Original Article

Population distribution and habitat analysis of Rufous treepie (*Dendrocitta vagabunda*) in Abbottabad, Pakistan

Distribuição da população e análise de habitat de Rufous treepie (*Dendrocitta vagabunda*) em Abbottabad, Paquistão

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Abstract

The Rufous treepie (*Dendrocitta vagabunda*) belongs to family corvidae, order Passeriformes which includes about 100 species. The current study was conducted to gather information about the Population distribution and habitat analysis of *D. vagabunda* at District Abbottabad, Pakistan. The data were collected on monthly basis both morning and evening times (2018-2019). "The ''Point count Method" was used for population estimation and ''Quadrates Method" for habitat analysis of study area. The result shows an average month-wise population density of *D. vagabunda* was maximum at Jhangra 0.14±0.039/ha, whereas minimum at Havelian 0.11±0.022/ha. There was no significant difference *(p>0.05)* among monthly population densities of *D. vagabunda,* however, a significant difference (*p<0.05*) was found between morning and evening times population of the specie. The present study revealed that importance value index (IVI) of plants species at Sherwan, Bakot, Havelian, Langra and Jhangra were 59.6±12.6, 50.1±6.9, 53.4±6.3, 66.8±10 and 60.1±7.7. Likewise, the frequency of shrubs at Sherwan, Bakot, Havelian, Langra and Jhangra were 33.3±4.2, 45±9.4, 46.7±8.2, 55.6±22.2 and 37.5±8.5. Similarly, the frequency of herbs at Sherwan, Bakot, Havelian, Langra and Jhangra were 40.4±6.0, 37.5±5.6, 53.3±7.4, 48.5±5.2 and 46.9±7.4 respectively. Our results show the study area as suitable habitat for *D. vagabunda*.

Keywords: population, quadrate method, habitat analysis, Abbottabad, *Dendrocitta vagabunda*.

Resumo

A trepadeira Rufous (*Dendrocitta vagabunda*) pertence à família corvidae, ordem Passeriformes que inclui cerca de 100 espécies. O estudo atual foi realizado para reunir informações sobre a distribuição da população e análise do habitat de *D. vagabunda* no distrito de Abbottabad, Paquistão. Os dados foram coletados mensalmente pela manhã e à noite (2018-2019). O "método de contagem de pontos" foi usado para estimativa da população e o "método dos quadrados" para análise de habitat da área de estudo. O resultado mostra que uma densidade populacional média mensal de *D. vagabunda* foi máxima em Jhangra 0,14 ± 0,039 / ha, enquanto a mínima em Havelian 0,11 ± 0,022/ha. Não houve diferença significativa (p> 0,05) entre as densidades populacionais mensais de *D. vagabunda*, entretanto foi encontrada diferença significativa (p <0,05) entre os períodos matutino e noturno da população da espécie. O presente estudo revelou que o índice de valor de importância (IVI) das espécies de plantas em Sherwan, Bakot, Havelian, Langra e Jhangra foi de: 59,6 ± 12,6, 50,1 ± 6,9, 53,4 ± 6,3, 66,8 ± 10 e 60,1 ± 7,7. Da mesma forma, a frequência de arbustos em Sherwan, Bakot, Havelian, Langra e Jhangra foi de: 33,3 ± 4,2, 45 ± 9,4, 46,7 ± 8,2, 55,6 ± 22,2 e 37,5 ± 8,5. Da mesma forma, a frequência de ervas em Sherwan, Bakot, Havelian, Langra e Jhangra foi: 40,4 ± 6,0, 37,5 ± 5,6, 53,3 ± 7,4, 48,5 ± 5,2 e 46,9 ± 7,4, respectivamente. Nossos resultados mostram a área de estudo como habitat adequado para *D. vagabunda*.

Palavras-chave: população, método dos quadrados, análise de habitat, Abbottabad, *Dendrocitta vagabunda*.

1. Introduction

Birds occupy a wide range of ecological positions (Sekercioglu, 2006; Mirza and Wasiq, 2012). Globally, Rufous treepie (*Dendrocitta vagabunda)* is distributed in Burma, India, Bangladesh, Bhutan, Cambodia, Myanmar, Nepal, Thailand, Vietnam and Pakistan (BirdLife International, 2013). The specie is widely distributed in whole of Punjab, Sindh, in South-eastern corner of Baluchistan including low hills of Azad Kashmir, Kohat and Peshawar valley and common in Islamabad, Margalla hills and Punjab and further spread towards Hazara (KP) (Mirza and Wasiq, 2012; Hornman, 2007; Jadoon et al., 2019; Ullah et al., 2020).

Density and abundance are the essential ecological information required for population ecology and scope of ecology covers distribution of organism and its abundance (Buckland et al., 2001; Stephens et al., 2019). *D. vagabunda* is fairly wide spreads throughout Indus plains and foot hills up to 2300m and prefers tree or bush cover and occupies altitudinal range of 1450-1700m in Bhowali, while its altitudinal range lies between 350-500m in Haldwani along with its status is recorded as residential species in Nainital district under conservation status of Indian wildlife protection Act (Grimmett et al., 2008; Joshi et al., 2012).

The *D. vagabunda* is arboreal bird of the teak forests, but seems at homes, in open scrub jungle, gardens, cultivated trees and scrub forest areas, not in desert without trees and prefers shrubby habitat (Sidhu et al., 2010; Mirza and Wasiq, 2012). The *D. vagabunda* occupied in whole of sub-tropical forest and tropical evergreen forest, and found abundant in all habitats, as a residential and winter visitor spp in Muzaffrabad city in Azad Jammu and Kashmir in Pakistan, also found in coniferous forest, mixed deciduous forests of scrubby areas in Chenani in lesser Himalayas in Jammu and Kashmir, India (Shahabuddin et al., 2006; Thakur et al., 2010; Singh et al., 2013).

2. Materials and Methods

2.1. Study area

The present study was conducted in District Abbottabad, positioned at an altitude of 1,225 meter, lies between 33° 50' and 34° 23' North latitude and 73° 35' and 73° 31' East longitude (Figure 1) with 1,967 km^2 area (Ali et al., 2017). Most of the area of District is comprised of mountainous topography and the average elevation of mountains ranges from 2500m to 2700m (IUCN Pakistan, 2004; Ullah et al., 2020). The aim of study was to determine the population density, distribution and habitat preference of *D. vagabunda* including Sherwan and Bakot (hilly areas), Havelian, Jhangra and Langra (plane areas) with the total area of 6942 hectares.

2.2. Methods

2.2.1. Population estimation

Field surveys were conducted (2018-2019). The "Point Count Method" was used in hilly area (Sherwan and Bakot) and plane area (Havelian, Langra and Jhangra). Preliminary surveys were conducted to allow covering a wider range of the potential habitats of *D. vagabunda*. In point count method "Vantage points" were selected of fixed radius (50 m^2) and duration of time (15 minutes) for population estimation both at morning and evening time (Rolando et al., 2007).
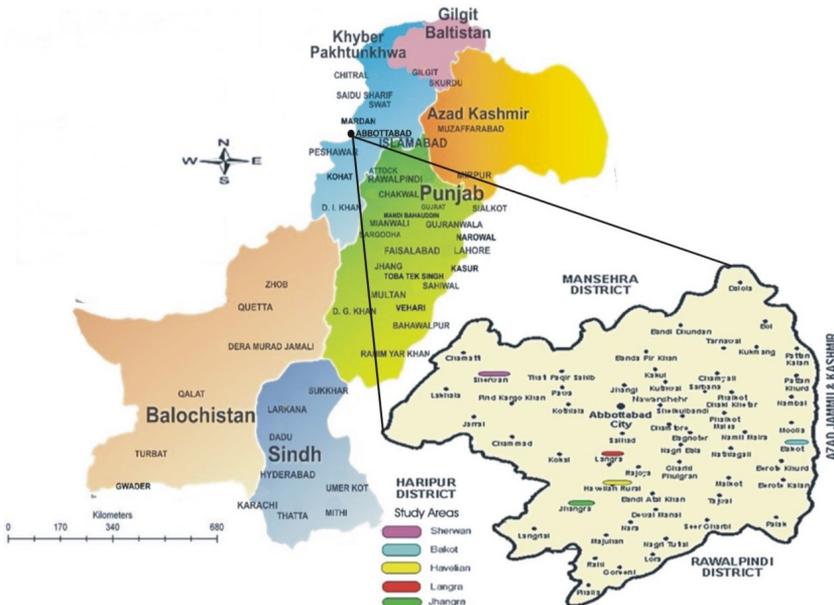

Figure 1. Map of the study area indicate District Abbottabad.

2.2.2. Estimation of population density

Population density estimation was carried through sighting observations to assess the accuracy of perpendicular measurement by Visual Encounter Method (VEM) (Ralph et al., 1995). Data recording was done by thoroughly surveys on monthly basis for the whole study period. The measurements were recorded on flushing the bird (Buckland et al., 2008).

Population density of *D. vagabunda* is represented by Formula 1.

$$Density = \frac{\text{Number of birds}}{\eth \, r^2} \qquad (1)$$

where, r = radius of circle = 50 m².

$$Total\ population\ =\ No\ of\ D.\ vagabunda\ in\ all\ sites\ \times \qquad (2)$$
$$Total\ area\ of\ study\ sites$$

2.3. Habitat analysis

In order to analyze the preferred habitat used by *D. vagabunda*, all major plant species were collected, identified and preserved in the form of herbarium sheets. Vegetation sampling was carried out by using "Quadrates Method" as described by (Sigdel, 2008). Among the vegetation, trees were examined by using quadrates of (10 × 10m), shrubs (5 × 5m) and herbs (1 × 1m) (Ali et al., 2018).

2.3.1. Vegetation analysis

The collected data were used to calculate species richness, density, relative density, frequency and relative frequency of trees, shrubs and herbs in the study area by using the following Formulas 3 to 7.

$$\text{Density of species} = \frac{\text{Total number of individuals of species A}}{\text{Total number of areas surveyed} \times \text{Area of plot}} \qquad (3)$$

$$\text{Relative density of species} = \frac{\text{Total number of individuals of species A}}{\text{Total number of individuals of all species}} \qquad (4)$$

$$\text{Frequency of species} = \frac{\text{Number of plots in which species A occurs} \times 100}{\text{Total number of plot samples}} \qquad (5)$$

$$\text{Relative Frequency of species} = \frac{\text{Frequency value of species A} \times 100}{\text{Total frequency value of all species}} \qquad (6)$$

$$\text{Relative dominance of species} = \frac{\text{Total basal area of species A} \times 100}{\text{Total basal area of all species}} \qquad (7)$$

Importance Value Index (IVI) was calculated as Formula 8 (Aryal et al., 2010):

$$IVI\ =\ Relative\ density\ +\ Relative\ frequency\ + \qquad (8)$$
$$Relative\ dominance$$

2.4. Statistical analysis

Analysis of Variance (ANOVA) was applied for analysis of data regarding in different habitats for month-wise population densities of *D. vagabunda*. Student's paired "t-test" was applied for comparison between morning and evening time's population densities.

3. Results

3.1. Month-wise population estimation

Month-wise population density of *D. vagabunda* was estimated at five sites of the study area. Average month-wise population density of the *D. vagabunda* was maximum in Jhangra (0.14±0.039/ha) while minimum in Havelian (0.11±0.022/ha) (Table 1) (Figure 2).

3.2. Fluctuation of D. vagabunda population

The morning and evening population density of *D. vagabunda* was considerably higher during morning as compared to that in evening time and this trend was consistently observed during the entire study period. Population density of *D. vagabunda* during morning was greater 0.038±0.0039/ha, than that of evening time (0.032±0.0019/ha) in Sherwan. Similarly, its population density was maximum (0.031±0.0032/ha), at morning and minimum (0.028±0.0032/ha) at evening time in Bakot. The population density at morning and evening was 0.037±0.0042/ha and 0.036±0.0025/ha, in Havelian respectively. In Langra, the maximum population density was 0.042±0.0047/ha, at morning and higher 0.033±0.0054/ha, at evening time (Figure 3). The population density was found 0.037±0.0038/ha, during morning and (0.035±0.0026/ha) at evening in Jhangra (Table 2) (Figure 4).

3.3. Habitat analysis

The presence of abundant trees, shrubs and herbs are essential for the survival of *D. vagabunda* at any area. The importance value index for trees, frequencies of shrubs and herbs indicates the relative population of *D. vagabunda* might survive in this area.

The major tree species for *D. vagabunda* at Sherwan site having dominant IVI 95.14 of *Zanthoxylum armatum* with co-dominant IVI 126.85 was recorded for *Grewia optiva*, whereas minimum IVI was observed for *Melia azedarach* and *Morus alba* 31.68. Similarly, the frequency of shrubs 33.3±4.2 and herbs was 40.4±6.0 (Table 3, 4 and 5).

At Bakot, the dominant tree species having IVI 62.77 of *Ailanthus altissima* with co-dominant IVI was recorded for *Acacia modesta* 93.87, and minimum IVI was observed for *Melia azedarach* 31.26. Therefore the frequency of shrubs and herbs at this site was 45±9.4 and 37.5±5.6 respectively (Table 6, 7 and 8).

The dominant tree species at Havelian having IVI 82.17 of *Dalbergia sissoo* and co-dominant IVI was observed for *Broussonetia papyrifera* 82.29, while minimum IVI was recorded for *Melia azedarach* 41.04. Similarly, the frequency of shrubs 46.7±8.2 and ground cover was 53.3±7.4 (Table 9, 10 and 11).

At Langra, among tree species the dominant IVI 89.06 of *Ficus palmata* with co-dominant IVI was recorded for *Broussonetia papyrifera* 89.44, and minimum IVI was observed for *Morus alba* and *Eucalyptus camaldulensis* 44.46. The frequency of shrubs and herbs at this site was 55.6±22.2 and 48.5±5.2 (Table 12, 13 and 14).

The major tree species having dominant IVI 90.16 of *Olea ferruginea Royle* with co-dominant IVI was recorded for *Broussonetia papyrifera* 90.34, whereas minimum IVI was observed for *Ficus palmata* 30.04 in Jhangra. Similarly frequency of shrubs 37.5±8.5 and herbs was 46.9±7.4 respectively (Table 15, 16 and 17).
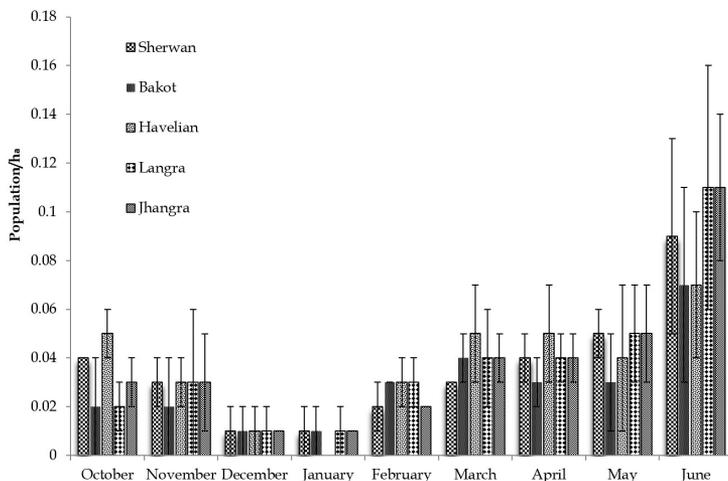
Figure 2. Overall month-wise population densities of *D. vagabunda* from five selected sites during the study period.

Figure 3. Snapshots of *D. vagabunda* captured during field survey of population estimation.
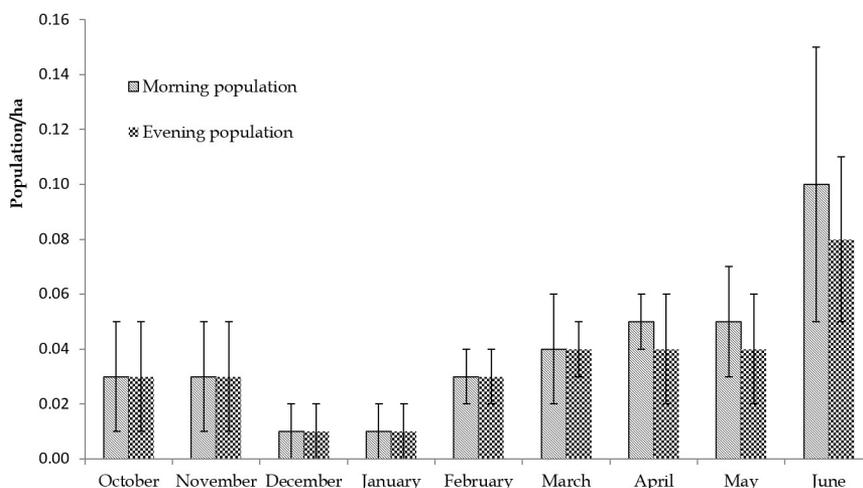

Figure 4. Overall morning and evening population densities/ha of *Dendrocitta vagabunda* during the study period in all selected study sites.

Table 1. Total month-wise Population density of *D. vagabunda* in selected sites of district Abbottabad.

Study sites	Area in ha	Population density/ha	Total population	P-value
Sherwan	1376	0.13±0.035	47	
Bakot	1422	0.13±0.029	51	
Havelian	1613	0.11±0.022	61	
Langra	1706	0.11±0.033	57	
Jhangra	825	0.14±0.039	31	
Total	**1388.40±342.78**	**0.12±0.031**	**247**	(***p>0.05***)

Table 2. Average Population Density of *D. vagabunda* at selected study sites at morning and evening time in District Abbottabad.

Tehsil	Study sites	Area in ha	Day Time	Population Density/ha	Total population	P (T<=t) one-tail	P (T<=t) two-tail
Abbottabad	**Sherwan**	1376	Morning time	0.038±0.0039	52		
			Evening time	0.032±0.0019	44		
	Bakot	1422	Morning time	0.031±0.0032	44		
			Evening time	0.028±0.0032	40		
Havelian	**Havelian**	1613	Morning time	0.037±0.0042	60		
			Evening time	0.036±0.0025	58		
	Langra	1706	Morning time	0.042±0.0047	72		
			Evening time	0.033±0.0054	56		
	Jhangra	825	Morning time	0.037±0.0038	31		
			Evening time	0.035±0.0026	29		
Total		**6942**			**486**		
Mean±S.D		1388.40±342.78	Morning time		51.80±15.56		
			Evening time		45.40±11.95		
						0.004449923	0.008899846

Total population = No of *D. vagabunda* in all transect × Total area of study sites. Total selected study area of Abbottabad = 6942 hectares. The average collective population at morning and evening times was estimated to be 486.

Table 3. Density, frequency and IVI of Trees species at Sherwan site in district Abbottabad.

Sr. No	Scientific Name	Density/ 10 m²	Relative Density	Frequency	Relative Frequency	Relative Dominance	IVI
1	*Celtis caucasica*	0.05	0.04	25	6.66	25	31.7
2	*Ficus palmate*	0.15	0.12	50	13.3	50	63.42
3	*Grewia optiva*	0.22	0.19	100	26.66	100	126.85
4	*Melia azedarach*	0.02	0.02	25	6.66	25	31.68
5	*Morus alba*	0.02	0.02	25	6.66	25	31.68
6	*Olea ferruginea Royle*	0.07	0.63	25	6.66	25	32.29
7	*Pinus roxburghii*	0.45	0.38	50	13.3	50	63.68
8	*Zanthoxylum armatum*	0.17	0.14	75	20	75	95.14
	Mean±S.E	**0.1±0.05**	**0.2±0.08**	**46.9±10**	**12.5±2.7**	**46.9±10**	**59.6±12.6**

S.E is a measure of the statistical accuracy of an estimate.

Table 4. Density and frequency of Shrubs species at Sherwan site in district Abbottabad.

Sr. No	Scientific Name	Density/ 5 m²	Relative Density	Frequency	Relative Frequency
9	*Barleria cristata*	0.2	0.04	25	7.69
10	*Berberis vulgaris*	0.3	0.07	25	7.69
11	*Elaeagnus umbellate*	0.05	0.01	25	7.69
12	*Daphne mucronata*	0.2	0.04	25	7.69
13	*Dicliptera clinopodia*	0.4	0.09	25	7.69
14	*Dodonaea viscosa*	0.2	0.04	50	15.38
15	*Malvastrum coromandelianm*	1.4	0.34	50	15.38
16	*Punica granatum*	0.5	0.12	25	15.38
17	*Rumex hastatus*	0.85	0.2	50	15.38
	Mean±S.E	**0.5±0.14**	**0.1±0.03**	**33.3±4.2**	**11.1±1.4**

Table 5. Density and frequency of Herbs species at Sherwan site in district Abbottabad.

Sr. No	Scientific Name	Density/ m²	Relative Density	Frequency	Relative Frequency
18	*Alternanthera pungens*	1.75	0.05	25	4.76
19	*Amaranthus spinosus*	1.25	0.03	25	4.76
20	*Clematis graveolens*	0.75	0.02	50	9.52
21	*Conyza canadensis*	2.5	0.07	25	4.76
22	*Dichanthium annulatum*	3.75	0.11	25	4.76
23	*Eleusine indica*	5.5	0.16	50	9.52
24	*Eragrostis curvula*	3.75	0.11	50	9.52
25	*Euphorbia hirta*	1.75	0.05	50	9.52
26	*Geranium dalmaticum*	4.5	0.13	100	19.04
27	*Oxalis corniculata*	3.25	0.09	50	9.52
28	*Pennisetum hohenackeri*	3	0.09	25	4.76
29	*Plantago lanceolata*	0.25	0.007	25	4.76
30	*Tagetes minuta*	1	0.03	25	4.76
	Mean±S.E	**2.5±0.44**	**0.1±0.01**	**40.4±6.0**	**7.7±1.1**

Table 6. Density, frequency and IVI of Trees species at Bakot site in district Abbottabad.

Sr. No	Scientific Name	Density/ 10 m²	Relative Density	Frequency	Relative Frequency	Relative Dominance	IVI
31	*Acacia modesta*	0.22	0.12	75	18.75	75	93.87
32	*Ailanthus altissima*	0.5	0.27	50	12.5	50	62.77
33	*Broussonetia papyrifera*	0.07	0.04	25	6.25	25	31.29
34	*Ficus palmate*	0.3	0.16	50	12.5	50	62.66
35	*Melia azedarach*	0.02	0.01	25	6.25	25	31.26
36	*Morus alba*	0.1	0.05	50	12.5	50	62.55
37	*Pinus roxburghii*	0.05	0.02	25	6.25	25	31.27
38	*Populus grandidentata Michx*	0.07	0.04	25	6.25	25	31.29
39	*Robinia pseudoacacia*	0.4	0.21	50	12.5	50	62.71
40	*Vitex pinnata*	0.07	0.04	25	6.25	25	31.29
	Mean±S.E	**0.2±0.05**	**0.1±0.03**	**40±5.5**	**10±1.4**	**40±5.5**	**50.1±6.9**

Table 7. Density and frequency of Shrubs species at Bakot site in district Abbottabad.

Sr. No	Scientific Name	Density/5 m²	Relative Density	Frequency	Relative Frequency
41	*Barleria cristata*	0.5	0.19	50	22.22
42	*Malvastrum coromandelianum*	1.05	0.4	75	33.33
43	*Dicliptera clinopodia*	0.25	0.09	25	11.11
44	*Solanum pseudocapsicum*	0.2	0.07	25	11.11
45	*Dodonaea viscosa*	0.6	0.23	50	22.22
	Mean±S.E	**0.5±0.15**	**0.2±0.06**	**45±9.4**	**20±4.2**

Table 8. Density and frequency of Herbs species at Bakot site in district Abbottabad.

Sr. No	Scientific Name	Density/ m²	Relative Density	Frequency	Relative Frequency
46	*Aristida purpurea*	2.25	0.08	25	6.66
47	*Mentha longifolia*	2.75	0.12	25	6.66
48	*Cannabis sativa*	3	0.11	25	6.66
49	*Conyza canadensis*	4.75	0.17	50	13.33
50	*Dichanthium annulatum*	1.5	0.05	25	6.66
51	*Digitaria ciliaris*	1.25	0.04	25	6.66
52	*Eragrostis curvula*	4.25	0.15	50	13.33
53	*Parthenium hysterophorus*	6	0.22	75	20
54	*Themeda anathera*	1	0.009	25	6.66
55	*Tagetes minuta*	3	0.02	50	13.33
	Mean±S.E	**3±0.51**	**0.1±0.02**	**37.5±5.6**	**10±1.5**

Table 9. Density, frequency and IVI of Trees species at Havelian site in district Abbottabad.

Sr. No	Scientific Name	Density/ 10 m²	Relative Density	Frequency	Relative Frequency	Relative Dominance	IVI
56	*Acacia modesta*	0.17	0.16	33.33	7.69	33.33	41.18
57	*Ailanthus altissima*	0.07	0.06	33.33	7.69	33.33	41.08
58	*Albizia procera* (Roxb) Benth	0.02	0.02	33.33	7.69	33.33	41.04
59	*Broussonetia papyrifera*	0.27	0.25	66.66	15.38	66.66	82.29
60	*Eucalyptus camaldulensis Dalbergia sissoo*	0.05	0.04	33.33	7.69	33.33	41.06
61	*Ficus palmate*	0.15	0.13	66.66	15.38	66.66	82.17
62	*Melia azedarach*	0.12	0.11	66.66	15.38	66.66	82.15
63	*Olea ferruginea Royle*	0.02	0.02	33.33	7.69	33.33	41.04
64	*Robinia pseudoacacia*	0.1	0.09	33.33	7.69	33.33	41.11
65		0.07	0.06	33.33	7.69	33.33	41.08
	Mean±S.E	**0.1±0.02**	**0.1±0.02**	**43.3±5.1**	**10±1.2**	**43.3±5.1**	**53.4±6.3**

Table 10. Density and frequency of Shrubs species at Havelian site in district Abbottabad.

Sr. No	Scientific Name	Density/ 5 m²	Relative Density	Frequency	Relative Frequency
66	*Dicliptera clinopodia*	0.46	0.15	33.33	14.28
67	*Malvastrum coromandelianum*	2.06	0.67	66.66	28.57
68	*Punica granatum*	0.13	0.04	33.33	14.28
69	*Rumex hastatus*	0.33	0.1	66.66	28.57
70	*Ziziphus lotus*	0.06	0.02	33.33	14.28
	Mean±S.E	**0.6±0.37**	**0.2±0.12**	**46.7±8.2**	**20±3.5**

Table 11. Density and frequency of Herbs species at Havelian site in district Abbottabad.

Sr. No	Scientific Name	Density/ m²	Relative Density	Frequency	Relative Frequency
71	*Achyranthes aspera lin*	0.33	0.006	33.33	6.24
72	*Alternanthera pungens*	3	0.05	33.33	6.24
73	*Cannabis sativa*	7.66	0.15	66.66	12.49
74	*Chenopodium ambrosioides*	2	0.03	33.33	6.24
75	*Cynodon dactylon*	9.66	0.18	66.66	12.49
76	*Ipomoea purpurea*	1	0.01	33.33	6.24
77	*Parthenium hysterophorus*	7	0.13	66.66	12.49
78	*Pennisetum hohenackeri*	6	0.11	33.33	6.24
79	*Oxalis corniculata*	7	0.13	66.66	12.49
80	*Rumex crispus*	7.33	0.14	100	18.75
	Mean±S.E	**5.1±1.02**	**0.1±0.02**	**53.3±7.4**	**10±1.4**

Table 12. Density, frequency and IVI of Trees species at Langra site in district Abbottabad.

Sr. No	Scientific Name	Density/ 10 m²	Relative Density	Frequency	Relative Frequency	Relative Dominance	IVI
81	*Broussonetia papyrifera*	0.7	0.56	66.66	22.22	66.66	89.44
82	*Dalbergia sissoo*	0.16	0.13	66.66	22.22	66.66	89.01
83	*Eucalyptus camaldulensis*	0.03	0.02	33.33	11.11	33.33	44.46
84	*Ficus palmate*	0.23	0.18	66.66	22.22	66.66	89.06
85	*Grewia optiva*	0.06	0.05	33.33	11.11	33.33	44.49
86	*Morus alba*	0.03	0.02	33.33	11.11	33.33	44.46
	Mean±S.E	**0.2±0.10**	**0.2±0.08**	**50±7.5**	**16.7±2.5**	**50±7.5**	**66.8±10**

Table 13. Density and frequency of Shrubs species at Langra site in district Abbottabad.

Sr. No	Scientific Name	Density/5 m²	Relative Density	Frequency	Relative Frequency
87	*Dicliptera clinopodia*	0.2	0.06	33.33	19.99
88	*Justicia adhatoda*	0.33	0.1	33.33	19.99
89	*Malvastrum coromandelianum*	2.66	0.83	100	60
	Mean±S.E	**1.1±0.80**	**0.3±0.25**	**55.6±22.2**	**33.3±13.3**

Table 14. Density and frequency of Herbs species at Langra site in district Abbottabad.

Sr. No	Scientific Name	Density/ m²	Relative Density	Frequency	Relative Frequency
90	*Achyranthes aspera linn*	1	0.025	33.33	6.25
91	*Amaranthus spinosus*	1	0.025	33.33	6.25
92	*Alternanthera pungens*	4.33	0.108	33.33	6.25
93	*Cannabis sativa*	2.66	0.066	66.66	12.5
94	*Chenopodium album*	0.66	0.016	33.33	6.25
95	*Cynodon dactylon*	7.5	0.225	66.66	12.5
96	*Dactyloctenium aegyptium*	4.66	0.116	33.33	6.25
97	*Eleusine indica*	3	0.075	33.33	6.25
98	*Oxalis corniculata*	6	0.15	66.66	12.5
99	*Parthenium hysterophorus*	3.33	0.083	66.66	12.5
100	*Rumex crispus*	4.33	0.108	66.66	12.5
	Mean±S.E	**3.5±0.65**	**0.1±0.02**	**48.5±5.2**	**9.1±1.0**

Table 15. Density, frequency and IVI of Trees species at Jhangra site in district Abbottabad.

Sr. No	Scientific Name	Density/ 10 m²	Relative Density	Frequency	Relative Frequency	Relative Dominance	IVI
101	*Acacia modesta*	0.17	0.1	75	15	75	90.1
102	*Ailanthus altissima*	0.07	0.04	50	10	50	60.04
103	*Broussonetia papyrifera*	0.57	0.34	75	15	75	90.34
104	*Dalbergia sissoo*	0.12	0.07	25	5	25	30.07
105	*Ficus palmata*	0.07	0.04	25	5	25	30.04
106	*Grewia optiva*	0.07	0.04	50	10	50	60.04
107	*Melia azedarach*	0.1	0.05	50	10	50	60.05
108	*Morus alba*	0.05	0.03	50	10	50	60.03
109	*Olea ferruginea Royle*	0.27	0.16	75	15	75	90.16
110	*Zanthoxylum armatum*	0.15	0.08	25	5	25	30.08
	Mean±S.E	0.2±0.05	0.1±0.03	50±6.45	10±1.29	50±6.45	60.1±7.7

Table 16. Density and frequency of Shrubs species at Jhangra site in district Abbottabad.

Sr. No	Scientific Name	Density/ 5 m²	Relative Density	Frequency	Relative Frequency
111	*Barleria cristata*	0.55	0.11	50	22.22
112	*Calotropis gigantean*	0.15	0.03	25	11.11
113	*Dicliptera clinopodia*	0.5	0.1	25	11.11
114	*Elaeagnus umbellate*	0.1	0.02	25	11.11
115	*Justicia adhatoda*	0.85	0.18	25	11.11
116	*Malvastrum coromandelianum*	2.55	0.54	75	33.33
	Mean±S.E	**0.8±0.37**	**0.2±0.08**	**37.5±8.5**	**16.7±3.8**

Table 17. Density and frequency of Herbs species at Jhangra site in district Abbottabad.

Sr. No	Scientific Name	Density/ m²	Relative Density	Frequency	Relative Frequency
117	*Cannabis sativa*	3.5	0.09	50	13.33
118	*Eragrostis curvula*	4.5	0.12	25	6.66
119	*Euphorbia hirta*	1.25	0.03	25	6.66
120	*Dichanthium annulatum*	9.25	0.26	50	13.33
121	*Oxalis corniculata*	8.75	0.24	75	20
122	*Parthenium hysterophorus*	5.25	0.14	75	20
124	*Rhynchosia minima*	0.25	0.007	25	6.66
125	*Rumex crispus*	2.5	0.07	50	13.33
	Mean±S.E	**4.4±1.16**	**0.1±0.03**	**46.9±7.4**	**12.5±2.0**

4. Discussion

The previous published literature shows that *D. vagabunda* is commonly found abundant in vegetation in sub-tropical forest and scrub areas in India as mentioned by Thakur et al. (2010), whereas Jayson and Mathew (2000) reported its abundance found in tropical evergreen forest in Kerala. Moreover, Mirza and Wasiq (2012) revealed habitat utilization of *D. vagabunda* in cultivated trees and scrub forest areas, not in desert without trees.

The present study investigated the population density of *D. vagabunda* from October 2018 to June 2019 at five study sites of the district Abbottabad. Our study agrees with Bashir et al. (2012), who reported the estimated population density of *D. vagabunda* (0.045±0.015) during bank searches of avian species in upper Ganges in India. Moreover, Palita et al. (2011) documented population density abundance of *D. vagabunda* (0.73 ± 0.96) at *Morus alba,* (0.53 ± 0.35) in *Ficus palmata,* (0.2 ± 0.41) in *Buddleja asiatica,* (0.13 ± 0.35) in *Phacelia crenulata,* (0.26 ± 0.45) in *Rubus ellipticus* and (0.9 ± 0.99) in *Pyrus communis* on fruit plants in summer fruiting season in Uttarakhand in India.

Similar results were reported earlier on by Saikia et al. (2014) for *D. vagabunda* 0.57 in dry season and 0.43 in wet season in North-East India, because the area is large as compared to our study area. However, Awan et al. (2009) also reported relative abundance of 0.010 *D. vagabunda* in Azad Jammu and Kashmir, Pakistan.

Chatterjee et al. (2014) reported density of *D. vagabunda* in Grasslands (0.00/ha), Swamp forests (0.00/ha), Riverine forests (1.04/ha), Miscellaneous plantations (1.56/ha), Forest edges (2.60/ha) and Wetlands (0.00/ha) in west Bengal India, because the area is large as compared to our study area. Whereas, Roy et al. (2012) reported the estimated population density of *D. vagabunda* in Gorumara National Park (4.9/ha), in Buxa Tiger Reserve (0.0/ha), and in Rasik Beel Wetland Complex (3.9/ha) in three different regions of North Bengal in India, because the area is too large as compared to our study area.

The present study is supported by Trivedi (2006), who reported the population density of *D. vagabunda* (1.93±0.86) in Gujarat in India. Similar results to the present study were obtained by Sidhu et al. (2010), where they also described average relative abundance of *D. vagabunda* in Forest (1.00), in Buffer (4.56) and in village (3.75) in Thattekad and in Forest (0.00), in Buffer (0.00) and in village (0.00) in Anamalai Hills in the Southern Western Ghats in India, because the area is large as compared to our study area.

No significant difference *(p>0.05)* was found among monthly *D. vagabunda* population densities/ha in hilly and plane areas through Analysis of Variance (ANOVA) (Table 1). However, Statistical analysis (t-test) indicates a significant difference *(p<0.05)* among population densities/ha between morning and evening time population.

5. Conclusion

The results of current study explain the wide distribution of Rufous treepie in District Abbottabad. At all selected sites the specie was not affected by the human population disturbance of nearby areas during study period, most probably because this bird belongs to family corvidae and is not hunted by locals, hence population is stable. Although habitat destruction is a major threat to population decline, however variety of vegetation is available for this bird species at all selected study sites, and as a result it prefers dominant IVI of trees 66.8±10 having population density 0.11±0.033 at Langra, whereas, minimum IVI of trees 50.1±6.9 with population density 0.13±0.029 at Bakot. Our results confirm that all selected hilly and plane study sites of Abbottabad were suitable habitat for *D. vagabunda.*

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