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COMMUNICATION

AVIFAUNA OF SAURASHTRA UNIVERSITY CAMPUS, RAJKOT, GUJARAT, INDIA

Varsha Trivedi & Sanjay Vaghela

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Avifauna of Saurashtra University Campus, Rajkot, Gujarat, India

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Abstract: We examined the avifauna of Saurashtra University Campus (SUC), Rajkot, Gujarat from July to December 2017. The study area was divided into four sections: North (N), East (E), South (S) and West (W) and surveyed over 18 visits (four line transects/visit). We recorded a total of 82 bird species from 67 genera, 40 families and 16 orders. Of these 57 species were terrestrial and 25 aquatic. By population size the most abundant birds were members of Columbidae (28%), Sturnidae (13%), and Charadridae (8%). Seventy per cent of birds observed (n=7665) were classed as very common and 2% (n=261) as very rare. Species density (S/N = 3.39) and population density (n/N = 196) were at their maximum in December. Ecological indices on temporal base reveal high species richness and Simpson diversity (1/D =17.0 and 1-D= 0.942) in August and November and Shannon diversity was high (H'=3.275) in November during study period.

Keywords: Birds, checklist, population density, status, temporal.

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Author contribution: The final manuscript was prepared, analyzed, read, approved and communicated by the VT and SV undertook field data collection, organized and assimilated the data, table and graphic preparation and drafted the manuscript.

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INTRODUCTION

Birds play key roles as agents of flower pollination and seed dispersal (Nason 1992). Likewise, structurally complex habitats provide more niche and diverse ways of exploiting environmental resources, increase species diversity (Bazzaz 1975), and the inter-relationship between vegetation and bird population (Mac Arthur & Mac Arthur 1961) including the positive and negative changes in the bird population result in the transformation of the natural environment (Emlen 1974). Skead (1966), Maxwell & Kale (1977), and McCrimmon (1978) have discussed that the habitat is significant for the successful completion of the life cycle of the organism. The highly dynamic nature of urban ecosystems means that a small effort in management can have a great effect on bird abundance and diversity (Savard et al. 2000). It is stated by Tews et al. (2004) that animal species diversity is driven by habitat heterogeneity.

The present work deals with urban ecosystems using birds as a target group. Birds are quite sensitive to changes in habitat structure and composition, and are, therefore, excellent indicators of changes and stresses in the urban ecosystem (Savard & Falls 1982; Clergeau et al. 1998). Joshi (2009) reported 79 species of birds from some reservoirs of Rajkot City and 30 species of water birds from Nyari Dam1 (Vadhel 2010) of Rajkot. Past record of year 2016 on avifauna from Saurashtra University Campus (SUC), Rajkot reports a total of 80 species of birds belonging to 66 genera of 39 families (Gohil 2017). The current study of avian fauna was carried out to understand the impact of the current developmental work being undertaken in the SUC on habitat suitability for wildlife in the coming years. Moreover, every year habitat characteristics are changing due to the construction of new buildings, decrease in open landscapes and fragmentation of the various macro and micro-habitats in SUC. So, the specific attention on avian diversity of SUC is the intention of the present study. In addition, the study also aims to develop a wildlife database on wildlife of this university campus.

This study presents a checklist of birds with updated systematic, familial distribution, abundance status, species composition, conservation status and their population on temporal base including ecological indices. Hypothetically, it is assumed that the overall bird population and their species community assemblage is expected to diversify on temporal scale as well as with changes in macro and microhabitat types at SUC, Rajkot.

STUDY AREA

Saurashtra University Campus (SUC) Rajkot (Latitude: 22.2916100°, Longitude: 70.7932200°, 140m) is located at the centre of peninsular Saurashtra region in Gujarat State (Fig. 1A). The climate of Rajkot is tropical arid to semi-arid with three distinct seasons each year, monsoon, winter, and summer. The annual rainfall is erratic in its occurrence, duration and intensity. Annual rainfall was high 1,311.2mm during 2017; average temperature varies between 21.5°C and 34.5°C and average humidity ranges between 57.9 and 88.4% (morning) and 17.4 to 80.3% (evening). The area is spread over 1,456km² (360 acres) with hilly terrain (Fig. 1B).

The ecological overview of all four sections of SUC include predominant vegetation layer such as trees: Azadirachta indica, Lawsonia inermis, Aegle marmelos, Delonix regia, Ficus benghalensis, F. religiosa, Kesiya auriculata, Prosopis juliflora, P. spicigera, Emblica officinalis, Tamarindus indica, Jetropha kalkas, Cassia roxburghii, C. fistula, Albizia lebbeck, Pongamia pinnata, etc.; shrubs: Ocimum tenuiflorum, Caesalpinia pulcherrima, Calotropis procera and Zyziphus numularia; ornamental plants: Tecoma stans, Cascabela thevetia, Duranta repens, Bougainvillea spectabilis, Catharanthus roseus, and Lantana camara.

METHODS

The work was carried out during July to December 2017 at Saurashtra University Campus (SUC), Rajkot Gujarat. To record the birds of all four sections (i.e., North, East, South, and West) surveyed using line transects (by road 1km long and 5m broad right and left using binocular) and some places at water reservoirs by point count methods. Inside each zone approaching peripheral boundaries by road with motor bike, by walk-ways and walk at random. Data records on bird sightings, the birds present in and around the selected four sections at SUC; including overflying individuals or flock, resting on trees, feeding on the ground and some individual as well as large flock by photos also.

In total 18 surveys (3 visits/month and 4 transects/ visit in each sections) were done during study periods from 06:00hrs to 12:00hrs and 90 minutes were spent at each section. The data were collected using a pair of binoculars (Olympus, 12 X 50) and photographs (Sony cyber shot 18.2 mega pixel 20x zoom) by digital still camera for close examinations.

Systematic updates, identification of birds were



followed by using references such as Ali & Ripley (1983), Sugathan & Varghese (1996), Ali (2012), Parasharya et al. (2004), Sangha & Naoroji (2005), Grimmett et al. (2013), Ansari & Nawab (2015), Ganpule (2016), Manohar et al. (2017); common name and scientific name updated as Praveen et al. (2018) and Satose et al. (2020).

Data analysis

The abundance status of the recorded bird species was categorized into five groups (i.e., VR—Very Rare (1–20 %), R—Rare (21–40%), O—Occasional (41–60 %), C—Common (61–80 %), and VC—Very Common (81–100 %), established on the basis of frequency (%) (Table 1, Fig. 2) and frequency calculated (i.e., total no of occurrence/total no of visit x 100).

A checklist of birds with systematics including

conservation status is followed as per IUCN (2020-version 1), WPA (1972) and CITES (2020) (Table 1). Classification was followed and updated (Praveen et al. 2018; Satose et al. 2020); familial number and percentages of individual birds, genera and species were calculated (Table 2; Fig. 3). Species community and their assemblages by month, cumulative count of individuals and species number (Fig. 4) on temporal scale were scrutinized.

The quantitative and qualitative analysis as population and species density, species diversity indices like Simpson diversity 1/D; 1-D; Shannon diversity –H', evenness - e^H/S, Margalef's species richness (d), and Fisher alpha diversity (α) were computed using software PAST (version: 3.15 March 2017) by Hammer et al. (2001).

RESULTS AND DISCUSSION

A total 82 species of birds, belonging to 67 genera, 40 families and 16 orders were recorded. Of these, terrestrial population (86.82%) of birds and species (n-57, 69.51%) were higher than aquatic population (13.18%) and numbers of species (n-25, 30.49%) of birds (Table 1, 2) during study period at studied areas.

Out of 40 families, Scolopacidae dominated with seven species (8.54%) followed by Muscicapidae with six species (7.32%), Accipitridae and Motacillidae with five species (6%), Ardeidae, Columbidae, Hirundinidae, Sturnidae with four species (4.88%) each, Charadriidae, Cisticolidae with three species (3.66%) each, Threskiornithidae, Anatidae, Phasianidae, Laridae, Cuculidae, Sylviidae, Leiothrichidae with two species (2.44%) each, whereas 23 families Rallidae, Pelecanidae, Burhinidae, Recurvirostridae, Strigidae, Upupidae, Megalaimidae, Meropidae, Alcedinidae, Psittaculidae, Oriolidae, Dicruridae, Laniidae, Corvidae, Nectariniidae, Ploceidae, Estrildidae, Passeridae, Alaudidae, Acrocephalidae, Psycnonotidae, Ciconiidae, Phalacrocoracidae with only one species each respectively (Table 2). The population of a member of family Columbidae (27.94%, n=3085) stands first; followed by Sturnidae (13.39%, n=1478) and Charadriidae (7.77%, n=858) has shown higher population and the lowest population Laniidae (0.04%, n = 4) i.e. Long-tailed Shrike Lanius schach. Maximum genus was found in family Muscicapidae (8.96%) and Accipitridae (7.465%) (Fig. 3).

Species community and status

Seventy per cent (n=7665) population of birds were very common, 2% (n=261) very rare, 27% (n=22) species were common, and only 10% were rare (n=8) (Table 1, Fig. 2). Of the 82 species recorded, the five species observed with highest population were the Rock Pigeon *Columba livia* (106 mean), Rosy Starling *Pastor roseus* (43 mean), Large Grey Babbler *Turdoides malcolmi* (35 mean), Red-wattled Lapwing *Vanellus indicus* (34 mean), and Common Myna *Acridotheres tristis* (33 mean) (Table 1).

Out of 17 very common bird species, nine species were sighted in every visit (100%) namely Rock Pigeon, Eurasian Collared Dove *Streptopelia decaocta*, Laughing Dove *Streptopelia senegalensis*, Asian Koel *Eudynamys scolopaceus*, Red-wattled Lapwing, House Sparrow *Passer domesticus*, Red-vented Bulbul *Pycnonotus cafer*, Common Myna and Indian Robin *Saxicoloides fulicatus*. There were eight common species sighted between 11 and 14 visits out of the 18 visits; among these, the most dominant were Rosy Starling (13 times out of 18, n=796); as Indian Silverbill *Euodice malabarica* (n=362) and Purple Sunbird *Cinnyris asiaticus* (14 times out of 18, n=139). Fifteen species were occasionally seen, 22 species rare and 20 species were very rare; among the very rare category, the rarest one was Marsh Sandpiper *Tringa stagnatilis*. Long-legged Buzzard *Buteo rufinus* and Lesser White throat (*Sylvia curruca*) were sighted only once during the survey (Table 1).

Conservation status of avian fauna

The SUC supports six species of birds included in Schedule I, 70 species included in Schedule IV of the Wildlife Protection Act (WPA, 1972) and six species that are listed in Appendix II of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES 2020). As per IUCN red list, SUC supports three Near-threatened (NT) species such as Painted Stork *Mycteria leucocephala*, Curlew Sandpiper *Calidris ferruginea* and River Tern *Sterna aurantia* (IUCN 2020ver. 1), remaining 79 species are under Least Concern (LC) (Table 1).

Species composition and assemblages on temporal scale

Throughout the six-month study period, it reflects that population of Rock Pigeon was maximum from August to December; second most was Rosy Starling and third most populous species (Large Grey Babbler) dominated from post monsoon to winter (October– December). Accumulation curve of number of species and individual shows a steep increase from July to October, thereafter, species and population of birds reveal gradual increase up to December (Fig. 4).

STATISTICAL ANALYSIS

Avian species density and diversity

Out of 11,041 individuals of birds reveal 82 species of all total survey (N=18). The species Density (S/N) was high 4.56 species per survey during entire study period. Evenness index (e): Evenness index is low (e < 0, 0.357). As evenness index increase with decrease in stress (Pielou 1966), this clears study areas has no stress elements. Species richness Margalof's index (d): Margalof's index of species richness was high 8.701; and this minimizes the effect of sample size bias (cited by Odum 1971). Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to those species which have very few individuals. Simpson's Index

Table 1. Checklist of birds of Saurashtra University Campus, Rajkot. (July to December 2017; Total Survey=18).

	Common name	Scientific name		Fr %	AS	IUCN	WPA	CITES
	Order: Anseriformes (i) Family: Anatidae	y:						
1	Lesser Whistling-duck	Dendrocygna javanica	0.78	28	R	LC	Sch-IV	-
2	Indian Spot-billed Duck	Anas poecilorhyncha	1.67	28	R	LC	Sch-IV	-
	Order: Galliformes (i) Family: Phasianidae							
3	Indian Peafowl	Pavocristatus	1.78	39	R	LC	Sch-I	-
4	Grey Francolin	Francolinus pondicerianus	9.39	56	0	LC	Sch-IV	-
	Order: Columbiformes (i) Family: Columbidae							
5	Rock Pigeon	Columba livia	105.72	100	VC	LC	Sch-IV	-
6	Eurasian Collared Dove	Streptopelia decaocta	29.28	100	VC	LC	Sch-IV	-
7	Red Collared Dove	Streptopelia tranquebarica	10.06	50	0	LC	Sch-IV	-
8	Laughing Dove	Streptopelia senegalensis	26.33	100	VC	LC	Sch-IV	-
	Order: Cuculiformes (i) Family: Cuculidae							
9	Greater Coucal	Centropus sinensis	2.00	72	с	LC	Sch-IV	-
10	Asian Koel	Eudynamys scolopaceus	2.94	100	VC	LC	Sch-IV	-
	Order: Gruiformes(i) Family: Rallidae							
11	Common Coot	Fulica atra	0.78	11	VR	LC	Sch-IV	-
	Order: Pelecaniformes (i) Family: Pelecanidae							
12	Great White Pelican	Pelecanus onocrotalus	0.89	11	VR	LC	Sch-IV	-
	(ii) Family: Ardeidae							
13	Indian Pond Heron	Ardeola grayii	1.00	39	R	LC	Sch-IV	-
14	Cattle Egret	Bubulcus ibis	8.56	94	VC	LC	Sch-IV	-
15	Intermediate Egret	Ardea intermedia	0.28	17	VR	LC	Sch-IV	-
16	Little Egret	Egretta garzetta	2.83	56	0	LC	Sch-IV	-
	(iii) Family: Threskiornithidae							
17	Indian Black Ibis	Pseudibis papillosa	2.44	61	с	LC	Sch-IV	-
18	Glossy Ibis	Plegadis falcinellus	0.28	22	R	LC	Sch-IV	-
	Order: Charadriiformes (i) Family: Burhinidae							
19	Indian Thick-Knee	Burhinus indicus	3.17	44	0	LC	Sch-IV	-
	(ii) Family: Recurvirostridae							
20	Black-winged Stilt	Himantopus himantopus	2.94	28	R	LC	Sch-IV	-
	(iii) Family: Charadriidae							
21	Little Ringed Plover	Charadrius dubius	1.00	28	R	LC	Sch-IV	-
22	Yellow-wattled Lapwing	Vanellus malabaricus	13.00	83	VC	LC	Sch-IV	-
23	Red-wattled Lapwing	Vanellus indicus	33.67	100	VC	LC	Sch-IV	-
	(iv) Family: Scolopacidae							
24	Curlew Sandpiper	Calidris ferruginea	1.11	17	VR	NT	Sch-IV	-
25	Little Stint	Calidris minuta	1.06	17	VR	LC	Sch-IV	-
26	Common Sandpiper	Actitis hypoleucos	1.22	44	0	LC	Sch-IV	-
27	Green Sandpiper	Tringa ochropus	0.56	22	R	LC	Sch-IV	-
28	Common Greenshank	Tringa nebularia	0.22	11	VR	LC	Sch-IV	-
29	Wood Sandpiper	Tringa glareola	0.72	17	VR	LC	Sch-IV	-
30	Marsh Sandpiper	Tringa stagnatilis	0.17	6	VR	LC	Sch-IV	-

Avifauna in Saurashtra University Campus

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	Common name	Scientific name	м	Fr %	AS	IUCN	WPA	CITES
	(v) Family : Laridae							
31	River Tern	Sterna aurantia	0.17	11	VR	NT	Sch-IV	-
32	Common Tern	Sterna hirundo	0.22	11	VR	LC	Sch-IV	-
	Order: Accipitriformes (i) Family: Accipitridae							
33	Black-winged Kite	Elanus caeruleus	0.17	11	VR	LC	Sch-I	App II
34	Shikra	Accipiter badius	1.72	67	С	LC	Sch-I	App II
35	Brahminy Kite	Halias turindus	0.56	33	R	LC	Sch-I	App II
36	Black Kite	Milvus migrans	0.50	28	R	LC	Sch-I	App II
37	Long-legged Buzzard	Buteo rufinus	0.11	6	VR	LC	Sch-I	App II
	Order: Strigiformes (i) Family: Strigidae							
38	Spotted Owlet	Athene brama	0.89	50	0	LC	Sch-IV	App II
	Order: Bucerotiformes (i) Family: Upupidae							
39	Common Hoopoe	Upupa epops	2.78	50	0	LC	-	-
	Order: Piciformes (i) Family:Megalaimidae							
40	Coppersmith Barbet	Psilopogon haemacephalus	2.28	50	0	LC	Sch-IV	-
	Order: Coraciiformes (i) Family: Meropidae							
41	Green Bee-eater	Merops orientalis	25.89	94	VC	LC	-	-
	(ii) Family: Alcedinidae							
42	White-throated Kingfisher	Halcyon smyrnensis	1.17	67	С	LC	Sch-IV	-
	Order: Psittaciformes (i) Family: Psittaculidae							
43	Rose-ringed Parakeet	Psittacula krameri	19.44	94	VC	LC	Sch-IV	-
	Order: Passeriformes (i) Family : Oriolidae							
44	Indian Golden Oriole	Oriolus kundoo	2.94	50	0	LC	Sch-IV	-
	(ii) Family:Dicruridae							
45	Black Drongo	Dicrurus macrocercus	19.44	94	VC	LC	Sch-IV	-
	(iii) Family: Laniidae							
46	Long-tailed Shrike	Lanius schach	0.22	11	VR	LC	Sch-IV	-
	(iv) Family:Corvidae							
47	Rufous Treepie	Dendrocitta vagabunda	3.11	78	С	LC	Sch-IV	-
	(v) Family:Nectarinidae							
48	Purple Sunbird	Cinnyris asiaticus	7.72	78	С	LC	Sch-IV	-
	(vi) Family: Ploceidae							
49	Baya Weaver	Ploceus philippinus	3.44	22	R	LC	Sch-IV	-
	(vii) Family: Estrildidae							
50	Indian Silverbill	Euodice malabarica	20.11	78	С	LC	Sch-IV	-
	(viii) Family: Passeridae							
51	House Sparrow	Passer domesticus	29.33	100	VC	LC	Sch-IV	-
	(ix) Family: Motacillidae							
52	Paddyfield Pipit	Anthus rufulus	2.06	39	R	LC	Sch-IV	-
53	Western Yellow Wagtail	Motacilla flava	0.89	50	0	LC	Sch-IV	-
54	Citrine Wagtail	Motacilla citreola	0.83	28	R	LC	Sch-IV	-
55	White-browed Wagtail	Motacilla maderaspatensis	0.39	28	R	LC	Sch-IV	-
56	White Wagtail	Motacilla alba	0.83	44	0	LC	Sch-IV	-

	Common name	name Scientific name		Fr %	AS	IUCN	WPA	CITES
	(x) Family : Alaudidae							
57	Ashy-crowned Sparrow Lark	Eremopterix griseus	10.72	83	VC	LC	Sch-IV	-
	(xi) Family: Cisticolidae							
58	Ashy Prinia	Prinia socialis	1.11	28	R	LC	Sch-IV	-
59	Plain Prinia	Prinia inornata	2.89	56	0	LC	Sch-IV	-
60	Common Tailorbird	Orthotomus sutorius	2.06	44	0	LC	Sch-IV	-
	(xii) Family:Acrocephalidae							
61	Paddy field Warbler	Acrocephalus agricola	3.83	22	R	LC	Sch-IV	-
	(xii) Family: Hirundinidae							
62	Red-rumped Swallow	Cecropis daurica	9.94	33	R	LC	-	-
63	Wire-tailed Swallow	Hirundo smithii	2.11	22	R	LC	-	-
64	Barn Swallow	Hirundo rustica	4.56	22	R	LC	-	-
65	Dusky Crag Martin	Ptyonoprogne concolor	3.61	50	0	LC	-	-
	(xiii) Family : Psycnonotidae							
66	Red-vented Bulbul	Pycnonotus cafer	17.50	100	VC	LC	Sch-IV	-
	(xiv) Family : Sylviidae							
67	Lesser Whitethroat	Sylvia curruca	0.11	6	VR	LC	Sch-IV	-
68	Yellow-eyed Babbler	Chrysomma sinense	2.44	17	VR	LC	Sch-IV	-
	(xv) Family:Leiothrichidae							
69	Large Grey Babbler	Argya malcolmi	35.00	94	VC	LC	Sch-IV	-
70	Common Babbler	Argya caudata	3.33	17	VR	LC	Sch-IV	-
	(xvi) Family:Sturnidae							
71	Rosy Starling	Pastor roseus	42.72	72	С	LC	Sch-IV	-
72	Brahminy Starling	Sturnia pagodarum	5.56	89	VC	LC	Sch-IV	-
73	Common Myna	Acridotheres tristis	33.28	100	VC	LC	Sch-IV	-
74	Bank Myna	Acridotheres ginginianus	0.56	11	VR	LC	Sch-IV	-
	(xvii) Family:Muscicapidae							
75	Indian Robin	Saxicoloides fulicatus	10.00	100	VC	LC	Sch-IV	-
76	Oriental Magpie Robin	Copsychus saularis	0.89	33	R	LC	Sch-IV	-
77	Spotted Flycatcher	Muscicapa striata	0.67	17	VR	LC	Sch-IV	-
78	Red-breasted Flycatcher	Ficedula parva	0.83	22	R	LC	Sch-IV	-
79	Black Redstart	Phoenicurus ochruros	0.50	17	VR	LC	Sch-IV	-
80	Pied Bushchat	Saxicola caprata		33	R	LC	Sch-IV	-
	Order: Ciconiiformes (i) Family: Ciconiid							
81	Painted Stork Mycteria leucocephala		0.78	11	VR	NT	Sch-IV	-
	Order: Suliformes (i) Family: Phalacroco	racidae						
82	Little Cormorant Phalacrocorax niger		4.50	50	0	LC	Sch-IV	-

M—Mean per visit | Fr—Frequency | AS—Abundance Status (frequency based) | LC—Least Concern | NT—Near Threatened | IUCN (2020-version 1) | Sch–I & IV (WPA, 1972) | App. II (CITES, 2020). Identification of birds followed as per Grimmett et al. (2013), Satose et al. (2020),and Common name & Scientific Name updated (Praveen et al. 2018). VR—Very Rare (1–20 %), R—Rare (21–40 %) | O—Occasional (41–60 %) | C—Common (61–80 %) | VC—Very Common (81–100 %) established on the basis of

frequency (%)

Avifauna in Saurashtra University Campus

Table 2. Familial numbers of genus and species of birds.

	Family	Genus	Species		
1	Anatidae	2	2		
2	Phasianidae	2	2		
3	Columbidae	2	4		
4	Cuculidae	2	2		
5	Rallidae	1	1		
6	Pelecanidae	1	1		
7	Ardeidae	4	4		
8	Threskiornithidae	2	2		
9	Burhinidae	1	1		
10	Recurvirostridae	1	1		
11	Charadriidae	2	3		
12	Scolopacidae	3	7		
13	Laridae	1	2		
14	Accipitridae	5	5		
15	Strigidae	1	1		
16	Upupidae	1	1		
17	Megalaimidae	1	1		
18	Meropidae	1	1		
19	Alcedinidae	1	1		
20	Psittaculidae	1	1		
21	Oriolidae	1	1		
22	Dicruridae	1	1		
23	Laniidae	1	1		
24	Corvidae	1	1		
25	Nectariniidae	1	1		
26	Ploceidae	1	1		
27	Estrildidae	1	1		
28	Passeridae	1	1		
29	Motacillidae	2	5		
30	Alaudidae	1	1		
31	Cisticolidae	2	3		
32	Acrocephalidae	1	1		
33	Hirundinidae	3	4		
34	Psycnonotidae	1	1		
35	Sylviidae	2	2		
36	Leiothrichidae	1	2		
37	Sturnidae	3	4		
38	Muscicapidae	6	6		
39	Ciconiidae	1	1		
40	Phalacrocoracidae	1 1			
-	Total	67	82		





Figure 2. Population and species status (%) of avifauna at SUC.

Dominance (D): The value of D ranges between 0 and 1. With this index, 0 represents infinite diversity and 1 no diversity. That is, the bigger the value of D, the lower the diversity. Here, Simpson's Index D is 0.0587 which is low far to zero so it concludes that the diversity of this study site has significantly higher diversity. Simpson's Index of Diversity 1-D: This index also ranges between 0 and 1, the greater the value, the greater the sample diversity. Here the Simpson's Index of Diversity (1-D) is 0.9413. So, it concludes that the diversity of this study site was higher. Simpson's Reciprocal Index 1 / D: This index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. Higher the value, greater the diversity, here the Simpson's Index of Diversity (1/D) is 17.04. So, it concludes that this study site has higher diversity of bird species. Shannon Weiner Index (H'): If the species are evenly distributed then the H' value would be high. So, the H' value allows us to know not only the number of species but how the abundance of the species is distributed among all the species in the avian community. Typical values of Shannon Weiner Index (H')



Figure 3. Familial percentages of individual birds recorded during study period at SUC.

Month	Total Survey (N)	Total no. of individuals (n)	Total No. of taxa(S)	Species Density (S/N)	Population Density (n/N)	Dominance (D)	Simpson's Index (1/D)	Simpson's Index (1-D)	Shannon Weiner (H')	Evennes index (e)	Margalof d=(S-1)/ logN	Fisher Diversity (α)
Jul	3	429	31	1.72	23.83	0.0725	13.79	0.9275	2.889	0.5799	4.949	7.67
Aug	3	942	43	2.39	52.33	0.0585	17.00	0.9415	3.179	0.5587	6.133	9.29
Sept	3	1691	58	3.22	93.94	0.0741	12.66	0.9259	3.134	0.396	7.668	11.63
Oct	3	2031	58	3.22	112.83	0.0666	14.93	0.9334	3.220	0.4317	7.484	11.13
Nov	3	2419	59	3.28	134.39	0.0588	17.00	0.9412	3.275	0.448	7.444	10.91
Dec	3	3529	61	3.39	196.06	0.0612	16.39	0.9388	3.273	0.4327	7.345	10.48
Total	18	11041	82	4.56	613.39	0.0587	17.04	0.9413	3.377	0.3573	8.701	12.02

Table 3. Month wise ecological indices of birds of Saurashtra University Campus.

are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase. Shannon Weiner Index H'= 3.377; So, it concludes that abundance of avian species at this study site was high (Table 3).

Data analysis on temporal scale shows that population (n/N=196) and species density (S/N = 3.39) of birds were higher in December; whereas diversity indices reveal birds species richness and Simpson diversity (1/D = 17.0)

and 1-D= 0.941) was significantly higher in August and November; as Shannon diversity high in November (H'=3.275); dominance (D= 0.0741), evenness- e^H/ S= 0.396), Margalef's species richness (d = 7.668) and Fisher alpha diversity (α = 11.63) significant high and evenly distributed in September during study period. Overall Fisher alpha diversity was high (α = 12.02) at study areas during entire study period. This may reflect comparatively less stress in their environment and the climatic factor (i.e., Annual rainfall – 1311.2mm, average





Figure 4. Accumulation curve of number of species and individuals of avifauna by month.

temperature 21.5–34.5 °C, average humidity ranges 57.9–88.4 % by morning, 2017), their physiography may provide suitable habitat and food availability during the study period at Saurashtra University Campus.

Comparing previous records from other sites reveals 68 species of birds from village areas of Gondal Taluka, Rajkot District (Borad 2009); 79 species from reservoirs of Rajkot City (Joshi 2009); 30 species of water birds of Nyari Dam1 (Vadhel 2010) Rajkot; 29 species from Sodvadar Reservoir and 24 species from Phophal Reservoir Jam-kandorna Tehsil, Rajkot District (Jambukiya 2014). From Randarda Lake, 62 species of water birds recorded by Yadav (2015) and 65 species of water birds by Kasundra (2017); 80 species of birds from Saurashtra University Campus Rajkot (Gohil 2017); 51 species of water birds recorded from Aji-1 Water reservoir, Rajkot (Vala & Trivedi 2018). This indicates that multi-habitat characteristics of Saurashtra University Campus areas support a wide range of specialist and generalist species of birds.

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