

## A study of Avifauna from Girnar Wildlife Sanctuary, Junagadh, Gujarat, India

Usha J. Zala<sup>1</sup>, Jatin V. Raval<sup>1\*</sup>, Romanch S. Nimavat<sup>1</sup> and Namrata K. Hun<sup>1</sup>

Zoology Lab, Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh, Gujarat, India

\*Corresponding author ✉: [drjatinraval@gmail.com](mailto:drjatinraval@gmail.com)

**Citation:** Zala, U. J., Raval, J. V., Nimavat, R. S. and Hun, N. K. (2022). A study of Avifauna from Girnar Wildlife Sanctuary, Junagadh, Gujarat, India. *Journal of Animal Diversity*, 4 (4): 74–90. <http://dx.doi.org/10.61186/JAD.4.4.74>

Received: 17 November 2022

Accepted: 16 December 2022

Published online: 31 December 2022

### Abstract

The present study was conducted to study avifaunal diversity of Girnar Wildlife Sanctuary, Junagadh, Gujarat, India. This study was carried out from August 2020 to August 2022. Data collection was done using a point count method and visual encounter method, with opportunistic sighting also included. A total of 276 species of birds belonging to 70 families and 21 orders were recorded from Girnar Wildlife Sanctuary. In the present study out of 70 families, Accipitridae and Muscipidae were the most dominant families with 24 species each. As per the IUCN status, 261 species are Least Concern, three species are Critically Endangered, one species is Endangered, eight species are Near Threatened and three are Vulnerable. Out of seven foraging guilds, species of birds classified as Insectivores were dominant. The results obtained provide baseline information on the avifaunal diversity of Girnar Wildlife Sanctuary, which will help in further conservation implications.

**Key words:** Birds species, ornithodiversity, Junagadh, migrant, mount, vulnerable

### Introduction

Birds play many roles in the ecosystem including pollinators, scavengers and predators, as well as helping in seed dispersal (Sekercioglu, 2006). They contribute towards ecosystem services such as provisioning, regulating, cultural and supporting services (Kremen and Ostfeld, 2005; Whelan et al., 2008). The study of birds is important for ecology and conservation because it allows one to assess how urbanization and climatic change have affected bird distribution and how birds are dealing with the ongoing climate change (Urfi, 2005; Van Buskirk et al., 2010). Assessment of the richness and distribution of species is fundamental to the fields of population biology and ecology (Sutherland, 2006).

Protected areas, such as wildlife sanctuaries, national parks and biodiversity reserves, are increasingly recognized as critical for supporting biodiversity and as playing a key role in essential ecological functions, such as ecosystem services and climatic stabilization (Koli, 2014).

There are 1,341 species of birds (26 orders, 113 families and 489 genera) recorded from India (Praveen et al., 2021) out of which, 612 species are recorded from Gujarat (Ganpule, 2021).

Gujarat, the westernmost state of India, has rich avian diversity because it hosts a variety of habitats, a geographical location along the Indus flyway and a long history of conservation (Khacher, 1996). With an elevation of 1,069 m, the Girnar Hill Complex is the highest mountain range in Gujarat state (Dharaiya and Dharaiya, 2021). It is situated on the Saurashtra Peninsula. It is a major igneous plutonic complex which intruded into the basalts towards the close of the Deccan Trap period (Dharaiya and Dharaiya, 2021). The area of Girnar Forest was declared a wildlife sanctuary in 2008. An area of 182 km<sup>2</sup> of Girnar Wildlife Sanctuary (GWS) is now known as a part of the greater Gir ecosystem constituted for the conservation of Asiatic lion and a prime habitat for wildlife. The GWS is surrounded by the towns of Junagadh, Bilkha and Bhesan (Patel et al., 2019).

The forest is considered sacred, having Hindu and Jain temples on the peaks of Mount Girnar that are visited by hundreds of thousands of pilgrims every year (Banerjee et al., 2010).

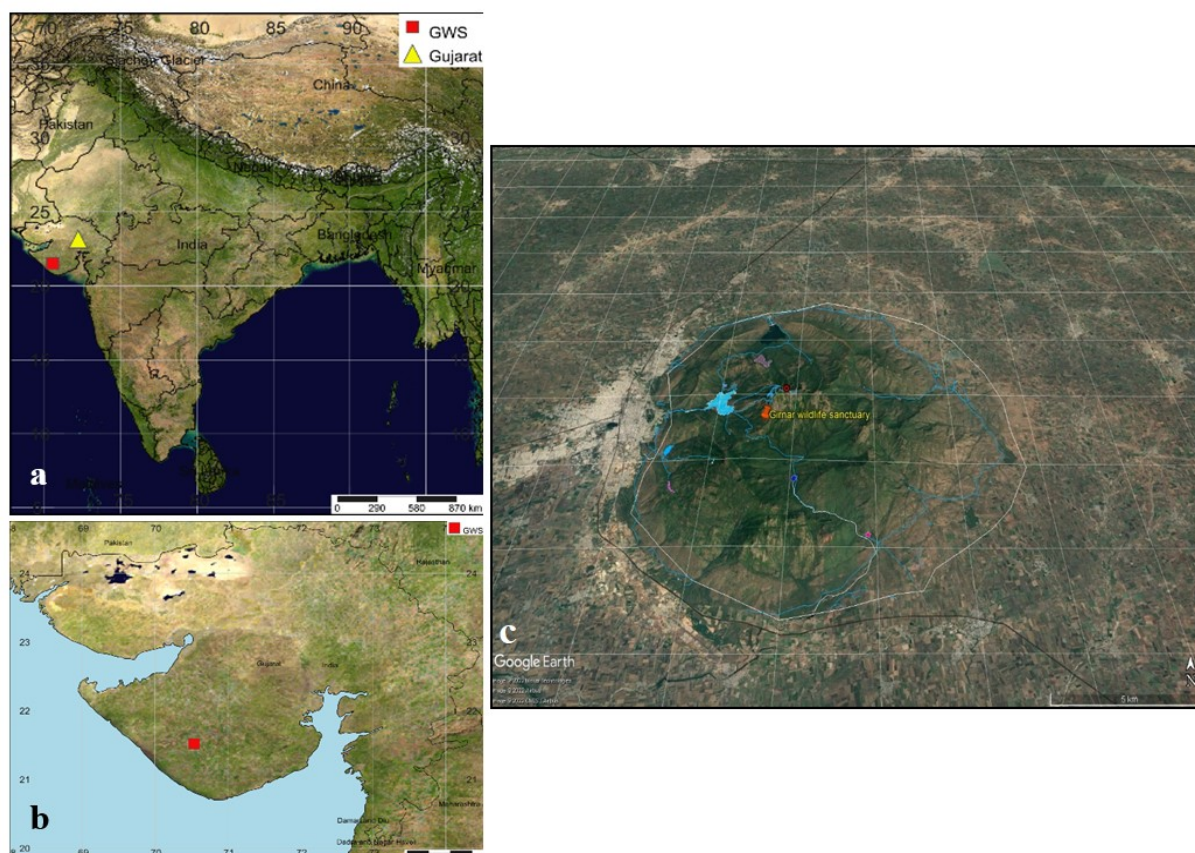
Despite the existence of a few records and checklists (Patel and Bagda, 2022; and see the online databases eBird (<https://ebird.org>), Avibase (<https://avibase.bsc-eoc.org>), and Birds of Gujarat (<https://birdsofgujarat.co.in>) no systematic database on avifauna is available specifically for Girnar Wildlife Sanctuary. Considering the current anthropogenic pressure and increased tourism activity the systematic study of the avifauna of Girnar is presently needed. Some initial efforts were made by the Mahiru Foundation and some local birdwatchers at Junagadh, but the data were not published scientifically. Here the first scientific attempt to document the avifaunal diversity of the Girnar Wildlife Sanctuary, Junagadh, India is presented.

## Material and Methods

### Study area

Mount Girnar (Fig. 1), comprising a cluster of peaks, is the oldest and highest mountain range of Gujarat. The Girnar Hills are situated between parallels of

latitude 21°25' to 21°35' N and meridians of longitude 70°30' to 70°40' E. Girnar Forest is described as “Type VII-A/c-1 Southern Tropical Dry Deciduous, Dry Teak Forest” (Bamaniya and Raval, 2022). It is divided into three parts including (a) the Teak forest, largely found on the foothills adjoining the plains and on the lower slopes of Girnar, covering more than half of the entire forest; (b) the miscellaneous forests, found in the eastern outer periphery of Girnar; and (c) scrub forest, found in all the degraded patches in the plain area as well as on the hilltops along the ridges of Girnar (Bamaniya and Raval, 2022) (Fig. 2). The dominant tree species of the area is *Tectona grandis* L. f. 1782, but other species such as *Butea monosperma* (Lam., Taub. 1894), *Haldina cordifolia* (Roxb.) Ridsdale 1978, *Holarrhena antidysenterica* (L.) Wall. 1829, *Pithocellobium dulce* (Roxb.) Benth. 1844, *Catunaregam spinosa* Thunb., Tirveng. 1979, *Zizyphus rotundifolia* (Burm. f.) Wight and Arn. 1833 and *Calotropis procera* (Aiton) W. T. Aiton, 1811 are commonly found with other plants (Champion and Seth, 1968; Nakar and Jadeja, 2015). The climate of Girnar is semi-arid with a mean temperature of 25.7 °C and mean annual precipitation of 827 mm (Dharaiya and Dharaiya, 2021).

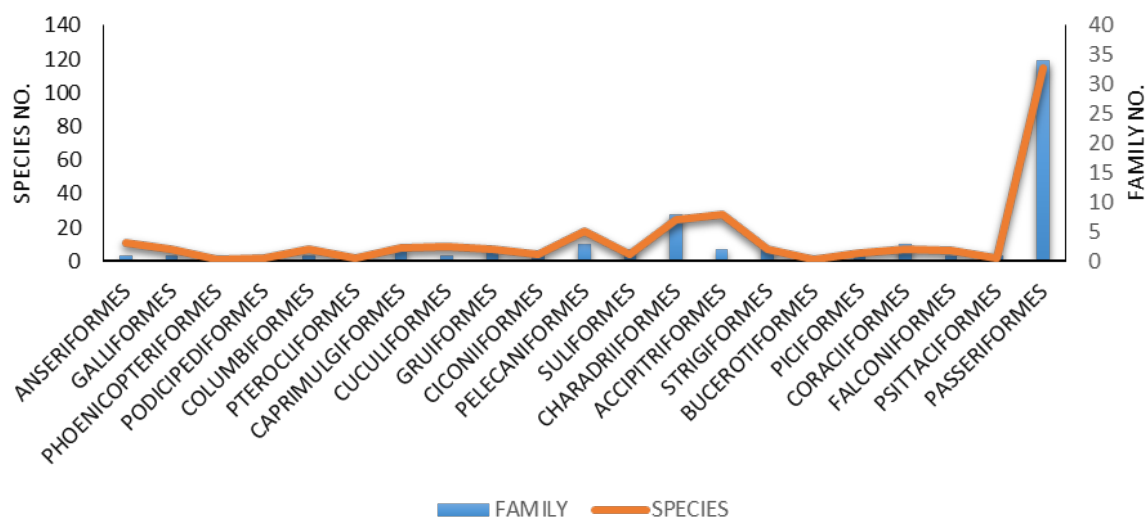


**Figure 1:** Maps showing the location of Girnar Wildlife Sanctuary (GWS). The position of GWS in the state of Gujarat on the west coast of India (a); an enhanced view of the location of GWS in Gujarat (b); satellite image of GWS prepared with Google Earth software (c) (Source: <https://earth.google.com/web>).





**Figure 2:** Habitat types of Girnar Wildlife Sanctuary. (A) Teak-dominated forest at the foothills of mount Girnar; (B) Valley of mixed deciduous forest of the adjoining hills of Girnar; (C) Miscellaneous scrub forest of Paturan. Photos by Usha Zala.



**Figure 3:** Order and family level representation of the avifauna from the Girnar Wildlife Sanctuary, India.

Field survey was carried out for a period of 25 months from August 2020 to August 2022. The survey was made twice a week for the entire study period. Birds were observed during the most active periods of the day, i.e., mornings (06:00 to 10:00 hours) and late afternoons (16:30 to 19:00 hours). Nocturnal bird survey observations were made during early dawn and late dusk (05:00 to 06:00; 18:00 to 20:00).

Bird presence was determined with the following methods: 1) Point count monitoring (Sutherland 2006; Narayana et al., 2018). Twelve sites were chosen. 2) Walking surveys. Walking surveys were conducted along all the trails of the sanctuary, 3 km for each. 3) Opportunistic encounters, photographs and various data sources (eBird, Avibase, Birds of Gujarat). No call playback method was used. The identification of birds and their occurrence were noted using a Nikon 10 × 40 binocular and Nikon Coolpix 900D camera (Photographs are provided in Appendix 1). Visual identifications were prioritized. Photographs taken during the surveys were used as voucher photos for the identified species.

The birdcalls were confirmed using the e-book by Grimmett et al. (2013) and the Xeno-canto database (Xeno-canto, 2022). Field photographs were thoroughly cross checked with the images available on the online database Oriental Bird Club Image Database with subsequent confirmation using the publications of Kazmierczak (2000), Ali and Ripley (2001), Grimmett et al. (2011), Rasmussen and Anderton (2012) and Grewal et al. (2016). The threatened status of the birds is given in the checklist below as per IUCN Red List of Threatened Species 2022). Diversity indices were estimated using PAST 3.26 and included the richness (S), Shannon diversity index (H) (Shannon, 1948), Pielou's evenness index (J) (Pielou, 1966), Margalef's diversity index (Margalef, 1968) and Berger-Parker dominance index (d) (Berger and Parker, 1970). A species rarefaction curve was also made in PAST 3.26.

The following abbreviations were used for residential status: R, Residential; WM, Winter Migrant; MM, Monsoon Migrant and Accidental and for foraging guild; AQ, Aquatic (feeds on fish, snails, planktons); O, Omnivorous; I, Insectivorous; G, Granivorous; N, Nectarivorous; F, Frugivorous; and C, Carnivorous.

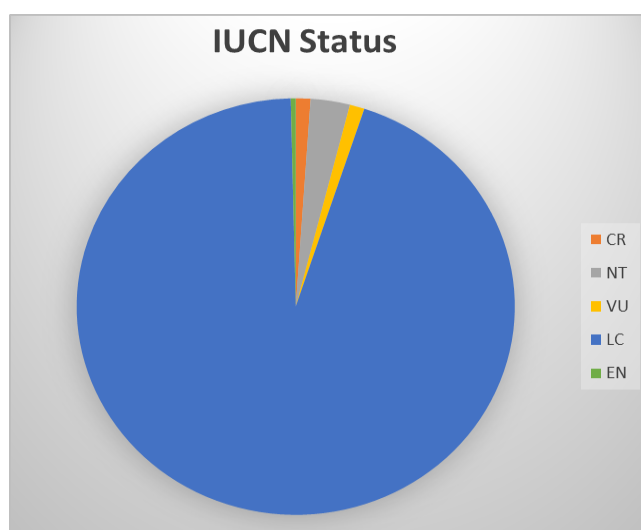
## Results and Discussion

During the entire study period of August 2020 to August 2022 a total of 276 bird species (Table 1) belonging to 21 orders and 70 families were recorded in the present survey and the previous literature on GWS; this represents a good number of the avifauna recorded from the Gujarat State. The high diversity observed could be due to intense alterations in habitat fidelity. Among the recorded 21 orders, Passeriformes had the highest (115) number of species followed by Accipitriformes (25) and Charadriiformes (25), while orders Phoenicopteriformes and Bucerotiformes had the lowest species diversity (one species each). The families Accipitridae and Muscicapidae with species richness of 24 each were most diverse among the 70 represented families; the second largest family was Ardeidae with 12 species. Moreover, there were 18 families which were represented by a single species (Table 1). A similar pattern of dominance of Passeriformes and Accipitridae was observed by different authors from various protected areas in India including the Araku Valley of the Ananthagiri Hills of the Eastern Ghats in Visakhapatnam, Andhra Pradesh (Kumar et al., 2010), a scrub forest of Sri Lankamalleswara Wildlife Sanctuary, Andhra Pradesh (Mali et al., 2017), Tamhini Wildlife Sanctuary, northern Western Ghats, Maharashtra (Vinayak and Mali, 2018), Bhimbandh Wildlife Sanctuary, Bihar (Khan and Pant, 2017), Hastinapur Wildlife Sanctuary, Uttar Pradesh (Arya et al., 2020), northern Western Ghats, Gujarat (Jambu and Patel, 2021), and Daroji Sloth Bear Sanctuary, Karnataka (Harisha et al., 2021).

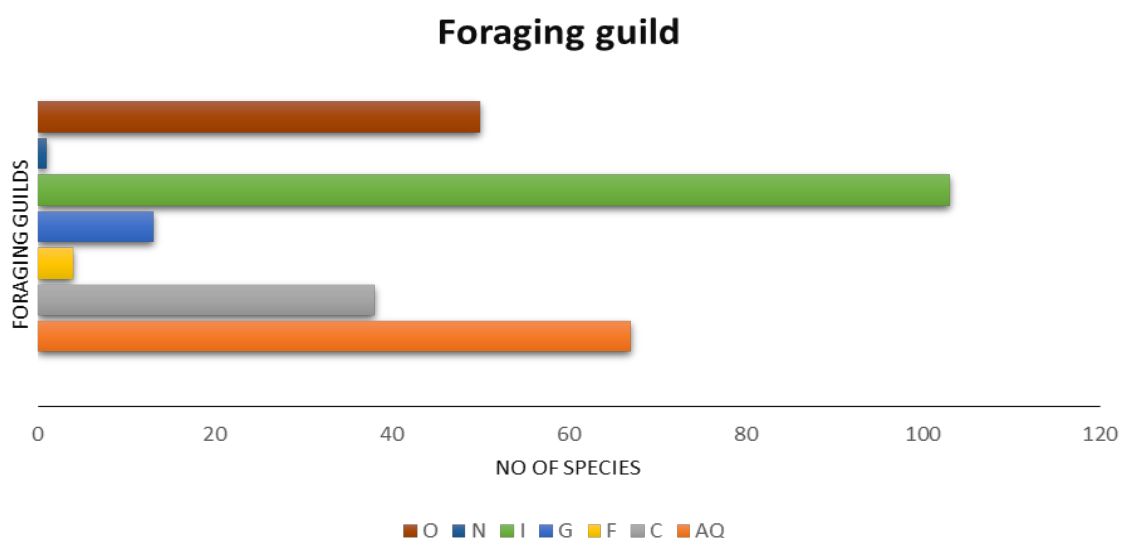
Eight of the recorded species are listed as Near Threatened, Painted stork *Mycteria leucocephala* (Pennant, 1769), Woolly-necked stork *Ciconia*

*episcopus* (Boddaert, 1783), Great white pelican *Pelecanus onocrotalus* Linnaeus, 1758, Black-headed ibis *Threskiornis melanocephalus* (Latham, 1790), Oriental darter *Anhinga melanogaster* Pennant, 1769, Great thick-knee *Esacus recurvirostris* (Cuvier, 1829), Bearded vulture *Gypaetus barbatus* (Linnaeus, 1758), and Cinereous vulture *Aegyptius monachus* (Linnaeus, 1766). Three species are listed as Vulnerable Common pochard *Aythya ferina* (Linnaeus, 1758), River tern *Sterna aurantia* Gray, 1831, Indian spotted eagle *Clanga hastata* (Lesson, 1831). Three are listed as Critically Endangered Red-headed vulture *Sarcogyps calvus* (Scopoli, 1786), White-rumped vulture *Gyps bengalensis* (J. F. Gmelin, 1788), Indian vulture *Gyps indicus* (Scopoli, 1786) and one is Endangered Egyptian

vulture *Neophron percnopterus* (Linnaeus, 1758) (Fig. 4). Foraging guilds were divided into seven categories. Regarding the seven foraging guilds (Fig. 5), Insectivorous was dominant (103 species, 37%), followed sequentially by Aquatic (67 species, 24%), Omnivorous (50 species, 18%), Carnivorous (38 species, 13%), Granivorous (13 species, 5%), Frugivorous (4 species, 2%) and Nectarivorous (one species). The presence of carnivorous species in the study area indicates the abundance of their prey. Prey bases such as small birds, lizards, snakes and rats are among the food sources for carnivores in the area. Due to their specialized diet and a low availability of preferable food resources, nectarivores and piscivores are traditionally less represented (Wiens, 1989).



**Figure 4:** IUCN status of the avifauna from the Girnar Wildlife Sanctuary (LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered).



**Figure 5:** Representation of foraging guilds of the avifauna from the Girnar Wildlife Sanctuary (AQ, Aquatic; O, Omnivorous; I, Insectivorous; G, Granivorous; N, Nectarivores; F, Frugivorous; C, Carnivorous).



**Table 1:** Systematic list of the Avifauna recorded from the Girnar Wildlife Sanctuary, India.

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Anseriformes: Anatidae</b>					
1	Lesser whistling duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	LC	AQ	WM
2	Common shelduck	<i>Tadorna tadorna</i> (Linnaeus, 1758)	LC	AQ	WM
3	Ruddy shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	LC	AQ	WM
4	Common pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	VU	AQ	R
5	Northern shoveler	<i>Spatula chrypeata</i> (Linnaeus, 1758)	LC	AQ	R
6	Indian spot-billed duck	<i>Anas poecilorhyncha</i> J.R. Forster, 1781	LC	AQ	R
7	Mallard	<i>Anas platyrhynchos</i> Linnaeus, 1758	LC	AQ	WM
8	Northern pintail	<i>Anas acuta</i> Linnaeus, 1758	LC	AQ	WM
9	Common teal	<i>Anas crecca</i> Linnaeus, 1758	LC	AQ	R
10	Comb duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	LC	AQ	WM
11	Cotton pygmy goose	<i>Nettapus coromandelianus</i> (J. F. Gmelin, 1789)	LC	AQ	WM
<b>Galliformes: Phasianidae</b>					
12	Indian peafowl	<i>Pavo cristatus</i> Linnaeus, 1758	LC	O	R
13	Common quail	<i>Coturnix coturnix</i> (Linnaeus, 1758)	LC	O	R
14	Rain quail	<i>Coturnix coromandelica</i> (J. F. Gmelin, 1789)	LC	O	MM
15	Jungle bush quail	<i>Perdica asiatica</i> (Latham, 1790)	LC	O	MM
16	Rock bush quail	<i>Perdica argoondah</i> (Sykes, 1832)	LC	O	R
17	Painted francolin	<i>Francolinus pictus</i> (Jardine and Selby, 1828)	LC	O	MM
18	Grey francolin	<i>Francolinus pondicerianus</i> (J. F. Gmelin, 1789)	LC	O	R
<b>Phoenicopteriformes: Phoenicopteridae</b>					
19	Greater flamingo	<i>Phoenicopterus roseus</i> Pallas, 1811	LC	AQ	WM
<b>Podicipediformes: Podicipedidae</b>					
20	Little grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	LC	AQ	R
21	Great crested grebe	<i>Podiceps cristatus</i> (Linnaeus, 1758)	LC	AQ	WM
<b>Columbiformes: Columbidae</b>					
22	Rock dove	<i>Columba livia</i> J. F. Gmelin, 1789	LC	G	R
23	Eurasian collared dove	<i>Streptopelia decaocto</i> (Frisvaldszky, 1838)	LC	G	R
24	Red collared dove	<i>Streptopelia tranquebarica</i> (Hermann, 1804)	LC	G	R
25	Spotted dove	<i>Streptopelia chinensis</i> (Scopoli, 1786)	LC	G	R
26	Laughing dove	<i>Streptopelia senegalensis</i> (Linnaeus, 1766)	LC	G	R
27	Yellow-legged green pigeon	<i>Treron phoenicopterus</i> (Latham, 1790)	LC	F	R
28	Oriental turtle dove	<i>Streptopelia orientalis</i> (Latham, 1790)	LC	G	WM
<b>Pteroclitiformes: Pteroclitidae</b>					
29	Chestnut-bellied sandgrouse	<i>Pterocles exustus</i> Temminck, 1825	LC	G	R
30	Painted sandgrouse	<i>Pterocles indicus</i> (J. F. Gmelin, 1789)	LC	G	R
<b>Caprimulgiformes: Caprimulgidae</b>					
31	Grey nightjar	<i>Caprimulgus indicus</i> Latham, 1790	LC	I	R
32	Sykes's nightjar	<i>Caprimulgus maharattensis</i> Sykes, 1832	LC	I	R
33	Indian nightjar	<i>Caprimulgus asiaticus</i> Latham, 1790	LC	I	R
34	Savanna nightjar	<i>Caprimulgus affinis</i> Horsfield, 1821	LC	I	R
<b>Caprimulgiformes: Apodidae</b>					
35	Crested treeswift	<i>Hemiprocne coronata</i> (Tickell, 1833)	LC	I	R
36	Asian palm swift	<i>Cypsiurus balasiensis</i> (Gray, 1829)	LC	I	R
37	Fork-tailed swift	<i>Apus pacificus</i> (Latham, 1801)	LC	I	R
38	Indian house swift	<i>Apus affinis</i> (Gray, 1830)	LC	I	R
<b>Cuculiformes: Cuculidae</b>					
39	Greater coucal	<i>Centropus sinensis</i> (Stephens, 1815)	LC	O	R
40	Sirkeer malkoha	<i>Taccocua leschenaultii</i> Lesson, 1830	LC	O	R
41	Jacobin cuckoo	<i>Clamator jacobinus</i> (Boddaert, 1783)	LC	I	MM
42	Asian koel	<i>Eudynamis scolopaceus</i> (Linnaeus, 1758)	LC	O	R
43	Grey-bellied cuckoo	<i>Cacomantis passerinus</i> (Vahl, 1797)	LC	I	MM
44	Drongo cuckoo	<i>Surniculus lugubris</i> (Horsfield, 1821)	LC	I	MM
45	Common hawk cuckoo	<i>Hierococcyx varius</i> (Vahl, 1797)	LC	I	MM
46	Indian cuckoo	<i>Cuculus micropterus</i> Gould, 1838	LC	I	R
47	Common cuckoo	<i>Cuculus canorus</i> Linnaeus, 1758	LC	I	MM
<b>Gruiformes: Rallidae</b>					
48	Spotted crane	<i>Porzana porzana</i> (Linnaeus, 1766)	LC	AQ	WM
49	Brown crane	<i>Zapornia akool</i> (Sykes, 1832)	LC	AQ	WM
50	White-breasted waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	LC	AQ	R
51	Purple swamphen	<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	LC	AQ	R
52	Common moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	LC	AQ	R
53	Common coot	<i>Fulica atra</i> Linnaeus, 1758	LC	AQ	WM
<b>Gruiformes: Gruidae</b>					
54	Demoiselle crane	<i>Grus virgo</i> (Linnaeus, 1758)	LC	O	WM

Table 1: (Continued).

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Ciconiiformes: Ciconiidae</b>					
55	Painted stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	NT	AQ	R
56	Asian openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	LC	AQ	WM
57	Black stork	<i>Ciconia nigra</i> (Linnaeus, 1758)	LC	AQ	WM
58	Woolly-necked stork	<i>Ciconia episcopus</i> (Boddaert, 1783)	NT	AQ	WM
<b>Pelecaniformes: Pelecanidae</b>					
59	Great white pelican	<i>Pelecanus onocrotalus</i> Linnaeus, 1758	NT	AQ	WM
60	Dalmatian pelican	<i>Pelecanus crispus</i> Bruch, 1832	LC	AQ	WM
<b>Pelecaniformes: Ardeidae</b>					
61	Eurasian bittern	<i>Botaurus stellaris</i> (Linnaeus, 1758)	LC	AQ	WM
62	Yellow bittern	<i>Ixobrychus sinensis</i> (J. F. Gmelin, 1789)	LC	AQ	WM
63	Indian pond heron	<i>Ardeola grayii</i> (Sykes, 1832)	LC	AQ	R
64	Cattle egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	LC	AQ	R
65	Grey heron	<i>Ardea cinerea</i> Linnaeus, 1758	LC	AQ	R
66	Purple heron	<i>Ardea purpurea</i> Linnaeus, 1766	LC	AQ	R
67	Great egret	<i>Ardea alba</i> Linnaeus, 1758	LC	AQ	R
68	Intermediate egret	<i>Ardea intermedia</i> Wagler, 1829	LC	AQ	R
69	Little egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	LC	AQ	R
70	Western reef egret	<i>Egretta gularis</i> (Bosc, 1792)	LC	AQ	WM
71	Black-crowned night heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	LC	AQ	R
72	Striated heron	<i>Butorides striata</i> (Linnaeus, 1758)	LC	AQ	R
<b>Pelecaniformes: Threskiornithidae</b>					
73	Black-headed ibis	<i>Threskiornis melanocephalus</i> (Latham, 1790)	NT	AQ	R
74	Eurasian spoonbill	<i>Platalea leucorodia</i> Linnaeus, 1758	LC	AQ	WM
75	Red naped ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	LC	AQ	R
76	Glossy ibis	<i>Plegadis falcinellus</i> (Linnaeus, 1766)	LC	AQ	R
<b>Suliformes: Phalacrocoracidae</b>					
77	Little cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	LC	AQ	R
78	Great cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	LC	AQ	R
79	Indian cormorant	<i>Phalacrocorax fuscicollis</i> Stephens, 1826	LC	AQ	R
<b>Suliformes: Anhingidae</b>					
80	Oriental darter	<i>Anhinga melanogaster</i> Pennant, 1769	NT	AQ	R
<b>Charadriiformes: Burhinidae</b>					
81	Eurasian thick-knee	<i>Burhinus oediconemus</i> (Linnaeus, 1758)	LC	I	R
82	Great thick-knee	<i>Esacus recurvirostris</i> (Cuvier, 1829)	NT	I	R
<b>Charadriiformes: Recurvirostridae</b>					
83	Pied avocet	<i>Recurvirostra avosetta</i> Linnaeus, 1758	LC	AQ	R
84	Black-winged stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	LC	AQ	R
<b>Charadriiformes: Charadriidae</b>					
85	Grey plover	<i>Pluvialis squatarola</i> (Linnaeus, 1758)	LC	AQ	WM
86	Little ringed plover	<i>Charadrius dubius</i> Scopoli, 1786	LC	AQ	WM
87	Yellow-wattled lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	LC	I	R
88	Red-wattled lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	LC	I	R
89	Common plover	<i>Charadrius hiaticula</i> (Linnaeus, 1758)	LC	AQ	R
<b>Charadriiformes: Rostratulidae</b>					
90	Greater painted snipe	<i>Rostratula benghalensis</i> (Linnaeus, 1758)	LC	AQ	WM
<b>Charadriiformes: Scolopacidae</b>					
91	Little stint	<i>Calidris minuta</i> (Leisler, 1812)	LC	AQ	R
92	Common snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	LC	AQ	WM
93	Common sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	LC	AQ	R
94	Green sandpiper	<i>Tringa ochropus</i> Linnaeus, 1758	LC	AQ	WM
95	Wood sandpiper	<i>Tringa glareola</i> Linnaeus, 1758	LC	AQ	WM
96	Marsh sandpiper	<i>Tringa stagnatilis</i> (Bechstein, 1803)	LC	AQ	WM
<b>Charadriiformes: Turnicidae</b>					
97	Small buttonquail	<i>Turnix sylvaticus</i> (Desfontaines, 1789)	LC	I	R
98	Yellow-legged buttonquail	<i>Turnix tanki</i> Blyth, 1843	LC	I	MM
99	Barred buttonquail	<i>Turnix suscitator</i> (J. F. Gmelin, 1789)	LC	I	R
<b>Charadriiformes: Glareolidae</b>					
100	Indian courser	<i>Cursorius coromandelicus</i> (J. F. Gmelin, 1789)	LC	O	R
101	Little pratincole	<i>Glareola lactea</i> Temminck, 1820	LC	I	WM
<b>Charadriiformes: Laridae</b>					
102	Brown-headed gull	<i>Chroicocephalus brunnicephalus</i> (Jerdon, 1840)	LC	AQ	WM
103	Black-headed gull	<i>Chroicocephalus ridibundus</i> (Linnaeus, 1766)	LC	AQ	WM
104	Little tern	<i>Sterna albifrons</i> (Pallas, 1764)	LC	AQ	R
105	Whiskered tern	<i>Chlidonias hybrida</i> (Pallas, 1811)	LC	AQ	WM
106	River tern	<i>Sterna aurantia</i> Gray, 1831	VU	AQ	WM
107	Common tern	<i>Sterna hirundo</i> Linnaeus, 1758	LC	AQ	WM

**Table 1: (Continued).**

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Accipitriformes: Pandionidae</b>					
108	Osprey	<i>Pandion haliaetus</i> (Linnaeus, 1758)	LC	C	R
<b>Accipitriformes: Accipitridae</b>					
109	Black-winged kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	LC	C	R
110	Oriental honey buzzard	<i>Pernis ptilorhynchus</i> (Temminck, 1821)	LC	C	R
111	Egyptian vulture	<i>Neophron percnopterus</i> (Linnaeus, 1758)	EN	C	WM
112	Crested serpent eagle	<i>Spilornis cheela</i> (Latham, 1790)	LC	C	WM
113	Short-toed snake eagle	<i>Circaetus gallicus</i> (J. F. Gmelin, 1788)	LC	C	WM
114	Red-headed vulture	<i>Sarcogyps calvus</i> (Scopoli, 1786)	CR	C	R
115	White-rumped vulture	<i>Gyps bengalensis</i> (J. F. Gmelin, 1788)	CR	C	WM
116	Indian vulture	<i>Gyps indicus</i> (Scopoli, 1786)	CR	C	R
117	Griffon vulture	<i>Gyps fulvus</i> (Hablizl, 1783)	LC	C	WM
118	Bearded vulture*	<i>Gypaetus barbatus</i> (Linnaeus, 1758)	NT	C	WM
119	Cinereous vulture*	<i>Aegypius monachus</i> (Linnaeus, 1766)	NT	C	WM
120	Changeable hawk eagle	<i>Nisaetus cirrhatus</i> (J. F. Gmelin, 1788)	LC	C	WM
121	Black eagle	<i>Ictinaetus malaiensis</i> (Temminck, 1822)	LC	C	WM
122	Indian Spotted eagle	<i>Clanga hastata</i> (Lesson, 1831)	VU	C	WM
123	Bonelli's eagle	<i>Aquila fasciata</i> Vieillot, 1822	LC	C	R
124	Booted eagle	<i>Hieraetus pennatus</i> (J. F. Gmelin, 1788)	LC	C	WM
125	Western marsh harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	LC	C	WM
126	Shikra	<i>Accipiter badius</i> (J. F. Gmelin, 1788)	LC	C	R
127	Besra*	<i>Accipiter virgatus</i> (Temminck, 1822)	LC	C	WM
128	Eurasian sparrowhawk	<i>Accipiter nisus</i> (Linnaeus, 1758)	LC	C	WM
129	Brahminy kite	<i>Haliastur indus</i> (Boddaert, 1783)	LC	C	WM
130	Black kite	<i>Milvus migrans</i> (Boddaert, 1783)	LC	C	R
131	White-eyed buzzard	<i>Butastur teesa</i> (Franklin, 1831)	LC	C	R
132	Common buzzard	<i>Buteo buteo</i> (Linnaeus, 1758)	LC	C	R
<b>Strigiformes: Tytonidae</b>					
133	Common barn owl	<i>Tyto alba</i> (Scopoli, 1769)	LC	C	R
<b>Strigiformes: Strigidae</b>					
134	Spotted owl	<i>Athene brama</i> (Temminck, 1821)	LC	C	R
135	Oriental scops owl	<i>Otus sunia</i> (Hodgson, 1836)	LC	C	R
136	Short-eared owl	<i>Asio flammeus</i> (Pontoppidan, 1763)	LC	C	R
137	Mottled wood owl	<i>Strix ocellata</i> (Lesson, 1839)	LC	C	R
138	Rock eagle owl	<i>Bubo bengalensis</i> Franklin, 1831	LC	C	R
139	Brown fish owl	<i>Ketupa zeylonensis</i> (J. F. Gmelin, 1788)	LC	C	R
<b>Bucerotiformes: Upupidae</b>					
140	Common hoopoe	<i>Upupa epops</i> Linnaeus, 1758	LC	O	R
<b>Piciformes: Picidae</b>					
141	Eurasian wryneck	<i>Jynx torquilla</i> Linnaeus, 1758	LC	I	R
142	Lesser golden-backed woodpecker	<i>Dinopium benghalense</i> (Linnaeus, 1758)	LC	I	R
143	Brown-capped pigmy woodpecker	<i>Dendrocopos moluccensis</i> (J. F. Gmelin, 1788)	LC	I	R
144	Yellow-crowned woodpecker	<i>Dendrocopos mahrattensis</i> (Latham, 1801)	LC	I	R
<b>Piciformes: Megalaimidae</b>					
145	Coppersmith barbet	<i>Psilopogon haemacephalus</i> (Stadius Muller, 1776)	LC	F	R
<b>Coraciiformes: Meropidae</b>					
146	Green bee-eater	<i>Merops orientalis</i> Latham, 1801	LC	I	R
147	Blue-cheeked bee-eater	<i>Merops persicus</i> Pallas, 1773	LC	I	WM
<b>Coraciiformes: Coraciidae</b>					
148	Indian roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	LC	I	WM
149	European roller	<i>Coracias garrulus</i> Linnaeus, 1758	LC	I	WM
<b>Coraciiformes: Alcedinidae</b>					
150	Common kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	LC	AQ	R
151	Pied kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	LC	AQ	R
152	White-throated kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	LC	AQ	R
<b>Falconiformes: Falconidae</b>					
153	Lesser kestrel	<i>Falco naumanni</i> Fleischer, 1818	LC	C	WM
154	Common kestrel	<i>Falco tinnunculus</i> Linnaeus, 1758	LC	C	R
155	Eurasian hobby	<i>Falco subbuteo</i> Linnaeus, 1758	LC	C	WM
156	Peregrine falcon	<i>Falco peregrinus</i> Tunstall, 1771	LC	C	WM
157	Amur falcon*	<i>Falco amurensis</i> Radde, 1863	LC	C	WM
158	Shaheen falcon	<i>Falco peregrinus peregrinator</i> Sundevall, 1837	LC	C	WM
<b>Psittaciformes: Psittaculidae</b>					
159	Plum-headed parakeet	<i>Psittacula cyanocephala</i> (Linnaeus, 1766)	LC	F	R
160	Rose-ringed parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	LC	F	R



Table 1: (Continued).

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Passeriformes: Pittidae</b>					
161	Indian pitta	<i>Pitta brachyura</i> (Linnaeus, 1766)	LC	I	MM
<b>Passeriformes: Campephagidae</b>					
162	Small minivet	<i>Pericrocotus cinnamomeus</i> (Linnaeus, 1766)	LC	I	R
163	Long-tailed minivet	<i>Pericrocotus ethologus</i> Bangs and J. C. Phillips, 1914	LC	I	R
164	Large cuckooshrike	<i>Coracina javensis</i> (Horsfield, 1821)	LC	O	R
165	Black-headed cuckooshrike	<i>Lalage melanoptera</i> (Rüppell, 1839)	LC	O	WM
<b>Passeriformes: Oriolidae</b>					
166	Black-hooded oriole	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	LC	I	R
167	Indian golden oriole	<i>Oriolus kundoo</i> Sykes, 1832	LC	I	R
<b>Passeriformes: Vangidae</b>					
168	Common woodshrike	<i>Tephrodornis pondicerianus</i> (J. F. Gmelin, 1789)	LC	I	R
<b>Passeriformes: Aegithinidae</b>					
169	Common iora	<i>Aegithina tiphia</i> (Linnaeus, 1758)	LC	I	R
170	Marshall's iora	<i>Aegithina nigrolutea</i> (G. F. L. Marshall, 1876)	LC	I	R
<b>Passeriformes: Dicruridae</b>					
171	Black drongo	<i>Dicrurus macrocercus</i> Vieillot, 1817	LC	I	R
172	Ashy drongo	<i>Dicrurus leucophaeus</i> Vieillot, 1817	LC	I	R
173	White-bellied drongo	<i>Dicrurus caeruleus</i> (Linnaeus, 1758)	LC	I	WM
<b>Passeriformes: Rhipiduridae</b>					
174	White-browed fantail	<i>Rhipidura aureola</i> Lesson, 1831	LC	I	R
175	White-throated fantail	<i>Rhipidura albicollis</i> (Vieillot, 1818)	LC	I	WM
<b>Passeriformes: Laniidae</b>					
176	Brown shrike	<i>Lanius cristatus</i> Linnaeus, 1758	LC	O	R
177	Isabelline shrike	<i>Lanius isabellinus</i> Hemprich & Ehrenberg, 1833	LC	O	R
178	Red-backed shrike	<i>Lanius phoenicuroides</i> Schalow, 1875	LC	O	R
179	Bay-backed shrike	<i>Lanius vittatus</i> Valenciennes, 1826	LC	O	R
180	Long-tailed shrike	<i>Lanius schach</i> Linnaeus, 1758	LC	O	R
<b>Passeriformes: Corvidae</b>					
181	Rufous treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	LC	O	R
182	House crow	<i>Corvus splendens</i> Vieillot, 1817	LC	O	R
183	Large-billed crow	<i>Corvus macrorhynchos</i> Wagler, 1827	LC	O	R
<b>Passeriformes: Monarchidae</b>					
184	Black-naped monarch	<i>Hypothymis azurea</i> (Boddaert, 1783)	LC	I	R
185	Indian paradise-flycatcher	<i>Terpsiphone paradisi</i> (Linnaeus, 1758)	LC	I	R
<b>Passeriformes: Dicaeidae</b>					
186	Thick-billed flowerpecker	<i>Dicaeum agile</i> (Tickell, 1833)	LC	O	R
187	Pale-billed flowerpecker	<i>Dicaeum erythrorhynchos</i> (Latham, 1790)	LC	O	R
<b>Passeriformes: Nectariniidae</b>					
188	Purple sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	LC	N	R
<b>Passeriformes: Ploceidae</b>					
189	Black-breasted weaver	<i>Ploceus benghalensis</i> (Linnaeus, 1758)	LC	O	R
190	Baya weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	LC	O	R
<b>Passeriformes: Estrildidae</b>					
191	Indian silverbill	<i>Euodice malabarica</i> (Linnaeus, 1758)	LC	G	R
192	Scaly-breasted munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	LC	G	R
<b>Passeriformes: Passeridae</b>					
193	House sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	LC	G	R
194	Chestnut-shouldered prinia	<i>Gymnoris xanthocollis</i> (E. Burton, 1838)	LC	G	R
<b>Passeriformes: Motacillidae</b>					
195	Forest wagtail	<i>Dendronanthus indicus</i> (J. F. Gmelin, 1789)	LC	O	WM
196	Tree pipit	<i>Anthus trivialis</i> (Linnaeus, 1758)	LC	I	R
197	Richard's pipit*	<i>Anthus richardi</i> Vieillot, 1818	LC	I	WM
198	Paddyfield pipit	<i>Anthus rufulus</i> Vieillot, 1818	LC	I	WM
199	Western yellow wagtail	<i>Motacilla flava</i> Linnaeus, 1758	LC	I	WM
200	Grey wagtail	<i>Motacilla cinerea</i> Tunstall, 1771	LC	I	WM
201	Citrine wagtail	<i>Motacilla citreola</i> Pallas, 1776	LC	I	WM
202	White-browed wagtail	<i>Motacilla maderaspatensis</i> J. F. Gmelin, 1789	LC	I	WM
203	White wagtail	<i>Motacilla alba</i> Linnaeus, 1758	LC	I	WM
<b>Passeriformes: Emberizidae</b>					
204	Black-headed bunting	<i>Granativora melanocephala</i> (Scopoli, 1769)	LC	O	R
205	Grey-necked bunting	<i>Emberiza bucharani</i> Blyth, 1845	LC	O	WM
206	Striolated bunting	<i>Fringillaria striolata</i> (M. H. C. Lichtenstein, 1823)	LC	O	WM
<b>Passeriformes: Stenostiridae</b>					
207	Grey-headed canary-flycatcher	<i>Culicicapa ceylonensis</i> (Swainson, 1820)	LC	I	WM

**Table 1: (Continued).**

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Passeriformes: Paridae</b>					
208	Cinereous tit	<i>Parus cinereus</i> Vieillot, 1818	LC	I	R
<b>Passeriformes: Alaudidae</b>					
209	Rufous-tailed lark	<i>Ammomanes phoenicura</i> (Franklin, 1831)	LC	O	WM
210	Ashy-crowned sparrow lark	<i>Eremopterix griseus</i> (Scopoli, 1786)	LC	G	R
211	Singing bush lark	<i>Mirafra cantillans</i> Blyth, 1845	LC	O	R
212	Indian bush lark	<i>Mirafra erythroptera</i> Blyth, 1845	LC	O	R
213	Lesser short-toed lark	<i>Alaudala rufescens</i> (Vieillot, 1819)	LC	O	R
214	Oriental sky lark	<i>Alauda gulgula</i> Franklin, 1831	LC	O	R
215	Sykes's lark	<i>Galerida deva</i> (Sykes, 1832)	LC	O	R
<b>Passeriformes: Cisticolidae</b>					
216	Common tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	LC	I	R
217	Gray-breasted prinia	<i>Prinia hodgsonii</i> Blyth, 1844	LC	I	R
218	Jungle prinia	<i>Prinia sylvatica</i> Jerdon, 1840	LC	I	R
219	Ashy prinia	<i>Prinia socialis</i> Sykes, 1832	LC	I	R
220	Plain prinia	<i>Prinia inornata</i> Sykes, 1832	LC	I	R
221	Zitting cisticola	<i>Cisticola juncidis</i> (Rafinesque, 1810)	LC	I	R
<b>Passeriformes: Acrocephalidae</b>					
222	Oriental reed warbler	<i>Acrocephalus orientalis</i> (Temminck and Schlegel, 1847)	LC	I	R
<b>Passeriformes: Locustellidae</b>					
223	Grasshopper warbler*	<i>Locustella naevia</i> (Boddaert, 1783)	LC	I	WM
<b>Passeriformes: Hirundinidae</b>					
224	Red-rumped swallow	<i>Cecropis daurica</i> (Laxmann, 1769)	LC	I	R
225	Wire-tailed swallow	<i>Hirundo smithii</i> Leach, 1818	LC	I	R
226	Barn swallow	<i>Hirundo rustica</i> Linnaeus, 1758	LC	I	R
227	Eurasian crag martin	<i>Ptyonoprogne rupestris</i> Scopoli, 1769	LC	I	R
228	Dusky crag martin	<i>Ptyonoprogne concolor</i> (Sykes, 1832)	LC	I	R
229	Plain martin	<i>Riparia paludicola</i> (Vieillot, 1817)	LC	I	R
<b>Passeriformes: Pycnonotidae</b>					
230	Red-vented bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	LC	O	R
<b>Passeriformes: Phylloscopidae</b>					
231	Yellow-browed warbler*	<i>Abornis inornatus</i> (Blyth, 1842)	LC	I	WM
232	Hume's leaf warbler	<i>Abornis humei</i> (W.E. Brooks, 1878)	LC	I	R
233	Common chiffchaff	<i>Phylloscopus collybita</i> (Vieillot, 1817)	LC	I	R
234	Sulphur-bellied warbler	<i>Phylloscopus griseolus</i> Blyth, 1847	LC	I	R
235	Green leaf warbler	<i>Seicercus nitidus</i> (Blyth, 1843)	LC	I	R
236	Greenish leaf warbler	<i>Seicercus trochiloides</i> (Sundevall, 1837)	LC	I	R
<b>Passeriformes: Sylviidae</b>					
237	Eastern orphean warbler	<i>Curruca crassirostris</i> (Cretzschmar, 1830)	LC	I	WM
238	Lesser whitethroat	<i>Curruca curruca</i> (Linnaeus, 1758)	LC	I	WM
<b>Passeriformes: Zosteropidae</b>					
239	Oriental white-eye	<i>Zosterops palpebrosus</i> (Temminck, 1824)	LC	I	R
<b>Passeriformes: Timaliidae</b>					
240	Tawny-bellied babbler	<i>Dumetia hyperythra</i> (Franklin, 1831)	LC	I	R
<b>Passeriformes: Leiothrichidae</b>					
241	Large grey babbler	<i>Argya malcolmi</i> (Sykes, 1832)	LC	O	R
242	Jungle babbler	<i>Turdoides striata</i> (Dumont, 1823)	LC	O	R
<b>Passeriformes: Sturnidae</b>					
243	Common starling	<i>Sturnus vulgaris</i> Linnaeus, 1758	LC	O	R
244	Rosy starling	<i>Pastor roseus</i> (Linnaeus, 1758)	LC	O	WM
245	Brahminy starling	<i>Sturnia pagodarum</i> (J. F. Gmelin, 1789)	LC	O	WM
246	Common myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	LC	O	R
247	Bank myna	<i>Acridotheres ginginianus</i> (Latham, 1790)	LC	O	R
248	Jungle myna	<i>Acridotheres fuscus</i> (Wagler, 1827)	LC	O	R

**Table 1: (Continued).**

Sl. No.	Common name	Scientific name	IUCN status	FG	RS
<b>Passeriformes: Muscicapidae</b>					
249	Indian robin	<i>Saxicoloides fulicatus</i> (Linnaeus, 1766)	LC	I	R
250	Oriental magpie robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	LC	I	R
251	Spotted flycatcher*	<i>Muscicapa striata</i> (Pallas, 1764)	LC	I	WM
252	Asian brown flycatcher	<i>Muscicapa dauurica</i> Pallas, 1811	LC	I	WM
253	Brown-breasted flycatcher	<i>Muscicapa muttui</i> (E. L. Layard, 1854)	LC	I	WM
254	Rusty-tailed flycatcher	<i>Muscicapa ruficauda</i> Swainson, 1838	LC	I	WM
255	Tickell's blue flycatcher	<i>Cyornis tickelliae</i> Blyth, 1843	LC	I	R
256	Blue-throated flycatcher	<i>Cyornis rubeculoides</i> (Vigors, 1831)	LC	I	WM
257	Verditer flycatcher	<i>Eumyias thalassinus</i> (Swainson, 1838)	LC	I	WM
258	Indian blue robin*	<i>Larvivora brunnea</i> Hodgson, 1837	LC	I	WM
259	Bluethroat	<i>Luscinia svecica</i> (Linnaeus, 1758)	LC	I	WM
260	Red-breasted flycatcher	<i>Ficedula parva</i> (Bechstein, 1792)	LC	I	WM
261	Taiga flycatcher	<i>Ficedula albicilla</i> (Pallas, 1811)	LC	I	WM
262	Black redstart	<i>Phoenicurus ochruros</i> (S. G. Gmelin, 1774)	LC	I	WM
263	Blue-capped rock thrush	<i>Monticola cinclorhyncha</i> (Vigors, 1832)	LC	I	WM
264	Blue rock thrush	<i>Monticola solitarius</i> (Linnaeus, 1758)	LC	I	WM
265	Eastern stonechat	<i>Saxicola maurus</i> (Pallas, 1773)	LC	I	R
266	Pied bush chat	<i>Saxicola caprata</i> (Linnaeus, 1766)	LC	I	R
267	Isabelline wheatear	<i>Oenanthe isabellina</i> (Temminck, 1829)	LC	I	R
268	Desert wheatear	<i>Oenanthe deserti</i> (Temminck, 1825)	LC	I	WM
269	Brown rock chat	<i>Oenanthe fusca</i> (Blyth, 1851)	LC	I	WM
270	Variable wheatear	<i>Oenanthe picata</i> (Blyth, 1847)	LC	I	WM
271	Red-tailed wheatear	<i>Oenanthe chrysopygia</i> (Defilippi, 1863)	LC	I	WM
272	Ultramarine flycatcher	<i>Ficedula superciliaris</i> (Jerdon, 1840)	LC	I	WM
<b>Passeriformes: Turdidae</b>					
273	Orange-headed thrush	<i>Geokichla citrina</i> (Latham, 1790)	LC	O	WM
274	Indian blackbird	<i>Turdus simillimus</i> Jerdon, 1839	LC	O	WM
275	Eyebrowed thrush*	<i>Turdus obscurus</i> J. F. Gmelin, 1789	LC	O	WM
276	Tickell's thrush	<i>Turdus unicolor</i> Tickell, 1833	LC	O	WM

\*Species recorded/photographed by other birdwatchers, not by the authors.

#All names follow Parveen et al. (2021).

IUCN Status: LC, Least Concern; DD, Data Deficient; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered (Source: <https://www.iucnredlist.org/>).

Foraging guild: AQ, Aquatic; O, Omnivorous; I, Insectivorous; G, Granivorous; N, Nectarivores; F, Frugivorous; and C, Carnivorous.

Residential status: R, Residential; WM, Winter Migrant; and MM, Monsoon Migrant.

The occurrence of a significant number of insectivorous bird communities indicates that the area contains a rich insect diversity and that these birds also play a major role as important biocontrol agents of insect pests of forest ecosystems (Mahabal, 2005; Thakur et al., 2010). Recorded bird species were classified as Residents (R), Monsoon Migrants (MM), and Winter Migrants (WM). Out of the 276 total recorded avian species, 164 (59%) were Resident, 102 (35%) were Winter Migrants and 10 (4%) were Monsoon Migrants (Fig. 6). The distribution of avifauna in a habitat is based on the availability, quality and quantity of food resources (Wiens, 1989; Jha, 2013).

Detailed documentation of avifaunal diversity has been much less in this landscape. Fifteen species fall under IUCN categories, but some of them (*Mycteria leucocephala*, *Esacus recurvirostris*, *Sarcogyps calvus*, *Gyps indicus*, *Ciconia episcopus*) were frequently seen and are resident in the study area. This reveals that the GWS is a potential habitat for bird species of conservation priority.

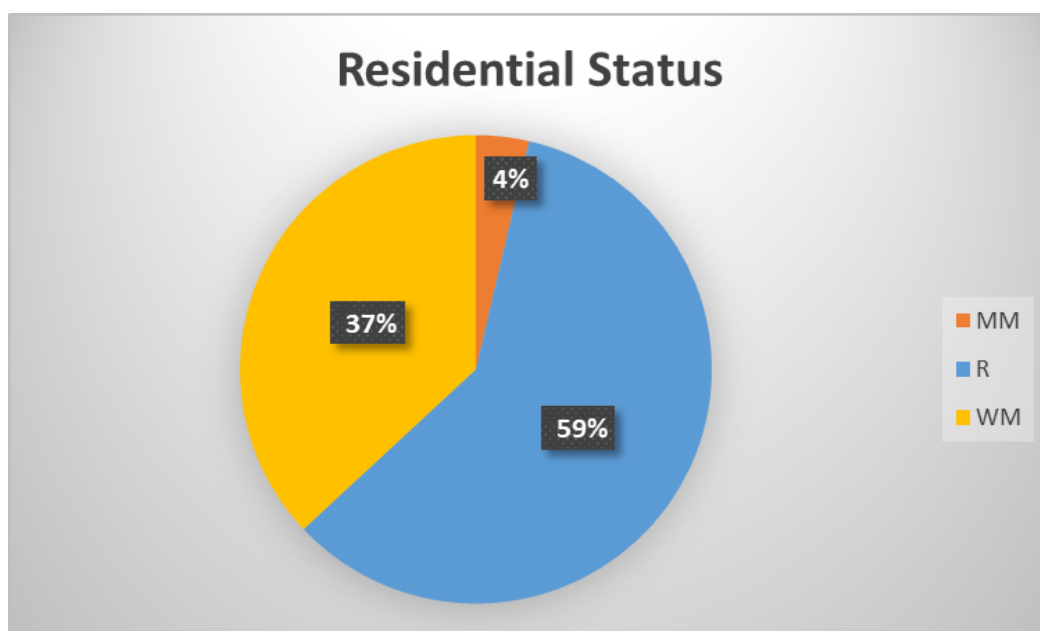
The results of various calculated diversity indices for the four different seasons of the present study are provided in Table 2. The maximum value of the Shannon diversity index was observed during winter 2021 (4.86) whereas the minimum value was during monsoon of 2021 and

2022 (4.28). According to Pielou's evenness index, it was seen that summer and monsoon of 2021 and summer and winter of 2022 (0.51) are the most evenly distributed seasons, followed by post monsoon of 2021 and monsoon of 2022 (0.49) (Table 2). The Margalef's index had the highest values (29.50) during the season of winter in both the years 2021 and 2022, and the lowest values (17.50) during the season of monsoon followed by summer (19.59). The Berger-Parker index had a maximum value during the summer 2022 and monsoons 2021 and 2022 (0.05) and minimum value during the winters 2021 and 2022 (0.03) (Table 2). Bird diversity is higher during the months of post monsoon and winter because the number of winter migratory birds is increasing. Similar studies on the seasonal diversity of birds have been carried out in various areas (e.g., Lakkavalli Range Forest, Bhadra Wildlife Sanctuary, Western Ghats, India (Harisha and Hosetti, 2009); Nagarjun Forest of Shivapuri Nagarjun National Park Kathmandu, Nepal (Jha, 2020); Kotagarh Wildlife Sanctuary, Odisha, Eastern Ghats, India (Giri, 2020)) which shows that the diversity is higher in the winter and post monsoon season. The maximum number of individuals was found during the months of winter followed by post monsoon and the minimum number of species and individuals were found during the monsoon season (Fig. 7).

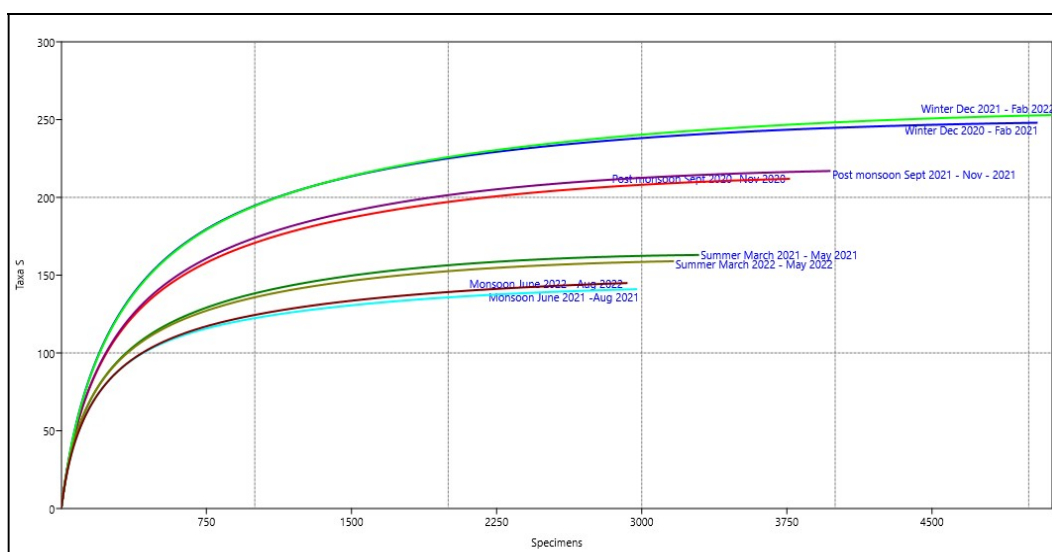


**Table 2:** Diversity indices for four seasons of years 2020–2022 for the birds of Girnar Wildlife Sanctuary, India.

Diversity index	Post monsoon Sep. 2020–Nov. 2020	Winter Dec. 2020– Feb. 2021	Summer March 2021– May 2021	Monsoon June 2021– Aug. 2021	Post monsoon Sep. 2021–Nov. 2021	Winter Dec. 2021– Feb. 2022	Summer March 2022– May 2022	Monsoon June 2022– Aug. 2022
Taxa_S	212	248	163	141	217	253	159	145
Individuals	3779	5054	3301	2981	3985	5133	3179	2935
Shannon_H	4.66	4.86	4.42	4.28	4.68	4.85	4.41	4.28
Evenness_e^H/S	0.5	0.52	0.51	0.51	0.49	0.51	0.51	0.49
Margalef	25.62	28.96	20	17.5	26.05	29.5	19.59	18.04
Berger-Parker	0.04	0.03	0.04	0.05	0.04	0.03	0.05	0.05



**Figure 6:** Residential status of the avifauna from the Girnar Wildlife Sanctuary (R, Residential; WM, Winter Migrant; MM, Monsoon Migrant).



**Figure 7:** Rarefaction curve of species found during different seasons of the years 2020–2022 (Graph made using PAST 3.26).

It is evident from earlier studies that the landscape with diverse habitats provides opportunities for diverse avian fauna assemblages (Karr and Roth, 1971). Over the last many years, no scientific checklist has been published on the avifaunal diversity of GWS though it is an important biodiversity area with a good amount of avifaunal diversity. Therefore, the present study is the first of its kind from the GWS. Previously in a 2013 survey in GWS done by the Mahiru Foundation, 103 species of birds were recorded. According to the databases of Birds of India, Birds of Gujarat and Avibase India, a total of 166 species of birds were recorded in GWS during their previous study.

We recorded 276 species of birds, which is 45% of Gujarat's avifaunal diversity indicating that the GWS is an important biodiversity area. Some of the noteworthy species and some recorded first in Gujarat species by birdwatchers are the Indian blue robin *Larvivora brunnea* Hodgson, 1837, Tiaga flycatcher *Ficedula albicilla* (Pallas, 1811), Eye-browed thrush *Turdus obscurus* J. F. Gmelin, 1789, Richard's pipit *Anthus richardi* Vieillot, 1818, Amur falcon *Falco amurensis* Radde, 1863, Tickell's thrush *Turdus unicolor* Tickell, 1833, Black shaheen *Falco peregrinus peregrinator* Sundevall, 1837, Blue-capped rock thrush *Monticola cinclorhyncha* (Vigors, 1832), Bearded vulture *Gypaetus barbatus* (Linnaeus, 1758), Besra *Accipiter virgatus* (Temminck, 1822), Grasshopper warbler *Locustella naevia* (Boddaert, 1783) and Yellow-browed warbler *Abornis inornatus* (Blyth, 1842) (Ganpule, 2014; Mashru, 2014; Bagda, 2015a, 2015b, 2015c; Bagda, 2016; Mori and Joshi, 2017; Vaghasiya and Bagda, 2017; Vadher, 2019; Doshi, 2020; Parmar, 2020; Bagda, 2022) from GWS.

The number of tourists to Girnar is increasing yearly, which directly affects the diversity. Nowadays, as a result of Girnar Ropeway both the number of tourists and anthropogenic activities are rising (personal observation). Steven and Castley (2013) reported that the 63 critically endangered and endangered bird species are threatened by tourism. Li et al. (2022) stated that the bird diversity and their foraging activities (seed dispersal) were affected by the disturbance of ropeway construction at China. Advanced methodology such as camera trap (for vulture), sound recording (for bird calls) and genetic tools for non-invasive samples such as feathers (Thatte et al., 2018) can be used to determine the presence of species and are trustworthy and efficient data sources. Long-term and regular monitoring of diversity and populations can help to improve the wildlife population.

## Conclusion

During the entire study period of 25 months, we recorded 276 species of birds. This contributes a good number towards Gujarat's avian diversity. Therefore, future studies need to be focused on GWS

with special reference to the avifauna. Furthermore, the monsoon survey has been overlooked, and future surveys might lead to interesting sightings (e.g., rails, crakes, raptors, flycatchers, etc.). The landscape holds a promising premise for raptor studies. In order to add new species to the list and monitor each species precise status in the landscape, we advise updating the checklist at least every two or three years. Long term monitoring of avifauna is required for keeping watch on ecosystem health and thus might be useful to foster its sustainable improvement.

## Acknowledgements

The authors would like to thank PCCF Gujarat Forest Department and CCF of Junagadh Circle for providing the necessary permission to work in the GWS. We are also thankful to the GWS Forest Department staff for the help in the fieldwork. We are thankful to the Head of the Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh and all faculty members for the support. Ms. Usha Zala is thankful to Mr. Vipul V. Bamaniya, Mr. Malay A. Vyas and Mr. Bhargav U. Oza for the support during the work. Usha Zala is thankful to the Education Department, Gujarat State for receiving a SHODH (ScHeme of Developing High Quality Research) scholarship. The authors are utmost thankful to the anonymous reviewers for their constructive suggestions.

## Conflict of interest

All the authors declare that there are no conflicting issues related to this research article.

## References

- Ali, S. (2002). *The book of Indian birds* (Thirteenth Edition, Revised by Daniel, J. C.). Bombay Natural History Society, Oxford University Press. 326 pp.
- Arya, A., Joshi, K., Bachheti, A., Raturi, V., Dubey, V., Bhatnagar, P. and Rawat, R. (2020). Avian survey at Haiderpur Wetland in Hastinapur Wildlife Sanctuary Uttar Pradesh, India. *Journal of Environment and Bio-Sciences*, 34 (2): 107–114.
- Avibase The World Bird Database (2022). <https://avibase.bsc-eoc.org/checklist.jsp?region=INnwj21&list=howardmoore> (Accessed 25/08/2022).
- Bagda, G. (2015a). Sighting of Eye-browed Thrush in Girnar Wildlife Sanctuary, Gujarat. *Flamingo*, 13 (3): 22.
- Bagda, G. (2015b). <https://birdingugujarat.wordpress.com/2015/11/24/probable-richards-pipit-near-junagadh/>
- Bagda, G. (2015c). <https://birdingugujarat.wordpress.com/2015/4/25/Sighting-of-AmurFalcon-in-April-near-Junagadh,-Gujarat/>

- Bagda, G. (2016). Sighting of Tickell's Thrush in Girnar Wildlife Sanctuary. *Flamingo*, 14 (1): 11
- Bagda, G. (2022). Sighting of Yellow-browed Warbler *Phylloscopus inornatus* at Girnar *Flamingo*, (2): 7.
- Bamaniya, V. V. and Raval, J. V. (2022). Extended distribution range of tricolour pied flat (*Coladenia indrani*) butterfly to Western Gujarat, India. *International Journal of Entomology Research*, 7 (4): 210–213.
- Banerjee, K., Jhala, Y. V. and Pathak, B. (2010). Demographic structure and abundance of Asiatic lions *Panthera leo persica* in Girnar Wildlife Sanctuary, Gujarat, India. *Oryx*, 44 (2): 248–251. <https://doi.org/10.1017/S0030605309990949>
- Berger, W. H. and Parker, F. L. (1970). Diversity of planktonic foraminifera in deep sea sediments. *Science*, 168: 1345–1347. <https://doi.org/10.1126/science.168.3937.1345>
- Birds of Gujarat (2022). [https://birdsofgujarat.co.in/place\\_birdlist.php?list=Girnar%20Wildlife%20Sanctuary](https://birdsofgujarat.co.in/place_birdlist.php?list=Girnar%20Wildlife%20Sanctuary) (Accessed 25/08/2022)
- Champion, H. G. and Seth, S. K. (1968). *A revised survey of the forest types of India*. Manager of Publications, Delhi, India. 404 pp.
- Dharaiya, A. and Dharaiya, N. (2021). Assessment of wildlife habitats using geo-spatial techniques; implications for long-term habitat management of Girnar Wildlife Sanctuary, Gujarat, India. *Journal of Environmental Studies*, 7 (1): 1–8. <https://doi.org/10.13188/2471-4879.1000031>
- Doshi, N. (2020). Besra *Accipiter virgatus* in Girnar, near Junagadh. *Flamingo*, (3): 22.
- E bird India (2022). <https://ebird.org/hotspot/L3313077?yr=all&m=&rank=mrec> (Accessed 25/08/2022)
- Ganpule, P. (2014). Taiga Flycatcher *Ficedula albicilla* in Gujarat: Status and distribution, with notes on its identification. *Indian Birds*, 9 (5): 152–154.
- Ganpule, P. (2021). Third update to the Gujarat checklist: December 2021. *Flamingo*, 4: 3–8.
- Giri, K. C., Jena, S. K., Dash, P. K., Nayak, S. and Behera, S. (2020). Seasonal abundance of avian diversity in kotagarh wildlife sanctuary, odisha, eastern ghats, India. *Journal of Experimental Zoology*, India, 23 (2): 1521–1529.
- Grimmett, R., Inskipp, C. and Inskipp, T. (2013). *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. e-book downloaded via [https://play.google.com/store/books/details/Richard\\_Grimmett\\_Birds\\_of\\_the\\_Indian\\_Subcontinent](https://play.google.com/store/books/details/Richard_Grimmett_Birds_of_the_Indian_Subcontinent).
- Grimmett, R., Inskipp, C. and Inskipp, T. (2011). *Birds of the Indian Subcontinent*. Second Edition. Oxford University Press and Christopher Helm, London. 528 pp.
- Harisha, M. N. and Hosetti, B. B. (2009). Diversity and distribution of avifauna of Lakkavalli range forest, Bhadra wildlife sanctuary, western ghat, India. *Ecoprint: An International Journal of Ecology*, 16: 21–27. <https://doi.org/10.3126/eco.v16i0.3469>
- Harisha, M. N., Samad, K. A. and Hosetti, B. B. (2021). Conservation status, feeding guilds, and diversity of birds in Daroji Sloth Bear Sanctuary, Karnataka, India. *Journal of Threatened Taxa*, 13 (7): 18738–18751. <https://doi.org/10.11609/jott.6855.13.7.18738-18751>
- IUCN (2022). The IUCN Red List of Threatened Species. Version 2022-2. <https://www.iucnredlist.org>. Accessed on 15 8 2022.
- Jambu, N. and Patel, K. G. (2021). Birds of Surat-Dangs: a consolidated checklist of 75 years (1944–2020) with special emphasis on noteworthy bird records and bird hotspots from northern Western Ghats of Gujarat, India. *Journal of Threatened Taxa*, 13 (7): 18752–18780. <https://doi.org/10.11609/jott.6259.13.7.18752-18780>
- Jha, K. K. (2013). Aquatic food plants and their consumer birds at Sandi Bird Sanctuary, Hardoi, Northern India. *Asian Journal of Conservation Biology*, 2 (1): 30–43.
- Jha, P. K. (2020). Seasonal diversity of birds in Nagarjun Forest of Shivapuri Nagarjun National Park, Kathmandu, Nepal. *Tribhuvan University Journal*, 35 (1): 33–43. <https://doi.org/10.3126/tuj.v35i1.35832>
- Karr, J. R. and Roth, R. R. (1971). Vegetation structure and avian diversity in several New World areas. *The American Naturalist*, 105 (945): 423–435. <https://doi.org/10.1086/282735>
- Kazmierczak, K. (2000). *A field guide to the birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh and the Maldives*. First Edition. Om Book Service, New Delhi, India. 352 pp.
- Khacher, L. (1996). The birds of Gujarat—a Salim Ali centenary year overview. *Journal of the Bombay Natural History Society*, 93: 331–373.
- Khan, M. S. and Pant, A. (2017). Conservation status, species composition, and distribution of Avian Community in Bhimbandh Wildlife Sanctuary, India. *Journal of Asia-Pacific Biodiversity*, 10: 20–26. <https://doi.org/10.1016/j.japb.2016.07.004>
- Koli, V. K. (2014). Diversity and status of avifauna in Todgarh-Raoli Wildlife Sanctuary, Rajasthan, India. *Journal of Asia-Pacific Biodiversity*, 7 (4): 401–407. <https://doi.org/10.1016/j.japb.2014.10.005>
- Kremen, C. and Ostfeld, R. S. (2005). A call to ecologists: measuring, analyzing, and managing ecosystem services. *Frontiers in Ecology and the Environment*, 3 (10): 540–548. [https://doi.org/10.1890/1540-9295\(2005\)003\[0540:ACTEMA\]2.0.CO;2](https://doi.org/10.1890/1540-9295(2005)003[0540:ACTEMA]2.0.CO;2)
- Kumar, T. S., Chandra, R. and Azeed, P. A. (2010). The birds of Araku, Visakhapatnam, Andhra Pradesh, India. *Journal of Threatened Taxa*, 2 (1): 662–665. <https://doi.org/10.11609/JoTT.o2108.662-5>
- Li, N., Tang, N., Ren, Y. and Wang, Z. (2022). Effects of forest ropeway construction on bird diversity and its seed dispersal mutualism for endangered taxus chinensis, Southeast China. *Global Ecology and Conservation*, 38: e02227. <https://doi.org/10.1016/j.gecco.2022.e02227>



- Mahabal, A. (2005). Aves, *Fauna of Western Himalaya*. Zoological Survey of India, Kolkata, India. pp. 275–339.
- Mali, S., Srinivasulu, C. and Rahmani, A. R. (2017). Avifaunal diversity in the scrub forest of Sri Lankamalleswara Wildlife Sanctuary, Andhra Pradesh, India. *Journal of Threatened Taxa*, 9 (9): 10679–10691.  
<https://doi.org/10.11609/jott.2720.9.9.10679-10691>
- Margalef, R. (1968). *Perspectives in ecological theory*. The University of Chicago Press, USA. 111 pp.
- Mashru, A. (2014). Records of Indian Blue Robin *Larvivora brunnea* from Gujarat, India. *Indian Birds*, 9 (5): 160–161.
- Nakar, R. N. and Jadeja, B. A. (2015). Flowering and fruiting phenology of some herbs, shrubs and undershrubs from Girnar Reserve Forest, Gujarat, India. *Current Science*, 108 (1): 111–118.
- Narayana, B. L., Rao, V. V. and Venkateswara Reddy, V. (2018). Composition of birds in agricultural landscapes of Peddagattu and Sherpally Area: a proposed uranium mining sites in Nalgonda, Telangana, India. *Proceedings of the Zoological Society*, 72 (4): 380–400.  
<https://doi.org/10.1007/s12595-018-0280-0>
- Parmar, P. (2020). Grasshopper Warbler *Locustella naevia* in Girnar Wildlife Sanctuary near Junagadh. *Flamingo*, 3 (4): 22
- Patel, H., Vyas, R., Dudhatra, B., Naik, V., Chavda, A., Chauhan, D. and Vaghashiya, P. (2019). Preliminary report on Herpetofauna of Mount Girnar, Gujarat, India. *Journal of Animal Diversity*, 1 (2): 9–35.  
<https://doi.org/10.29252/JAD.2019.1.2.2>
- Patel, R. and Bagda, G. (2022). A brief avian species richness report of Juagadh, Gujarat, India. *Journal of Forest Research*, 11 (2): 1–6.
- Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, 13: 131–44.  
[https://doi.org/10.1016/0022-5193\(66\)90013-0](https://doi.org/10.1016/0022-5193(66)90013-0)
- Praveen, J., Jayapal, R. and Pittie, A. (2021). Checklist of the birds of India (V 5.1).  
<https://www.indianbirds.in/india> (Accessed 29/08/2022).
- Sekercioglu, C. (2006). Increasing awareness of avian ecological function. *Trends in Ecology and Evolution*, 21 (8): 464–471.  
<https://doi.org/10.1016/j.tree.2006.05.007>
- Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, 27: 379–423.  
<https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>
- Steven, R. and Castley, J. G. (2013). Tourism as a threat to critically endangered and endangered birds: global patterns and trends in conservation hotspots. *Biodiversity and Conservation*, 22 (4): 1063–1082.  
<https://doi.org/10.1007/s10531-013-0470-z>
- Sutherland, W. J. (2006). *Ecological Census Techniques*. Second Edition. Cambridge University Press, UK. 450 pp.  
<https://doi.org/10.1017/CBO9780511790508>
- Thakur, M. L., Mattu, V. K., Lal, H., Sharma, V. N., Raj, H. and Thakur V. (2010). Avifauna of Arki Hills, Solan (Himachal Pradesh), India. *Indian Birds*, 5 (6): 162–166.
- Thatte, P., Patel, K. and Ramakrishnan, U. (2018). Rapid species identification of sloth bears from non-invasive samples: a PCR-based assay. *Ursus*, 29 (1): 67–70.  
<https://doi.org/10.2192/URSUS-D-17-00024.2>
- The Oriental Bird Club Image Database (2022).  
<https://www.macaulylibrary.org/oriental-bird-images> (Accessed 25/08/2022)
- Urfi, A. J., Sen, M., Kalam, A. and Meganathan, T. (2005). Counting birds in India: Methodologies and trends. *Current Science*, 89 (12): 1997–2003.
- Vadher, D. (2019). Bearded Vulture *Gypaetus barbatus* in Girnar Wildlife Sanctuary, Junagadh, Gujarat. *Indian Birds*, 15 (1): 24–25.
- Vaghashiya, P. and Bagda, G. (2017). Status of Blue-capped Rock Thrush in Girnar Wildlife Sanctuary. *Flamingo*, 15 (2): 14–15.
- Van Buskirk, J., Mulvihill, R. S. and Leberman, R. C. (2010). Declining body sizes in North American birds associated with climate change. *Oikos*, 119 (6): 1047–1055.  
<https://doi.org/10.1111/j.1600-0706.2009.18349.x>
- Vinayak, D. C. and Mali, S. V. (2018). A checklist of bird communities in Tamhini Wildlife Sanctuary, the northern Western Ghats, Maharashtra, India. *Journal of Threatened Taxa* 10 (3): 11399–11409.  
<https://doi.org/10.11609/jott.3377.10.3.11399-11409>
- Whelan, C. J., Wenny, D. G. and Marquis, R. J. (2008). Ecosystem services provided by birds. *Annals of the New York Academy of Sciences*, 1134 (1): 25–60.  
<https://doi.org/10.1196/annals.1439.003>
- Wiens, J. A. (1989). *The ecology of bird communities*. Cambridge University Press, Cambridge, UK. 539 pp.  
<https://doi.org/10.1017/CBO9780511608568>
- Xeno-canto (2022). Sharing birds sounds from around the world. Electronic database accessible at: <https://xeno-canto.org/> (Downloaded on 12-10-2022).

**Appendix 1:** Photographic plates.





Appendix 1: (Continued).



**Photographic plate:** 1. *Ictinaetus malaiensis* (Temminck, 1822), 2. *Clamator jacobinus* (Boddaert, 1783), 3. *Monticola cinclorhyncha* (Vigors, 1832), 4. *Monticola solitarius* (Linnaeus, 1758), 5. *Culicicapa ceylonensis* (Swainson, 1820), 6. *Sarcogyps calvus* (Scopoli, 1786), 7. *Locustella naevia* (Boddaert, 1783), 8. *Dendronanthus indicus* (J. F. Gmelin, 1789), 9. *Ficedula parva* (Bechstein, 1792), 10. *Pitta brachyura* (Linnaeus, 1766), 11. *Turdus unicolor* Tickell, 1833, 12. *Turdus simillimus* (Jerdon, 1839), 13. *Eumyias thalassinus* (Swainson, 1838), 14. *Bubo bengalensis* (Franklin, 1831), 15. *Spilornis cheela* (Latham, 1790), 16. *Gyps indicus* (Scopoli, 1786). Photos 1, 2, 4, 5, 6, 8, 9, 10, 13, 14, 15, 16 by Romanch Nimavat; 3, 11, 12 by Kaushal Sharma; and 7 by Pushparajsinh Parmar.