UTTAR PRADESH JOURNAL OF ZOOLOGY

41(9): 128-139, 2020
ISSN: 0256-971X (P)

EFFECT OF *Prosopis juliflora* ON AVIFAUNA IN UDAIPUR DISTRICT, RAJASTHAN, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Authors NLC and NC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NLC and NC managed the analyses of the study. Author NLC managed the literature searches. Both authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. A. Jebanesa, Professor, Annamalai University, India.
Reviewers:
(1) V. K. Misra, Krishi Vigyan Kendra, India.
(2) Ismail Younis Al-Hadeedy, Kirkuk University, Iraq.

Received: 20 May 2020
Accepted: 27 July 2020
Published: 31 July 2020

Original Research Article

ABSTRACT

Prosopis juliflora plant species is an exotic species that is widely spreads in India. Present study (August, 2017 to February, 2020 in Udaipur district, Rajasthan) indicates that abundance of *Prosopis juliflora* and native floral species were correlated with the bird's species diversity, richness and abundance. Study divided into four categories on the basis abundance of *Prosopis juliflora*- very low abundance of *Prosopis juliflora* (VALPJ), low abundance of *Prosopis juliflora* (LAPJ), medium abundance of *Prosopis juliflora*(MAPJ) and high abundance of *Prosopis juliflora* (HAPJ). Distribution of bird's species in different area can be directly related to the density of native vegetation and *P. juliflora* composition. Highest bird diversity and abundance was observed in VLAPJ followed by LAPJ, MAPJ and lowest observed in HAPJ. *P. juliflora* leads to change in habitat and affect availability of food and nesting sites due to alleo-chemical substance releasing in soils, they inhibit growth of other native plant. Simpson diversity (0.9699) and Shannon diversity (3.872) were maximum observed in VALPJ area and minimum Simpson diversity (0.9556) and Shannon diversity (3.34) observed in HAPJ area. Birds abundance of VALPJ area was (Brillouin = 3.834, Fisher_ alpha= 15.85) maximum and minimum birds abundance was recorded in HAPJ area (Brillouin= 3.227, Fisher_ alpha= 7.541). Highest species richness was observed in VLAPJ (Menhinick= 1.193, Margalef's= 10.74, Chao-1=95.6) and lowest richness was recorded in HAPJ (Menhinick=1.029, Margalef's= 5.328, Chao-1=40). Common species like babbler, house sparrow, dove were generally observed in HAPJ area, but environmental sensitive species vultures, kites, eagles and owls were completely absent in high abundance of HAPJ area. Present study shows high abundance of *P. juliflora* (HAPJ) negatively affects bird's diversity, abundance and richness. While native vegetations provide better habitat and suitable habitat for birds.

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Keywords: Birds; diversity; environmental sensitive species; exotic species; habitat; *Prosopis juliflora*; richness.

1. INTRODUCTION

Many invasive plant species grows and spreads into native ecosystems, they have changed composition and structure of vegetation in ecosystem, results of invasion causes adverse effect on native plant community [1,2,3]. Globally four hundreds thirty four exotic species are identified so far, they changes vegetation structure in native ecosystem [4]. First reason of biodiversity declining due to anthropogenic activities and major changes in climate, and second most important factor responsible for biodiversity declining is invasion of exotic species, exotic species altered native habitat of resident species. Exotic species altered native habitat of resident's species [5,6,7].

A *P. juliflora* is a native plant species of arid and semi arid region of Central and South America, where it is most economically and ecological important species [8,9,10,11] and further introduced in some other countries including India [10,12]. *P. juliflora* was earlier introduced in arid and semiarid regions due to fast growing and having strong colonizing ability in adverse climatic condition. [12,10]. It is generally planted for the aim of excessive production of fuel wood, wood charcoal, fertilizer, pods as a fodder, obtaining gum and resin and flowers used in apicultural farming [13,14,15]. After some years it was studied appointed that it became threats for native vegetation and largely spread in forest and agricultural areas [16,17,18] cause habitat modification and alteration [19], by decreasing soil moisture and releasing allele-chemical substances in soil [20,8,21]. These substances inhibit growth of native floral species in *Prosopis juliflora* dominated landscape due to high regeneration capacity [17]. Birds are broadly distributed animal group, living in all continents of earth; they are generally colonized in the area which should be suitable for breeding habitat and availability of food resources, and safe from human disturbance. And Change among in vegetation structure due to habitat alteration by exotic species causes negative impact on bird's diversity, abundance and distribution in ecosystem [22]. Bird's richness and abundance indicate health of ecosystem [23,24,25]. However, no detail study has been made on *P. juliflora* and its effect on diversity and abundance of birds. Earlier study shows impact of exotic species on native vegetation structure, diversity and stability hypothesis [26] and the diversity invisibility hypothesis [27,28,29,30]. Birds are excellent bio-indicator and most prominent species on earth; they are very sensitive towards environment and habitat alteration [31,32]. They are tolerant towards habitats modification and show wide range of food choices [33]. Birds plays important role in ecosystem and play functional role as a pollinators, seed dispersal, scavengers, nutrient depositors, predator of insects and rodents [34,35,36].

2. OBJECTIVE OF STUDY

The main object of this study is to provide a detailed observation of effect of *P. juliflora* abundance on bird's community. This study also provide comparative details of bird's diversity and density according to abundance of native and (*P. juliflora)* exotic vegetation.

3. MATERIALS AND METHODS

The birds studies were conducted according to abundance of *P. juliflora* and native vegetation by using quadrate method based on long term observation (August, 2017 to February, 2020). The birds were recorded on a monthly basis using direct identification, binocular, and camera Nikon P900, Canon D-60D, Sigma 150-500 lens use for data collection during four hours of a day 7.00am-9.00am and 5.00pm-7.00pm of each quadrates and same quadrates used throughout study period.

Point count method generally used for to estimate or calculate bird's diversity & abundance and to study between different major & minor habitats [37,38]. The study was based on abundance of *P. juliflora* in each quadrates, quadrates were divided into following types on the basis of abundance of *Prosopis juliflora*-very low abundance (VLAPJ), low abundance (LAPJ), medium (MAPJ) and high abundance (HALPJ) of *Prosopis juliflora* in each quadrates, size of each quadrates was approximate 200 feet wide and 200 feet in length. Identification of birds was done by using standard identification book of Indian birds of subcontinent and Birds of Rajasthan [39,40].

4. CHARACTRISTICS OF STUDY AREA

The study was conduct through quadrate methods on the basis of the abundance of *P. juliflora* and native flora in Udaipur district. Total four quadrates used for these studies. Quadrates area divided on the basis of the density and abundance of *P. juliflora*, size of quadrates were approximately 200 feet X 200 feet. Quadrates were randomly selected in *P. juliflora* dominated area in Udaipur district.

A. **0-5% (Very low abundance of *Prosopis juliflora*) (VLAPJ)-** These quadrates having almost less than five percent *P. juliflora* plants in each quadrates and reaming plant species are native generally found in southern Rajasthan.
B. **20-30% (Low abundance of *Prosopis juliflora*) (LAPJ)-** Each quadrates have approximate maximum thirty percentage area of quadrates occupied by *P. juliflora* and remaining vegetations are native species.
C. **40-60% (Medium abundance of *Prosopis juliflora*) (MAPJ)-** Each quadrates having approximate fifty percent abundance of *P. juliflora* and same abundance of native tree species.
D. **90-100% (High abundance of *Prosopis juliflora*) (HAPJ)-** In these quadrates almost all area occupied by *P. juliflora* plant species and less than one to two percentage of trees are a native species.

5. DIVERSITY INDEXES

Alpha and beta diversity indexes calculated through SPSS & PAST software and following formula were used to calculated butterflies diversity, species richness, abundance and evenness.

1. **Dominance (D) -** Dominance index generally used to find out species richness and evenness in the various study sites or habitats. Dominance index measure the diversity of any two individuals in community, they are belonging to same species/ taxas. Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely).

$$\mathbf{D} = \Sigma\left(\frac{n}{N}\right)^2$$

Where n = the total number of individual of each species, N = the total number of individuals of all species occur in habitat.

The first nonparametric measure of diversity was proposed by Simpson [41]. Simpson suggested that diversity was inversely related to the probability that two individuals picked at random belong to the same species.

2. **Simpson's index of diversity (1-D) -** Simpson's index of diversity is calculated via 1- D (Dominance). They are generally using for biodiversity measuring in study area.

Simpson's diversity index = 1- D

Where D= Dominance

3. **Shannon index –** The index used for the comparison of two or more study area or sites in the biological community.

$$\mathbf{Hs} = \sum_{i=1}^{S} \mathbf{Pi}\,ln\,\mathbf{Pi}$$

Where $P_{i=}$ i is the proportion of individuals found in the i^{th} species and it represent in natural logarithm.

4. **Brillouin index-** The index is used for the calculates reflect species abundance in study area. It is put in more importance of species richness and it is moderately sensitive to sample size. Brillouin diversity index used in all conditions, where sampling is a non random or the well planned structure of community. Brillouin and Shannon indices give similar comparative measurement and proposed by Pielou [42].

$$\mathbf{H_B} = \frac{\ln(N!) - \Sigma \ln(ni!)}{N}$$

Where N = Total number of individuals in the community, ni = The number of individuals in the i^{th} species

5. **Menhinick's richness index** - The ratio of the number of taxa/ species to the square root of sample size.

$$\mathbf{Dmn} = \frac{S}{\sqrt{N}}$$

Where N = Total number of individuals in sample size, S= Number of species in sample

6. **Margalef's richness index:**

$$\mathbf{Margalef's\ Richness\ index} = \frac{(S-1)}{\ln(n)}$$

Where *S* = the number of taxa/ species, n = the number of individuals.

7. **Equitability J-** Shannon diversity divided by the logarithm of number of taxa. This measures the evenness with which individuals are divided among the taxa present. This indices used for a calculated of equitability comparison of the Shanon-Weiner index and used for against the distribution of individuals between the observed species, they are widely distributed.

$$\mathbf{J} = \frac{H}{Log(S)}$$

Where S= Total number of species in sample size, H= Shanon-weiner index

8. **Fisher's alpha** –This is a parametric index of diversity that conclude that the abundance of species in log series distribution and this index given by Kempton and Tylor, Hayek [43] and Buzas [44].

Fisher's alpha –ax, $ax^2/2$, $ax^3/3$ ……ax^n/n

Where – each term represent number of species predicted to have 1, 2, 3, n = number of individuals in a sample

9. **Chao-1-** This index uses for the estimate of species richness in different habitat or area, proposed by Chao [45].

$$\hat{S}max = S_{obs} + (a^2/2b)$$

Where $S_{obs=}$ Actual number of species present in sample, a = Number of species represented by a single individuals, b= Number of species represented by two individuals.

Beta diversity indices- Beta diversity calculates the species diversity with transects and it is mainly applicable on the analysis of environmental gradients. It is calculated throughout two different variables, the number of selective habitats within a region and the replacement of species by another disconnected part of same habitat. It is assumed that the samples are organized in the data grid in their order of occurrence along the transects. The six indices calculated which are described and designed by Wilson and Schmida [46].

1. **Whittaker,s beta diversity indices** [47,48,49]

$$\beta w = (S/\alpha) - 1$$

Where S= the total number of species recorded in study area, α = Average of species richness of the sample

2. **Cody's beta diversity indices** [50]

$$\beta c = g(H) + I(H)/2$$

Where g (H) = Number of species recorded in study area, I (H) = the number of species absent along transect

3. **Rout ledge's beta diversity indices** [51,46]

$$B_{R=} \frac{S^2}{2r+S} - 1$$

Where S= Total species number recorded in transect in study area, r= the number of species pairs with overlapping distributions:

$$\beta_{I=} \log(T) - [(\tfrac{1}{T})\Sigma ei \log(ei)] - [(\tfrac{1}{T})\Sigma \alpha_i \log(\alpha_i)]$$

$e_{i=}$ The number of samples along the transect in which species i is present
$\alpha_{i=}$ Species richness of sample i
$T = \Sigma e_i$

$$B_{T=} \exp(\beta_1)^{-1}$$

4. **Wilson and Schmida's beta diversity index** [46].

$$B_{T=} \frac{[g(H)+I(H)]}{2a}$$

Where βc= Cody's indices, βw= Whittaker's indices

Based on an judgment of the important valuable of a useful indices, ability to estimate change, additive, independence of sample size; are given by Wilson and Schmida [46] manage that βw was best in calculation. Schmida and Wilson's own measure 'T' came a closed second in that study.

5. **Mourelle indices** [52]

$$B_{me=} \frac{g(H)+1(H)}{2a(N-1)}$$

Principle component analysis (PCA) was to assessed to evaluate the similarity and dissimilarity between groups, p value less than 0.05 is considered as a statically significant and value exceed more than 0.05 considered statically non significant.

6. RESULTS

Species richness is mainly used to calculate the diversity of a biotic community and it is helpful in monitoring of many biological species in animal and plant taxa [53,54,55]. Species diversity, abundance and richness of birds depend upon the availability of food resources and vary with the landscape across geographical areas [54,55]. The species richness and relative abundance of birds species mainly depends upon availability & abundance of food materials, presence or absence of roosting and nesting sites [56], variation in habitats are also responsible for changes among abundance and diversity in birds communities [57,58]. We found that area where very low abundance (VLAPJ) of *Prosopis juliflora* in vasion there would be negligible effects on bird species diversity and its abundance. As density of *Prosopis juliflora* increased that would negatively affects bird's

species richness and abundance. Species richness and abundance of bird's were observed in various quadrates designed during study period, quadrates were categorized on the basis of abundance of *Prosopis juliflora* as comparisons to native vegetation. Study were subdivided into four quadrates namely – Very low abundance of *P. juliflora* (VLAPJ), Low abundance of *P. juliflora* (LAPJ), Medium abundance of *P. juliflora* (MAPJ) and high abundance of *P. juliflora* (HAPJ). Maximum birds diversity was recorded in (VLAPJ= 95 species) followed by (LAPJ= 72 species), (MAPJ= 59 species) and minimum birds species recorded in (HAPJ= 40 species) (Table 1).

Species dominance was calculated through dominance index (D); Maximum dominance was recorded in VLAPJ (0.03009) followed by LAPJ (0.0378), MAPJ (0.04193) and minimum species dominance observed in HAPJ (0.04439) areas.

Alpha diversity of different areas (quadrates) were calculated from Simpson and Shannon diversity indexes; maximum species diversity were observed in VLAPJ (Simpson= 0.9699, Shannon = 3.872) followed by LAPJ (Simpson= 0.9622, Shannon= 3.641), MAPJ (Simpson = 0.9581, Shannon= 3.498) and minimum diversity recorded in high abundance of *P. juliflora* area (HALP) (Simpson= 0.9556, Shannon= 3.34).

Species abundance of various quadrates were calculated through- Brilluion and Fisher_ alpha abundance indices; maximum abundance of birds was recorded in VLAPJ (Brillouin=3.834, fisher_ alpha= 15.85) followed by LAPJ (Brillouin= 3.595, fisher_ alpha=12.61), MAPJ (Brillouin = 3.45, fisher_alpha = 10.38) and minimum birds abundance of birds recorded in HAPJ (Brillouin= 3.277; fisher_ alpha= 7.541). birds richness of various quadrates were calculated through using Menhinick's, Margalf's and Chao-1 species richness indices; maximum birds richness was observed in VLAPJ (Manhinick's= 1.193, Margalf's = 10.74, Chao-1= 95.6) followed by LAPJ (Manhinick's = 1.168, Margalf's= 8.614, Chao-1= 72.25), MAPJ (Manhinick's = 1.069, Margalf's = 7.231, Chao-1= 60) and minimum species richness were observed in HAPJ (Manhinick's= 1.029, Margalf's= 5.328, Chao-1= 40). Evenness of study area were recorded through Equitability-J indices; species evenness of VLAPJ (Equitability-J = 0.8503) followed by LAPJ (Equitability- J= 0.8514), MAPJ (Equitability-J = 0.8578) and HAPJ (0.9055) recorded. All alpha diversity indices- species richness, abundance, evenness and dominance indices represent in Table 2.

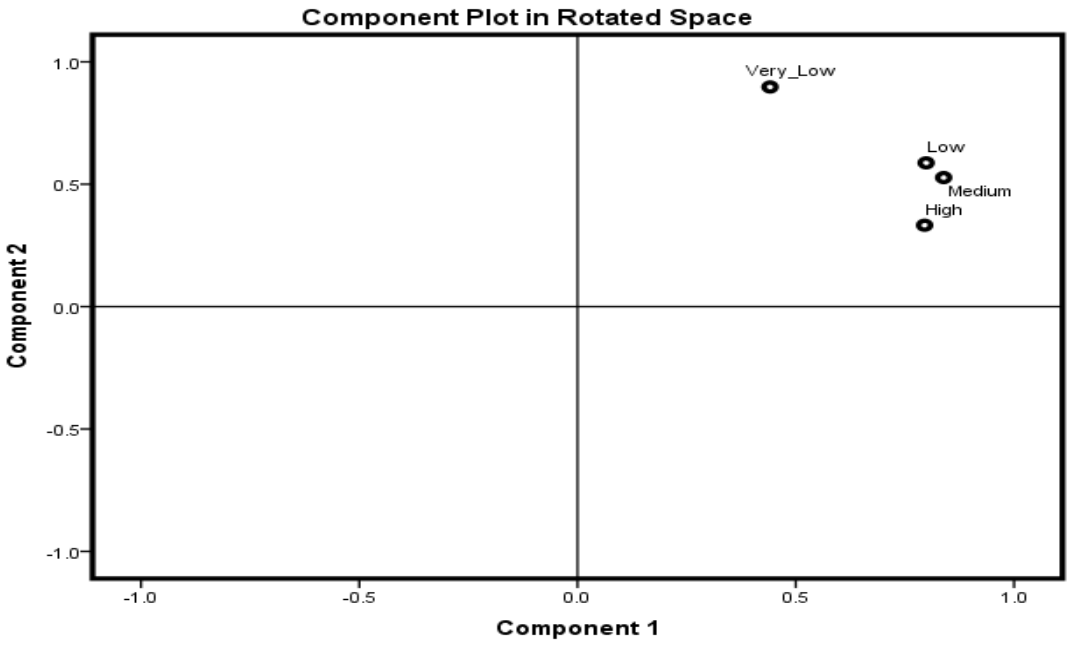

Fig. 1. Principle component analysis (PCA) in rotated space represent abundance of *Prosopis juliflora* along birds

Table 1. Birds species recorded in different quadrates (VLAPJ-Very low abundance of *Prosopis juliflora*, LAPJ- Low abundance of *Prosopis juliflora*, MAPJ- Medium abundance of *Prosopis juliflora*, HAPJ- High abundance of *Prosopis juliflora*) of study area, Udaipur district

Sr. no	Common name	Scientific Name	VLAP	LAPJ	MAPJ	HAPJ
1	Ashy prinia	*Prinia socialis stewarti*	+	+	+	+
2	Ashy-crowned Sparrow-Lark	*Eremopterix griseus*	+	-	-	-
3	Asian Koel	*Eudynamys scolopaceus scolopaceus*	+	+	+	+
4	Asian paradise-Flycatcher	*Terpsiphone paradisi*	+	-	-	-
5	Asian pied Starling	*Gracupica contracontra*	+	+	+	+
6	Bank Myna	*Acridotheres ginginianus*	+	+	-	-
7	Bay bake shrike	*Lanius vittatus nargianus*	+	+	+	+
8	Baya Weaver	*Ploceus philippinus philippinus*	+	+	+	+
9	Black drongo	*Dicrurus macrocercus minor*	+	+	+	+
10	Black kite	*Milvus migrans govinda*	+	+	+	-
11	Black Redstart	*Phoenicurus ochruros rufiventris*	+	+	+	+
12	Black-headed Cuckooshrike	*Caracina melanoptera*	+	-	-	-
13	Black-headed white ibis	*Threskiornis melanocephalus*	+	+	+	-
14	Black-winged kite	*Elanus caeruleus*	+	+	+	-
15	Blue Rock Thrush	*Monticola solitarius*	+	-	-	-
16	Blue throat	*Luscinia svecicaab boti*	+	+	+	+
17	Brahmin Starling	*Sturnus pagodarum*	+	+	+	+
18	Brown Rock Chat	*Cercomela fusca*	+	+	+	+
19	Cattle Egret	*Egretta garzetta garzetta*	+	+	+	+
20	Citrine wagtail	*Motacilla citreola*	+	+	+	+
21	Common Babbler	*Turdoides caudate*	+	+	+	+
22	Common chiffchaff	*Phylloscopus collybita*	+	+	+	+
23	Common Hoopoe	*Upupa epops*	+	+	+	+
24	Common iora	*Aegithina tiphia deignani*	+	+	+	+
25	Common Kestrel	*Falco tinnuculus*	+	-	-	-
26	Common kingfisher	*Alcedo atthis*	+	+	+	-
27	Common Myna	*Acridotheres tristi*	+	+	+	+
28	Common rose finch	*Carpodacus erythrinus erythrinus*	+	+	-	-
29	Common wood shrike	*Tephrodornis pondicerianus*	+	+	+	-
30	Coppersmith Barbet	*Megalaima haemacephala indicus*	+	+	-	-
31	Crested Serpent-Eagle	*Spilornis cheela*	+	-	-	-

Sr. no	Common name	Scientific Name	VLAP	LAPJ	MAPJ	HAPJ
32	Egyptian vulture	*Neophron percnopterus percnopterus*	+	+	+	-
33	Eurasian collared Dove	*Streptopelia decaocto decaocto*	+	+	+	+
34	Eurasian Griffon	*Gyps fulvus*	+	+	-	-
35	Eurasian wire neck	*Jynx torquilla torquilla*	+	-	-	-
36	European Roller	*Coracias garrulus*	+	+	+	-
37	Glossy ibis	*Plegadis falcinellus*	+	+	+	-
38	Great Cormorant	*Phalacrocorax carbo*	+	-	-	-
39	Great egret	*Egretta alba alba*	+	+	+	-
40	Greater cukaal	*Centropus sinensis sinensis*	+	+	+	+
41	Green Bee-eater	*Merops orientalis*	+	+	+	+
42	Grey Francolin	*Francolinus pondicerianus*	+	+	-	-
43	Grey Wagtail	*Motacilla cinerea*	+	+	+	-
44	Grey-headed Canary-Flycatcher	*Culicicapa ceylonensis*	+	-	-	-
45	House crow	*Corvus splendens splendens*	+	+	+	+
46	House sparrow	*Passer domesticus indicus*	+	+	+	+
47	Golden Oriole	*Orioluskundoo*	+	-	-	-
48	Indian Grey hornbill	*Ocyceros birostris*	+	+	-	-
49	Indian Peafowl	*Pavo cristatus*	+	+	+	-
50	Indian Pita	*Pitta brachyura*	+	-	-	-
51	Indian pond heron	*Ardeola grayii*	+	+	+	+
52	Indian Robin	*Saxicoloides fulicatus cambaiensi*	+	+	+	+
53	Indian Roller	*Coracias benghalensis*	+	+	-	-
54	Indian silverbill	*Spermestes fringilloides*	+	+	+	+
55	Intermediate egret	*Egretta intermedia*	+	+	-	-
56	Jungle Babbler	*Turdoides malcokm*	+	+	+	+
57	Jungle crow	*Corvus macrorhynchos*	+	+	+	-
58	Laughing Dove	*Streptopelia senegalensis cambayensis*	+	+	+	+
59	Lesser Golden-Backed Woodpecker	*Dinopioum benghalense*	+	-	-	-
60	Little Cormorant	*Phalacrocoraxniger*	+	-	-	-
61	Indian vulture	*Gyps indicus*	+	+	-	-
62	Oriental magpie-robin	*Copsychus saularis saularis*	+	+	+	+
63	Oriental white eye	*Zosteropus palpebrosa*	+	+	+	-
64	PaddyfieldPipit	*Anthus rufulus waitei*	+	+	+	-
65	Painted Stork	*Mycteria leucocephala*	+	-	-	-

Sr. no	Common name	Scientific Name	VLAP	LAPJ	MAPJ	HAPJ
66	Pied kingfisher	*Ceryle rudis leucomelanurus*	+	+	-	-
67	Plan Prinia	*Prinia inornata inornata*	+	+	+	+
68	Plum-Headed Parakeet	*Psittacula cyanocephala*	+	-	-	-
69	Purple Sunbird	*Nectarinia asiaticus asiaticus*	+	+	+	+
70	Red breasted flycatcher	*Ficedula subrubra*	+	-	-	-
71	Red Collared Dove	*Sterptopelia tranquebarica*	+	+	+	+
72	Red Munia	*Amandava amandava*	+	+	+	-
73	Red-napped Black ibis	*Pseudibis papillosa*	+	-	-	-
74	Red-vented bulbul	*Pycnonotus cafer*	+	+	+	+
75	Red-wetted lapwing	*Vanellus indicus indicus*	+	+	+	+
76	Rock pigeon	*Columba livia intermedia*	+	+	-	-
77	Rose-ring parakeet	*Psittacula krameri parvirosnis*	+	+	+	+
78	Rosy Starling	*Sturnus roseus*	+	+	+	-
79	Ruffoustree pie	*Dendrocitta vagabunda*	+	+	+	+
80	Shikra	*Accipiter badius*	+	+	+	-
81	Siberian stone chat	*Saxicola maurus maurus*	+	+	+	+
82	Small minivet	*Pericrocotu sethologus*	+	-	-	-
83	Spotted Dove	*Streptopelia chinensis chinensis*	+	+	+	+
84	Spotted Owlet	*Athene brama*	+	+	-	-
85	Tick ell's Blue-Flycatcher	*Cyornis tickelliae tickelliae*	+	-	-	-
86	Tree pipit	*Anthus trivialis haringtoni*	+	+	-	-
87	Veriditer Flycatcher	*Eumyias thalassinus thalassinus*	+	-	-	-
88	White browned fantail	*Rhipidura aureola compressirostris*	+	+	+	+
89	White napped tit	*Parus nuchalis*	+	+	+	-
90	White-necked Stork	*Ciconia espiscopus*	+	-	-	-
91	White-throated kingfisher	*Halcyon smyrnensis smyrnensis*	+	+	+	-
92	Wire-tailed swallow	*Hirundo smithii*	+	+	+	+
93	Yellow footed green pigeon	*Treron phoenicopterus*	+	-	-	-
94	Yellow Wagtail	*Motacilla flava*	+	-	-	-
95	Yellow-Throated Sparrow	*Petronia xanthocollis*	+	-	-	-

Note- VLAP- Very low abundance of Prosopis juliflora, LAPJ- Low abundance of Prosopis juliflora, MAPJ- Medium abundance of Prosopis juliflora, HAPJ- High abundance of Prosopis juliflora, + = Bird species present , - = Bird species absent

Table 2. Alpha diversity indices of different quadrates based on the abundance of *Prosopis juliflora*

Alpha diversity indices	**0-5% (Very low abundance of *Prosopis juliflora* plants)**	**20-30% (Low abundance of *Prosopi sjuliflora* plants)**	**40-60% (Medium abundance of *Prosopi sjuliflora* plants)**	**90-100% (High abundance of *Prosopis juliflora* plants)**
Dominance	0.03009	0.0378	0.04193	0.04439
Simpson_1-D	0.9699	0.9622	0.9581	0.9556
Shannon_H	3.872	3.641	3.498	3.34
Evenness_e^H/S	0.5057	0.5297	0.56	0.7057
Brillouin	3.834	3.595	3.45	3.277
Menhinick	1.193	1.168	1.069	1.029
Margalef	10.74	8.614	7.231	5.328
Equitability_J	0.8503	0.8514	0.8578	0.9055
Fisher_alpha	15.85	12.61	10.38	7.541
Chao-1	95.6	72.25	60	40

Table 3. Pair wise comparison for similarity and dis-similarity between different quadrates of *Prosopis juliflora*

Pair wise comparison	0-5 % (Very low)	20-30% (Low)	40-60%(Medium)	90-100% (High)
0-5 % (Very low)	0	0	0	0
20-30% (Low)	0.13772	0	0	0
40-60%(Medium)	0.23377	0.099237	0	0
90-100% (High)	0.40741	0.28571	0.19192	0

Beta diversity of study area was calculated through (Whittaker beta diversity= 0.42857, Cody beta diversity indices = 27.5 Routledge=0.88315, Wilson and Shmida diversity = 0.41353 and Mourelle= 0.13784). Pair wise comparison used for to determine similarity and dis-similarity pattern between different groups of *P. juliflora* abundance based with respect to birds. Pair wise comparison observed dissimilarity between all *P. juliflora* groups, value of dissimilarity between 0-5% (VLAPJ) with 20-30% (LAPJ) was a (0.13772) and continuously increase in 0-5% (VLAPJ) with 40-60% (MAPJ) (0.23377), 0-5% (VLAPJ) with 90-100% (HAPJ) (0.40741). Same pair wise dis-similar pattern was observed between 20-30% (LAPJ) with 40-60% (MAPJ) (0.0992377), 20-30% with 90-100% (HAPJ) value (0.19192) obtained (Table 3).

Principle component analysis (PCA) was evaluating the similarity and dissimilarity between groups, p value determines similarity and dissimilarity between groups. Less than 0.05 is considered statically significant and more than 0.05 is considered non significant. The PCA analysis was observed that high (HAPJ) and medium (MAPJ) abundance (more similar) pattern, it is resemble with low abundance (LAPJ) and dissimilar pattern observed in very low (VLAPJ) abundance *P. juliflora* dominant area (Fig. 1).

7. DISSUSION AND CONCULUSION

Variation among birds diversity and abundance are mainly depends upon ecological health of ecosystems [34,35]. In present, bird's diversity has been decline due to loss of habitat, alteration in habitat and invasion of exotic plant species and due to anthropogenic activities [59]. Habitat alteration create many negative impact on biodiversity such as direct mortality of birds, physiological stress, rapid population declined, retardation in normal and sexual behavior, segmentation of interbreeding population, change in species interaction and deforestation cause major threats of birds survival [60]. In similar manner *P. juliflora* becoming severe threats birds' survival. During studywe found that in villages and city old large trees were cut by villager for wood and fodders, cutting of trees destroy many birds' nests and heronry birds sites located on *P. juliflora*. In another important observation we found that species like – raptors (Vultures, owl, and eagle) are generally absent in highly abundant *P. juliflora* area. The study concluded that high *P. juliflora* abundance reduced bird species richness and abundance. While native plant having high bird species richness and abundance due to availability of wide varieties of food preference, when *P. juliflora* densities/abundance increase in quadrates they were negatively affecting birds diversity and abundance. Some furgivorous and insectivorous birds were generally observed in high abundance of *P. juliflora* areas.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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