee, 2017). Raptors have hooked beak, strong, powerful feet and long curved talons, good vision, powerful and strong wings (Christopher *et al*., 2018). They are top predators of various ecosystems such as grasslands, scrublands, forests and deserts (Olson *et al.,* 2001). Pasturing, deforestation, cattle breeding, establishment of commercial projects such as sugar factories, stone crushing plants, goat farming, poultry farms, trekking tourism are various manmade changes found in India in raptor habitats affecting food, nesting, movements, roosting and habitat use by the raptors (Sonawane *et al*., 2021). In various parts of India about 100 species of raptors are found (Lees et al., 2001). The grassland-steppe area around Solapur city is least studied for the raptor diversity and their habitat use in special. Less research is undertaken in this region as compared to studies on waders and water birds in Ujjani-Bhigwan Bird Sanctuary (Chavan and Kumbhar, 2020). The present survey was planned to investigate raptor diversity, distribution, conservational status and their food in approximately 70-80 Km^2 around Solapur city the district, Maharashtra, India.

Materials and Methods-

Study area:

By line transect and point count method survey was conducted in the study area. Existing tar roads were used to reach the villages such as Boramani (17^0 45' 02 " N, 76 " 02' 35" E), Gangewadi (17^0 45' 02 " N, 76 ^{0} 02' 35" E), Pimpla (Bk.) (17^0 50' 17" N, 76^0 01' 07" E), Kegaon (17^0 42' 37 " N, 75^0 48' 52" E) and Katgaon (17^0 46' 31 " N, 76^0 02' 45" E) around Solapur city. It is steppe plateau area with lowland patches. Pasturing activity is common in the study area. The trails connected from these villages to the main road were used as line transects of approximately 100 meters from start to end point for the walking survey. NIKON D-7200 and D-500 camera with 70 mm, 300-500 mm lenses were used for photography. NIKON binocular was used for sighting of raptors and other bird species in the area. Field data sheet for birding was used to record the occurrence of raptor species and associated avifauna from the region. The raptors were identified using reference books (Grimmett, 2016; Pande et al., 2013; Ali, S., 2002; Ali & Repley, 1996). The raptor species found in the study area are classified for their conservational status as per IUCN, 2019; Birdlife International, 2019, as LC, NT, VU, En, Cr, Ew and E. The estimates of trend of population direction applied were increasing, stable, decreasing or unknown (Van der Hoek *et. al*., 2017). The Raptors were marked at local stations as Common (C), Occasional (O), Rare (R), Winter migrants (W), Uncommon (U).

Result and Discussion-

During this study total 22 species (Figure 1. A to X) of raptors were identified from the study area (Table.1.). Indian Spotted Eagle *Clenga hastate*, Tawny Eagle *Aquila rapax* and Greater Spotted Eagle *Aquila clanga* (13.63 %) and were vulnerable (VU) and Pallid Harrier *Circus macrourus* and Red-necked Falcon *Falco chicquera* (13.04 %) were Near Threatened (NT). Other species of raptors were 69.56 % under least concern (LC) category. From the observed raptors 11 species (50.00 %) were winter visitors indicates the importance of this region around Solapur city, 10 species (43.45 %) were residents and 02 species (9.09 %) were passage migrants indicating that few raptors use this area as transit stay ground (Bildstein, 2006). The raptors were accompanied by 35 species of local birds (Table 2), 6 species of mammals (Table 3) and 5 species of reptiles (Table 4). The raptors also use the small mammals, the birds and reptile species as food. One Montagu's Harrier was seen with radio antenna fixed on its back and was also ringed in its left leg (Fig. 1-C). This ringed and radio telemetry antenna fixed species have been observed by several regular birders in this region since year 2018. Based on the sighting status of the raptor species in the study area 13 species (59.09 %) were under common category, 8 species (36.36 %) species were rare whereas 2 species (9.09 %) were occasionally found. We observed that unidentified grasshoppers were the main food of the raptors. Locally available locusts (Bhusnar, 2015) included 18 species of grasshoppers (Mayya *et al.,* 2003). In the region Bhusnar (2015) reported that *Phlaeoba infumata* was most dominant species of grasshopper (Kirby, 1914) with maximum population in post monsoon season.

Roosting behavior and inter-specific interactions in raptors:

At sunset the Montagu's Harriers and Pallid Harriers arrived in the area in 100s of number and gather in isolated groups of 60-70 and roost on

ground till very early morning, similar observation was recorded by others (Cristina et al., 2017). They hovered for 10-15 min at about 100 ft height above the roosting ground. We once recorded a single Laggar Falcon and Peregrine Falcon attacking a flock of 20-30 each Pallid Harrier and Montagu's Harriers but they were chased away by the Harriers; and were forced to take shelter in thick tree canopy. And eventually fly away. Globally, 18 % raptors are threatened with extinction and 52 % have declining global population (Rahmani, 2012; Sergio et al., 2008). It was also found that the south and south-east Asia has highest richness and the largest number of threatened raptors species compared to rest of the distributional patterns in the world with the highest richness of raptor species found in Indonesia (119 species) whereas China and Russia has highest raptor species diversity in the world (Risser et al., 1981). Agriculture and logging are the important threats for decline in raptor population. Distribution of raptors is identified in 10 IBA's all over the world of which 6 are in Nepal (Newton, 1979; Olson et al., 2001). For raptor conservation, highest priority is to conserve their habitats. Raptors are more sensitive to anthropogenic impacts due to their highest trophic level in the ecosystem they inhabit (Sergio et al., 2008). Ecosystem degradation and ecosystem conservation are two important strategies that affected the raptors worldwide (Goriup & Tucker, 2007). It is estimated that 131 raptor species (24%) can be conserved by land and water protection, 78 species (14%) by education and awareness, 71 species (13%) by management of water and land (Bildstein, 2006; Goriup and Tucker, 2007; Virani and Watson, 1998). Education and awareness are most frequently listed actions reported for raptor conservation. In of the study by Sonwane *et al.* (2020) 29 species of raptors were recorded near Manyarkheda lake region, Jalgaon, Maharashtra which is similar to the number of species (n=22) found in present study, but we did not record any vulture species. To maintain this rich ecosystem conservation of land, water and other food resources in the region is essential.

Conclusion

In all 22 raptor species including 50% winter migratory species were recorded between October and April in plateau and grassland area around Solapur city in Maharashtra. Grasshoppers, other birds, reptiles and mammals were also recorded in the area. Cattle grazing, increasing agriculture practices, cutting of trees and establishment of stone crushing industries are important threats identified for the wintering raptor species. Conservation of grassland and scrublands around Solapur city is highly recommended to save this raptor rich ecosystem.

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Author Contributions-

The Corresponding author Shivaji Chavan (SPC) conceived the idea, drafted the manuscript, and analyzed the data; SH, RK and AK surveyed and photographed the raptors, and reviewed the manuscript.

Table-1: Species diversity, IUCN status, migratory status and population richness of raptors in steppe and scrublands around Solapur city, Maharashtra.

Sr. No.	Common Name	Family and Scientific Name	IUCN Status	Migrat-ion Status	Sighting Status And Number in study area
1.	Short-toed Snake Eagle	*Circaetus gallicus* (Gmelin, 1788)	LC	RS	C, 03 pairs regularly found; 09 pairs during Nov. to Dec. 2019 as breeding and laying period
2a	Montague's Harrier	*Circus pygargus* (Linnaeus, 1758)	LC	W	C, (One individual with leg-Ringed and Radio antenna fixed on the back)
2b	Montagu's Harrier	*Circus pygargus* (Linnaeus, 1758)	LC	W	C, Frequently found at every visitduring winter season
3	Booted Eagle	*Hieraaetus pennatus* (Gmelin, 1788)	LC	W	C, Count of 08. Seasonal, winter visitor
4	Indian Spotted Eagle	*Clenga hastate* (Lesson, 1834)	VU	W	R, 1-2, in hilly region only.
5	Tawny Eagle.	*Aquila rapax* (Temminck, 1828)	VU	W	R, 1-2, Rare, uncommon, migrant
6	Bonelli's Eagle	*Aquila fasciata* (Vieillot, 1822)	LC	RS	C, Large prey killer, attacked GIB. Fox, Black Buck, Rabbit. Spread population, Large nest on trees found.
7	Greater Spotted Eagle	*Aquila clanga* (Pallas, 1811)	GT	W	R, Uncommon, Very rarely 1-2 individuals.
8	Pallid Harrier	*Circus macrourus* (Gmelin, 1770)	NT	W	R, Non breeding,
9	Common Kestrel	*Falco tinnunculus* (Linnaeus, 1758)	LC	W	C, Non breeding,
10	Laggar Falcon	*Falco jugger* (J. E. Gray, 1834)	NT	RS	R, Uncommon
11	Lesser Kestrel	*Falco naumanni* (Fleischer, 1818)	GT	PM	R, First photographic record of Male and female in Solapur District
12	Peregrine Falcon	*Falco peregrines* (Tunstall, 1771)	LC,	W	O, Migrant, Uncommon, Jan-April
13	Eurasian Sparrow Hawk	*Accipiter nisus* (Linnaeus, 1758)	LC	W	O, Rare, Migratory to India
14	White Eyed Buzzard	*Butastur teesa* (Franklin, 1831)	LC	RS	C, Many Local migratory
15	Indian Eagle Owl	*Bubo bengalensis* (Franklin, 1831)	LC,	RS	C, Common. Breeding Oct-April, Nest on Cliffs
16	Short Eared Owl	*Asio flammeus* (Pontoppidan, 1763)	LC	RS	C, Winter migrant but common. Prefer grass

17	Shikra	*Accipiter badius* (Gmelin, 1788)	LC	RS	C, Nesting on trees, breed in March-June. In cities and outskirts area of cities
18	Red Necked Falcon	*Falco chicquera* (Daudin, 1800)	NT	RS	R, Decreased trend. Remain away and isolated from other Raptors
19	Eurasian Marsh Harrier	*Circus aeruginosus* (Gmelin, 1788)	LC	W	C, Uncommon, Migratory, Near water bodies
20	Amur Falcon	*Falco amurensis*	LC	PM	R, 1-4, Rare, Winter migrant
21	Black shoulder Kite	*Elanus axillaris* (Lathom, 1801)	LC	RS	C, Breeding in Jan-Apr
22	Common Kite	*Milvus migrans*	LC	RS	C, Not seen very commonly

(RS: Resident, W: Winter visitor, PM: Passage migrant, C: Common, R: Rare, O: Occasional, LC: Least Concern, NT: Near Threatened, GT: Globally Threatened)

Table. 2. The Avifauna other than raptors found in the study area.

Sr. No.	Common Name	Family and Scientific Name	IUCN Status	Migrat-ion Status	Sighting Status And Number in study area
1	Painted Francolin	*Francolinus pictus* (Jardine & Selby, 1828)	LC	RS	R, Early morning at sunrise the noise heard in the region.
2	Painted Stork	*Mycteria leucocephala* (Pennant, 1769)	NT	RS	C, Found at perennial water bodies in the region.
3	White-necked stork	*Ciconia episcopus* (Boddaert, 1783)	NT	RS	C, Frequently visit the drying water bodies in late winter.
4	Black Ibis	*Pseudibis papillosa* (Temminck, 1824)	LC	RS	C, Frequently visit the drying water bodies in late winter.
5	Black-headed Ibis	*Treskiornis melanocephalus* (Latham, 1790)	NT	RS	R, Sometimes found at coastal area of ponds in the region.
6	Eurasian Spoonbill	*Platalea Leucorodia* (Linnaeus, 1758)	LC	RS	C, Visit the water bodies accompanied usually with Painted Storks in group.
7	Grey Francolin	*Ortygornis pondicerianus* (Gmelin, 1798)	LC	RS	C, Frequently sighted with Indian Courser, Sand grouse during March to May each year.
8	Indian Pond Heron	*Ardeola grayii*	LC	RS	C, In the Marginal area of ponds in region. Well camouflaged with background.
9	Cattle Egret	*Bubulcus ibis* (Bonaparte, 1858)	LC	RS	C, Frequently found in the region. It was attacked by raptors in the region.
10	Grey Heron	*Ardea cinerea* (Linnaeus, 1758)	LC	RS	R, Sometimes found at coastal area of ponds in the region.
11	Yellow-wattled Lapwing	*Vanellus malabaricus* (Boddaert, 1789)	LC	RS	O, Decline population trend observed.
12	Red-wattled Lapwing	*Vanellus indicus* ((Boddaert, 1783)	LC	RS	C, Sporadic occurrence mainly at and near water bodies in the region.

13	Indian Courser	Cursooorius coromandelicus (Gmelin, 1789)	LC	RS	C, Frequently found during visits to the area in summer season mainly.
14	Sand grouse	*Pterocles namaqua* (Gmelin, 1789)	LC	SM	C, Frequently sighted with Indian Courser during March to May each year.
15	Collared Dove	*Streptopalia decaocto* (Frivaldszky, 1838)	LC	RS	C, Isolated pairs, frequently seen in the scrub area.
16	Red Dove	*Streptopalia tranquebarica* (Hermann, 1804)	LC	W	R, Rarely found at large medium size Acacia trees in the region.
17	Common Rock Pigeon	*Columba livia* (Gmelin, 1789)	LC	RS	C, In the scrublands of region.
18	Indian Roller	*Coracias benghalensis* ((Linnaeus, 1758)	LC	RS	C, Found in open grasslands and dry lands of the region.
19	European Roller	*Coracias garrulous* (Linnaeus, 1758)	LC	RS	W, For short period it was found in late summer.
20	White-breasted Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	LC	RS	C, Found near the agriculture area and water bodies.
21	Small Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	LC	RS	R, Found in early winter season near water bodies.
22	Long-tailed Shrike	*Lanius schach* (Linnaeus, 1758)	LC	RS	C, Marginal region of agriculture area.
23	Sykes' Lark	*Galerida deva* (Sykes, 1832)	LC	RS	C, Mainly in scrub patches.
24	Ashy-crowned Sparrow- Lark	*Eremopterix griseus* (Scopoli, 1786)	LC	RS	C, Commonly found in the region.
25	Greater Short Toed Lark	*Calandrella brachydactyla* (Leisler, 1814)	LC	RS	R, Scrublands, throughout year.
26	Bush Lark	*Mirafra erythroptera* (Blyth, 1845)	LC	RS	C, Found in the short to medium bushes.
27	Red Vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	LC	RS	C, Commonly found in the region.
28	Common Babbler	*Argya caudate* (Dumont, 1823)	LC	RS	C, frequently seen in the mid and late monsoon
29	Ashy Prinia	*Prinia socialis* (Sykes, 1832)	LC	RS	C, Common in agricultural area of the region.
30	Common Myna	*Acredotheres tristis* (Linnaeus, 1766)	LC	RS	R, Sometimes found at coastal area of ponds and agricultural marginal areas in the region.

31	Brahminy Myna	*Sturnia pagodarum* (Gmelin, 1789)	LC	RS	R, Sometimes found in agricultural marginal areas in the region. And thorny bushes.
32	Green Bea eater	*Merops orientalis* (Latham, 1801)	LC	RS	C, Found on wire fencing of private lands in the region.
33	Black Drongo	*Dicrurus macrocercus* (Vieillot, 1817)	LC	RS	C, Marginal regions of Agriculture lands.
34	Common Tailor Bird	*Orthotomus sutorius* (Pennant, 1769)	LC	RS	C, Frequently found in the area.
35	Gray-headed Bunting	*Emberiza fucata* (Pallas, 1776)	LC	W	C, Reach to grasslands in Late winter for short time. This is first report in Solapur region.

(RS: Resident, W: Winter visitor, PM: Passage migrant, C: Common, R: Rare, O: Occasional, LC: Least Concern, NT: Near Threatened, GT: Globally Threatened)

Table 3. Mammalian species found in the study area: Grasslands around Solapur city.

Sr. No.	Common Name	Family and Scientific Name	IUCN Status	Migration Status	Sighting Status And Number in study area
1	Brown Rat	*Rattus norvegicus* (Berkenhout, 1769)	LC	RS	C, All over the scrublands, along roadsides found. Near marginal area of agriculture fields.
2	Black Buck or Indian Antelope	*Antilope cervicapra* (Linneaus, 1758))	LC	RS	O, Adults, and Young ones found, the larger Rafters found attacking on the young ones.
3	Black Napped Hare or Indian Hare	*Lepus nigricollis* (Linnaeus, 1758)	LC	RS	R, But found in winter and summer season all over the study area.
4	Indian Jackal	*Canis c. aureus* (Linnaeus, 1758)	LC	RS	C, Found throughout year in the region. Mixed population of adults and young ones.
5	Bengal Fox	*Vulpes bengalensis* (Shaw, 1800)	LC	RS	O, Found throughout year in the region. Mixed population of adults and young ones.
6	Indian Gray Wolf	*Canis lupus pallipes* (Sykes, 1831)	LC	RS	R, Isolated or pairs of adults found 4 times in a year.

(RS: Resident, W: Winter visitor, PM: Passage migrant, C: Common, R: Rare, O: Occasional, LC: Least Concern, NT: Near Threatened, GT: Globally Threatened

Table 4. Reptile species found in the study area: Grasslands around Solapur city.

Sr. No.	Common Name	Family and Scientific Name	IUCN Status	Migrat-ion Status	Sighting Status And Number in study area
1	Rat Snake	*Ptyas mucosa* (Linnaeus, 1758)	LC	RS	C, Found throughout year in the entire scrublands and grassland plateau.
2	Saw Scale Viper	*Echis carinatus* (Schneider, 1801)	LC	RS	C, Found especially during summer
3	Monitor Lizard	*Varanus varius* (Merrem,1820)	LC	RS	C. Found at the onset of monsoon
4	Jerdon's snake eye Gecko	Ophisops jerdonii)	LC	RS	C, rarely found near termite mounds
5	Indian Spectacled Cobra	*Naja naja*	LC	RS	TC, Throughout Year.

(RS: Resident, W: Winter visitor, PM: Passage migrant, C: Common, R: Rare, O: Occasional, LC: Least Concern, NT: Near Threatened, GT: Globally Threatened)

Table 5. IUCN status and migratory status of raptor species in steepe area around Solapur city (n = 22).

Sr. No.	IUCN status and Migratory status	% values for n = 22
1.	Resident (n=10)	43.45
2	Winter visitors (n=11)	50.00
3	Passage migratory (n=02)	09.09
4	Least Concern (n=16)	72.72
5	Near Threatened (NT=03)	13.63
6	Vulnerable (n=02)	09.09
7	Globally Threatened (n=02)	09.09
8	Common (n=13)	59.09
9	Rare (n=08)	36.36
10	Occasional (n=02)	09.09

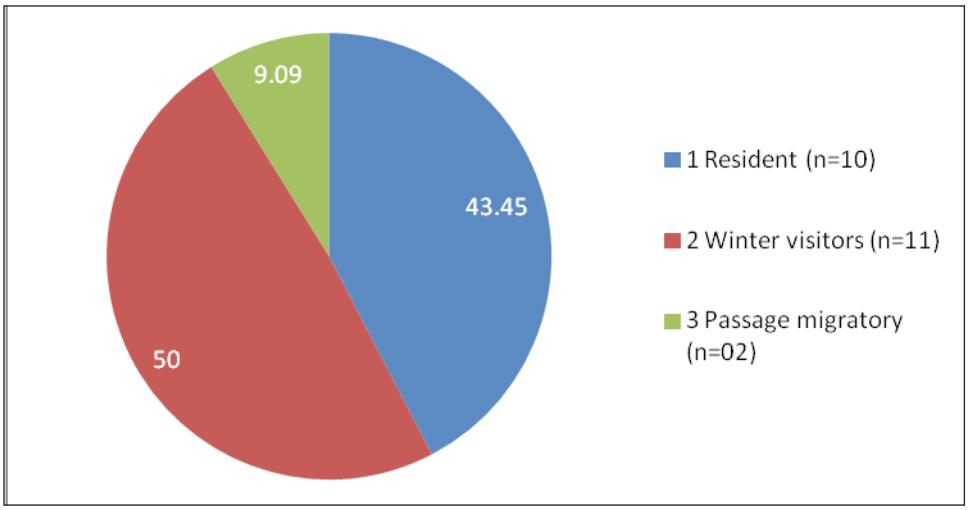


Fig. 2. Sighting status of Raptor species in steepe area around Solapur city, Maharashtra

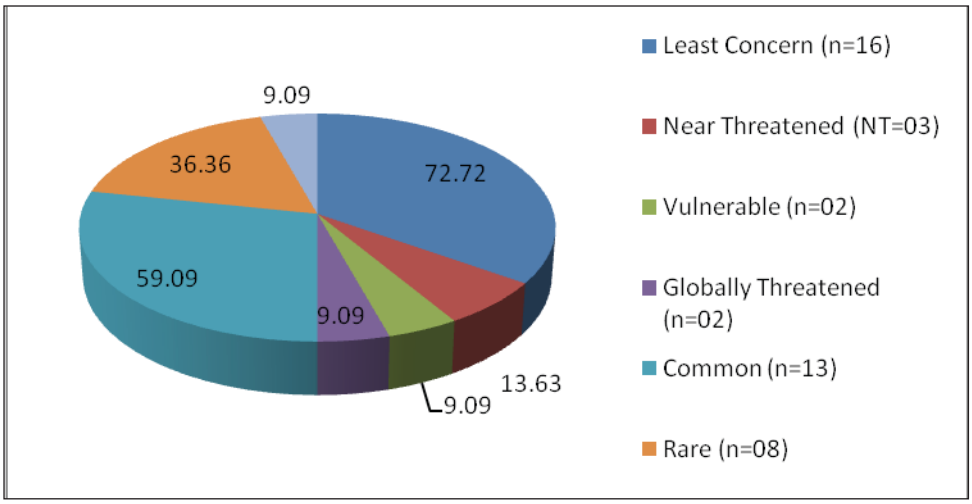


Fig. 3. IUCN status of Raptor species in steepe area around Solapur city, Maharashtra

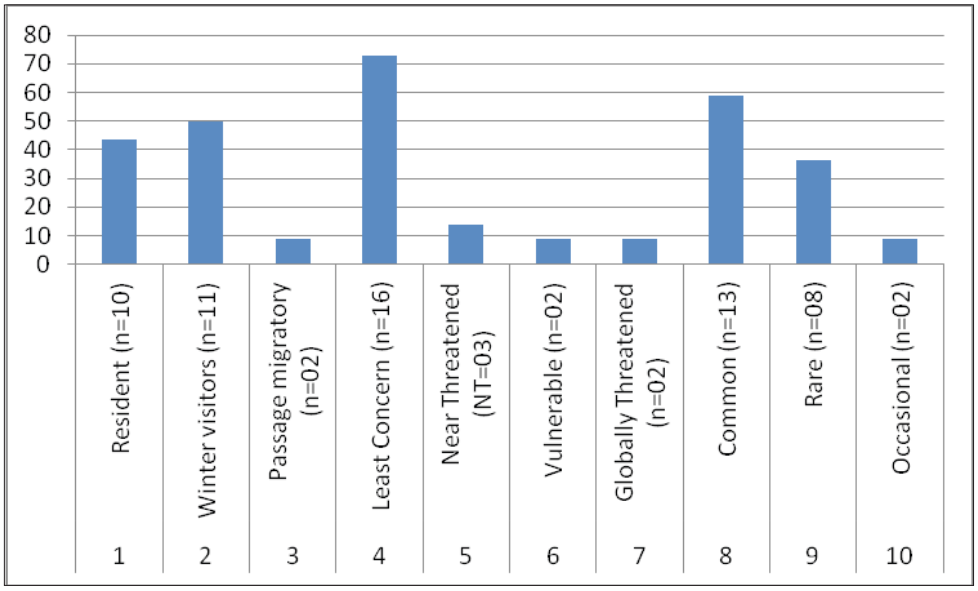
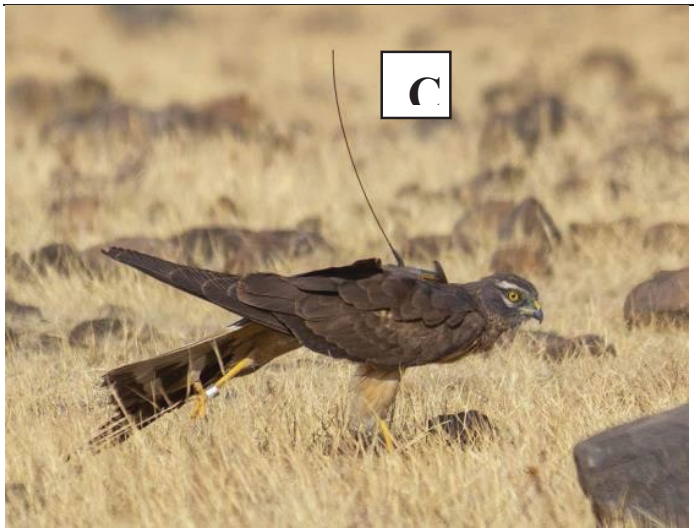


Fig. 4. IUCN status, Migratory status and Sighting status of Raptors species in steepe area around Solapur city, Maharashtra.(Values in %)

FIGURES Raptors (Resending on Date 01/02/2022)

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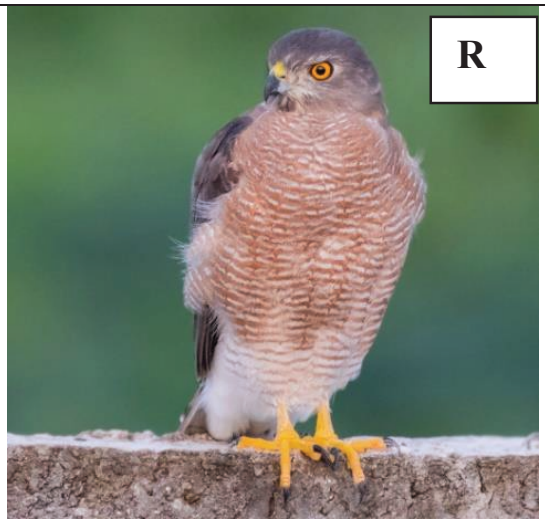
R

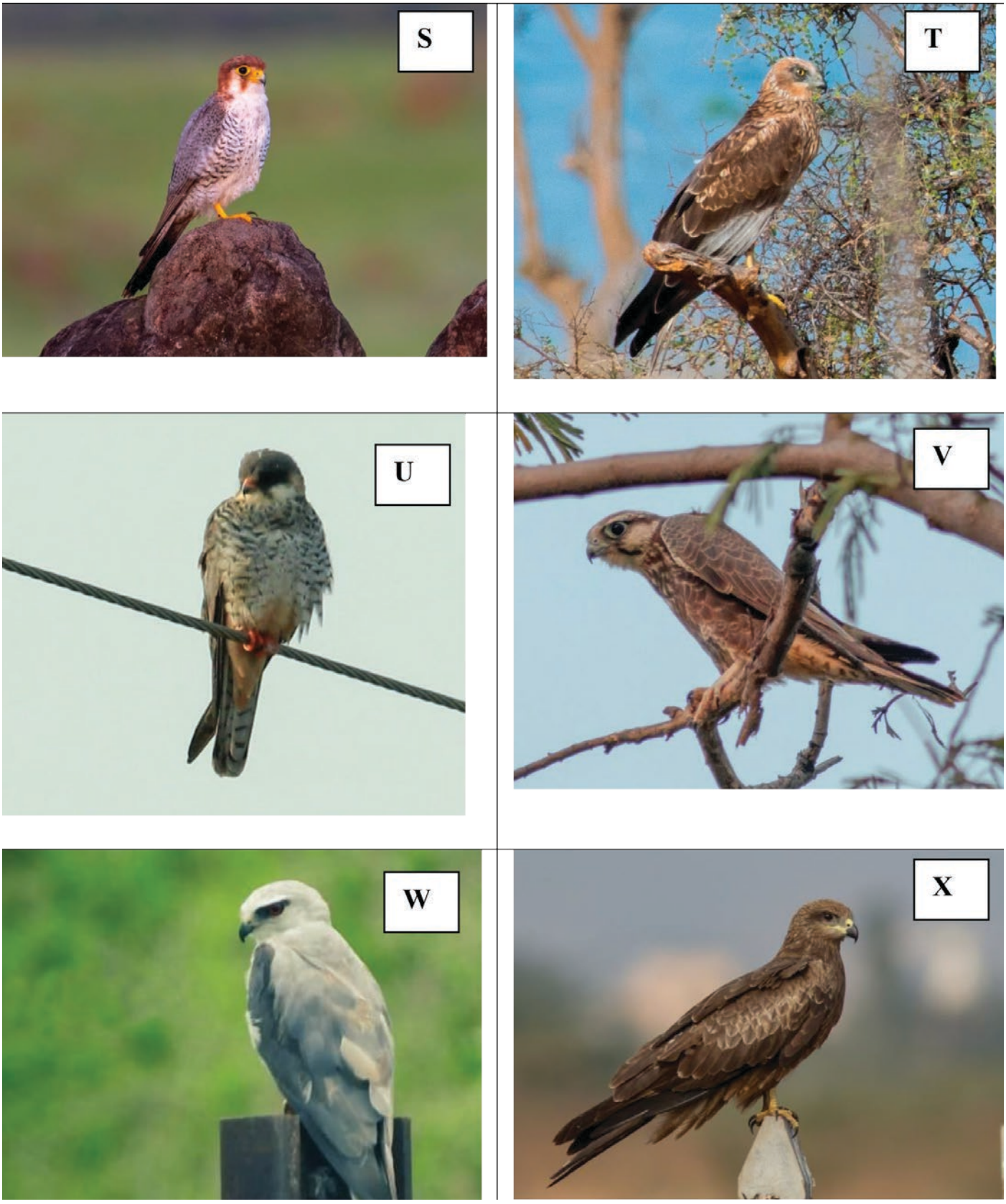

Fig. 1(A to X). Raptors in the study area of Solapur, Maharashtra: (A). Short Toed Snake Eagle (B). Montagu's Harrier (C). Short Toed Snake Eagel (D). Booted Eagle (E). Indian Spotted Eagle (F). Tawny Eagle (G). Bonelli's Eagle (H). Greater Spotted Eagle (I). Pallid Harrier (J). Common Kestrel (k). Laggar Falcon (L). Lesser Kestrel (M). Peregrine Falcon (N). Euresian Sparrow hawk (O). White Eyed Buzzard (P). Indian Eagle Owl (Q). Short Eared Owl (R) Shikra. (S). Red Necked Falcon (T). Marsh Harrier (U). Amur Falcon (V). Laggar falcon (W). Black shoulder Kite (X). Black kite.

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Diversity Survey of Birds in Shree Siddheshwar Van Vihar, Solapur, Maharashtra, India.

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Abstract:

The present paper records the avifaunal diversity of Shree Siddheshwar Van Vihar which is a grassland with thorny scrub and woody vegetation located at the outskirts of Solapur city. 101 bird species belonging to 50 families were recorded during the study period of July, 2020 to June 2021. These included residential (78), local migratory(11), summer migratory (11) and winter migratory(1) species.

Keywords : Avifauna; Diversity; Migratory; Reserved forest; Siddheshwar van vihar.

Introduction:

Birds play several roles in ecosystem including pest control, pollination, seed dispersal (Grimmette et al 2015). The eBird database contains 1333 bird species from India and Siddheshwar Van Vihar is one of them (State of India's Bird, 2020). The objective of present work was to study the status and diversity of birds in Shree Siddheshwar Van Vihar.

Materials and Methods:

Shree Siddheshwar Van Vihar, located 2 km from the Solapur city on Vijapur road (17^0 40'39.4860" N and 75^0 53'42.7020" E) is a reserved forest. (googlemaps.com) The average rainfall is 603.79 mm per annum. The temperature ranges between 14^0C in winter and 42^0 C in summer. Van Vihar development project began in 1997 and was completed in 2002[4]. The present survey was done during July, 2020 to June 2021 including all three seasons *i.e.* monsoon, winter and summer. Due to covid-19 pandemic, regular visits had limitations (Saha and Chouhan 2021). The survey was conducted

Location of study site : Shree Siddheshwar Van Vihar (www.googlemaps.com)

on Sunday early from sunrise to 9 AM and in evening from 5 PM to sunset by direct field observation and head count method. Birds were counted using 10 X 50 Olympus binocular. Bird identification was done with the help of standard field guide Pande *et al.,* 2013 and Grimmett *et al.,* 2015. The photographs were taken by Nikon 5300 camera with zoom lens of 55mm to 200mm.

Results and Discussion:

Table: 1. Bird species found in Shree Siddheshwar Van Vihar, Solapur.

Sr.No	Common Name	Scintific Name	Family	Status
1	Little Grebe	*Tachybaptus ruficollis*	Podicipedidae	R
2	Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	R
3	Little Cormorant	*Microcarbo niger*		R
4	Grey Heron	*Ardea cinerea*	Ardeidae	LM
5	Purple Heron	*Ardea perpureo*		R
6	Large Egret	*Egretta alba*		R
7	Intermediate Egret	*Egretta intermedia*		R
8	Little Egret	*Egretta garzetta*		R
9	Indian Pond Heron	*Ardeola grayii*		R
10	Painted Stork	*Mycteria leucocephala*	Ciconiidae	R
11	Wooly-necked Stork	*Ciconia episcopus*		R
12	Black-headed Ibis	*Threskiornis melanocephalus*	Threskiornithidae	R
13	Glossy Ibis	*Plegadis falcinellus*		R
14	Eurasian Spoonbill	*Platalea leucorodia*		R
15	Common Pochard	*Aythya ferina*	Anatidae	M
16	Gadwal	*Mareka strepera*		M
17	Indian Spotbilled Duck	*Anas poecilorhyncha*		R

18	Black-Shouldered Kite	*Elanus caeruleus*	Accipitridae	R
19	Brahminy Kite	*Haliastur indus*		LM
20	Western Marsh Harrier	*Circus aeruginosus*		M
21	Black Kite	*Milvus migrans*		R
22	Shikra	*Accipiter badius*		R
23	Grey Francolin	*Francolinus pondicerianus*	Phasianidae	R
24	Indian Peafowl	*Pavo cristatus*		R
25	Indian Moorhen	*Gallinula chloropus*	Rallidae	R
26	Eurasian Coot	*Fulica atra*		R
27	Black Drongo	*Dicrurus macrocercus*	Dicruridae	R
28	Ashy Drongo	*Dicrurus leucocephaeus*		LM
29	Black-winged Stilt	*Himantopus himantopus*	Recurvirostridae	R
30	Yellow Wattled Lapwing	*Vanellus malbaricus*	Charadridae	R
31	Red Wattled Lapwing	*Vanellus indicus*		R
32	Wood Sandpiper	*Tringa glareola*	Scolopacidae	M
33	Commom Sandpiper	*Actitis hypoleucos*		M
34	Indian Courser	*Cursorius coromandelicus*	Glareolidae	R
35	Bay Backed Shrike	*Lanius vittatus*	Lanidae	R
36	Long-tailed Shrike	*Lanius schach*		R
37	Rock Pigeon	*Columbia livia*	Columbidae	R
38	Eurasian Collared Dove	*Streptopelia decaocto*		R
39	Laughing Dove	*Spilopelia senegalensis*		R
40	Rose Ringed Parakeet	*Psittacula krameri*	Psittacidae	R
41	Plum-headed Parakeet	*Psittacula cyanocephala*		R
42	Jacobin Cuckoo	*Clamator jacobinus*	Cuculidae	LM
43	Indian Cuckoo	*Cuculus micropterus*		R
44	Common Hawk Cuckoo	*Hierococcyx varius*		M
45	Asian Koel	*Eudynamys scolopaceus*		R
46	Greater Coucal	*Cebtropus parroti*		R
47	Spotted Owlet	*Athene brama*	Strigidae	R
48	Common Myna	*Acridotheres tristis*		R
49	Brahmany Starling	*Sturnia pagodarum*		R
50	Indian Nightjar	*Camprimulgus asiaticus*	Caprimulgidae	R
51	Little Swift	*Apus affinis*	Apodidae	R
52	Common Kingfisher	*Alcedo atthis*	Alcedinidae	R
53	White-throated Kingfisher	*Halcyon smyrnensis*		R
54	Pied Kingfisher	*Ceryle rudis*		R
55	Green Bee-Eater	*Merops orientalis*	Meropidae	R
56	Indian Roller	*Coracias benghalensis*	Coraciidae	LM

57	Common Hoopoe	*Upupa epops*	Upupidae	LM
58	Indian Grey Hornbill	*Ocyceros birostris*	Bucerotidae	LM
59	Coppersmith Barbet	*Psilopogon haemacephalus*	Megalaimidae	R
60	Yellow Crowned Woodpecker	*Leiopicus mahrattensis*	Picidae	R
61	Eurasian Wryneck	*Jynx torquilla*		M
62	Ashy Crowned Sparrow Lark	*Ermopterix griseus*	Alaudidae	R
63	Wire-tailed Swallow	*Hirundo smithii*	Hirudinidae	R
64	Red-rumped Swallow	*Cecropis daurica*		R
65	Common Woodshrike	*Tephrodornis pondicerianus*	Tephrodornithidae	R
66	Red Vented Bulbul	*Pycnonotus cafer*	Pycnonotidae	R
67	Small Minivet	*Pericrocotus cinamomeus*	Campephagidae	R
68	Indian Robin	*Saxicoloides fulicatus*	Muscicapidae	R
69	Oriental Magpie Robin	*Copsychus saularis*		R
70	Black Redstart	*Phoenicurus ochruros*		LM
71	Pied Bush Chat	*Saxicola maurus*		R
72	Plain Prinia	*Prinia inornata*	Cisticolidae	R
73	Ashy Prinia	*Prinia socialis*		R
74	Common Tailor Bird	*Orthotomus sutorius*		R
75	Indian Pitta	*Pitta brachyuran*	Pittidae	R
76	Forest Wagtail	*Dendronanthus indicus*	Motacillidae	M
77	Western Yellow Wagtail	*Motacilla flava*		WM
78	Grey Wagtail	*Motacilla cinerea*		M
79	Tree Pipit	*Anthus trivialis*		LM
80	Purple Rumped Sunbird	*Leptocoma zeylonica*	Nectarinidae	R
81	Purple Sunbird	*Cynniris asiaticus*		R
82	Oriental White Eye	*Zosterops palpebrosus*	Zosteropidae	R
83	Grey Necked Bunting	*Emberiza buchanani*	Emberizidae	M
84	Black Headed Bunting	*Emberiza bruniceps*		M
85	Red Avadvat	*Amanadava amandava*	Estrididae	R
86	Indian Silverbill	*Euodice malbarica*		R
87	Scaly Breasted Munia	*Lonchura punctulata*		R
88	House Sparrow	*Passer domesticus*	Passeridae	R
89	Baya Weaver	*Ploceus philippinus*	Ploceidae	R
90	Indian Golden Oriole	*Oriolus kundoo*	Oriolidae	R
91	Large billed Crow	*Corvus macrorhynchos*	Corvidae	R
92	House Crow	*Corvus splendens*		R
93	Common Kestrel	*Falco tinnunculus*	Falconidae	R
94	Eurasian Hobby	*Falco subbuteo*		LM
95	White Spotted Fantail	*Rhipidura albicollis*	Rhipiduridae	R

96	Orange Headed Thrush	*Geokichla citrine*	Turdidae	LM
97	Phesant-tailed Jacana	*Hydrophasianus chirurgus*	Jacanidae	R
98	Bronze-winged Jacana	*Metopidius indicus*		R
99	Large Grey Babbler	*Turdoides malcolmi*	Leiothricidae	R
100	Jungle Babbler	*Turdoides striata*		R
101	Yellow Eyed Babbler	*Chrysomma sinense*		R
Total	**Species = 101**		**Families = 50**	**R = 78**
				WM=1
				LM=11
				SM=11

Key to abbreviations: R : Resident, WM : Winter Migratory, LM : Local Migratory, SM : Summer Migratory.

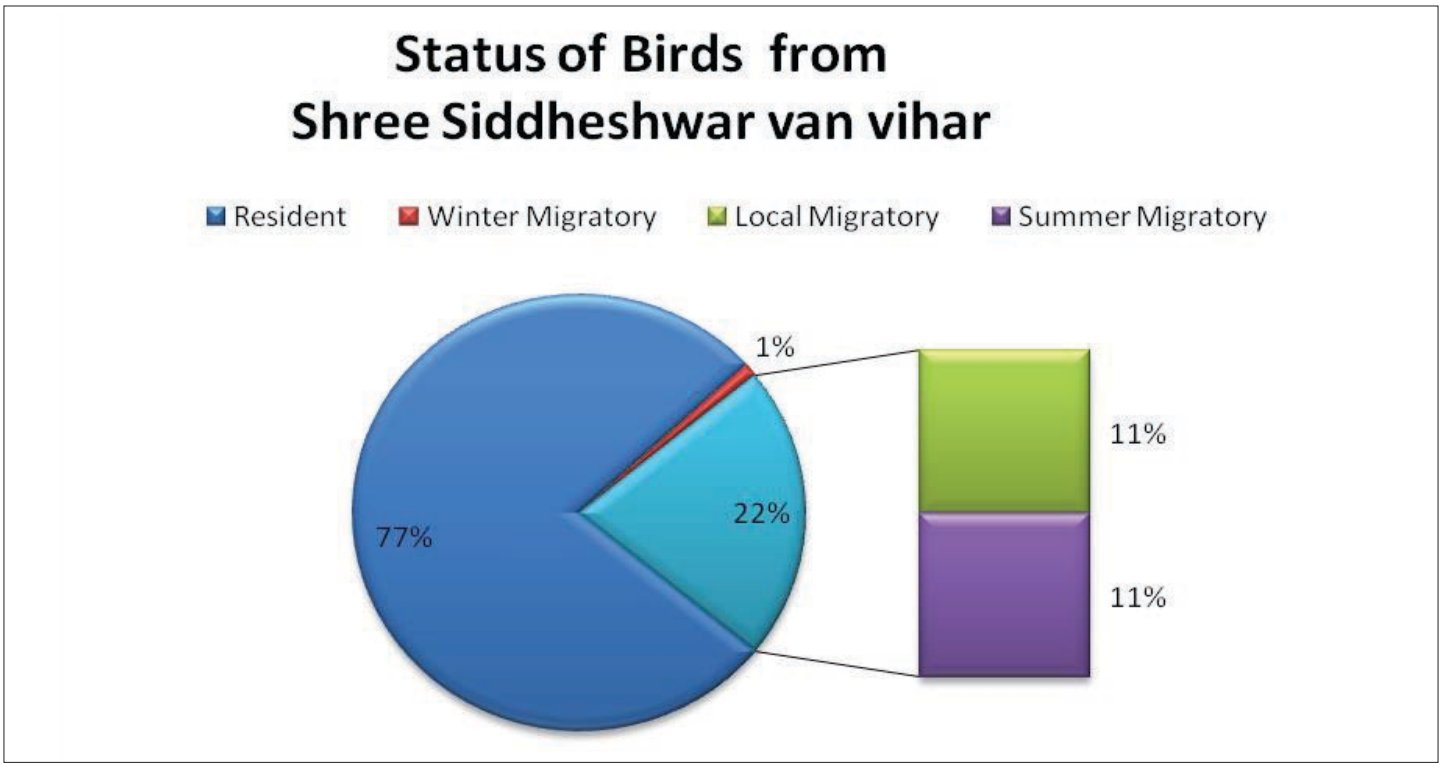

Figure: 1. Status of Birds.

Total 101 species of birds belonging to 50 families were recorded from the study site (Table: 1). Maximum bird species were from family Ardeidae (6) Out of 101 bird species, 78 (77%) were resident, 1 (1%) was winter migratory, 11 (11%) were local migratory and 11 (11%) were summer migratory (Fig: 1). The study area with grassland, thorny scrub and woody vegetation, two waterholes (1 natural, 1 man made) provide safe place for nesting and roosting of birds. Plenty of food and shelter and lack of distubance attract avifauna to the Van Vihar. In present investigation we compared the avifaunal abundance before and after Covid-19 pandemic and it reveals the change in bird species composition and commumity structure of Shree Siddheshwar Vanvihar. In Siddheshwar Van Vihar nearly 16% of the Indian avian species are observed and more than 50% birds of Solapur district are found here[4]. Joshi *et al.,*(2021) studied avian diversity in forest, agricultural and water steam habitats of Dehradun. They recorded 231 species belonging to 54 families.

Figure: 2. Study site Shree Siddheshwar Vanvihar Solapur :

a) Site map

b) Guidelines for visitors

c) Bird watching point

d) Nature eco-education centre

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Author's Contributions:

Survey and Data collection, Mansuscript Prepartation–Mahesh Nilange. Data analysis – Arvind Kumbhar.

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Rare sighting of Peregrine Falcon *Falco peregrinus* at wetland area of village Dalaj No.1, Tahsil Indapur, Dist. Pune, Maharashtra, India.

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- Name of species: Peregrine Falcon
- Family: Falconidae
- Scientific name: *Falco peregrinus*
- Status: Least concern, IUCN 2019
- Date of sighting: 17th February 2020
- Time of sighting: 3.15 pm
- Weather: Sunny
- Number of times sighted: Single
- Gender of bird: Male
- Locality: Dalaj No.1, Tahsil Indapur, Dist. Pune, Maharashtra state, India
- Habitat description: Wetland of Bhima river
- Distance from human civilization: 3 km
- Any other bird/animal associates: Birds observed at the muddy wetland area were- *Phalacrocorax niger, Egretta alba, Ardea cineria, Threskiomis melanocephalus, Platalea leucorodia, Anas poecilorhyncha, Fulica atra, Charadrius hiaticula, Charadrius dubius, Charadrius alexandrines, Limosa limosa, Tringa glareola and Himantopus himantopus*
- Bird behavior: While boating in Bhima river a Peregrine Falcon was perched on a branch of dead tree in a water logged area.
- Threats to the habitat: Bird poaching.
- Previous records: No documented record of Peregrine Falcon from this locality.

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