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Cover: Dorsal view of Mantis Shrimp *Cloridina ichneumon* (Fabricius, 1798) & *Gonodactylus demanii* (Henderson, 1893). © Fisheries Research Station, Junagadh Agricultural University, Sikka.



A checklist of avifauna from different habitats of semi-arid landscape in western parts (Mandsaur and Ratlam districts) of Madhya Pradesh, India

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Abstract: We prepared a checklist of avian species recorded from two western districts (Mandsaur and Ratlam) of Madhya Pradesh, situated in a semi-arid region with comments on their habitat preference, feeding habits, migratory, and conservation status; 133 bird species belonging to 47 families were recorded during the present study. About 30% of the species were migratory in status. In terms of habitat fidelity, 74 avian species were found only in a single habitat. Habitat-wise avian richness varied widely. Among five habitats identified during the present study, wetland supported the highest number (69) of avian species of which 58 species were exclusively recorded from this habitat. Eight foraging guilds were identified among which omnivores were dominant. Six species of globally threatened and seven species of near-threatened species were recorded during the present study. The presence of significant numbers of winter migrants and globally threatened species indicated the importance, both ecologically and biologically, of the semi-arid landscape for breeding and migratory birds. Therefore, this work will provide baseline information to conservationists for the development of conservation and management policies for the two districts.

Keywords: Avian diversity, central India, conservation, feeding habits, habitat fidelity, migratory, semi-arid landscape, threatened species, wetlands, winter migrants.

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Author contributions: Both of the authors were involved in field survey, documentation, literature review and manuscript preparation, editing and finalizing the manuscript.

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INTRODUCTION

Birds are one of the most widely distributed and abundant vertebrate taxa, living in diverse habitat types across different ecosystems. In a particular ecosystem, the avian community plays a variety of functional roles and provides different important ecosystem services (Sekercioglu 2006, 2012; Whelan et al. 2008). Change in vegetation composition affects the habitat quality for birds in terms of food, nesting site, which in turn affect the species richness, abundance, and distribution (Western & Grimsdell 1979). Birds generally colonize an area that is suitable in terms of resources for their survival (Veech et al. 2011). Many species of birds show fidelity towards a particular habitat (Chatterjee et al. 2013) so, alteration or degradation of that particular habitat leads to a declining population (Khan et al. 2019). Therefore, they act as an important bioindicator of habitat quality, environmental degradation, pollution, and ecosystem health (Gregory et al. 2003; Zhang & Ma 2011). Due to these essential ecological functions, birds have always been extensively used for conservation and environmental impact assessment studies (Knegeting et al. 2005).

Semi-arid regions are climatic zones that are intermediate between humid and arid (desert) climates. This zone is characterized by scanty precipitation and an aridity index between 0.20–0.50. Generally, the semi-arid region supports scrubby and grassland vegetation along this region has agricultural potential (with proper irrigation and management practices). Globally, about 65% of the area of total dry land in the world comes under arid and semi-arid regions (FAO 1993). In India, the semi-arid biogeographic zone is situated in transition between desert (arid) and other zones like the Himalaya, Western Ghats, Deccan Peninsula, and Gangetic plains (Rodgers & Panwar 1988). This region accounts for 16.60% of the total geographic area of the country covering the states of Rajasthan, Gujarat, Madhya Pradesh, Punjab, Haryana, Uttar Pradesh, and Maharashtra. Two-hundred-and-seventeen endemic bird areas (EBA) with a large number of endemic bird species, identified by Birdlife International, are located within the arid and semi-arid regions of the World (Stattersfield et al. 2005). Avian populations in semi-arid regions are declining rapidly due to several factors such as unplanned development activities, climate change, and urbanization. Therefore, proper documentation of avian species, identification of their habitats, and breeding grounds is essential for proper conservation and management of avian communities and their habitat

(Khan et al. 2019).

Avifaunal study in central India started before independence with the earliest work by King in the year 1911 who enlisted around 155 resident bird species from Saugar and Damoh (Chandra & Singh 2004). Later several other studies in this field were conducted by authors like Baker (1930a,b); D'Abreu (1931); Hewetson (1939), and Ali (1939, 1940). Grimmett & Inskipp (2003) listed 469 species of birds but due to lack of a comprehensive study, Chandra & Singh (2004) undertook a literature survey and reported around 488 taxa from Madhya Pradesh. In western Madhya Pradesh, 139 avian species were reported from the Gandhisagar reservoir (Vyas & Singh 2004) while Dange & Kumar (2013) listed 94 species of birds from the Ratlam district.

Preparing a checklist of taxa is the first and foremost task to acquire knowledge of biodiversity in a particular geographic area. This checklist acts as a basis for further in-depth studies, viz., systematics, taxonomy, distribution, evaluation, and conservation (Núñez-Zapata et al. 2016). Keeping this in mind the main aim of this study was to observe, record, and prepare a checklist of avian species from two western districts of Madhya Pradesh, situated in the semi-arid region with comments on their habitat preference, feeding habit, migratory and conservation status.

MATERIALS AND METHODS

Study area

Mandsaur (Site I) and Ratlam (Site II), two western districts of Madhya Pradesh located in the Malwa region covers an area of 5,521 and 4,861 km², respectively (Figure 1). The climatic conditions of these two areas are generally dry except during the monsoon season when it receives rainfall from the southwest monsoon. This area is generally classified under a semi-arid biogeographical zone (Rodgers & Panwar 1988). The average annual rainfall is 786 and 937 mm, respectively for the sites. Summer temperature ranges 38–44 °C while the winter temperature ranges 4–8 °C (Dange & Kumar 2013; NIC 2020).

We classified our study area into five habitat types (Image 1) based on their vegetation type, land use, and land cover which includes:

Wetland (WL): Both natural and man-made wetlands are present in the study area that are home to a wide variety of bird species that includes wintering and resident waterfowl, waders, raptors, etc.

Grassland (GL): Dominated by grass species of the

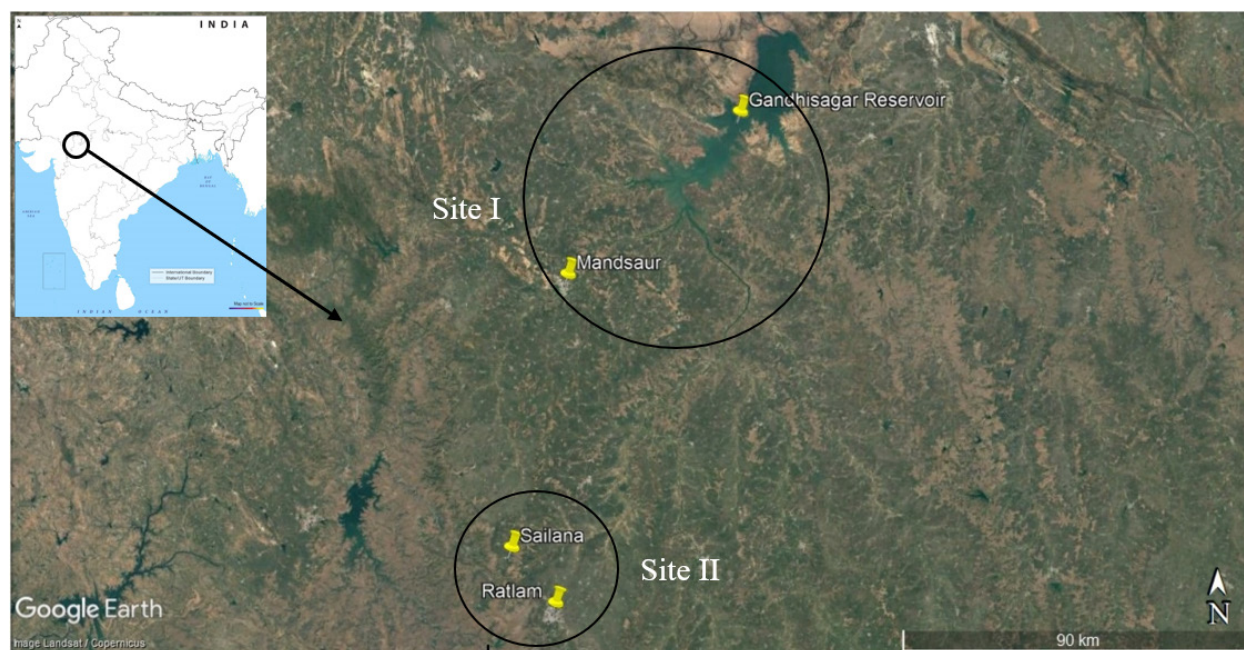


Figure 1. Map of the study sites (Site I: Mandsaur and Site II: Ratlam) at semi-arid landscape of western Madhya Pradesh.

genus *Bothriochloa*, *Themeda*, and *Dichanthium* provide shelter to different raptors like Montagu's Harrier, Short-toed Snake Eagle, various passerines, and others.

Open scrub jungle (OS): Dominated by *Acacia* and *Balanities*. Bird species inhabiting this area include Shikra, Common Kestrel, dove, bushchat, bunting, and starling.

Agricultural land (AL): Several crops like Soybean *Glycine max*, Wheat *Triticum aestivum*, Gram *Cicer arietinum*, Mustard *Brassica*, and Maize *Zea mays* are cultivated in this area.

Dry deciduous forest (DF): Most of the forests covers in these two districts are mainly Tropical dry deciduous forests which are dominated by Teak *Tectona grandis* and *Butea* sp. mixed with other species like Saja *Terminalia tomentosa*, Sal *Shorea robusta*, Bija *Pterocarpus marsupium*, Lendia *Lagerstroemia parviflora*, Haldu *Adina cardifolia*, Dhaora *Anogeissus latifolia*, Salai *Boswellia serrata*, Amla *Embllica officinalis*, Amaltas *Cassia fistula*, and Gamhar *Gmelina arborea* (Singh 2014).

Field visits were carried out in the morning (0600–1100 h) and in the afternoon (1500–1900 h), when birds were found to be most active during December 2015 and February 2016. Various survey methods like line transect (3 in each habitat, about 900–1,150 m long track) and point transect (5 in each habitat) that were randomly placed, along with opportunistic sightings were used to record various bird species of the region (Bibby et al.

2000; Sutherland 2006). Olympus 10×50 DPSI binoculars and Canon PowerShot sx500 IS camera were used for observation and photographs were taken whenever it was possible. Identification and categorization of avian species according to their migratory status either resident (R), winter visitor (WV), or passage visitor (PM) was done using field guides (Kazmierczak & van Perlo 2000; Grimmett et al. 2011). Bird species included in different IUCN Red List categories (IUCN 2020) and Schedule under the Wildlife (Protection) Act, 1972 (BNHS 2002) were also taken into account while preparing the checklist. Based on the frequency of observation, following categorizations were made: Common (C): frequently observed in the study area (encountered during sampling in more than 60% cases); Uncommon (UC): spotted on multiple occasions but not as frequently as in case of common (encountered during sampling in more than 30% but less than 60% cases); Rare (R): not frequently encountered in the entire study period (encountered during sampling in less than 30% cases). Feeding habits (guilds) of birds were recorded as per observation and following published literature (Ali & Ripley 1987).

RESULTS AND DISCUSSION

One-hundred-and-thirty-three bird species belonging to 47 families and 13 orders were recorded during the

study period of which 123 were recorded from Site I and 112 were recorded from Site II (Table 1). The highest number of bird species were recorded from Accipitridae and Anatidae family (11 spp. each) followed by Turdinae (8 spp.) and Ardeidae (7 spp.). The checklist of birds of the two districts is represented in Table 1 while the number of bird species and their families is graphically represented in Figure 2. According to the observed frequency, 37 bird species (27.82 %) were common, 79 species (59.40 %) were uncommon, and 17 species (12.78 %) were rare. Availability of diverse resources, habitat heterogeneity, and different anthropogenic factors influences the avian diversity of the studied sites. Avian species were categorized according to their migratory status (either resident, winter visitor, or passage visitor). Ninety-three species were resident, 39 species were winter visitors and only a single species was passage visitor (Rosy Starling).

Habitat-wise avian richness varied widely during the present study. Wetland (WL) harboured a maximum number (69) of avian species, followed by agricultural land (AL, 56 spp.) and open scrub jungle (OS, 50 spp.). These high numbers might indicate the ability of certain bird species to occupy diverse habitat types. However, in grassland (GL) and dry deciduous forest (DF) habitats, avian richness was quite low; 33 and 24 species were recorded from GL and DF habitats respectively (Figure

3). Wetlands were an important habitat that sustains a substantial number of waterbirds and wetland-associated birds (Kumar et al. 2005). However, most of the small water bodies were temporary that eventually dried up in summer. During winter, water was pumped out for irrigation by farmers of nearby agricultural fields but still, the wetlands harboured rich avifauna. Agricultural fields were also an important habitat that sustains the rich diversity of avifauna in different landscapes (Hossain & Aditya 2014; Swamy et al. 2015; Kumar & Sahu 2020). The present study also revealed the importance of wetland and agricultural fields as avian habitats.

In the present study, we recorded that 74 avian species (i.e., 55.64 % of total recorded spp.) were found exclusively in a single habitat (Figure 4). Among this, highest number of species (58 spp.) were exclusively recorded from WL habitat. Similar findings were also recorded by Chatterjee et al. (2013) while working in sub-Himalayan forest patches. Waterbirds were specialists in resource utilization (utilizing feeding habitat and foraging technique selection) therefore they show strong fidelity towards wetlands (Chatterjee et al. 2020). However, in other habitats, the number of species that were solely found in that habitat was much less. In DF, AL, and OS the number of species was seven, six, and three, respectively. In GL no such species were recorded

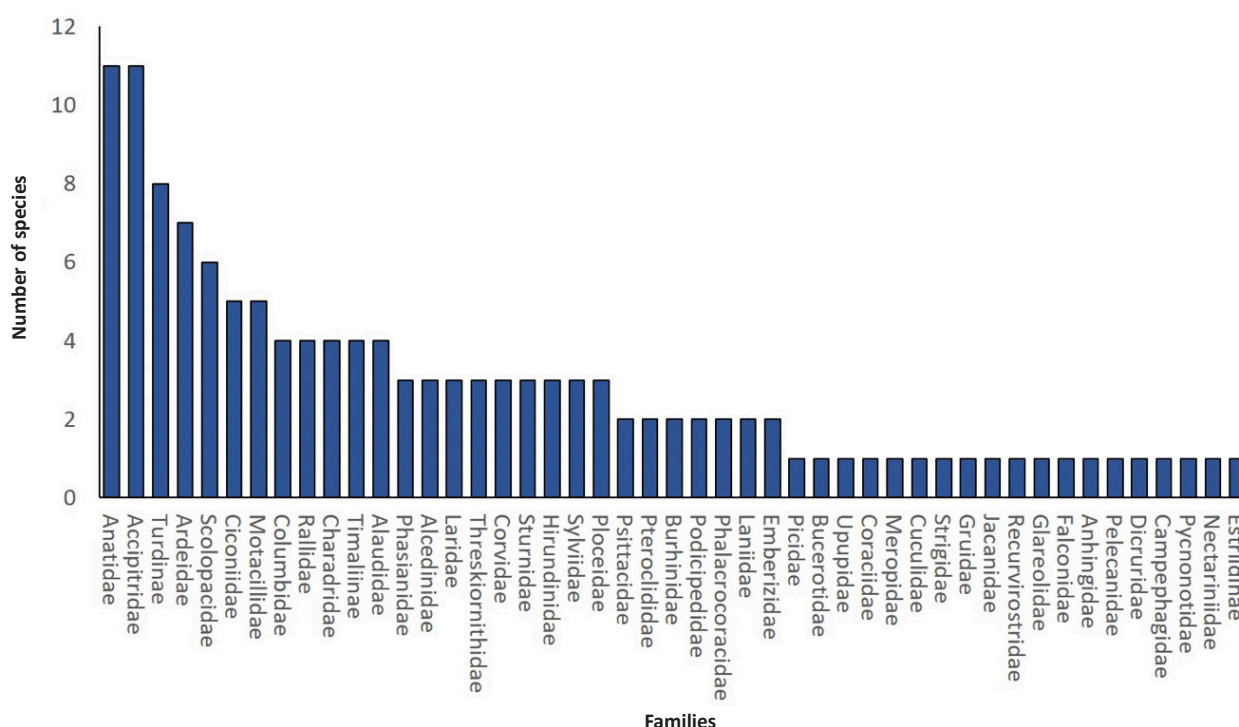


Figure 2. Family wise distribution of bird species recorded during present study.

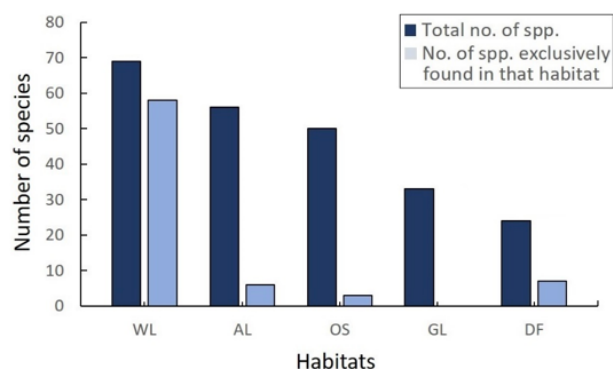


Figure 3. Distribution of bird species in different habitats (total number of species and species exclusively found in that habitat), viz., wetland (WL), grassland (GL), open scrub jungle (OS), agricultural land (AL) and dry deciduous forest (DF).

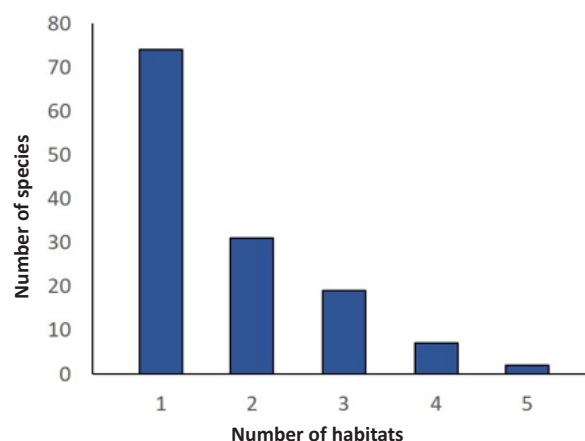


Figure 4. Habitat fidelity of bird species at semi-arid landscape of western Madhya Pradesh. Number of bird species in a single habitat, and consequently 2–5 studied habitats are given in the graph.

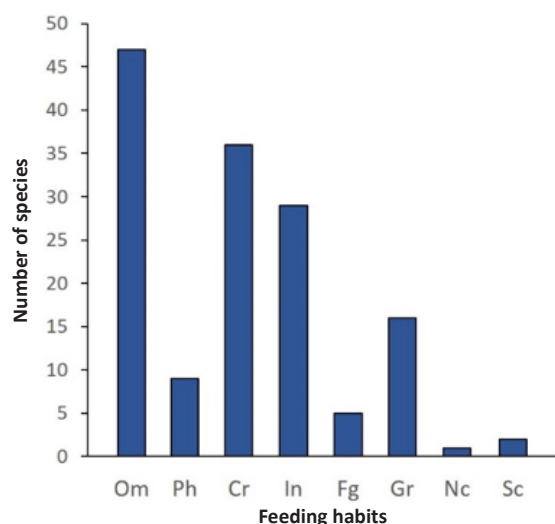


Figure 5. Distribution of bird species of different foraging habits (guilds) i.e., omnivorous (Om), phytophagous (Ph), carnivorous (Cr), insectivorous (In), frugivorous (Fg), granivorous (Gr), nectarivores (Nc) and scavengers (Sc) recorded during present study.

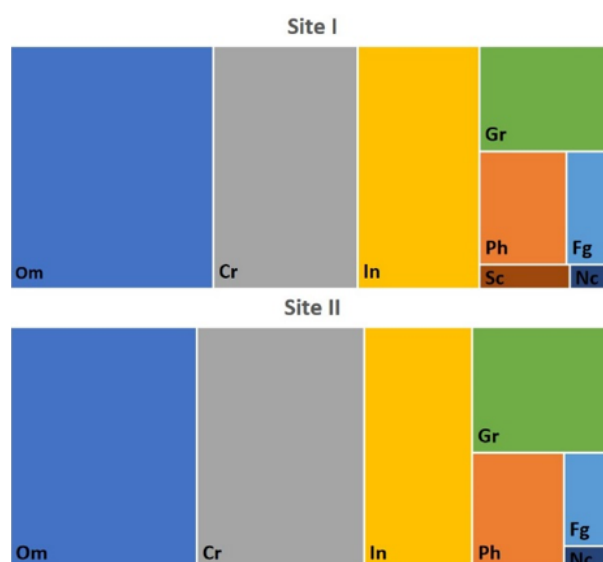


Figure 6. Site wise distribution of bird species belonging to different foraging habits (guilds).

(Figure 3). The rest of the species are found in more than one habitat. 31 species (23.31 %) were found in two habitats, 19 species (14.29 %) in three habitats, seven species (5.26 %) in four habitats, and only two species (1.50 %) were recorded from all five habitats (Figure 4).

A total of eight feeding habits (guilds) were recorded including omnivorous (Om), phytophagous (Ph), carnivorous (Cr), insectivorous (In), frugivorous (Fg), granivorous (Gr), nectarivores (Nc), and scavengers (Sc). Few species had more than one feeding habit and species feeding on diverse food items belonging to different trophic levels were designated as Om. Om birds were most abundant (47 spp.) followed by Cr (36 spp.), In (29 spp.), Gr (16 spp.), Ph (9 spp.), and Fg (5

spp.). Foraging guilds dominated by Om birds were also recorded by several workers like Yashmita-Ulman & Singh (2021), Noreen & Sultan (2022). The increase in the abundance of Om birds is possibly due to a change in food resources as a result of urbanization (Marzluff & Rodewald 2008). Two species, recorded during the present study were scavengers (Sc) viz., *Neophron percnopterus* (Egyptian Vulture), and *Gyps bengalensis* (White-rumped Vulture). Scavengers play an important role in the ecosystem by feeding on carcasses and/or human garbage (Moleón et al. 2014) and are much susceptible to anthropogenic effects (Ogada et al. 2011). Once vultures were abundantly distributed in this region as mentioned by the local inhabitants in and around

Table 1. Checklist of avifauna recorded from semi-arid landscape of western Madhya Pradesh (Site I: Mandsaur and Site II: Ratlam).

Scientific name	Common name	Migratory status	IUCN Red List category	WPA schedule	Site I	Site II	Frequency of observation	Habitat (s)	Feeding habit
Order: Galliformes									
Family: Phasianidae									
<i>Pavo cristatus</i>	Indian Peafowl	R	LC	I	+	+	UC	AL, OS	Om
<i>Francolinus pondicerianus</i>	Grey Francolin	R	LC	IV	+	+	C	GL, OS	Om
<i>Francolinus pictus</i>	Painted Francolin	R	LC	IV	+	+	UC	GL, OS	Om
Order: Anseriformes									
Family: Anatidae									
<i>Anser indicus</i>	Bar-headed Goose	WV	LC	IV	+	+	UC	WL	Ph
<i>Anas crecca</i>	Common Teal	WV	LC	IV	+	+	UC	WL	Ph
<i>Nettapus coromandelianus</i>	Cotton Pygmy-Goose	R	LC	IV	+	+	UC	WL	Ph/Cr
<i>Tadorna ferruginea</i>	Ruddy Shelduck	WV	LC	IV	+	+	UC	WL	Om
<i>Aythya fuligula</i>	Tufted Duck	WV	LC	IV	+	+	UC	WL	Ph/Cr
<i>Anas acuta</i>	Northern Pintail	WV	LC	IV	+	+	UC	WL	Ph/Cr
<i>Anas clypeata</i>	Northern Shoveler	WV	LC	IV	+	+	UC	WL	Cr
<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	R	LC	IV	+	+	UC	WL	Ph/Cr
<i>Anser anser</i>	Greylag Goose	WV	LC	IV	+	+	R	WL	Ph
<i>Netta rufina</i>	Red-crested Pochard	WV	LC	IV	+	+	UC	WL	Ph/Cr
<i>Aythya ferina</i>	Common Pochard	WV	VU	IV	+	+	UC	WL	Ph/Cr
Order: Piciformes									
Family: Picidae									
<i>Dendrocopos maharattensis</i>	Yellow-crowned Woodpecker	R	LC	IV	-	+	UC	OS, DF	In
Order: Bucerotiformes									
Family: Bucerotidae									
<i>Ocyrcas birostris</i>	Indian Grey Hornbill	R	LC	I	+	+	UC	DF	Om
Order: Upupiformes									
Family: Upupidae									
<i>Upupa epops</i>	Common Hoopoe	R	LC	NI	+	+	UC	AL	In
Order: Coraciiformes									
Family: Coraciidae									
<i>Coracias benghalensis</i>	Indian Roller	R	LC	IV	+	+	C	OS, AL	Om
Family: Alcedinidae									
<i>Ceryle rudis</i>	Pied Kingfisher	R	LC	IV	+	+	UC	WL	Cr
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	R	LC	IV	+	+	C	WL	Om
<i>Alcedo atthis</i>	Common Kingfisher	R	LC	IV	+	+	C	WL	Cr
Family: Meropidae									
<i>Merops orientalis</i>	Green Bee-eater	R	LC	NI	+	+	C	OS, AL	In
Order: Cuculiformes									
Family: Cuculidae									
<i>Eudynamis scolopaceus</i>	Asian Koel	R	LC	IV	+	+	C	DF	Om
Order: Psittaciformes									
Family: Psittacidae									
<i>Psittacula cyanocephala</i>	Plum-headed Parakeet	R	LC	IV	+	+	C	AL, DF	Fg
<i>Psittacula krameri</i>	Rose-ringed Parakeet	R	LC	IV	+	+	C	AL, DF	Fg

Scientific name	Common name	Migratory status	IUCN Red List category	WPA schedule	Site I	Site II	Frequency of observation	Habitat (s)	Feeding habit
Order: Strigiformes									
Family: Strigidae									
<i>Athene brama</i>	Spotted Owlet	R	LC	IV	+	-	UC	OS, AL, DF	Cr
Order: Columbiformes									
Family: Columbidae									
<i>Columba livia</i>	Common Pigeon	R	LC	IV	+	+	C	AL, DF, OS, WL, GL	Gr
<i>Streptopelia decaocto</i>	Eurasian Collared-Dove	R	LC	IV	+	+	C	AL, DF, OS, WL, GL	Gr
<i>Spilopelia senegalensis</i>	Laughing Dove	R	LC	IV	+	+	C	OS, AL, DF	Gr
<i>Spilopelia chinensis</i>	Spotted Dove	R	LC	IV	+	+	C	AL, DF, OS, GL	Gr
Order: Gruiformes									
Family: Gruidae									
<i>Antigone antigone</i>	Sarus Crane	R	VU	IV	+	+	R	AL	Om
Family: Rallidae									
<i>Gallinula chloropus</i>	Common Moorhen	R	LC	IV	+	+	UC	WL	Om
<i>Porphyrio porphyrio</i>	Grey-headed Swamphen	R	LC	IV	-	+	UC	WL	Om
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	R	LC	IV	+	+	UC	WL	Om
<i>Fulica atra</i>	Eurasian Coot	R	LC	IV	+	+	C	WL	Om
Order: Ciconiiformes									
Family: Pteroclididae									
<i>Pterocles exustus</i>	Chestnut-bellied Sandgrouse	R	LC	IV	+	+	UC	AL	Gr
<i>Pterocles indicus</i>	Painted Sandgrouse	R	LC	IV	-	+	UC	AL, OS	Gr
Family: Scolopacidae									
<i>Gallinago gallinago</i>	Common Snipe	WV	LC	IV	+	+	UC	WL	Cr
<i>Limosa limosa</i>	Black-tailed Godwit	WV	NT	IV	+	+	UC	WL	Cr
<i>Tringa totanus</i>	Common Redshank	WV	LC	IV	+	+	UC	WL	Cr
<i>Actitis hypoleucos</i>	Common Sandpiper	WV	LC	IV	+	+	C	WL	Cr
<i>Tringa stagnatilis</i>	Marsh Sandpiper	WV	LC	IV	-	+	R	WL	Cr
<i>Calidris pugnax</i>	Ruff	WV	LC	IV	+	-	R	WL	Om
Family: Jacanidae									
<i>Metopidius indicus</i>	Bronze-winged Jacana	R	LC	IV	+	+	UC	WL	Om
Family: Burhinidae									
<i>Burhinus oedecnemus</i>	Eurasian Thick-knee	R	LC	IV	-	+	UC	WL	Cr
<i>Esacus recurvirostris</i>	Great Thick-knee	R	NT	IV	-	+	R	WL	Cr
Family: Charadriidae									
<i>Charadrius dubius</i>	Little Ringed Plover	R	LC	IV	+	+	UC	WL	Cr
<i>Charadrius alexandrinus</i>	Kentish Plover	WV	LC	IV	+	+	UC	WL	Cr
<i>Vanellus malabaricus</i>	Yellow-wattled Lapwing	R	LC	IV	+	+	UC	WL, AL	Cr
<i>Vanellus indicus</i>	Red-wattled Lapwing	R	LC	IV	+	+	C	WL, AL	Cr
Family: Recurvirostridae									
<i>Himantopus himantopus</i>	Black-winged Stilt	WV	LC	IV	+	+	UC	WL	Cr
Family: Glareolidae									
<i>Cursorius coromandelicus</i>	Indian Courser	R	LC	NI	+	-	R	AL	In

Scientific name	Common name	Migratory status	IUCN Red List category	WPA schedule	Site I	Site II	Frequency of observation	Habitat (s)	Feeding habit
Family: Laridae									
<i>Larus ridibundus</i>	Black-headed Gull	WV	LC	IV	+	+	UC	WL	Om
<i>Sterna aurantia</i>	River Tern	WV	NT	IV	+	+	UC	WL	Om
<i>Chlidonias hybrida</i>	Whiskered Tern	WV	LC	IV	+	-	R	WL	Om
Family: Falconidae									
<i>Falco tinnunculus</i>	Common Kestrel	WV	LC	IV	+	+	C	OS, DF, GL, AL	Om
Family: Accipitridae									
<i>Neophron percnopterus</i>	Egyptian Vulture	R	EN	IV	+	-	R	OS, DF	Sc
<i>Gyps bengalensis</i>	White-rumped Vulture	R	CR	IV	+	-	R	DF	Sc
<i>Milvus migrans</i>	Black Kite	R	LC	I	+	+	C	AL, OS	Om
<i>Elanus caeruleus</i>	Black-winged Kite	R	LC	I	+	+	C	AL, OS	Om
<i>Spilornis cheela</i>	Crested Serpent Eagle	R	LC	I	-	+	UC	DF	Cr
<i>Circaetus gallicus</i>	Short-toed Snake Eagle	R	LC	I	+	+	C	AL, GL, DF, OS	Cr
<i>Circus pygargus</i>	Montagu's Harrier	WV	LC	I	+	+	UC	OS, AL, WL, GL	Om
<i>Accipiter badius</i>	Shikra	R	LC	I	+	+	UC	AL, GL, DF, OS	Cr
<i>Pernis ptilorhynchus</i>	Oriental Honey Buzzard	R	LC	I	+	+	UC	DF	In
<i>Butastur teesa</i>	White-eyed Buzzard	R	LC	I	+	-	UC	AL, GL, OS	Om
<i>Pandion haliaetus</i>	Osprey	WV	LC	I	+	+	UC	WL	Cr
Family: Podicipedidae									
<i>Tachybaptus ruficollis</i>	Little Grebe	R	LC	IV	+	+	UC	WL	Om
<i>Podiceps cristatus</i>	Great-crested Grebe	WV	LC	IV	+	+	R	WL	Om
Family: Anhingidae									
<i>Anhinga melanogaster</i>	Oriental Darter	WV	NT	IV	+	+	R	WL	Cr
Family: Phalacrocoracidae									
<i>Microcarbo niger</i>	Little Cormorant	R	LC	IV	+	+	C	WL	Cr
<i>Phalacrocorax carbo</i>	Great Cormorant	R	LC	IV	+	+	UC	WL	Cr
Family: Ardeidae									
<i>Ardea cinerea</i>	Grey Heron	R	LC	IV	+	+	UC	WL	Cr
<i>Egretta garzetta</i>	Little Egret	R	LC	IV	+	+	UC	WL	Om
<i>Bubulcus ibis</i>	Cattle Egret	R	LC	IV	+	+	C	WL, AL	Om
<i>Ardea alba</i>	Great Egret	R	LC	IV	+	+	UC	WL	Cr
<i>Ardea intermedia</i>	Intermediate Egret	WV	LC	IV	+	+	UC	WL	Cr
<i>Ardeola grayii</i>	Indian Pond Heron	R	LC	IV	+	+	C	WL	Om
<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	R	LC	IV	+	-	UC	WL	Om
Family: Threskiornithidae									
<i>Threskiornis melanocephalus</i>	Black-headed Ibis	R	NT	IV	+	+	UC	WL	Om
<i>Plegadis falcinellus</i>	Glossy Ibis	R	LC	IV	+	-	UC	WL	Om
<i>Platalea leucorodia</i>	Eurasian Spoonbill	R	LC	IV	+	+	UC	WL	Om
Family: Pelecanidae									
<i>Pelecanus philippensis</i>	Spot-billed Pelican	R	NT	IV	+	-	R	WL	Cr
Family: Ciconiidae									
<i>Anastomus oscitans</i>	Asian Openbill	R	LC	IV	+	+	UC	WL	Om
<i>Ciconia nigra</i>	Black Stork	WV	LC	IV	+	+	UC	WL	Cr

Scientific name	Common name	Migratory status	IUCN Red List category	WPA schedule	Site I	Site II	Frequency of observation	Habitat (s)	Feeding habit
<i>Mycteria leucocephala</i>	Painted Stork	R	NT	IV	+	+	UC	WL	Cr
<i>Ciconia episcopus</i>	Woolly-necked Stork	R	VU	IV	+	+	UC	WL	Cr
<i>Ciconia Ciconia</i>	White Stork	WV	LC	IV	+	-	R	WL	Om
Order: Passeriformes									
Family: Laniidae									
<i>Lanius vittatus</i>	Bay-backed Shrike	R	LC	NI	+	+	C	OS	In
<i>Lanius meridionalis</i>	Southern Grey Shrike	R	VU	NI	+	+	UC	OS, AL	Om
Family: Dicruridae									
<i>Dicrurus macrocercus</i>	Black Drongo	R	LC	IV	+	+	C	GL, AL, OS	Om
Family: Corvidae									
<i>Dendrocitta vagabunda</i>	Rufous Treepie	R	LC	IV	+	+	UC	DF	Om
<i>Corvus macrorhynchos</i>	Indian Jungle Crow	R	LC	IV	+	+	C	OS, GL, WL	Om
<i>Corvus splendens</i>	House Crow	R	LC	V	+	+	C	AL, OS, WL, GL	Om
Family: Sturnidae									
<i>Acridotheres tristis</i>	Common Myna	R	LC	IV	+	+	C	AL, OS, GL	Om
<i>Pastor roseus</i>	Rosy Starling	PM	LC	IV	+	+	UC	AL, OS, GL	Om
<i>Gracupica contra</i>	Asian Pied Starling	R	LC	IV	+	-	UC	AL, OS, GL	Om
Family: Hirundinidae									
<i>Ptyonoprogne concolor</i>	Dusky Crag Martin	R	LC	NI	+	-	UC	AL	In
<i>Hirundo rustica</i>	Barn Swallow	WV	LC	NI	+	+	UC	WL, AL	In
<i>Hirundo smithii</i>	Wire-tailed Swallow	R	LC	NI	+	+	UC	WL, AL	In
Family: Campephagidae									
<i>Pericrocotus ethologus</i>	Long-tailed Minivet	R	LC	IV	+	-	R	DF	In/Fg
Family: Pycnonotidae									
<i>Pycnonotus cafer</i>	Red-vented Bulbul	R	LC	IV	+	+	C	OS, AL, DF, GL	Fg
Family: Timaliinae									
<i>Chrysomma sinense</i>	Yellow-eyed Babbler	R	LC	IV	+	-	UC	OS, AL	Om
<i>Turdoides striata</i>	Jungle Babbler	R	LC	IV	+	-	UC	OS, DF	Om
<i>Argya malcolmi</i>	Large Grey Babbler	R	LC	IV	+	+	C	AL, OS, GL	Om
<i>Argya caudata</i>	Common Babbler	R	LC	IV	+	+	C	AL, OS, GL	Om
Family: Sylviidae									
<i>Prinia socialis</i>	Ashy Prinia	R	LC	IV	+	+	C	AL, OS, GL	In
<i>Prinia inornata</i>	Plain Prinia	R	LC	IV	+	+	C	AL, OS, GL	In
<i>Orthotomus sutorius</i>	Common Tailorbird	R	LC	IV	+	+	C	AL, OS, GL, DF	In
Family: Alaudidae									
<i>Eremopterix griseus</i>	Ashy-crowned Sparrow Lark	R	LC	IV	+	+	C	AL, OS, GL	Gr/In
<i>Galerida cristata</i>	Crested Lark	R	LC	IV	-	+	UC	AL	Gr/In
<i>Mirafra erythroptera</i>	Indian Bushlark	R	LC	IV	+	+	UC	OS	Gr/In
<i>Ammomanes phoenicurus</i>	Rufous-tailed Lark	R	LC	IV	+	+	UC	AL, GL	Gr/In
Family: Nectariniidae									
<i>Cinnyris asiaticus</i>	Purple Sunbird	R	LC	IV	+	+	UC	OS, DF, AL	Nc
Family: Ploceidae									
<i>Ploceus philippinus</i>	Baya Weaver	R	LC	IV	+	-	UC	OS	Gr

Scientific name	Common name	Migratory status	IUCN Red List category	WPA schedule	Site I	Site II	Frequency of observation	Habitat (s)	Feeding habit
<i>Passer domesticus</i>	House Sparrow	R	LC	IV	+	+	C	AL, GL	Gr
<i>Gymnoris xanthocollis</i>	Chestnut-tailed Petronia	R	LC	IV	-	+	R	AL, OS	Gr
Family: Estrildinae									
<i>Euodice malabarica</i>	Indian Silverbill	R	LC	IV	+	+	UC	AL, GL, OS	Gr
Family: Turdinae									
<i>Monticola solitarius</i>	Blue Rock Thrush	WV	LC	IV	+	-	UC	OS, AL	In
<i>Saxicoloides fulicatus</i>	Indian Robin	R	LC	IV	+	+	C	AL, OS	In/Fg
<i>Copsychus saularis</i>	Oriental Magpie Robin	R	LC	IV	+	+	UC	AL, OS, DF	In
<i>Phoenicurus ochruros</i>	Black Redstart	WV	LC	IV	+	+	UC	OS, GL	In
<i>Saxicola torquata</i>	Common Stonechat	WV	LC	IV	+	+	C	AL, GL, OS	In
<i>Saxicola caprata</i>	Pied Bushchat	WV	LC	IV	+	+	UC	AL, GL, OS	In
<i>Oenanthe isabellina</i>	Isabelline Wheatear	WV	LC	IV	+	-	R	AL, GL	In
<i>Cyanecula svecica</i>	Bluethroat	WV	LC	IV	+	+	UC	WL, GL	In
Family: Motacillidae									
<i>Motacilla alba</i>	White Wagtail	WV	LC	IV	+	+	UC	WL	In
<i>Motacilla maderaspatensis</i>	White-browed Wagtail	R	LC	IV	+	+	UC	WL	Om
<i>Motacilla citreola</i>	Citrine Wagtail	WV	LC	IV	+	-	UC	WL	In
<i>Motacilla cinerea</i>	Grey Wagtail	WV	LC	IV	+	+	UC	WL	In
<i>Anthus rufulus</i>	Paddyfield Pipit	R	LC	IV	+	-	UC	GL, AL	In
Family: Emberizidae									
<i>Emberiza melanocephala</i>	Black-headed Bunting	WV	LC	IV	+	+	R	AL, OS	Gr
<i>Melophus lathami</i>	Crested Bunting	R	LC	IV	+	+	UC	OS, GL	Gr

Migratory status: R—Resident | WV—Winter visitor | PM—Passage migrant; IUCN Category: CR—Critically Endangered | EN—Endangered | LC—Least Concern | NT—Near Threatened | VU—Vulnerable; WPA Schedule: NI—bird species that are not included either in Schedule-I, Schedule-IV or Schedule-V of the Wildlife (Protection) Act, 1972; Frequency of observation: R—Rare | C—Common | UC—Uncommon; Habitat type: WL—Wetland | GL—Grassland | OS—Open scrub jungle | AL—Agricultural land | DF—Dry deciduous forest; Feeding habit: Om—omnivorous | Ph—phytophagous | Cr—carnivorous | In—insectivorous | Fg—frugivorous | Gr—granivorous | Nc—nectarivores | Sc—scavenger.

the study site, but during our study period, they were recorded only from Site I and the encounter rate was rare (less than 5 individuals in the entire study area) for both the species. The decline in the number of vultures may be attributed to the use of diclofenac drugs, habitat destruction, food scarcity, deforestation, and other reasons like power line collisions & natural disasters (Jha et al. 2020). *Cinnyris asiaticus* Purple Sunbird was the only Nc species observed during the present study (Figure 5). Site-wise composition of avian species based on feeding habit was represented in Figure 6.

During our present study, we recorded more than 400 individuals of *Anser indicus* Bar-headed Goose (Image 2A) from a partially dried-up wetland. This species is assessed as Least Concern (LC) according to the IUCN Red List. Though the population trend appears to be declining (BirdLife International 2020b), based on the IUCN Red List of threatened species (version 2020-1), Critically Endangered species like *Gyps bengalensis*

(White-rumped Vulture, Image 2B), Endangered species like *Neophron percnopterus* (Egyptian Vulture, Image 2C), Vulnerable species like *Aythya ferina* (Common Pochard), *Antigone antigone* (Sarus Crane), *Lanius meridionalis* (Southern Grey Shrike, Image 2D) and *Ciconia episcopus* (Woolly-necked Stork, Image 2E) were recorded during the present study. Near Threatened bird species like *Threskiornis melanocephalus* (Black-headed Ibis, Image 2F), *Limosa limosa* (Black-tailed Godwit, Image 2G), *Esacus recurvirostris* (Great Thick-knee, Image 2H), *Anhinga melanogaster* (Oriental Darter), *Mycteria leucocephala* (Painted Stork, Image 2I), *Sterna aurantia* (River Tern, Image 2J) and *Pelecanus philippensis* (Spot-billed Pelican, Image 2K) were also observed in the study area. Besides 11 avian species listed in Schedule I under the Wildlife (Protection) Act, 1972 were recorded during the present study. The majority of the globally threatened species were recorded exclusively from wetlands. During wintering seasons these water bodies

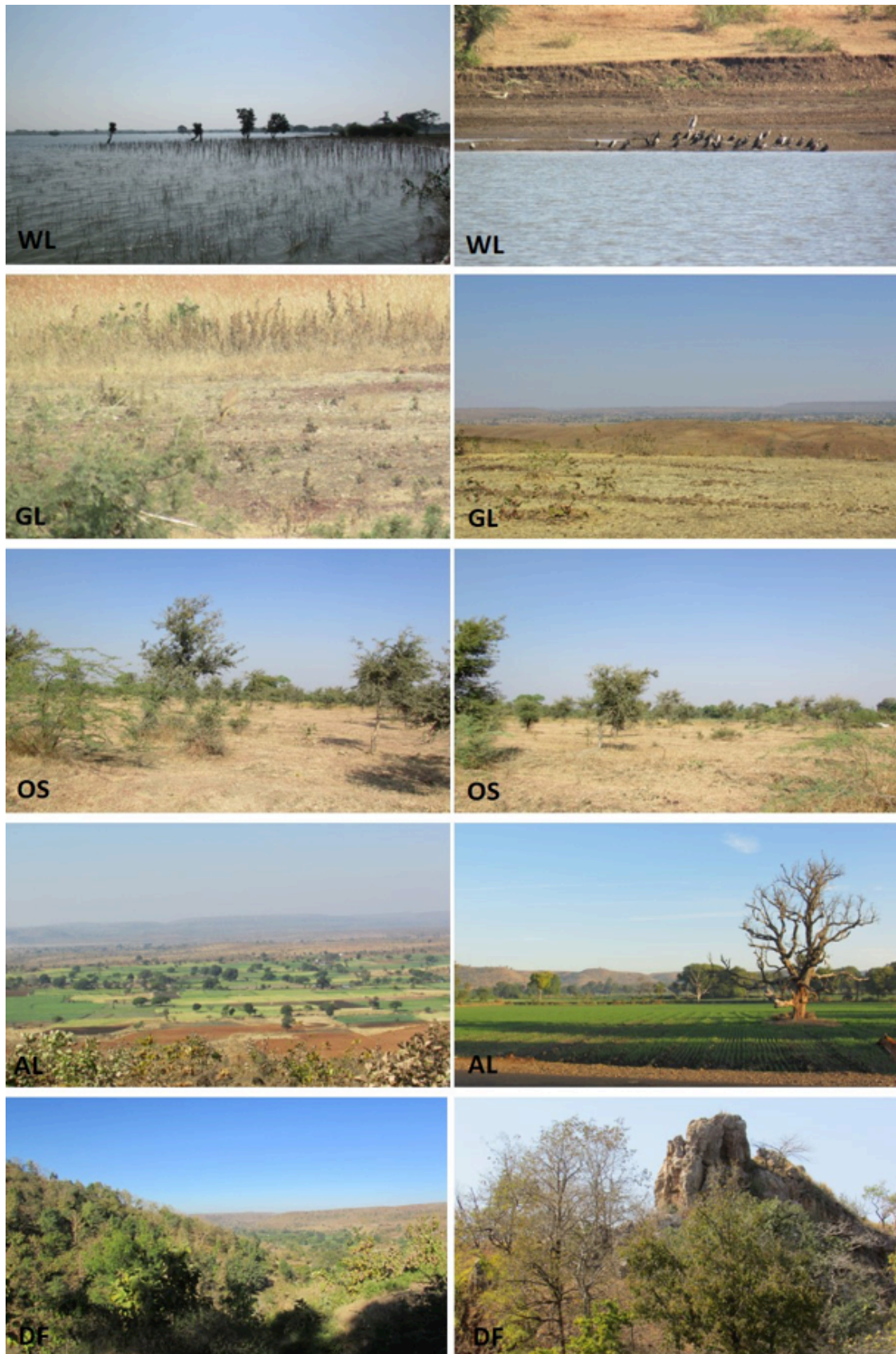


Image 1. Photographs of different habits i.e., wetland (WL), grassland (GL), open scrub jungle (OS), agricultural land (AL) and dry deciduous forest (DF), identified for present study at semi-arid landscape of western Madhya Pradesh.



Image 2. Some species recorded during present study: A—Bar-headed Goose *Anser indicus* | B—White-rumped Vulture *Gyps bengalensis* | C—Egyptian Vulture *Neophron percnopterus* | D—Southern Grey Shrike *Lanius meridionalis* | E—Woolly-necked Stork *Ciconia episcopus* | F—Black-headed Ibis *Threskiornis melanocephalus* | G—Black-tailed Godwit *Limosa limosa* | H—Great Thick-knee *Esacus recurvirostris* | I—Painted Stork *Mycteria leucocephala* | J—River Tern *Sterna aurantia* | K—Spot-billed Pelican *Pelecanus philippensis*.

were used for irrigation of agricultural fields. This water usage accelerates the drying of small wetlands. To protect the waterbird diversity in this region proper management policies should be taken. It is necessary to adopt alternative irrigation schemes for farmers to conserve the wetland habitats.

This semi-arid landscape had immense importance in the avian study. There were two Important Bird and Biodiversity Areas (IBAs) situated within the present study area viz, Gandhisagar Reservoir (IN-MP-06) and Sailana Kharmor Sanctuary (IN-MP-15). This region especially, Sailana Kharmor Sanctuary is a native breeding ground

of endangered Lesser Florican *Sypheotides indicus* and many other species (Rahmani et al. 2016). This region of the Indian subcontinent serves as a terminus for avian species who migrate following the Central Asian/ South Asian Flyway. These birds breed in the northern part of Russia (Siberia) in the east to as far west as Europe covering parts of China, central and western Asia. *Anser indicus*, the world's highest-altitude migrant follow this route directly over the Himalaya (BirdLife International 2020a) and congregate in different wetlands of sub-Himalayan regions. The presence of a large non-breeding wintering population of *Anser indicus*, never reported earlier within the study site indicated the importance of conservation of wetland habitats of this region.

The present study area is situated within Biome 11 (i.e., Indo-Malayan tropical dry zone) and harbours many biome-restricted birds. BirdLife International identified 59 such species from this biome. We recorded several biome-restricted species which included *Gyps bengalensis* (White rumped vulture), *Butastur teesa* (White-eyed Buzzard), *Pavo cristatus* (Indian Peafowl), *Vanellus malabaricus* (Yellow-wattled Lapwing), *Psittacula cyanocephala* (Plum-headed Parakeet), *Ocyrceros birostris* (Indian Grey Hornbill), *Eremopterix griseus* (Ashy-crowned Sparrow-lark), *Saxicoloides fulicata* (Indian Robin), *Turdoides malcolmi* (Large Grey Babbler), *Turdoides striatus* (Jungle Babbler), *Prinia socialis* (Ashy Prinia) (Parveen & Ilyas 2019).

The presence of significant numbers of winter migrants, globally threatened species, biome-restricted species amply supported that this semi-arid landscape was both ecologically and biologically significant for breeding and migratory birds. However, presently avian populations in semi-arid regions are declining rapidly due to unplanned developmental activities, urbanization, and climate change (Khan et al. 2019). Therefore, it is need of the hour to develop different conservation strategies like raising awareness among local residents, community participation, long term monitoring, and research, conservation of unique avian habitats, and restoration of degraded habitats. Implementation of proper management policies both at the central and state government levels with the involvement of different stakeholders is necessary to protect the avian species and their habitats outside the protected areas.

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