

A Comparative Study of Avian Diversity at Three Selected Sites of Porbandar, Gujarat, India

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ABSTRACT

Present study on avian diversity was carried out from July 2020 to June 2022 at three selected sites of Porbandar, which is in the western part of Gujarat state in India. Rain is the major source of water for all the three selected sites, so wetland conditions get adverse with decreasing water levels. The study area was surveyed twice a month and a total of 48 visits were made during the study for each wetland. The present study aims to study: abundance, migratory status and diversity of avian fauna. This study could lead to a better understanding of the selected wetlands that are being preferred by the birds (especially winter migrants). Birds from twenty-two orders and fifty-five families were identified. The Scolopacidae family contributed the highest species, i.e., eighteen species, followed by Anatidae and Laridae. During the research, we observed that all the wetlands selected for the study, although present in the urban set up and under constant pressure by various anthropogenic activities, still remained a preferred site for the winter migrants, as these winter migratory birds account for more than fifty percent of its avian diversity.

Keywords: Winter migrants, Birds, IUCN status, Abundance.

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INTRODUCTION

Since birds have long been a popular among naturalists, both amateur and professional, their distribution and systematics are better known than those of any other comparable animal groups, maybe with the exception of large mammals.^[1] They are a vital part of biodiversity and have enormous ecological, economic, and aesthetic values.^[2] Seasonal changes in habitat structure and food abundance potentially influence the species richness of birds in most terrestrial environments.^[3] They also play a crucial role in the ecosystem of wetlands and depend on wetlands for activities including breeding, nesting, providing water for drinking, feeding, and resting.^[4] Therefore, any modification to the wetlands' physical, chemical, and biological components has an impact on the variety and abundance of the avian fauna,

either directly or indirectly. It is commonly known that wetlands are home to large populations of birds.^[5] 11,158 known living bird species are found worldwide. (Source: Bird Life International, 2020 retrieved from <http://datazone.birdlife.org/sowb/casestudy/waterbirds-are-showing-widespread-declines-particularly-in-asia>). India is home to 1341 species out of which there are 26 orders, 113 families, and 489 genera.^[6] Gujarat has 612 species recorded as well.^[7]

These wetlands occur in all heights from tropical deserts to cold tundra, at all elevations from beneath the ocean level to around 6000 m high in the Himalaya.^[8] Being an unloading ground of anthropogenic release, these wetlands brought about a special biological system by eutrophication and subsequently support expanding biomass of phytoplankton, gelatinous zooplankton, benthic and epiphytic algae. This unique environment likewise upholds a variety of organisms such as phytoplanktons, zooplanktons, hardy fish species, crustaceans and molluscs that allure fauna particularly birds which feed upon them.^[9] However, due to urbanisation and rural seepage, close to 60–70% of all wetlands globally have been lost since the start of

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the twentieth century.^[10] and of those remaining, many are degraded.^[11]

Several author such as Das and Saikia in 2012,^[12] Patel and Raval in 2019,^[13] Raval and Vyas in 2019,^[14] Akram and Ilyas in 2021,^[15] have studied Bird Diversity of wetlands and have observed that wetlands provide an excellent habitat for the Avian fauna. They also observed that it is very important to understand avian diversity of wetlands so we can conserve and protect it properly.

Our Present research work was to assess Avian diversity of Three selected wetlands of Porbandar i.e.: Chhaya wetland, Karli wetland and subhashnagar wetland as these are very important and preferred sites of winter birds. It is home to a good number of bird species therefore by conserving these wetlands. we can save floral and faunal diversity along with avian fauna. As there was no systematic data available regarding Avian diversity. we attempted to fill the research gap by preparing a detailed and systematic checklist of birds, which would be helpful in further references as well.

MATERIALS AND METHODS

Study area

The Research was carried out on Chhaya wetland (21°37'21.02"N, 69°38'7.55"E), Karli wetland (21°37'47.83"N, 69°39'5.48"E) and Subhash Nagar wetland (21°39'3.94"N, 69°36'47.65"E) which is located at Porbandar in the western part of Gujarat state in India (Figure 1). The major source of water is rain water which nourishes the wetland and other secondary water sources apart from rain water were sewage water, waste

water and industrial effluents from nearby households and industry respectively. The climate of selected study area is semi-arid (yearly rainfall is between 200 – 700 mm).

Data Collection

The study was carried out over a two-year period, from July 2020 to June 2022. Two surveys each month were conducted throughout the research area, total 48 visits per each wetland. The field visits were planned for early in the day (6:00 to 9:00 hrs) and late in the day (16:00 to 19:00 hrs), when birds were most active. Nikon binoculars were utilized to watch birds (ACULON A211 10x50). Using the field guide by Grimmett and the available scientific sources, birds were identified.^[16] and other published literature. Random sampling and point-count observation methods were used for data collection of Avian fauna.

Data Analysis

As per the data collected during the study, we categorised Migratory status of birds as Resident (RE), Winter migrant (WM), Passage Migrant (PM), Monsoon Migrant (MM) and Summer Migrant (SM). Based on the number of sightings made throughout the study period, the presence of each species in the study site was also reported as Very Common (≥ 8 sighting), Common (5-7 sighting), Uncommon (3-4 sighting), and Rare (1-2 sighting). Each identified species was cross referenced with the latest IUCN status and were categorised into endangered (EN), vulnerable (VU), near threatened (NT) and least concern (LC) category (IUCN 2022). Diversity indices such as Dominance_D, Simpson diversity 1/D; 1-D; Shannon diversity $-H'$, Brillouin, Menhinick, Margalef's species richness (d), Fisher alpha diversity (α) and Berger-Parker were computed using software PAST.^[17]

RESULTS

During the study a total of 199 species from 22 orders and 55 families were recorded (Table 1). Order Passeriformes represents nineteen families followed by Charadriiformes with eight families (Figure 2). highest diversity of avian fauna was recorded from Site 2 while lowest was recorded from site 3 (Table 2). Scolopacidae family contributes 18 species which is highest among all the families, Anatidae and Laridae recorded 16 and 13 species respectively. All the three wetlands are home to several migratory birds, 109 species are winter migrants (WM), 2 species are monsoon migrants (MM), 1-1 species each are passage migrant (PM) and summer migrants (SM) respectively. 86 species are residents (RE) (Figure 3). These wetlands provide habitat to birds



Figure 1: Location of selected sites of study: Porbandar, Gujarat, India (Source: <https://earth.google.com/web/>).

Table 1: Systematic list of Birds recorded from selected study sites of Porbandar, Gujarat, India (July 2020 to June 2022) showing Bird's Common name, Scientific name, Order, Family, IUCN status, Residential status and Abundance.

Sr. no	Scientific Name	Family	IUCN	Residential Status	Abundance	
Common Name						
Order: Accipitriformes						
1	Black kite	<i>Milvus migrans</i>	Accipitridae	LC	RE	VC
2	Black-winged Kite	<i>Elanus caeruleus</i>		LC	RE	C
3	Brahminy Kite	<i>Haliastur indus</i>		LC	WM	UC
4	Eurasian Marsh-Harrier	<i>Circus aeruginosus</i>		LC	WM	C
5	Greater Spotted Eagle	<i>Clanga clanga</i>		VU	WM	UC
6	Indian Spotted Eagle	<i>Clanga hastata</i>		VU	WM	R
7	Montagu's Harrier	<i>Circus pygargus</i>		LC	WM	R
8	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>		LC	RE	C
9	Short-toed Snake-Eagle	<i>Circaetus gallicus</i>		LC	WM	UC
10	Shikra	<i>Accipiter badius</i>		LC	RE	VC
11	Osprey	<i>Pandion haliaetus</i>	Pandionidae	LC	WM	C
Order: Anseriformes						
12	Common Pochard	<i>Aythya ferina</i>	Anatidae	VU	WM	UC
13	Eurasian Wigeon	<i>Mareca penelope</i>		LC	WM	UC
14	Ferruginous Duck	<i>Aythya nyroca</i>		NT	WM	UC
15	Gadwall	<i>Mareca strepera</i>		LC	WM	UC
16	Garganey	<i>Anas querquedula</i>		LC	WM	UC
17	Green-winged Teal	<i>Anas carolinensis</i>		LC	WM	C
18	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>		LC	RE	VC
19	Knob-billed Duck	<i>Sarkidiornis melanotos</i>		LC	RE	VC
20	Lesser Whistling-Duck	<i>Dendrocygna javanica</i>		LC	WM	C
21	Northern Pintail	<i>Anas acuta</i>		LC	WM	UC
22	Northern Shoveler	<i>Spatula clypeata</i>		LC	WM	C
23	Ruddy Shelduck	<i>Tadorna ferruginea</i>		LC	WM	UC
24	Graylag Goose	<i>Anser anser</i>		LC	WM	UC
25	Mallard	<i>Anas platyrhynchos</i>		LC	WM	UC
26	Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>		LC	WM	R
27	Tufted Duck	<i>Aythya fuligula</i>		LC	WM	UC
Order: Apodiformes						
28	Asian Palm-Swift	<i>Cypsiurus balasiensis</i>	Apodidae	LC	RE	C
29	Little Swift	<i>Apus affinis</i>		LC	WM	C
30	Alpine Swift	<i>Tachymarptis melba</i>		LC	WM	UC
Order: Bucerotiformes						
31	Eurasian Hoopoe	<i>Upupa epops</i>	Upupidae	LC	WM	C
Order: Caprimulgiformes						
32	Sykes's Nightjar	<i>Caprimulgus mahrattensis</i>	Caprimulgidae	LC	WM	R
33	Indian Nightjar	<i>Caprimulgus asiaticus</i>		LC	RE	C
Order: Charadriiformes						
34	Indian Thick-knee	<i>Burhinus indicus</i>	Burhinidae	LC	RE	C
35	Great Thick-knee	<i>Esacus recurvirostris</i>		NT	RE	UC

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Table 1: Cont'd.

Sr. no	Common Name	Scientific Name	Family	IUCN	Residential Status	Abundance
36	Greater Sand Plover	<i>Charadrius leschenaultii</i>	Charadriidae	LC	WM	UC
37	Kentish Plover	<i>Charadrius alexandrinus</i>		LC	WM	UC
38	Lesser Sand-Plover	<i>Charadrius mongolus</i>		LC	WM	C
39	Little Ringed Plover	<i>Charadrius dubius</i>		LC	WM	VC
40	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>		LC	RE	C
41	White-tailed Lapwing	<i>Vanellus leucurus</i>		LC	WM	UC
42	Pacific Golden-Plover	<i>Pluvialis fulva</i>		LC	WM	UC
43	Red-wattled Lapwing	<i>Vanellus indicus</i>		LC	RE	VC
44	Collared Pratincole	<i>Glareola pratincola</i>	Glareolidae	LC	WM	R
45	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	Jacanidae	LC	WM	UC
46	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	Laridae	LC	RE	VC
47	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>		LC	RE	C
48	Caspian Tern	<i>Hydroprogne caspia</i>		LC	WM	UC
49	Gull-billed Tern	<i>Gelochelidon nilotica</i>		LC	WM	UC
50	Lesser Black-backed Gull	<i>Larus fuscus</i>		LC	WM	UC
51	Pallas's Gull	<i>Ichthyaetus ichthyaetus</i>		LC	WM	C
52	River Tern	<i>Sterna aurantia</i>		VU	RE	VC
53	Common Tern	<i>Sterna hirundo</i>		LC	WM	C
54	Indian Skimmer	<i>Rynchops albicollis</i>		EN	WM	UC
55	Bridled Tern	<i>Onychoprion anaethetus</i>		LC	WM	UC
56	Slender-billed Gull	<i>Chroicocephalus genei</i>		LC	WM	UC
57	Little Tern	<i>Sternula albifrons</i>		LC	WM	UC
58	Whiskered Tern	<i>Chlidonias hybrida</i>		LC	WM	C
59	Black-winged Stilt	<i>Himantopus himantopus</i>	Recurvirostridae	LC	RE	VC
60	Pied Avocet	<i>Recurvirostra avosetta</i>		LC	WM	C
61	Greater Painted-Snipe	<i>Rostratula benghalensis</i>	Rostratulidae	LC	WM	C
62	Black-tailed Godwit	<i>Limosa limosa</i>	Scolopacidae	NT	WM	C
63	Common Greenshank	<i>Tringa nebularia</i>		LC	WM	UC
64	Common Redshank	<i>Tringa totanus</i>		LC	WM	C
65	Common Sandpiper	<i>Actitis hypoleucos</i>		LC	WM	VC
66	Common Snipe	<i>Gallinago gallinago</i>		LC	WM	C
67	Eurasian Curlew	<i>Numenius arquata</i>		NT	WM	UC
68	Green Sandpiper	<i>Tringa ochropus</i>		LC	WM	C
69	Little Stint	<i>Calidris minuta</i>		LC	WM	C
70	Marsh Sandpiper	<i>Tringa stagnatilis</i>		LC	WM	C
71	Ruff	<i>Calidris pugnax</i>		LC	WM	UC
72	Terek Sandpiper	<i>Xenus cinereus</i>		LC	WM	UC
73	Ruddy Turnstone	<i>Arenaria interpres</i>		LC	WM	UC
74	Bar-tailed Godwit	<i>Limosa lapponica</i>		NT	WM	UC
75	Curlew Sandpiper	<i>Calidris ferruginea</i>		NT	WM	UC
76	Red-necked Phalarope	<i>Phalaropus lobatus</i>		LC	WM	R
77	Spotted Redshank	<i>Tringa erythropus</i>		LC	WM	UC

Continued...

Table 1: Cont'd.

Sr. no	Common Name	Scientific Name	Family	IUCN	Residential Status	Abundance
78	Temminck's Stint	<i>Calidris temminckii</i>		LC	WM	UC
79	Wood Sandpiper	<i>Tringa glareola</i>		LC	WM	UC
Order: Ciconiiformes						
80	Asian Openbill	<i>Anastomus oscitans</i>	Ciconiidae	LC	WM	UC
81	Woolly-necked Stork	<i>Ciconia episcopus</i>		NT	WM	R
82	Painted Stork	<i>Mycteria leucocephala</i>		NT	RE	VC
Order: Columbiformes						
83	Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	Columbidae	LC	RE	VC
84	Laughing Dove	<i>Spilopelia senegalensis</i>		LC	RE	C
85	Red Collared-Dove	<i>Streptopelia tranquebarica</i>		LC	RE	UC
86	Rock Pigeon	<i>Columba livia</i>		LC	RE	VC
Order: Coraciiformes						
87	Pied Kingfisher	<i>Ceryle rudis</i>	Alcedinidae	LC	RE	C
88	Common Kingfisher	<i>Alcedo atthis</i>		LC	RE	C
89	White-throated Kingfisher	<i>Halcyon smyrmensis</i>		LC	RE	VC
90	Indian Roller	<i>Coracias benghalensis</i>	Coraciidae	LC	RE	UC
91	European Roller	<i>Coracias garrulus</i>		LC	PM	UC
92	Green Bee-eater	<i>Merops orientalis</i>	Meropidae	LC	RE	VC
93	Blue-cheeked Bee-eater	<i>Merops superciliosus</i>		LC	WM	UC
94	Blue-tailed Bee-eater	<i>Merops philippinus</i>		LC	SM	UC
Order: Cuculiformes						
95	Asian Koel	<i>Eudynamys scolopaceus</i>	Cuculidae	LC	RE	VC
96	Greater Coucal	<i>Centropus sinensis</i>		LC	RE	VC
Order: Falconiformes						
97	Eurasian Kestrel	<i>Falco tinnunculus</i>	Falconidae	LC	WM	UC
98	Peregrine Falcon	<i>Falco peregrinus</i>		LC	WM	UC
Order: Galliformes						
99	Gray Francolin	<i>Ortygornis pondicerianus</i>	Phasianidae	LC	RE	VC
100	Indian Peafowl	<i>Pavo cristatus</i>		LC	RE	VC
Order: Gruiformes						
101	Common Crane	<i>Grus grus</i>	Gruidae	LC	WM	R
102	Demoiselle Crane	<i>Grus virgo</i>		LC	WM	C
103	Baillon's Crake	<i>Porzana pusilla</i>	Rallidae	LC	WM	UC
104	Brown Crake	<i>Zapornia akool</i>		LC	WM	UC
105	Eurasian Coot	<i>Fulica atra</i>		LC	WM	VC
106	Eurasian Moorhen	<i>Gallinula chloropus</i>		LC	RE	VC
107	Gray-headed Swamphen	<i>Porphyrio poliocephalus</i>		LC	RE	C
108	Little Crake	<i>Porzana parva</i>		LC	WM	R
109	Water Rail	<i>Rallus aquaticus</i>		LC	WM	R
110	Spotted Crake	<i>Porzana porzana</i>		LC	WM	R
111	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>		LC	RE	VC

Continued...

Table 1: Cont'd.						
Sr. no	Common Name	Scientific Name	Family	IUCN	Residential Status	Abundance
Order: Passeriformes						
112	Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	Acrocephalidae	LC	WM	VC
113	Paddyfield Warbler	<i>Acrocephalus agricola</i>		LC	WM	C
114	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>		LC	WM	UC
115	Booted Warbler	<i>Iduna caligata</i>		LC	WM	UC
116	Common Iora	<i>Aegithina tiphia</i>	Aegithinidae	LC	RE	C
117	Ashy-crowned Sparrow-Lark	<i>Eremopterix griseus</i>	Alaudidae	LC	RE	VC
118	Crested Lark	<i>Galerida cristata</i>		LC	RE	C
119	Rufous-tailed Lark	<i>Ammomanes phoenicura</i>		LC	RE	VC
120	Sand Lark	<i>Calandrella raytal</i>		LC	RE	UC
121	Common Tailorbird	<i>Orthotomus sutorius</i>	Cisticolidae	LC	RE	VC
122	Zitting Cisticola	<i>Cisticola juncidis</i>		LC	WM	UC
123	Plain Prinia	<i>Prinia inornata</i>		LC	RE	VC
124	Ashy Prinia	<i>Prinia socialis</i>		LC	RE	C
125	House Crow	<i>Corvus splendens</i>	Corvidae	LC	RE	VC
126	Large-billed crow	<i>Corvus macrorhynchos</i>		LC	RE	C
127	Rufous Treepie	<i>Dendrocitta vagabunda</i>		LC	RE	VC
128	Black Drongo	<i>Dicrurus macrocercus</i>	Dicruridae	LC	RE	VC
129	Ashy Drongo	<i>Dicrurus leucophaeus</i>		LC	RE	UC
130	Indian Silverbill	<i>Euodice malabarica</i>	Estrildidae	LC	RE	VC
131	Barn Swallow	<i>Hirundo rustica</i>	Hirundinidae	LC	WM	UC
132	Bank Swallow	<i>Riparia riparia</i>		LC	WM	UC
133	Dusky Crag-Martin	<i>Ptyonoprogne concolor</i>		LC	RE	C
134	Gray-throated Martin	<i>Riparia chinensis</i>		LC	WM	UC
135	Red-rumped Swallow	<i>Cecropis daurica</i>		LC	RE	C
136	Wire-tailed Swallow	<i>Hirundo smithii</i>		LC	RE	C
137	Isabelline Shrike	<i>Lanius isabellinus</i>	Laniidae	LC	WM	UC
138	Long-tailed Shrike	<i>Lanius schach</i>		LC	WM	C
139	Bay-backed Shrike	<i>Lanius vittatus</i>		LC	WM	VC
140	Common Babbler	<i>Argya caudata</i>	Leiothrichidae	LC	RE	VC
141	Large Gray Babbler	<i>Argya malcolmi</i>		LC	RE	C
142	Jungle Babbler	<i>Argya striata</i>		LC	RE	VC
143	Paddyfield Pipit	<i>Anthus rufulus</i>	Motacillidae	LC	WM	UC
144	Tawny Pipit	<i>Anthus campestris</i>		LC	WM	UC
145	Western Yellow Wagtail	<i>Motacilla flava</i>		LC	WM	C
146	White Wagtail	<i>Motacilla alba</i>		LC	WM	VC
147	White-browed Wagtail	<i>Motacilla maderaspatensis</i>		LC	RE	C
148	Gray Wagtail	<i>Motacilla cinerea</i>		LC	WM	UC
149	Long-billed Pipit	<i>Anthus similis</i>		LC	WM	UC
150	Citrine Wagtail	<i>Motacilla citreola</i>		LC	WM	C
151	Indian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	Monarchidae	LC	RE	UC
152	Indian Robin	<i>Saxicoloides fulicatus</i>	Muscicapidae	LC	RE	VC

Continued...

Table 1: Cont'd.

Sr. no	Common Name	Scientific Name	Family	IUCN	Residential Status	Abundance
153	Pied Bushchat	<i>Saxicola caprata</i>		LC	WM	UC
154	Oriental Magpie-Robin	<i>Copsychus saularis</i>		LC	RE	VC
155	Isabelline Wheatear	<i>Oenanthe isabellina</i>		LC	WM	UC
156	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>		LC	RE	C
157	Bluethroat	<i>Luscinia svecica</i>		LC	WM	UC
158	Siberian Stonechat	<i>Saxicola maurus</i>		LC	WM	C
159	Purple Sunbird	<i>Cinnyris asiaticus</i>	Nectariniidae	LC	RE	VC
160	Yellow-throated Sparrow	<i>Gymnoris xanthocollis</i>	Passeridae	LC	RE	C
161	House Sparrow	<i>Passer domesticus</i>		LC	RE	VC
162	Common Chiffchaff	<i>Phylloscopus collybita</i>	Phylloscopidae	LC	WM	UC
163	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	LC	RE	VC
164	Baya Weaver	<i>Ploceus philippinus</i>	Ploceidae	LC	MM	VC
165	Black-breasted Weaver	<i>Ploceus benghalensis</i>		LC	MM	UC
166	Bank Myna	<i>Acridotheres ginginianus</i>	Sturnidae	LC	RE	C
167	Common Myna	<i>Acridotheres tristis</i>		LC	RE	VC
168	Rosy Starling	<i>Pastor roseus</i>		LC	RE	VC
169	Brahminy Starling	<i>Sturnia pagodarum</i>		LC	RE	C
Order: Pelecaniformes						
170	Cattle Egret	<i>Bubulcus ibis</i>	Ardeidae	LC	RE	VC
171	Gray Heron	<i>Ardea cinerea</i>		LC	RE	C
172	Great Egret	<i>Ardea alba</i>		LC	RE	UC
173	Indian Pond-Heron	<i>Ardeola Greyii</i>		LC	RE	VC
174	Intermediate Egret	<i>Ardea intermedia</i>		LC	RE	VC
175	Little Egret	<i>Egretta garzetta</i>		LC	RE	VC
176	Purple Heron	<i>Ardea purpurea</i>		LC	RE	C
177	Western Reef-Heron	<i>Egretta gularis</i>		LC	RE	C
178	Black-crowned Night-heron	<i>Nycticorax nycticorax</i>		LC	RE	UC
179	Dalmatian Pelican	<i>Pelecanus crispus</i>	Pelecanidae	NT	WM	UC
180	Great White Pelican	<i>Pelecanus onocrotalus</i>		LC	WM	UC
181	Black-headed ibis	<i>Threskiornis melanocephalus</i>	Threskiornithidae	NT	RE	C
182	Eurasian Spoonbill	<i>Platalea leucorodia</i>		LC	RE	C
183	Glossy Ibis	<i>Plegadis falcinellus</i>		LC	WM	UC
184	Red-naped Ibis	<i>Pseudibis papillosa</i>		LC	RE	VC
Order: Phoenicopteriformes						
185	Greater Flamingo	<i>Phoenicopus roseus</i>	Phoenicopteridae	LC	WM	UC
186	Lesser Flamingo	<i>Phoeniconaias minor</i>		NT	RE	VC
Order: Piciformes						
187	Eurasian Wryneck	<i>Jynx torquilla</i>	Picidae	LC	WM	UC
188	Coppersmith barbet	<i>Megalaima haemacephala</i>	Megalaimidae	LC	RE	VC

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Table 1: Cont'd.

Sr. no	Common Name	Scientific Name	Family	IUCN	Residential Status	Abundance
Order: Podicipediformes						
189	Great Crested Grebe	<i>Podiceps cristatus</i>	Podicipedidae	LC	WM	UC
190	Eared Grebe	<i>Podiceps nigricollis</i>		LC	WM	R
191	Little Grebe	<i>Tachybaptus ruficollis</i>		LC	RE	VC
Order: Psittaciformes						
192	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittaculidae	LC	RE	VC
Order: Pteroclitiformes						
193	Chestnut-bellied Sandgrouse	<i>Pterocles exustus</i>	Pteroclitidae	LC	RE	UC
Order: Strigiformes						
194	Spotted Owlet	<i>Athene brama</i>	Strigidae	LC	RE	VC
195	Short-eared Owl	<i>Asio flammeus</i>		LC	WM	R
Order: Suliformes						
196	Oriental Darter	<i>Anhinga melanogaster</i>	Anhingidae	NT	RE	C
197	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	Phalacrocoracidae	LC	WM	C
198	Great Cormorant	<i>Phalacrocorax carbo</i>		LC	WM	UC
199	Little Cormorant	<i>Microcarbo niger</i>		LC	RE	VC

from four IUCN Categories: 1 species (Indian Skimmer *Rynchops albicollis*) belong to Endangered (EN) category, 4 species (Greater Spotted Eagle *Clanga clanga*, Indian Spotted Eagle *Clanga hastata*, Common Pochard *Aythya farina*, River Tern *Sterna aurantia*) belong to Vulnerable (VU) category, 12 species belong to Near threatened (NT) category and 182 species belong to least concern (LC) category (Figure 4). As per abundance status Bird are categorised into 4 categories: 27% (54 species) are Very Common and 28% (56 species) are Common, 38% (76 species) are Uncommon and 7% (13 species) are Rare (Figure 5). Lower values of Dominance_D and Berger-Parker while Higher values of Brillouin, Simpson_1-D, Shannon H, Margalef, Menhinick and Fisher_alpha indicate a good diversity of Avian fauna is observed at these wetlands. highest Values of Dominance were found in Site 3(0.059342) and lowest in Site 2(0.03776). For other diversity indices, highest values were obtained from Site 2 and lowest from Site 3. This indicate that Dominance was found to be negatively correlated with other diversity indices. Simpson's index and Shannon wiener index was found to be highest in Site 2(1-D- 0.96225, H-3.521042) and lowest in Site 3 (1-D- 0.940654, H-3.06575) (Table 3). Hence, Site 3 shows least diversity and Site 2 shows highest diversity among three selected sites of Porbandar, Gujarat, India.

IUCN status: endangered (EN), vulnerable (VU), near threatened (NT) and least concern (LC) category (Source: <https://www.iucnredlist.org/>).



Figure 2: Order wise distribution of Avian fauna.

Residential status: Resident (RE), Winter migrant (WM), Summer migrant (SM), Monsoon migrant (MM) and Passage migrant (PM).

Abundance status: Very common (VC), Common (C), Uncommon (UC) and Rare (R).

Order Passeriformes represents highest no. of families (19) and species (58) of total Avian families followed by Charadriiformes with (8) families and (46) species (Figure 2).

Highest number of order (21) is recorded from Site 2 and Lowest number of order (14) is recorded from Site 3, Highest number of family (54) is recorded from Site 2 and Lowest number of family (31) is recorded from Site 3, Highest number of Species (183) is recorded from Site 2 and Lowest number of Species (69) is recorded from Site 3 (Figure 3).

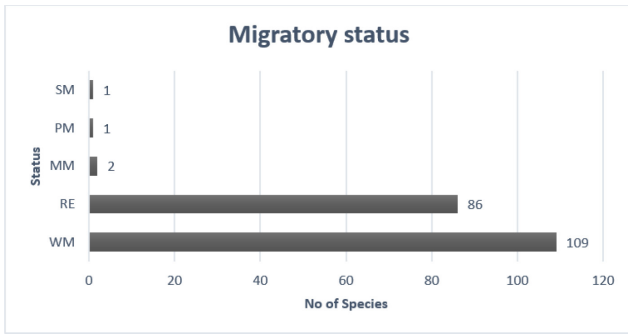


Figure 5: Migratory status.

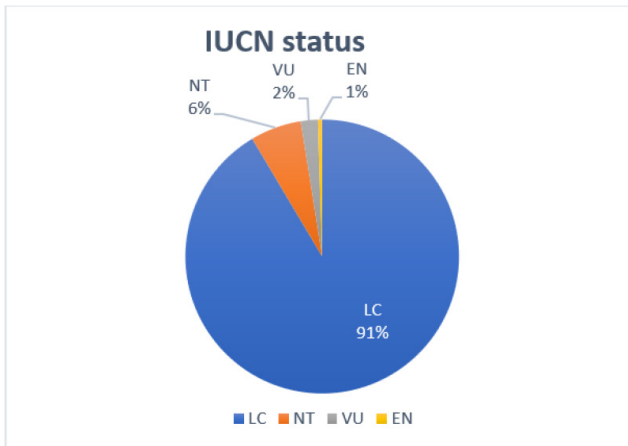


Figure 4: IUCN Status.

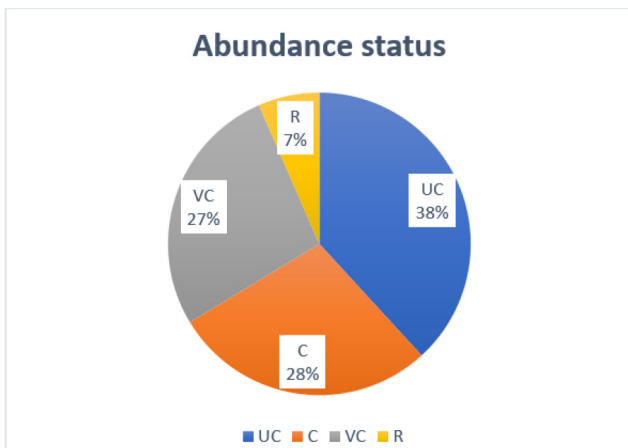


Figure 5: Abundance status.

As per the abundance status of Avian diversity, (27%) species were Categorised as Very Common (VC), (28%) species as Common (C), (38%) species as Uncommon (UC) and (7%) species were Rare (R) (Figure 4).

As per the Migratory status of Avian diversity, (109) species are winter migrant (WM), (86) species are resident (RE), (2) species are monsoon migrant (MM), (1) species is passage migrant and (1) species is summer migrant (Figure 3).

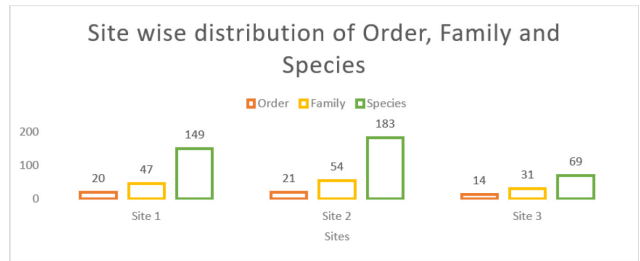


Figure 6: Site wise distribution of Order, Family and Species (Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland).

As per the IUCN status (91%) species belongs to Least concern (LC) category, (6%) species belongs to Near threatened (NT) category, (2%) species belongs to Vulnerable (VU) category and (1%) species belongs to Endangered (EN) category (Figure 6).

DISCUSSION

During the research we recorded a total of 199 species of avian fauna (July 2020 to June 2022). Out of which highest species (183) are recorded from site 2 and Lowest species (69) are recorded from site 3. Migratory birds Accounted for $\geq 55\%$ species of total avian fauna at all the selected sites. Of total recorded species 113 species are migratory (109 WM, 2 MM, 1 SM, 1 PM) while 86 species are resident. These habitats (Site 1, 2, 3) attracts a good number of migratory birds (Especially winter migrants). Highest species richness was observed during winter season in all the three sites, making all the selected sites of Porbandar, Gujarat, India, a preferred location for Migratory birds. Kushwaha found in 2021 that the Suhelwa Wildlife Sanctuary's wetlands have a significant potential for sustaining a diverse range of wetland birds, especially key migratory species.^[18] Worldwide destruction of wetland is being experienced by many countries as reported by Davidson in 2014.^[10] Similarly, Chhaya wetland is also under great pressure due to anthropogenic activities going around it.

Order Passeriformes with 19 families were more abundant followed by Order charadiformes with 8 families while Order Coraciiformes and Pelecaniformes contributed 3 families each. Gibru and Mengesha's research of the species composition, seasonal abundance, and distribution of avifauna in the Eastern Wetland environments in 2021 found that the order Charadiformes was more abundant than the order Passeriformes.^[19] During December, January and February, bird diversity as well as winter migratory birds were observed in large numbers. Meena in 2021 reported the highest population of the migratory birds during the month of December January and February.^[20]

Table 2: Comparative Avian diversity of Porbandar, Gujarat, India.

Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland

Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
Order: Accipitriformes					
1	Black kite	Accipitridae	+	+	-
2	Black-winged Kite		+	+	-
3	Brahminy Kite		+	+	-
4	Eurasian Marsh-Harrier		+	+	-
5	Greater Spotted Eagle		-	+	-
6	Indian Spotted Eagle		-	+	-
7	Montagu's Harrier		-	+	-
8	Oriental Honey-buzzard		-	+	-
9	Short-toed Snake-Eagle		-	+	-
10	Shikra		+	+	+
11	Osprey	Anionite	+	+	+
Order: Anseriformes					
12	Common Pochard	Anatidae	+	+	-
13	Eurasian Wigeon		+	+	-
14	Ferruginous Duck		+	+	-
15	Gadwall		+	+	-
16	Garganey		+	+	-
17	Green-winged Teal		+	+	+
18	Indian Spot-billed Duck		+	+	+
19	Knob-billed Duck		+	+	-
20	Lesser Whistling-Duck		+	+	-
21	Northern Pintail		+	+	+
22	Northern Shoveler		+	+	+
23	Ruddy Shelduck		+	+	-
24	Graylag Goose		-	+	-
25	Mallard		-	+	-
26	Cotton Pygmy-Goose		+	-	-
27	Tufted Duck		+	+	-
Order: Apodiformes					
28	Asian Palm-Swift	Apodidae	+	+	-
29	Little Swift		+	+	-
30	Alpine Swift		-	+	-
Order: Bucerotiformes					
31	Eurasian Hoopoe	Upupidae	+	+	-
Order: Caprimulgiformes					
32	Sykes's Nightjar	Caprimulgidae	-	+	-
33	Indian Nightjar		-	+	-
Order: Charadriiformes					
34	Indian Thick-knee	Burhinidae	+	+	-
35	Great Thick-knee		+	-	-
36	Greater Sand Plover	Charadriidae	+	+	-
37	Kentish Plover		+	+	+
38	Lesser Sand-Plover		+	+	+

Table 2: Cont'd.

Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland					
Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
39	Little Ringed Plover		+	+	+
40	Yellow-wattled Lapwing		-	+	-
41	White-tailed Lapwing		-	+	-
42	Pacific Golden-Plover		+	+	-
43	Red-wattled Lapwing		+	+	+
44	Collared Pratincole	Glareolidae	-	+	-
45	Pheasant-tailed Jacana	Jacanidae	+	+	-
46	Black-headed Gull	Laridae	+	+	-
47	Brown-headed Gull		+	+	+
48	Caspian Tern		+	+	+
49	Gull-billed Tern		+	+	+
50	Lesser Black-backed Gull		+	+	-
51	Pallas's Gull		+	+	-
52	River Tern		+	+	+
53	Common Tern		-	+	+
54	Indian Skimmer		-	+	+
55	Bridled Tern		+	-	-
56	Slender-billed Gull		+	-	-
57	Little Tern		-	+	-
58	Whiskered Tern		+	+	+
59	Black-winged Stilt	Recurvirostridae	+	+	+
60	Pied Avocet		+	+	+
61	Greater Painted-Snipe	Rostratulidae	-	+	-
62	Black-tailed Godwit	Scolopacidae	+	+	+
63	Common Greenshank		+	+	-
64	Common Redshank		+	+	+
65	Common Sandpiper		+	+	+
66	Common Snipe		+	+	-
67	Eurasian Curlew		+	+	-
68	Green Sandpiper		+	+	-
69	Little Stint		+	+	+
70	Marsh Sandpiper		+	+	+
71	Ruff		+	+	+
72	Terek Sandpiper		+	-	-
73	Ruddy Turnstone		+	-	-
74	Bar-tailed Godwit		+	-	+
75	Curlew Sandpiper		+	-	+
76	Red-necked Phalarope		+	-	-
77	Spotted Redshank		+	+	-
78	Temminck's Stint		+	+	-
79	Wood Sandpiper		+	+	-

Continued...

Table 2: Cont'd.					
Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland					
Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
Order: Ciconiiformes					
80	Asian Openbill	Ciconiidae	+	+	-
81	Woolly-necked Stork		-	+	-
82	Painted Stork		+	+	+
Order: Columbiformes					
83	Eurasian Collared-Dove	Columbidae	+	+	+
84	Laughing Dove		+	+	-
85	Red Collared-Dove		-	+	-
86	Rock Pigeon		+	+	+
Order: Coraciiformes					
87	Pied Kingfisher	Alcedinidae	+	+	-
88	Common Kingfisher		-	+	+
89	White-throated Kingfisher		+	+	+
90	Indian Roller	Coraciidae	-	+	-
91	European Roller		-	+	-
92	Green Bee-eater	Meropidae	+	+	-
93	Blue-cheeked Bee-eater		-	+	-
94	Blue-tailed Bee-eater		-	+	-
Order: Cuculiformes					
95	Asian Koel	Cuculidae	+	+	+
96	Greater Coucal		+	+	-
Order: Falconiformes					
97	Eurasian Kestrel	Falconidae	-	+	-
98	Peregrine Falcon		+	+	-
Order: Galliformes					
99	Gray Francolin	Phasianidae	+	+	-
100	Indian Peafowl		+	+	-
Order: Gruiformes					
101	Common Crane	Gruidae	+	+	-
102	Demoiselle Crane		+	+	+
103	Baillon's Crake	Rallidae	+	+	-
104	Brown Crake		+	+	-
105	Eurasian Coot		+	+	-
106	Eurasian Moorhen		+	+	-
107	Gray-headed Swampphen		+	+	-
108	Little Crake		-	+	-
109	Water Rail		-	+	-
110	Spotted Crake		-	+	-
111	White-breasted Waterhen		+	+	+
Order: Passeriformes					
112	Clamorous Reed Warbler	Acrocephalidae	+	+	+
113	Paddyfield Warbler		+	+	-
114	Blyth's Reed Warbler		-	+	-
115	Booted Warbler		-	+	-

Continued...

Table 2: Cont'd.

Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland					
Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
116	Common Iora	Aegithinidae	+	+	-
117	Ashy-crowned Sparrow-Lark	Alaudidae	+	+	-
118	Crested Lark		+	+	-
119	Rufous-tailed Lark		+	+	-
120	Sand Lark		+	+	-
121	Common Tailorbird	Cisticolidae	+	+	+
122	Zitting Cisticola		-	+	-
123	Plain Prinia		+	+	-
124	Ashy Prinia		-	+	-
125	House Crow	Corvidae	+	+	+
126	Large-billed crow		+	+	+
127	Rufous Treepie		+	+	-
128	Black Drongo	Dicruridae	+	+	+
129	Ashy Drongo		+	-	-
130	Indian Silverbill	Estrildidae	+	+	-
131	Barn Swallow	Hirundinidae	+	+	+
132	Bank Swallow		+	-	-
133	Dusky Crag-Martin		+	+	-
134	Gray-throated Martin		+	-	-
135	Red-rumped Swallow		+	+	-
136	Wire-tailed Swallow		+	+	+
137	Isabelline Shrike	Laniidae	+	+	-
138	Long-tailed Shrike		-	+	-
139	Bay-backed Shrike		-	+	-
140	Common Babbler	Leiothrichidae	+	+	+
141	Large Gray Babbler		-	+	-
142	Jungle Babbler		+	+	+
143	Paddyfield Pipit	Motacillidae	+	+	-
144	Tawny Pipit		+	+	-
145	Western Yellow Wagtail		+	+	+
146	White Wagtail		+	+	-
147	White-browed Wagtail		+	+	+
148	Gray Wagtail		-	+	-
149	Long-billed Pipit		-	+	-
150	Citrine Wagtail		-	+	-
151	Indian Paradise-Flycatcher	Monarchidae	-	+	-
152	Indian Robin	Muscicapidae	+	+	-
153	Pied Bushchat		-	+	-
154	Oriental Magpie-Robin		+	+	-
155	Isabelline Wheatear		-	+	-
156	Tickell's Blue Flycatcher		-	+	-
157	Bluethroat		+	-	-
158	Siberian Stonechat		+	+	-
159	Purple Sunbird	Nectariniidae	+	+	+

Continued...

Table 2: Cont'd.					
Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland					
Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
160	Yellow-throated Sparrow	Passeridae	+	-	-
161	House Sparrow		+	+	+
162	Common Chiffchaff	Phylloscopidae	+	+	-
163	Red-vented Bulbul	Pycnonotidae	+	+	-
164	Baya Weaver	Ploceidae	-	+	-
165	Black-breasted Weaver		-	+	-
166	Bank Myna	Sturnidae	+	+	-
167	Common Myna		+	+	+
168	Rosy Starling		+	+	+
169	Brahminy Starling		-	+	-
Order: Pelecaniformes					
170	Cattle Egret	Ardeidae	+	+	+
171	Gray Heron		+	+	+
172	Great Egret		+	+	+
173	Indian Pond-Heron		+	+	+
174	Intermediate Egret		+	+	+
175	Little Egret		+	+	+
176	Purple Heron		+	+	-
177	Western Reef-Heron		+	+	+
178	Black-crowned Night-heron		-	+	-
179	Dalmatian Pelican	Pelecanidae	+	+	-
180	Great White Pelican		+	+	+
181	Black-headed ibis	Threskiornithidae	+	+	+
182	Eurasian Spoonbill		+	+	+
183	Glossy Ibis		+	+	+
184	Red-naped Ibis		+	+	+
Order: Phoenicopteriformes					
185	Greater Flamingo	Phoenicopteridae	+	+	+
186	Lesser Flamingo		+	+	+
Order: Piciformes					
187	Eurasian Wryneck	Picidae	-	+	-
188	Coppersmith barbet	Megalaimidae	-	+	+
Order: Podicipediformes					
189	Great Crested Grebe	Podicipedidae	+	+	-
190	Eared Grebe		+	-	-
191	Little Grebe		+	+	-
Order: Psittaciformes					
192	Rose-ringed Parakeet	Psittaculidae	+	+	+
Order: Pterocliiformes					
193	Chestnut-bellied Sandgrouse	Pteroclididae	+	-	-
Order: Strigiformes					
194	Spotted Owlet	Strigidae	-	+	-
195	Short-eared Owl		-	+	-

Continued...

Table 2: Cont'd.

Site 1- Chhaya wetland, Site 2- Karli wetland and Site 3- Subhashnagar wetland					
Sr. No.	Common Name	Family	Site 1	Site 2	Site 3
Order: Suliformes					
196	Oriental Darter	Anhingidae	+	+	-
197	Indian Cormorant	Phalacrocoracidae	+	+	+
198	Great Cormorant		+	+	+
199	Little Cormorant		+	+	+

Table 3: Diversity indices.

Diversity Indices	Site 1	Site 2	Site 3
Dominance_D	0.04285	0.03776	0.059342
Simpson_1-D	0.95715	0.96225	0.940654
Shannon_H	3.420167	3.521042	3.06575
Brillouin	2.907792	3.019875	2.471333
Menhinick	4.066208	4.221625	3.800083
Margalef	8.513292	9.235375	6.580667
Fisher_alpha	27.25458	29.04917	26.78458
Berger-Parker	0.114558	0.095224	0.1394

One species (Indian Skimmer *Rynchops albicollis*) belongs to Endangered (EN) category, four species (Greater Spotted Eagle *Clanga clanga*, Indian Spotted Eagle *Clanga hastata*, Common Pochard *Aythya farina*, River Tern *Sterna aurantia*) belong to Vulnerable (VU) category were reported from the selected study sites making them an important site these endangered as well as vulnerable species along with them 12 species (Lesser Flamingo *Phoeniconaias minor*, Dalmatian Pelican *Pelecanus crispus*, Oriental Darter *Anhinga melanogaster*, Black-headed ibis *Threskiornis melanocephalus*, Eurasian Curlew *Numenius arquata*, Curlew Sandpiper *Calidris ferruginea*, Black-tailed Godwit *Limosa limosa*, Bar-tailed Godwit *Limosa lapponica*, Painted Stork *Mycteria leucocephala*, Great Thick-knee *Esacus recurvirostris*, Ferruginous Duck *Aythya nyroca*, Woolly-necked Stork *Ciconia episcopus*) belonging to Near threatened (NT) category. And 136 species belong to least concern (LC). In 2019, Vargiya and Chakraborty recorded one (1.4% of all species) Vulnerable species (Common Pochard *Aythya ferina*), six (8.5%) Near Threatened species (Lesser Flamingo, Oriental Darter *Anhinga melanogaster*, Dalmatian Pelican *Pelecanus crispus*, Black-headed Ibis *Threskiornis melanocephalus*, Black-tailed Godwit *Limosa limosa*, and River Tern *Sterna aurantia*), and 63 (82.9%) species from Chhaya Wetland categorised as Least Concern.^[21]

Chhaya wetland has a good potential to become a Ramsar site due to high number of Waterbirds and winter migrants. As per the current situation the wetland is under the huge anthropogenic pressure,

such as household construction and acquisition of land in the name of urbanization around the wetland. Vargiya and Chakraborty noticed that salt and soda ash from the previous salt production had an impact on the Chhaya Rann wetland complex in 2019. Domestic sewage and rainwater have been the main sources of water in recent years. It is crucial for the state and national authorities to propose formal designation of the area as a Ramsar site because it appears that these conditions are still favourable to attract flamingos and other waterbirds in internationally important numbers (>20,000 individuals), as per Set of criteria five of the Ramsar Convention on Wetlands.^[21]

CONCLUSION AND SUMMARY

This study on wetlands of Porbandar, Gujarat, India helped us understand the importance and contribution of wetlands as a valuable habitat for Avian Fauna. Out of the total recorded species, 199 species of birds (July 2020 to June 2022) were identified during the study period: 113 species are migratory (109 WM, 2 MM, 1 SM, 1 PM) while 86 species are resident. Although the wetlands are surrounded by housing colonies and industry, they remain a preferred site for these migratory birds. Thus, conservation of such habitat is highly recommended. Conservation of these wetlands could help preserve the Avian diversity of the Porbandar, Gujarat, India and other organism which are directly or indirectly related to the Avian diversity.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

EN: Endangered; **VU:** Vulnerable; **NT:** Near threatened; **LC:** Least concern; **RE:** Resident; **WM:** Winter migrant; **SM:** Summer migrant; **MM:** Monsoon Migrant; **PM:** Passage migrant; **VC:** Very common; **C:** Common; **UC:** Uncommon; **R:** Rare; **VM:** Vyas Malay.

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