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## Study of bird diversity & distribution of Visnagar, Mehsana, (U.G.), India

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### Abstract

The aim of the research was to collect information about the feeding behaviours, IUCN status, and diversity of birds in 8 rural and 1 urban locations. We also calculated Shannon's and Simpson's diversity indices to assess bird diversity. Birds are considered reliable indicators of habitat quality, and their feeding habits are crucial aspects of their habitat. The research area covered a total of 12.53 square kilometres. During the study period between 2020-2022, we recorded 143 bird's species belongs to 18 order & 51 families in which Passeriformes order was dominant in the study area. Based on IUCN Red data list criteria 138 were least concern, 02 were vulnerable, 03 were near threatened & no endangered species were recorded. The research documented 40 migratory birds and 103 resident birds. Our survey suggests that diverse avian species can be found in undisturbed areas away from human presence, such as riverbanks, swamps, lakes, and wetland areas. These habitats offer a wide range of avifaunal species.

**Keywords:** Visnagar, status, feeding habit, diversity

### Introduction

According to Gadgil and Rao (1998)<sup>[7]</sup>, India is renowned for its remarkable diversity, ranking among the most diverse nations globally. It encompasses two notable global biodiversity hotspots and is home to seven distinct bird areas that are found nowhere else in the world. (Grimmet *et al.*, 1998)<sup>[13]</sup>. 10,324 bird species are listed as existing in the globe according to the bird checklist. There are 1,412 species listed in the South Asian area, compared to 1,392 species listed in the Indian subcontinent roughly 1,318 bird species are listed on the checklist for India specifically, which accounts for roughly 12.5% of the world's avifaunal variety (Grimmet *et al.*, 2011; Praveen *et al.*, 2020c)<sup>[12, 22]</sup>. Gampule (2020)<sup>[9]</sup> reports that 605 bird species in Gujarat state have recently undergone updates. As pollinators, prey, predators, scavengers, and seed dispersers among other things, birds play crucial roles in ecosystems. Birds are recognised as important environmental indicators because of their ecological importance (Singh *et al.*, 2018; Abie *et al.*, 2019; Jha, 2021; Patel *et al.*, 2021; Kushwaha *et al.*, 2021)<sup>[24, 1, 14, 18, 15]</sup>. According to Loreau *et al.* (2001)<sup>[16]</sup>, the environmental quality of every area has a direct impact on the variety of birds that inhabit there. According to Gregory *et al.* (2010)<sup>[11]</sup> and Balodi *et al.* (2018)<sup>[25]</sup>, the features of the vegetation have a significant impact on the existence, abundance, and geographic distribution of bird populations. The northern area of Gujarat has gotten very little scientific attention, despite the fact that there have been several studies on the avifauna of Gujarat (Patel *et al.*, 2021; Parihar *et al.*, 2020; and Dharaiya, 2016)<sup>[18, 24, 19]</sup>. This study's main goal is to explore the semi-arid area of North Gujarat and gather essential information on the diversity of bird species that live there. Visnagar is situated in the Gujarat district of Mehsana, in biogeographic zone 4's semiarid region. Due to the semi-arid environment, the wintertime lows can reach 12 °C, while the summertime highs can reach 45 °C. With an average yearly rainfall of roughly 729 mm, the number of wet days is much lower during the months of July and August.

### Material and Methods

#### Study area

The study area, which includes both rural and urban areas of Visnagar, is situated in the northern part of Gujarat state, geographically located between 23.7°N 72.55° East an elevation of approximately 117 meters above mean sea level (MSL) (Figure 1).

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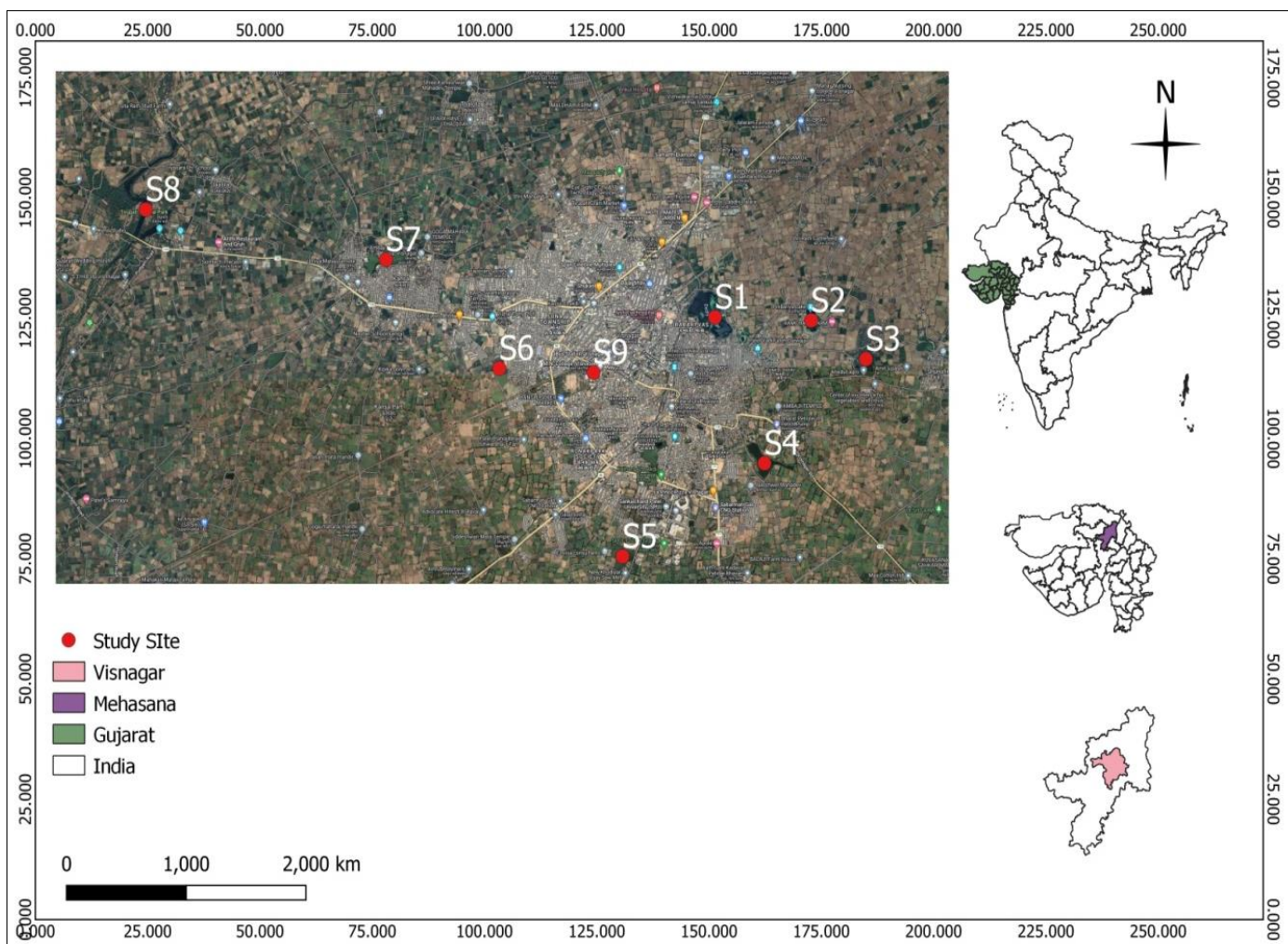
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With both rural and urban regions, Visnagar Taluka has a total size of 12.53 km<sup>2</sup>. Around the agricultural fields in the study region are several tiny pockets of marsh that are largely covered with shrubs and a few solitary trees. Through the region flows the Rupen River, which dries up in the summer. In the study area's agricultural areas, woodlands, and sporadic scrub lands, there are several types of vegetation present.

There are other excellent bodies of water nearby, including Pindariya Lake, Dediya Lake, Jadeshwar Lake, and Singhoda Lake. There is good flora diversity such as *Azadirachta indica*, *Acacia Nilotica*, *Derris indica*, *Cassia fistula*, *Tamarindus indica*, *Delonix regia*, *Polyalthia longifolia*, *Ziziphus jujube*, *Prosopis cineraria*, and *Prosopis juliflora*.



**Fig 1:** The location map of Visnagar taluka and nearby wetlands (Dist: Mehsana)

**Table 1:** Site characteristic and GPS location of the study area

Code	Site name	Site characteristic	Coordinates [N, E]	Area (m <sup>2</sup> )
S1	Dediya lake	Rural, close to human residential area & near area	23.7048, 72.5499	248414
S2	Pindariya lake	Rural, very less human encouragement activity	23.7045, 72.5626	108945
S3	Singhoda lake	Rural, protected area & near by	23.7013, 72.5722	340616
S4	Jadeshwar lake	Rural, close to human residential area & their nearest area	23.6991, 72.5623	101583
S5	Kamana road lake	Nearest area to kamana village, close to agriculture field	23.68058, 72.54197	91770
S6	Kansa N.A rural	Rural, close to human residential area & near area	23.69941, 72.52754	130453
S7	Kansa lake	Rural, close to human residential area & near area	23.71029, 72.51427	315157
S8	Rupen river	Rural, From Rampura to Pudagam	23.7105, 72.5362	479882
S9	Visnagar rural and sub area	Urban multi structural habitat	23.6990, 72.5368	10717437

**Data collection**

Based on the survey findings, birds tend to be most active and mobile during periods of low to medium light frequency. Consequently, field data collection was conducted during the morning hours (between 6 and 10 o'clock) as well as in the evening hours (from 4 to 6 o'clock). Data were gathered over a 24-month period, commencing in July 2020 and ending in July 2022, encompassing each of the three different seasons.

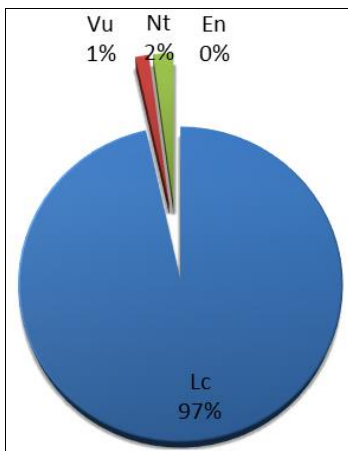
During the data collection phase, the study involved a total of 96 field trips, averaging around 4-5 visits per month. With the use of binoculars (Celestron 18 x 55, Celestron Spotting Scope 60X Zoom), the birds were recognized, and pictures were taken with a Canon 6600D, Nikon D3500, and Canon HX 530HS. We utilised reference materials including taxonomy books like Indian Subcontinental Birds (Grimmett *et al.*, 2011) [12] for the identification of birds. The field guide

used for bird identification in this study was the "Field guide to Birds of Gir foundation", along with the classification of vertebrates. The electronic edition from 2021-2022 was referenced, and each bird species was categorized based on its IUCN status using information from the IUCN (2021). Using the Gujarat Bird Checklist, the migratory status of the birds was reported (Ganpule, 2016) [18]. According to Ali (1996) [2] classified various bird species into distinct categories, including insectivores, herbivores, carnivores, omnivores, nectarivores, frugivores, and Graminivore. When compiling the bird checklist, we adhered to the standards established by Birds Life International.

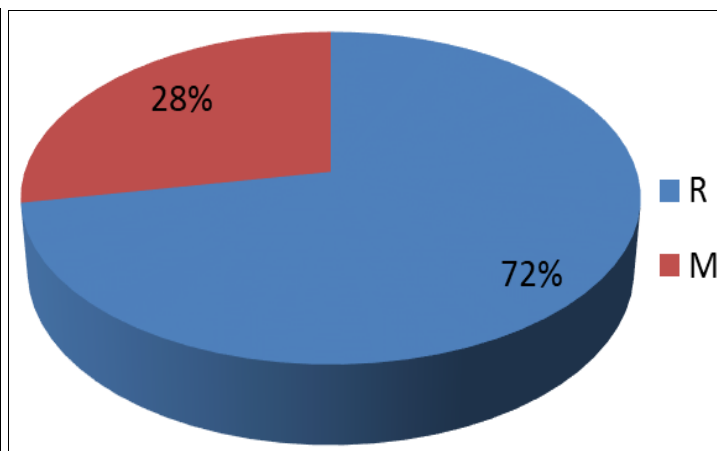
**Results and Discussion**

In our 2 years of field study from July2020 to July 2022 we recorded a total no of 7854 individuals,143species of birds belonging to 107 genera, 51 families, 18 order (checklist is

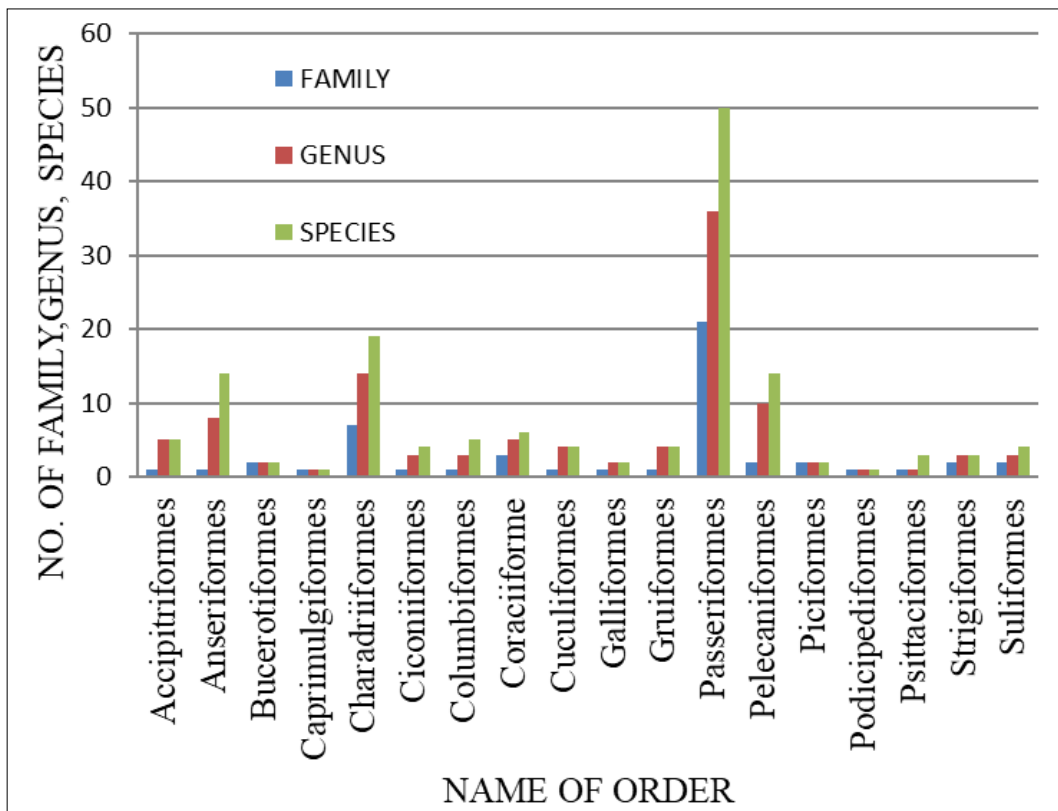
provided in table-3.), From our 9 sites (Table-1) which include rural and urban areas. Among them 103 were residential and 40 were migratory (Figure-3). We have noticed that Carnivore and Omnivores were larger in proportion as compare to other feeding habit. The most recent checklist of birds of Gujarat (birdsofgujarat.co.in) lists a total of 234 bird species that may be found in the Mehsana district. Ganpule (2020) [9] said that Gujarat has 605 different bird species. Approximately 61.11% of Mehsana district's bird variety and 23.63% of Gujarat state's bird diversity, according to the statistics available, are found in Visnagar city and its surrounding region. The study region offers a large variety of plants and a temperature that is ideal for attracting different bird species. The conservation status of the avifauna according to the IUCN is shown in Figure 2, with 97% being of least concern, 2% being near threatened, and 1% being endangered.



**Fig 2:** Visnagar’s avifaunal diversity is distributed according to the IUCN status. (Dist. Mehsana).



**Fig 3:** Residential and Migratory status of bird of Visnagar.



**Fig 4:** Showing the Comparison of Order, Family and Genus & Species.

**Table 2:** Showing the Order of Bird Diversity with Family, Genus & Species.

No.	Order	Family	Genus	Species
1.	Accipitriformes	1	5	5
2.	Anseriformes	1	8	14
3.	Bucerotiformes	2	2	2
4.	Caprimulgiformes	1	1	1
5.	Charadriiformes	7	14	19
6.	Ciconiiformes	1	3	4
7.	Columbiformes	1	3	5
8.	Coraciiformes	3	5	6
9.	Cuculiformes	1	4	4
10.	Galliformes	1	2	2
11.	Gruiformes	1	4	4
12.	Passeriformes	21	36	50
13.	Pelecaniformes	2	10	14
14.	Piciformes	2	2	2
15.	Podicipediformes	1	1	1
16.	Psittaciformes	1	1	3
17.	Strigiformes	2	3	3
18.	Suliformes	2	3	4

**Table 3:** Record of bird diversity in Visnagar, Dist: Mehsana, Gujarat.

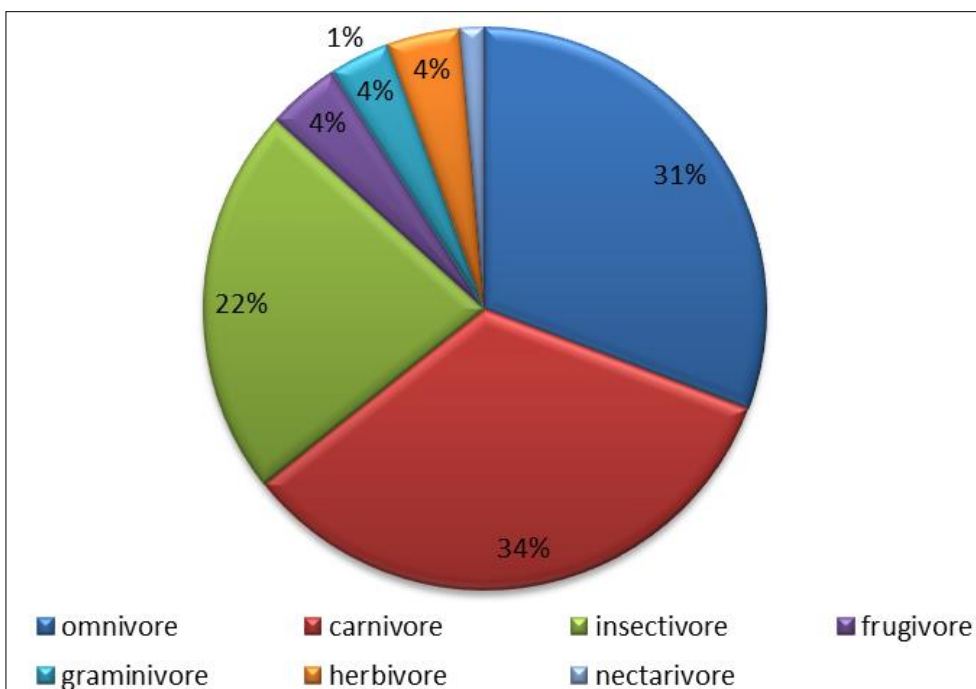
No.	Common name	Scientific name	IUCN Status	Abundance Status	Feeding Habits
<b>Order: Accipitriformes</b>					
<b>Family: Accipitridae</b>					
1	Shikra	<i>Accipiter badius</i> Gmelin.	Lc	R	C
2	Eurasian Marsh Harrier	<i>Buteo Buteo</i> Linnaeus	Lc	M	C
3	Black-winged Kite	<i>Elanus Caeruleus</i> Desfontaines	Lc	R	C
4	Black Kite	<i>Milvus migrans</i> Boddaert	Lc	R	C
5	Oriental Honey Buzzard	<i>Pernis apivorus</i> Linnaeus	Lc	R	C
<b>Order: Anseriformes</b>					
<b>Family: Anatidae</b>					
6	Northern Pintail	<i>Anas acuta</i> Linnaeus	Lc	M	H
7	Common Teal	<i>Anas crecca</i> Linnaeus	Lc	M	H
8	Mallard Duck	<i>Anas platyrhynchos</i> Linnaeus	Lc	M	H
9	Indian spot-billed Duck	<i>Anas poecilorhyncha</i> Forster	Lc	R	O
10	Common Pochard	<i>Aythya ferina</i> Linnaeus	Vn	M	O
11	Tufted Duck	<i>Aythya fuligula</i> Linnaeus	Lc	M	O
12	Lesser Whistling Duck	<i>Dendrocygna javanica</i> Horsfield	Lc	R	O
13	Eurasian wigeon	<i>Mareca penelope</i> Linnaeus	Lc	M	H
14	Gadwall	<i>Mareca strepera</i> Linnaeus	Lc	M	H
15	Cotton Pygmy Goose	<i>Nettapus coromandelianus</i> Gmelin	Lc	R	O
16	Knob-billed Duck	<i>Sarkidiornis melanotos</i> Pennant	Lc	M	O
17	Northern Shoveler	<i>Spatula clypeata</i> Linnaeus	Lc	M	O
18	Garganey	<i>Spatula querquedula</i> Linnaeus	Lc	M	H
19	Ruddy Shelduck	<i>Tadorna ferruginea</i> Pallas	Lc	M	O
<b>Order: Bucerotiformes</b>					
<b>Family: Bucerotidae</b>					
20	Indian Grey Hornbill	<i>Ocyrceros birostris</i> Scopoli	Lc	R	O
<b>Family: Upupidae</b>					
21	Common Hoopoe	<i>Upupa epops</i> Linnaeus	Lc	R	O
<b>Order: Caprimulgiformes</b>					
<b>Family: Apodidae</b>					
22	Little Swift	<i>Apus affinis</i> JE Gray	Lc	R	I
<b>Order: Charadriiformes</b>					
<b>Family: Burhinidae</b>					
23	Indian Thick-knee	<i>Burhinus oedicnemus</i> Salvadori	Lc	R	O
<b>Family: Charadriidae</b>					
24	Little-ringed Plover	<i>Charadrius dubius</i> Scopoli	Lc	M	O
25	Red-wattled Lapwing	<i>Vanellus indicus</i> Boddaert	Lc	R	O
26	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> Boddaert	Lc	R	O
<b>Family: Jacanidae</b>					
27	Pheasant-tailed jacana	<i>Hydrophasianus chirurgus</i> Scopoli	Lc	R	O
28	Brown Wing Jacana	<i>Metopidius indicus</i> Latham	Lc	R	O
<b>Family: Laridae</b>					
29	River Tern	<i>Sterna aurantia</i> JE Gray	Vu	M	C
<b>Family: Recurvirostridae</b>					
30	Black-winged Stilt	<i>Himantopus himantopus</i> Linnaeus	Lc	R	O
<b>Family: Rostratulidae</b>					
31	Greater-painted Snipe	<i>Rostratula benghalensis</i> Linnaeus	Lc	M	O
<b>Family: Scolopacidae</b>					
32	Common Sandpiper	<i>Actitis hypoleucos</i> Linnaeus	Lc	M	C

33	Little Stint	<i>Calidris minuta</i> Leisler.	Lc	M	C
34	Temminck's Stint	<i>Calidris temminckii</i> Leisler	Lc	R	C
35	Common snipe	<i>Gallinago gallinago</i> Linnaeus	Lc	R	C
36	Black-tailed Godwit	<i>Limosa limosa</i> Linnaeus	Nt	M	O
37	Pied Avocet	<i>Recurvirostra avosetta</i> Linnaeus	Lc	R	C
38	Wood Sandpiper	<i>Tringa glareola</i> Linnaeus	Lc	R	C
39	Green Sandpiper	<i>Tringa ochropus</i> Linnaeus	Lc	M	C
40	Marsh Sandpiper	<i>Tringa stagnatilis</i> Bechstein	Lc	M	C
41	Common Redshank	<i>Tringa totanus</i> Linnaeus	Lc	M	C
<b>Order: Ciconiiformes</b>					
<b>Family: Ciconiidae</b>					
42	Asian Openbill	<i>Anastomus oscitans</i> Boddaert	Lc	R	C
43	White Stork	<i>Ciconia ciconia</i> Linnaeus	Lc	M	C
44	Woolly-necked Stork	<i>Ciconia episcopus</i> Boddaert	Vu	R	C
45	Painted Stork	<i>Mycteria leucocephala</i> Pennant	Nt	M	C
<b>Order: Columbiformes</b>					
<b>Family: Columbidae</b>					
46	Rock Pigeon	<i>Columba livia</i> Gmelin	Lc	R	G
47	Eurasian-collared Dove	<i>Streptopelia decaocto</i> Frivaldszky	Lc	R	G
48	Laughing Dove	<i>Streptopelia senegalensis</i> Linnaeus	Lc	R	G
49	Red Collared Dove	<i>Streptopelia tranquebarica</i> Hermann	Lc	R	G
50	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i> Latham	Lc	R	F
<b>Order: Coraciiformes</b>					
<b>Family: Alcedinidae</b>					
51	Common Kingfisher	<i>Alcedo atthis</i> Linnaeus	Lc	R	C
52	Pied Kingfisher	<i>Ceryle rudis</i> Linnaeus	Lc	R	C
53	White-throated Kingfisher	<i>Halcyon smyrnensis</i> Linnaeus	Lc	R	C
<b>Family: Coraciidae</b>					
54	Indian Roller	<i>Coracias benghalensis</i> Linnaeus	Lc	R	C
55	European Roller	<i>Coracias garrulous</i> Linnaeus	Lc	M	C
<b>Family: Meropidae</b>					
56	Green Bee-eater	<i>Merops orientalis</i> Latham	Lc	R	I
<b>Order: Cuculiformes</b>					
<b>Family: Cuculidae</b>					
57	Greater Coucal	<i>Centropus sinensis</i> Stephens	Lc	R	O
58	Jacobin Cuckoo	<i>Clamator jacobinus</i> Boddaert	Lc	M	O
59	Common Cuckoo	<i>Cuculus canorus</i> Linnaeus	Lc	M	O
60	Asian Koel	<i>Eudynamis scolopacea</i> Linnaeus	Lc	R	O
<b>Order: Galliformes</b>					
<b>Family: Phasianidae</b>					
61	Grey Francolin	<i>Ortygornis pondicerianus</i> Gmelin	Lc	R	O
62	Indian Peafowl	<i>Pavo cristatus</i> Linnaeus	Lc	R	O
<b>Order: Gruiformes</b>					
<b>Family: Rallidae</b>					
63	White-breasted waterhen	<i>Amaurornis phoenicurus</i> Pennant	Lc	R	O
64	Common Coot	<i>Fulica atra</i> Linnaeus	Lc	M	O
65	Common Moorhen	<i>Gallinula chloropus</i> Linnaeus	Lc	R	O
66	Purple Swamphen	<i>Porphyrio porphyrio</i> Linnaeus	Lc	R	O
<b>Order: Passeriformes</b>					
<b>Family: Aegithinidae</b>					
67	Common Iora	<i>Aegithina tiphia</i> Linnaeus	Lc	R	I
<b>Family: Campephagidae</b>					
68	Large Cuckooshrike	<i>Coracina macei</i> Lesson	Lc	R	I
69	Small Minivet	<i>Pericrocotus cinnamomeus</i> Linnaeus	Lc	R	I
<b>Family: Cisticolidae</b>					
70	Common Tailorbird	<i>Orthotomus sutorius</i> Pennant	Lc	R	I
71	Plain Prinia	<i>Prinia inornata</i> Sykes	Lc	R	I
72	Ashy Prinia	<i>Prinia socialis</i> Sykes	Lc	R	I
<b>Family: Corvidae</b>					
73	Common Raven	<i>Corvus corax</i> Linnaeus	Lc	R	O
74	Jungle Crow	<i>Corvus macrorhynchos</i> Wagler	Lc	R	O
75	House Crow	<i>Corvus splendens</i> Vieillot	Lc	R	O
76	Rufous Treepie	<i>Dendrocitta vagabunda</i> Latham	Lc	R	O
<b>Family: Dicruridae</b>					
77	Ashy Drongo	<i>Dicrurus leucophaeus</i> Vieillot	Lc	M	I
78	Black Drongo	<i>Dicrurus macrocercus</i> Vieillot	Lc	R	I
79	White-bellied Drongo	<i>Dicrurus caerulescens</i> Linnaeus	Lc	R	I
<b>Family: Estrilididae</b>					
80	Indian Silverbill	<i>Euodice malabarica</i> Linnaeus	Lc	R	G
81	Scaly Breasted Munia	<i>Lonchura punctulata</i> Linnaeus	Lc	R	I
<b>Family: Hirundinidae</b>					
82	Red-rumped Swallow	<i>Cecropis daurica</i> Laxmann	Lc	R	I
83	Wire-tailed Swallow	<i>Hirundo simithii</i> Leach	Lc	M	I
84	Dusky Crag Martin	<i>Ptyonoprogne concolor</i> Sykes	Lc	R	I
<b>Family: Laniidae</b>					

85	Bay-backed Shrike	<i>Lanius vittatus</i> Valenciennes	Lc	R	C
86	Long-tailed Shrike	<i>Lanius schach</i> Linnaeus	Lc	R	C
<b>Family: Leiotrichidae</b>					
87	Common Babbler	<i>Argya caudata</i> Dumont	Lc	R	O
88	Large Grey Babbler	<i>Argya malcolmi</i> Sykes	Lc	R	O
89	Jungle Babbler	<i>Turdoides striata</i> Dumont	Lc	R	O
<b>Family: Motacillidae</b>					
90	Paddyfield Pipit	<i>Alauda pratensis</i> Vieillot	Lc	R	I
91	White Wagtail	<i>Motacilla Alba</i> Linnaeus	Lc	M	I
92	Grey Wagtail	<i>Motacilla cinerea</i> Tunstall	Lc	M	I
93	Citrine Wagtail	<i>Motacilla citreola</i> Pallas	Lc	M	I
94	Yellow Wagtail	<i>Motacilla flava</i> Linnaeus	Lc	R	I
95	White browed Wagtail	<i>Motacilla maderaspatensis</i> Gmelin	Lc	R	I
<b>Family: Muscipidae</b>					
96	Oriental Magpie Robin	<i>Copsychus saularis</i> Linnaeus	Lc	R	I
97	Red-breasted Flycatcher	<i>Ficedula parva</i> Bechstein	Lc	M	I
98	Brown Rockchat	<i>Oenanthe fusca</i> Blyth	Lc	R	I
99	Indian Robin	<i>Saxicoloides fulicatus</i> Linnaeus	Lc	R	I
<b>Family: Nectariniidae</b>					
100	Purple Sunbird	<i>Cinnyris asiaticus</i> Latham	Lc	R	N
101	Purple Rumped Sunbird	<i>Leptocoma zeylonica</i> Linnaeus	Lc	R	N
<b>Family: Passeridae</b>					
102	Chestnut Shouldered petronia	<i>Gymnoris xanthocollis</i> Burton	Lc	R	O
103	House Sparrow	<i>Passer domesticus</i> Linnaeus	Lc	R	O
<b>Family: Phylloscopidae</b>					
104	Common Chiffchaff	<i>Phylloscopus collybita</i> Vieillot	Lc	M	I
<b>Family: Ploceidae</b>					
105	Baya Weaver	<i>Ploceus philippinus</i> Linnaeus	Lc	R	I
<b>Family: Pycnonotidae</b>					
106	Red-vented Bulbul	<i>Pycnonotus cafer</i> Linnaeus	Lc	R	O
107	White-eared Bulbul	<i>Pycnonotus leucotis</i> Gould	Lc	R	O
<b>Family: Rhipiduridae</b>					
108	White-browed Fantail	<i>Rhipidura aureola</i> Lesson	Lc	R	I
109	White-spotted Fantail	<i>Rhipidura albogularis</i> Lesson	Lc	R	I
<b>Family: Stenostridae</b>					
110	Grey-headed canary Flycatcher	<i>Culicicapa ceylonensis</i> Swainson	Lc	R	I
<b>Family: Sturnidae</b>					
111	Bank Myna	<i>Acridotheres ginginianus</i> Latham	Lc	R	O
112	Common Myna	<i>Acridotheres tristis</i> Linnaeus	Lc	R	O
113	Rosy Starling	<i>Pastor roseus</i> Linnaeus	Lc	M	O
114	Brahminy Starling	<i>Sturnus pagodarum</i> Gmelin	Lc	R	O
<b>Family: Sylviidae</b>					
115	Lesser Whitethroat	<i>Curruca curruca</i> Linnaeus	Lc	M	I
<b>Family: Zosteropidae</b>					
116	Indian White-eye	<i>Zosterops palpebrosus</i> Temminck	Lc	R	F
<b>Order: Pelecaniformes</b>					
<b>Family: Ardeidae</b>					
117	Great Egret	<i>Ardea alba</i> Linnaeus	Lc	R	C
118	Grey Heron	<i>Ardea cinerea</i> Linnaeus	Lc	R	C
119	Intermediate Egret	<i>Ardea intermedia</i> Wagler	Lc	R	C
120	Purple Heron	<i>Ardea purpurea</i> Linnaeus	Lc	R	C
121	Indian Pond Heron	<i>Ardeola grayii</i> Skyes	Lc	R	C
122	Cattle Egret	<i>Bubulcus Ibis</i> Linnaeus	Lc	R	C
123	Little Egret	<i>Egretta garzetta</i> Linnaeus	Lc	R	C
124	Western reef Heron	<i>Egretta gularis</i> Bosc	Lc	M	C
125	Black Bittern	<i>Ixobrychus flavicollis</i> Latham	Lc	M	C
126	Black Crown-night Heron	<i>Nycticorax nycticorax</i> Linnaeus	Lc	R	C
<b>Family: Threskiornithidae</b>					
127	Eurasian Spoonbill	<i>Platalea leucorodia</i> Linnaeus	Lc	M	C
128	Glosy Ibis	<i>Plegadis falcinellus</i> Linnaeus	Lc	R	C
129	Red-naped Ibis	<i>Pseudibis papillosa</i> Temminck	Lc	R	C
130	Black-headed Ibis	<i>Threskiornis melanocepheus</i> Latham	Lc	R	C
<b>Order: Piciformes</b>					
<b>Family: Megalaimidae</b>					
131	Coppersmith Barbet	<i>Psilopogon haemacephal</i> Statius Muller	Lc	R	F
<b>Family: Picidae</b>					
132	Golden-backed Woodpecker	<i>Dinopium benghalense</i> Linnaeus	Lc	R	I
<b>Order: Podicipediformes</b>					
<b>Family: Podicipedidae</b>					
133	Little Grebe	<i>Tachybaptus ruficollis</i> Pallas	Lc	R	C
<b>Order: Psittaciformes</b>					
<b>Family: Psittacidae</b>					
134	Plum-headed Parakeet	<i>Psittacula cyanocephala</i> Linnaeus	Lc	R	F
135	Alexandrine Parakeet	<i>Psittacula eupatria</i> Linnaeus	Nt	R	F
136	Rose-ringed Parakeet	<i>Psittacula krameri</i> Scopoli	Lc	R	F

Order: Strigiformes					
Family: Strigidae					
137	Spotted Owlet	<i>Athene brama</i> Temminck	Lc	R	C
138	Indian Scops Owl	<i>Otus bakkamoena</i> Pennant	Lc	R	C
Family: Tytonidae					
139	Barn Owl	<i>Tyto alba</i> Scopoli	Lc	R	C
Order: Suliformes					
Family: Anhingidae					
140	Oriental Darter	<i>Anhinga melanogaster</i> Pennant	Nt	R	C
Family: Phalacrocoracidae					
141	Little Cormorant	<i>Microcarbo niger</i> Vieillot	Lc	R	C
142	Great Cormorant	<i>Phalacrocorax carbo</i> Linnaeus	Lc	M	C
143	Indian Cormorant	<i>Phalacrocorax fuscicollis</i> Stephens	Lc	R	C

**Abbreviation:** C- Carnivore, I- Insectivore, O- Omnivore, F- Frugivore, G- Graminivore, H- Herbivore, N- Nectarivore, Lc- Least concern, Nt- Near threatened, Vu-Vulnerable, R- Residential, M- Migratory,

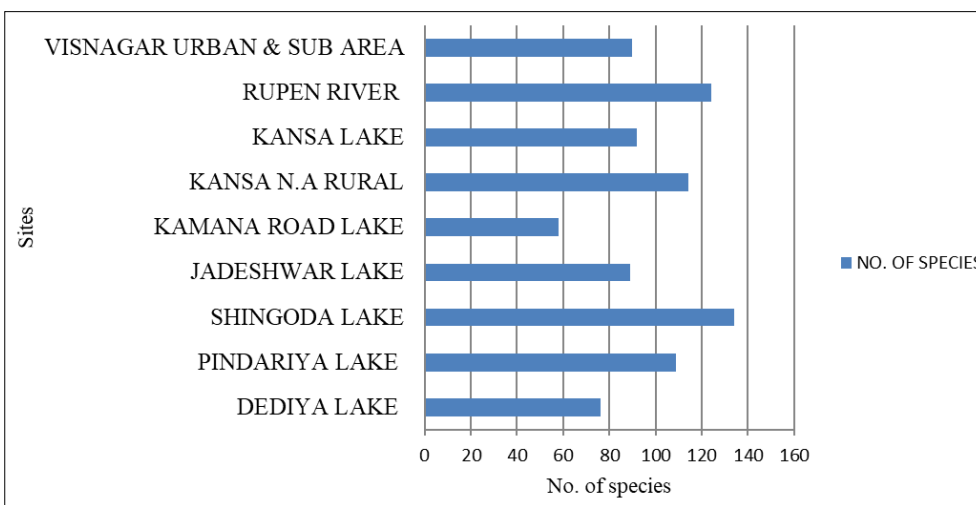


**Fig 5:** The avifaunal diversity in Visnagar (Dist. Mehsana) is distributed based on the feeding habits.

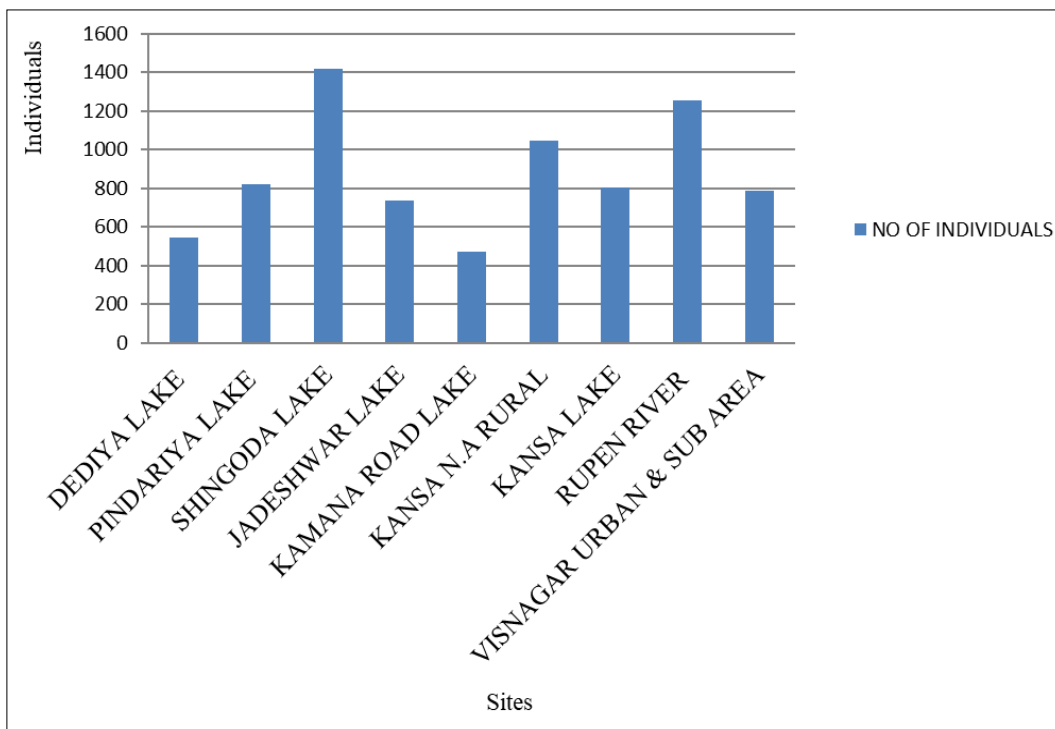
**Site- Wise distribution**

Throughout the course of the study, a total of 788 individuals were counted at the one urban site and 7096 individual at the eight rural locations. The most individuals (1416) and species

(134) were discovered at the remote Singhoda Lake location. The Singhoda Lake also produced the most Indian Spot-billed Duck individuals (64), according to records. Less people (473) were counted at Kamana Lake.



**Fig 6:** Site-wise distribution of avian species in field study.



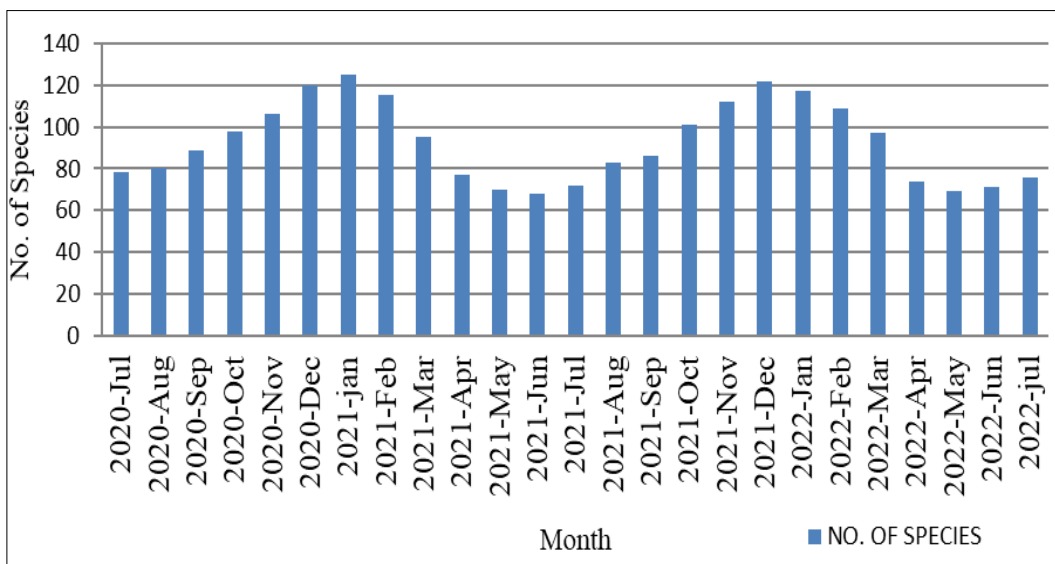
**Fig 7:** Site-wise distribution of avian individuals in field study.

**Month-wise distribution**

The highest bird dispersion was observed during our two-year study, specifically in January 2021 during the winter season. This was followed by another peak in bird dispersion during the winter season in December 2021, and finally, a third peak occurred during the summer season in May and June (refer to

Figures 8 and 9).

Winter (82) was the season with the highest number of Common teal duck individuals reported, followed by monsoon (57) and summer (35) seasons. The Indian Pond Heron species has the most site-wide occurrences (70).



**Fig 8:** Month wise distribution of avian species during field study.



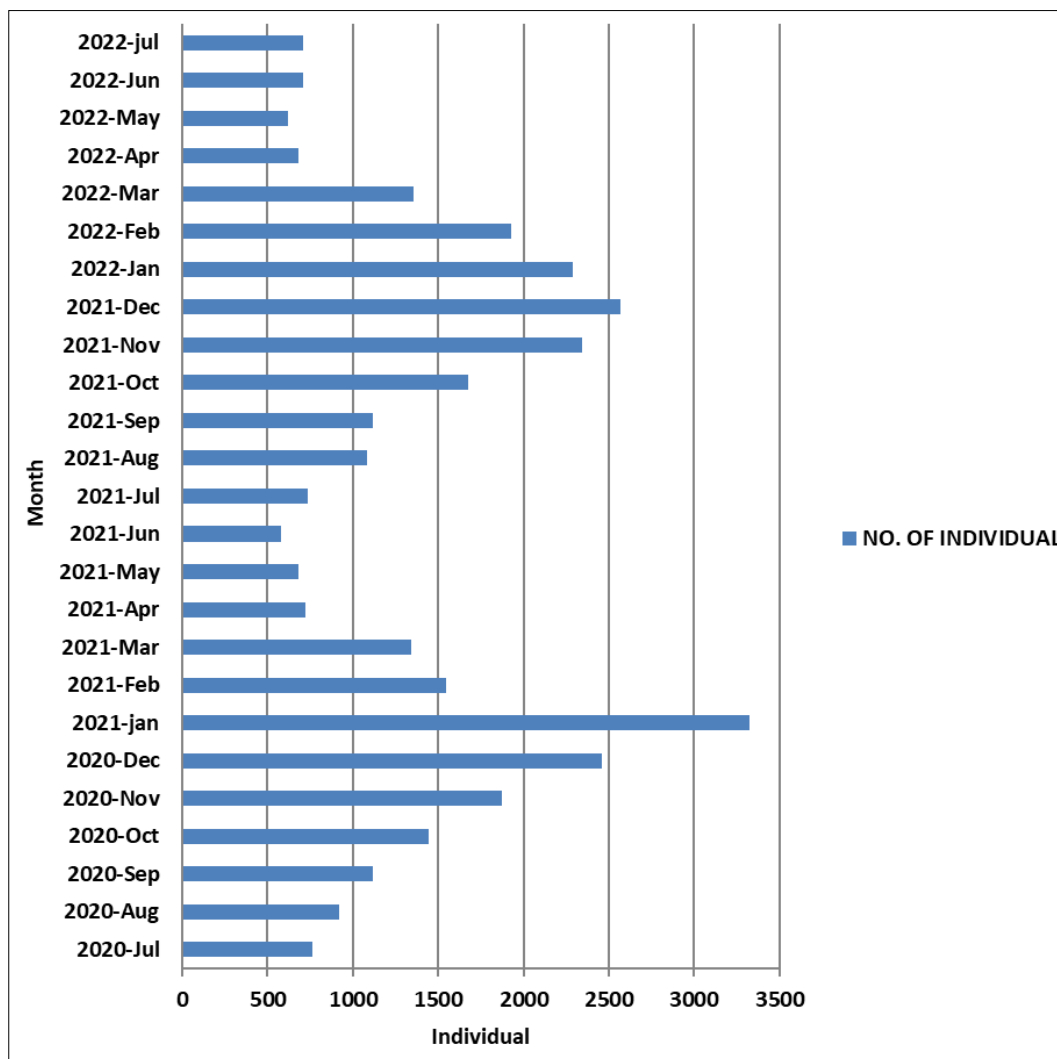


Fig-9: Month wise distribution of avian individual during field study.

**Site-wise diversity indices:**

The dominance (D) value of 0.01 and the significant Simpson index (1-D) were observed in the rural sites, namely Pindariya Lake, Singhoda Lake, Jadeshwar Lake, Kansa N.A, Rupen River, and Kansa Lake. Additionally, the urban site of Visnagar City also exhibited significant diversity data. As we have taken one urban site so its insignificant diversity data are (D = 0.01451, 1-D = 0.98549, 1/D=68.9062, H=4.29078,

H'=73.0235). Now in rural sites Shannon (H) and Shannon wiener (H') was significant in the Singhoda lake site (H = 4.7161, H' = 111.731) and insignificant in Kamana Lake (H=3.89628, H'=49.2189). The findings suggest that the diversity indices were significantly higher in the rural sites compared to the urban site. This is because of uninterrupted area by human activity as compare to urban city area, and remaining data of other sites we have mentioned in table-4.

Table 4: Diversity indices of bird's species in rural and urban sites

Sites	D	1-D	1/D	H	H'
Dediya Lake	0.021364	0.978636	46.80770515	3.989158745	54.00943455
Pindariya Lake	0.01403854	0.98596146	71.23249894	4.39627846	81.14830936
Singhoda lake	0.0097233	0.9902767	102.8457037	4.716098256	111.7314536
Jadeshwar Lake	0.01451248	0.98548752	68.90622222	4.290808985	73.02552116
Kamana Lake	0.02069373	0.97930627	48.32380895	3.896278112	49.21892046
Kansa N.A.	0.01060499	0.98939501	94.29520604	4.589649557	98.45991951
Kansa Lake	0.01324846	0.98675154	75.48045385	4.374470987	79.39782599
Rupen	0.01010227	0.98989773	98.98769246	4.654296519	105.0353037
Visnagar	0.01451248	0.98548752	68.90622222	4.290781362	73.02350403

Abbreviation: D=Dominance (Simpson's index), 1-D=Simpson's index of diversity, 1/D= Simpson's reciprocal index, H= Shannon index, H'= Shannon Wiener index.

**Statistical analysis**

Our analysis on bird diversity indices such as Simpson's index (D), Simpson's diversity index (1-D), Simpson's reciprocal index (1/D), Shannon index(H) & Shannon Wiener

index(H') are calculated using below listed formulas:

$$D = \sum n(n - 1) / N(N - 1)$$

$$H = -\sum_{i=1}^n p_i (\ln p_i)$$

$$H' = \text{Exp} -\sum_{i=1}^n p_i (\ln p_i)$$



**1. Great Cormorant**



**2. Great Egret**



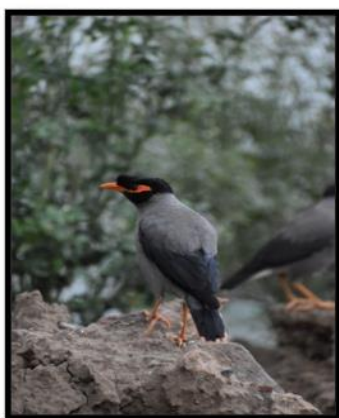
**3. Indian Grey Hornbill**



**4. Ashy Prinia**



**5. Small Minivet**



**6. Bank Myna**



**7. Bay-Backed Shrike**



**8. Black Bittern**



**9. Black Winged Stilt**



**10. Common Myna**



**11. Common Teal**



**12. Citrine Wagtail**



**13. Cattle Egret**



**14. Black Kite**



**15. Red Wattled Lapwing**



**16. Western reef Heron**



**17. Woolly Necked Stork**

**18. Shikra****19. Indian Pond Heron**

### Conclusion

Our Current study on Visnagar city and their nearby Rural and Urban sites noticed that, our rural and urban sites are surrounded by gardens, farms, reservoirs, ponds, lakes, wetlands, river etc. which sustains great bird diversity. One thing we noticed is that from our total 143bird species, 90 were from Visnagar city (Urban area) which is because of availability of food, shelter and suitable climate. Other than this more no. of species also observed near river area where there are little bit human activities. We observed that in this river side area there is fishing activity by local fisherman which should be reduced to maintain diversity of species. Our records indicate that the highest diversity of species was observed in the Passeriformes order, with 21 families and 50 species. This was followed by the Charadriiformes order, which consisted of 7 families and 19 species. In descending order of diversity, the Coraciiformes order had 3 families and 6 species, Pelecaniformes had 2 families and 14 species, Suliformes had 2 families and 4 species, Strigiformes had 2 families and 3 species, Bucerotiformes had 2 families and 2 species. Additionally, Accipitriformes, Anseriformes, Caprimulgiformes, Ciconiiformes, Columbiformes, Cuculiformes, Galliformes, Gruiformes, Podicipediformes, and Psittaciformes each had 1 family, representing a range of species diversity.

**Authors Contribution:** All author contributed equally.

### Conflicts of interests

The authors declare that there are no conflicts of interests.

### Data and materials availability

All data associated with this study are present in the paper.

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