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Full Length Research Paper

Avian diversity and its association with vegetation structure in different elevational zones of Nainital district (Western Himalayan) of Uttarakhand

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Avian diversity was studied in the Nainital district of Uttarakhand, India at different elevations. A total of 174 bird species belonging to 38 families were identified along with the elevational zone of forest habitats. We sampled in different elevational forest habitats to understand the vegetation structure and its effect on avian community. Field studies were conducted during January 2006 to January 2008. Results illustrate that bird community value in terms of species richness (7.74) and species diversity (3.68) was higher at mid elevation (1450 to 1700 m asl). Avian species diversity and richness were positively correlated (r = 0.21, 0.78, 0.22, 0.95, 47, 92, 0.95 and 0.83) with the plant species diversity (BSD versus PSD, r = 0.95 and BSR versus PSD, r = 0.83) and foliage height diversity (BSR versus FHD, r = 0.78 and BSR versus FHD, r = 0.92). It is suggested that vegetation structure of the habitat seems to be one of the key features which influence the avian species at local level.

Key words: Avian diversity, vegetation association, elevation zone, Nainital district, bird species diversity.

INTRODUCTION

Biodiversity is not evenly distributed across the earth. It may be influenced by biogeography (Karr, 1976). Some landscape exhibit high richness in biological diversity whereas others show an impoverished flora and fauna. Mountain ecosystems are usually recognized as biodiversity hotspots harboring rich biota often with high number of endemic species. In these mountains decrease in species richness with increasing elevation is a widely recognized pattern (Begon et al., 1990). While, others suggest a unimodal relationship with a peak in species richness at low to mid elevations (Rahbek, 1995; Stotz et al., 1996; Stotz, 1998; Brown, 2001; Lomolino, 2001; Kattan and Franco, 2004: Gaston, 2004).

Generally, organisms do not respond directly to the elevational gradient as such, but to variables correlated with the gradient such as climate or productivity (Terborgh, 1977; Brown, 2001). In addition factors operating at multiple spatial and temporal scales may also influence species diversity. For example local climate, ecotones, competition, habitat structure and heterogeneity play a prominent role in determining species diversity at local level (Terborgh, 1977, 1985; Ricklefs and Schluter, 1993; Huston, 1999; Lomolino, 2001).

As elevation increases, the availability of resources for birds diminishes reflecting differences in forest stand structure, site productivity, vegetation composition, distribution pattern, secondary biotic interactions and available land area (Able and Noon, 1976; McCoy, 1990; Rahbek, 1995; Sabo, 1980; Hofer et al., 1999; Waterhouse et al., 2002). In fact avian community composition and diversity along elevational gradient has not received enough attention in India.

A few studies have, however, been conducted to look at avian diversity mainly in South Indian forests (Price, 1979; Joshua and Johnsing, 1986; Pramod et al., 1997;

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Kunte et al., 1999). Though many researchers tried to explain factors responsible for the species distribution along the elevations (Lee, 2004; Joshi, 2009; Bhatt and Joshi, 2011), however, almost nothing is known about the influence of factors, which vary with elevation (for example, forest structure) on bird species distribution. Some studies had established a close relationship between bird species diversity and vegetation (Terborgh, 1971, 1985; Able, 1976; Hawkins, 1999) and predict the species distribution along the elevation depend on vegetation.

In the present study, we made an attempt to compare the avian distribution and vegetation composition with the elevation as well as the study tried to understand the factors influencing distribution of avian species along the elevations.

MATERIALS AND METHODS

We selected three elevational sections of forest habitats across three study sites of Nainital district (Western Himalaya; 29° N 79° E): (A) Nainital (high elevation 1900 to 2450 m asl, 29° 24' 04"N, 79° 26' 38"E), (B) Bhowali (mid elevation 1450 to 1700 m asl, 29° 22' 38"N, 79° 31' 59"E) and (C) Haldwani (low elevation 350 to 500 m asl, 29° 13' 00"N, 79° 31' 00"E) along different elevational gradients (Figures 1a, b, c and 2 and Table 1).

Forest habitat consisted of oaks *Quercus leucotrichophora* and deodar *Cedrus deodara* (Nainital; high elevation), oaks *Q. leucotrichophora* and pines *Pinus roxburghii* (Bhowali; mid elevation) and sal *Shorea robust* and khair *Acacia catechu* (Haldwani; low elevation) (Saxena and Singh, 1982; Singh and Singh, 1992).

Field studies were conducted over two years from January 2006 to 2008. Field binoculars (7×50) were used to observe the birds and GPS (e-trex Vista) used to mark the location. Here, we adopted a transect method (Verner, 1985) whereas line transects allow the observer to cover a wider range while simultaneously recording (Buckland et al., 2001). We recorded all birds seen in a 50 m wide strip on each side of the transect, while walking. Transects were located randomly and transects were sufficiently separated (about 400 m) to avoid double counting of birds.

At each study area, three 1 km transects were used and each transect was visited monthly. The total number of transects was 18 (each transect was 5 km): 4 transects (forest habitat) × 3 study areas (Low mid and High). We visited each transect 12 times in the first year and were revisited 12 times in the following year. The time of sampling was between 07:30 to 10:30 during winter and 05:00 to 08:00 during summer. Sampling was avoided on rainy days. Identification of birds in the field was based on Grimmett et al. (1998).

To understand the bird-vegetation associations in different elevational zones, I did vegetation sampling in the forest habitat. The vegetation samples were collected along the line transects (5 km) of the study areas. Quadrates of 10 × 10 m size were laid to sample trees; 5 × 5 m was used for shrubs and 1 × 1 m for herb species into the tree sample site (Mumby et al., 1997; Hudon, 1997; Fernandez-Alaez et al., 2002).

Twenty quadrates were laid in each transect line with 50 m intervals and the mean value was used for analysis (Daniels, 1991). Canopy cover was measured walking on the 1000 m strip and scoring the foliage overhead as 0 when there is none, 1 when adjacent crowns barely meet; 2 when they overlap; 3 when sky is no longer visible. This was done at 50 m intervals and obtains a total of 20 points scores. Foliage height was measured directly in meters. Twenty readings were taken in each habitat and the average was used for analysis (Greig-Smith, 1983).

We pooled the data across years for the assessment of bird species richness (BSR) and bird species diversity (BSD). Maximum detection was taken to the assessment of number of species. The mean value of individuals of each species was used to calculate the number of individuals and the average of monthly mean abundance of both years was accounted for abundance of the species. This value was then used to measure BSD and BSR. The mean value for individuals was also used to statistically compare abundance of species between habitats.

BSD and BSR were measured using Shannon's index (H`) and Margalef's index, respectively (MacArthur and MacArthur, 1961, Magurran, 1988). To know the similarity among species composition at different elevations, Sorensen's quantitative index (Magurran, 1988) was used. Beta diversity ($\beta = S/\acute{\alpha}$) value was obtained between micro forest habitats of each study area (low, mid and high elevation) to know extent of variation among the study area. Pearson's correlations coefficient (r) and ANOVA test (Zar,1984)were used for analysis of bird – vegetation relationship and species distribution among the sites.

RESULTS

A diverse population of birds has been identified in the Nainital district at different elevations either as breeding populations, wintering, and summer visitors or during migration. A total of 174 bird species belonging to 38 families were reported in the forest habitats of Nainital region (See Appendix). It was noted that Muscicapidae (27.01%) followed by Picidae (9.19%), Corvidae (5.17%) and Accipitridae (4.59%) were the most dominant families among the study sites.

Muscicapidae emerged as the most dominant family with 47 species. Out of 174 species, 18 species were found exclusively in site A (Nainital, 1900 to 2450 m asl), 38 species were found exclusive to site B (Bhowali, 1450 to 1700 m asl) and 25 species were found exclusively in site C (Haldwani, 350 to 500 m asl). The most dominant exclusive species in among the forest habitat were large billed crow (*Corvus macrorhynchos*), Himalayan bulbul (*Pycnonotus leucogenys*) and Jungle babbler (*Turdoides striatus*), respectively.

The site B (Bhowali) at 1450 to 1700 m asl (mid elevation) had more complex bird community structure in terms of higher species richness and species diversity (Table 2). Analysis shows that a significantly higher BSR (Anova single factor: $F2 = 7.07$, $P < 0.002$) and BSD ($F2 = 3.28$, $P < 0.01$) were observed at mid elevations (Bhowali) than low (Haldwani) and high elevations (Nainital).

A comparison of bird communities among the elevational zone of forest habitats revealed that high beta diversity values in elevation zone (0.58 high, 0.38 mid and 0.48 low elevation zone) showing the greater variation in species composition among the elevational zone (Table 3). However, bird communities were compared among forest habitats high beta diversity values were observed between high and low elevation forest habitats.

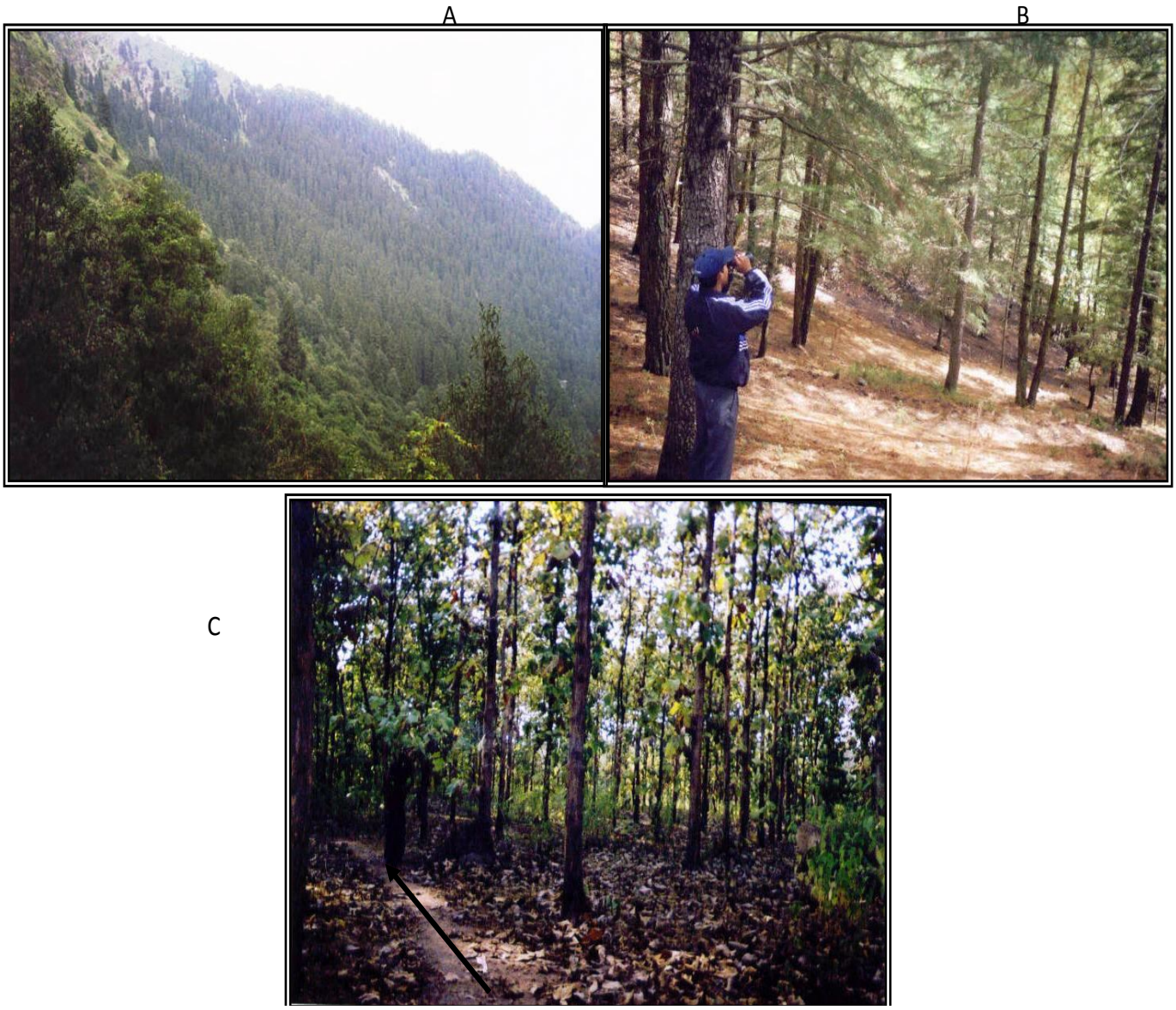

Figure 1. A: Showing site A, Nainital forest (elevation 1900 to 2450 m asl). B: Showing site B, Bhowali forest (elevation 1450 to 1700 m asl). A: Showing site C, Haldwani (low elevation 350 to 500 m asl.

The vegetation structure that is, mean canopy cover, trees density, foliage height density and plant species diversity [Canopy Cover (CC), Tree density (TD), Foliage height density (FHD) and Plant species diversity (PSD)] in different elevation zones, were high at site B forest (Table 2). The correlation between avian diversity parameters and vegetation structure revealed that BSR and BSD are significantly positively correlated with the vegetation foliage height density (FHD, r^2 = 0.92; r^2 = 0.60), plant species diversity (PSD, r^2 = 0.95; r^2 = 0.90), tree density (TD, r^2 = 0.95; r^2 = 0.04) and canopy cover (CC, r^2 = 0.22; r^2 = 0.04) (Table 4).

Among all the parameters of vegetation the plant species diversity (PSD) and foliage height density (FSD) was significantly high (ANOVA single factor: PSD, $F2$ = 2.24, P < 0.01; FHD, $F2$ = 2.42, P < 0.01) at mid elevational zone. However, the abundance, bird species richness and bird species diversity was highest (106) at the site B (Pine mixed forest) followed by the site C (95, Sal forest) and site A (88, Deodar) forest habitat.

DISCUSSION

ANOVA test separately carried out among the bird communities of the forest habitats and plant species diversity of the study sites revealed that mid elevation zone forest had higher birds species diversity (BSD), bird

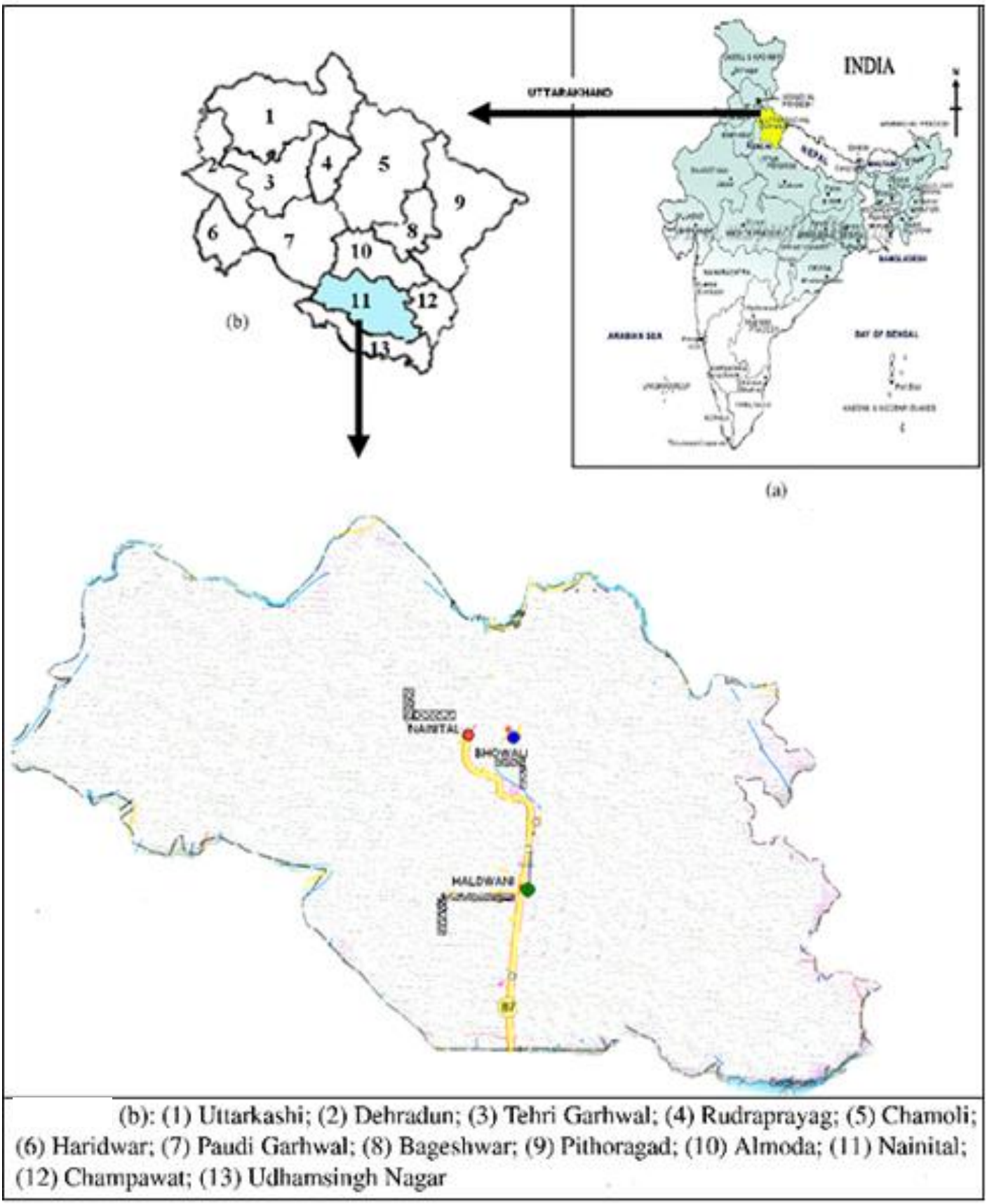

Figure 2. Showing the study sites in the Nainital District of Uttarahand.

Table 1. Characteristic of the different elevation zone forest in Nainital district.

Parameter	Pine forest	Mixed pine forest	Oak mixed forest
Elevation	950-1350 m asl	1350-1800 m asl	1800-2250 m asl
Dominant tree species	Cheer Pine	Cheer Pine + Oak	Deodar
Landscape	Hills	Hills	Hills
Fire	Common	Rare	Rare
Human disturbance	Common	Common	Moderate

Table 2. Comparison of bird species diversity parameter in different elevation forest types.

Parameter	Site A (Nainital 1900 to 2450 m asl)	Site B (Bhowali 1450 to 1700 m asl)	Site C (Haldwani 350 to 500 m asl)
Shannon Species diversity (*H'*)	3.38	3.68	3.50
Exclusive species	18	25	38
Species richness (*R*)	6.38	7.74	7.16
Total species abundance (N_0)	88	106	95
Species Individuals (N)	6029	9443	8726
Plant species diversity (PHD)*	2.11	2.30	2.23
Foliage height density (FHD)*	2.26	2.41	2.19
Canopy Cover (CC %)	68.53	70.26	42.20
Tree density (TD)	109	116	96

*Significant P<0.01.

Table 3. Showing the beta diversity values among the forest habitat of study sites.

Forest site	A (Nainital) forest	B (Bhowali) forest	C (Haldwani) forest
A	0	0.38	0.58
B		0	0.48
C			0

Table 4. Correlation values between bird species richness (BSR) / bird species diversity (BSD) with vegetation structure of forest habitat.

Parameter	Correlation value, r	P-value	R^2
BSR Versus CC	0.47	0.6	0.22
BSR Versus FHD	0.92	0.2	0.84
BSR Versus TD	0.95	0.1	0.90
BSR Versus PSD	0.83	0.3	0.67
BSD Versus CC	0.21	0.8	0.04
BSD Versus FHD	0.78	0.4	0.60
BSD Versus TD	0.22	0.8	0.04
BSD Versus PSD	0.95	0.2	0.90

species richness (BSR) and plant species diversity (PSD) than other forests, which is understandable that variety of plant species or plant species diversity provide food, good shelter and roosting sites to the bird communities.

Some studies indicates positive correlation between plant species diversity (PSD), foliage high density (FHD) and bird species diversity (BSD) and have shows the variety of plant species supports more bird species in tropical area as compare to temperate habitats (Orians, 1969; Lee and Rotenberry, 2005). On the other hand, tree density (TD) and canopy cover (CC) exhibited positive correlation with BSD and BSR but could not

seem significant role to determining BSD and BSR in the study areas.

Although, some studies (James, 1971) suggested that the TD and CC were the most important variables that affected BSD. Willson (1974) has also shown a linear correlation between BSD and TD. Daniels (1989) found that bird diversity was negatively correlated with canopy density but positively correlated with the coefficient of variation of canopy density suggesting that a uniform canopy has lesser number of bird species. Aleixo (1999) reported that the loss of large canopy trees had the negative impacts on the abundance of bird species.

The present study found the variation in forest habitat, FHD could account for some 84% of the variation in BSD. This data allow us to assume that FHD has also important factor to increase BSD in forest. Mac-Arthur (1961) found that BSD was correlated with FHD and predicted that tropical regions would contain more bird species if there were more FHD and if bird recognized the same vegetation layers as in temperate regions. Cody (1985) found that variation in FHD could account for some 80% of the variation in species diversity of birds. In the forest structure element such as FHD has advantage for managing bird habitat (Poulsen, 2002). However, some studies have disproved this relationship (Ralph, 1985).

Able and Noon (1976), Sabo (1980), McCoy (1990), Rahbek (1995, 1997), Hofer et al. (1999), Waterhouse et al. (2002), Lee et al. (2004) and Romdal and Grytnen (2007) have determined that elevation increases the availability of resources diminish, reflecting differences in forest stand structure, site productivity, vegetation species composition and distribution pattern. According to them secondary biotic interactions and available land area is influencing factor of the species distribution along the elevation.

In the present study found that avian species were significantly higher at mid elevation than the low and high elevations. The fact that a number of avian species do overlap at mid elevation forest this may be connected to the availability of variety and number of plant species. The results of this study also showed that BSD and BSR were highly correlated with the PSD and FHD in forest habitats. At the mid elevation forest of the study site, the study found the maximum PSD and FHD. Vegetation structure is thought to be one of the key features influencing avian species richness / diversity at the local level (Roth, 1976; Finch, 1989, 1991; Wiens, 1989).

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Appendix. List of the avian species recorded during the study along the elevation (2006 to 2008).

S/N	Family	Common name	Scientific name	Feeding guild	Distribution status	Conservation status (IUCN)	Conservation status (IWPA)	Alt. range (m asl)
1	Accipitridae	Black - shouldered kite	*Elanus caeruleus*	sc	R	-	Schedule IV	B – C
		Black kite	*Milvus migrans*	sc	R	-	Schedule IV	A – C
		Booted hawk eagle*	*Hieraaetus pennatus*	atc	R	-	Schedule IV	C
		Common buzzard	*Buteo buteo*	atc	Wv	-	Schedule IV	A
		Egyptian vulture	*Neophron percnopterus*	tc	R	-	Schedule IV	C
		Himalayan griffon	*Gyps himalayensis*	tc	am	-	Schedule IV	A – B
		Besra sparrow hawk*	*Accipiter virgatus*	sc	r	-	Schedule IV	B
		White - rumped vulture	*Gyps bengalensis*	tc	r	CR	Schedule I	B
2	Alaudidae	Eurasian skylark	*Alauda arvensis*	gse	wv	-	Schedule IV	B
		Oriental skylark	*Alauda gulgula*	gse	wv	-	Schedule IV	B
3	Alcedinidae	Pied kingfisher*	*Ceryle rudis*	wc	r	-	Schedule IV	A
		White - throated kingfisher	*Halcyon smyrnensis*	wc	r	-	Schedule IV	A-B-C
4	Apodidae	House swift	*Apus affinis*	ai	r	-	Schedule IV	A-B-C
5	Ardeidae	Cattle egret	*Bubulcus ibis*	gli	r	-	Schedule IV	C
		Intermediate egret*	*Mesophoyx intermedia*	gli	r	-	Schedule IV	C
6	Bucerotidae	Grey horn bill	*Ocyceros birostris*	fse	r	-	Schedule IV	C
7	Campephagidae	Bar - winged flycatcher-shrike	*Hemipus picatus*	ai	r/am	-	Schedule IV	B-C
		Common wood shrike	*Tephrodornis pondicerianus*	usi	r	-	Schedule IV	C
		Large cuckoo shrike	*Coracina macei*	to	r/am	-	Schedule IV	A - C
		Long - tailed minivet	*Pericrocotus ethologus*	si	wv	-	Schedule IV	A-B-C
		Small minivet	*Pericrocotus cinnamomeus*	ai	r	-	Schedule IV	A - C
8	Capitonidae	Blue - throated barbet	*Megalaima asiatica*	fse	r	-	Schedule IV	B - C
		Brown - headed barbet*	*Megalaima zeylanica*	fgi	r	-	Schedule IV	C
		Coppersmith barbet*	*Megalaima haemacephala*	fgis	r	-	Schedule IV	C
		Great hill barbet	*Megalaima virens*	fgis	r/am	-	Schedule IV	A - B
		Large green barbet*	*Megalaima lineata*	fgsi	r	-	Schedule IV	C
9	Certhiidae	Bar - tailed treecreeper	*Certhia himalayana*	bgi	wv	-	Schedule IV	A
		Eurasian treecreeper	*Certhia familiaris*	bgi	r/am	-	Schedule IV	A - B

Appendix. Cont

10	Charadriidae	Red - wattled lapwing	*Vanellus indicus*	gli	r/am	-	Schedule IV	B - C
		Blue rock pigeon	*Columba livia*	gse	r	-	Schedule IV	A-B-C
		Emerald dove*	*Chalcophaps indica*	gse	r	-	Schedule IV	B
11	Columbidae	Oriental turtle dove	*Streptopelia orientalis*	gse	r/wv	-	Schedule IV	A-B-C
		Eurasian collared dove	*Streptopelia decaocto*	gse	r/am	-	Schedule IV	A-B-C
		Spotted dove	*Streptopelia Chinensis*	gse	r/am	-	Schedule IV	A-B-C
12	Coraciidae	Indian roller	*Coracias benghalensis*	ai	r	-	Schedule IV	C
		Black - headed jay	*Garrulus lanceolatus*	ato	r/am	-	Schedule IV	A-B
		Common crow	*Corvus splendens*	ato	r/am	-	Schedule IV	A-B-C
		Common raven	*Corvus corax*	ato	r/am	-	Schedule IV	A
		Eurasian jay	*Garrulus glandarius*	fgis	r/am	-	Schedule IV	A-B
13	Corvidae	Grey tree pie	*Dendrocitta formosae*	ato	r/am	-	Schedule IV	A-B
		Large - billed crow	*Corvus macrorhynchos*	ato	r/am	-	Schedule IV	A-B-C
		Red - billed blue magpie	*Urocissa erythrorhyncha*	ato	r/am	-	Schedule IV	A-B
		Rufous treepie	*Dendrocitta vagabunda*	ato	r	-	Schedule IV	B-C
		Yellow billed blue magpie	*Urocissa flavirostris*	ato	r/am	-	Schedule IV	A
14	Cuculidae	Asian koel	*Eudynamys scolopacea*	ato	r	-	Schedule IV	A-B-C
		Eurasian cuckoo	*Cuculus canorus*	ato	sv	-	Schedule IV	B-C
		Greater coucal	*Centropus sinensis*	to	r	-	Schedule IV	B-C
		Indian cuckoo	*Cuculus micropterus*	ato	r	-	Schedule IV	A-B-C
		Lesser coucal	*Centropus bengalensis*	to	r	-	Schedule IV	A-B-C
		Pied crested cuckoo	*Clamator jacobinus*	ato	sv	-	Schedule IV	C
15	Dicaeidae	Fire - breasted flower pecker	*Dicaeum ignipectus*	bgi	am	-	Schedule IV	A-B
		Thick - billed flowerpecker	*Dicaeum agile*	bgi	am	-	Schedule IV	A-B
16	Dicruridae	Black drongo	*Dicrurus macrocercus*	ai	r	-	Schedule IV	A-B-C
		Spangled drongo	*Dicrurus hottentottus*	ai	r	-	Schedule IV	B-C
17	Emberizidae	Crested bunting *	*Melophus lathami*	ai	sv	-	Schedule IV	B
18	Estrildidae	Scaly - breasted munia	*Lonchura punctulata*	gse	r/am	-	Schedule IV	B-C
19	Hirundinidae	Common swallow	*Hirundo rustica*	ai	sv	-	Schedule IV	A-B-C
		Wire - tailed swallow *	*Hirundo smithii*	ai	r	-	Schedule IV	C

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20	Irenidae	Common iora *	*Aegithina tiphia*	usi	r	-	Schedule IV	C
		Orange - bellied leafbird *	*Chloropsis hardwickii*	fgi	r/am	-	Schedule IV	B
21	Laniidae	Bay - backed shrike	*Lanius vittatus*	ai	r/am	-	Schedule IV	B-C
		Grey - backed shrike	*Lanius tephronotus*	ai	sv	-	Schedule IV	A-B-C
22	Meropidae	Green bee eater	*Merops orientalis*	ai	r/am	-	Schedule IV	C
23	Motacillidae	Grey wagtail	*Motacilla cinerea*	gli	wv	-	Schedule IV	A-B-C
		Paddyfield pipit	*Anthus rufulus*	gse	r	-	Schedule IV	B
		Tree pipit	*Anthus trivialis*	gse	wv	-	Schedule IV	B
		Upland pipit	*Anthus sylvanus*	gse	r/wa	-	Schedule IV	B-C
		White wagtail	*Motacilla alba*	gli	wv	-	Schedule IV	A-B-C
24	Muscicapidae	Aberrant bush warbler	*Cettia flavolivacea*	si	r	-	Schedule IV	C
		Asian Paradise fly catcher	*Terpsiphone paradisi*	ai	sv	-	Schedule IV	A-B-C
		Black - backed forktail	*Enicurus immaculatus*	fgi	r	-	Schedule IV	B
		Blue - capped rock thrush	*Monticola cinclorhynchus*	si	sv	-	Schedule IV	B
		Blue - throated flycatcher*	*Cyornis rubeculoides*	si	sv	-	Schedule IV	A
		Blue whistling thrush	*Myophonus caeruleus*	gsi	r/am	-	Schedule IV	A-B-C
		Brown rock - chat	*Cercomela fusca*	gsi	r	-	Schedule IV	C
		Buff - barred warbler	*Phylloscopus pulcher*	usi	wv	-	Schedule IV	A-B
		Common babbler	*Turdoides caudatus*	fgi	r	-	Schedule IV	C
		Common stone chat	*Saxicola torquata*	ai	r/am	-	Schedule IV	B-C
		Common tailorbird	*Orthotomus sutorius*	si	r	-	Schedule IV	C
		Striated prinia	*Prinia criniger*	ai	r	-	Schedule IV	C
		Greenish warbler	*Phylloscopus trochiloides*	usi	wv	-	Schedule IV	A-B-C
		Golden – spectacled warbler	*Seicercus burkii*	usi	r/am	-	Schedule IV	A
		Grey - headed canary flycatcher	*Culicicapa ceylonensis*	usi	r/am	-	Schedule IV	A-B-C
		Grey - hooded warbler	*Seicercus xanthoschistos*	usi	r/am	-	Schedule IV	A
		Grey - sided bush warbler	*Cettia brunnifrons*	usi	am	-	Schedule IV	A
		Grey - winged blackbird	*Turdus boulboul*	fgi	r/am	-	Schedule IV	A
		Ashy - throated warbler	*Phylloscopus maculipennis*	ai	r	-	Schedule IV	B
		Indian robin	*Saxicoloides fulicata*	fgi	r	-	Schedule IV	C
		Jungle babbler	*Turdoides striatus*	fgi	r	-	Schedule IV	B-C
		Lemon - rumped warbler	*Phylloscopus chloronotus*	usi	r/am	-	Schedule IV	A-B
		Lesser whitethroat *	*Sylvia curruca*	usi	wv	-	Schedule IV	B
		Oriental Magpie robin	*Copsychus soularis*	gli	r	-	Schedule IV	B-C

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		Pale footed bush warbler	*Cettia pallidipes*	usi	r	-	Schedule IV	B
		Pied bush chat	*Saxicola caprata*	si	r/am	-	Schedule IV	A-B-C
		Plumbeous water redstart	*Rhyacornis fuliginosus*	si	r	-	Schedule IV	A-B
		Red throated fly catcher	*Ficedula parva*	si	wv	-	Schedule IV	B
		Rufous - bellied niltova	*Niltava sundara*	si	r/am	-	Schedule IV	B
		Streaked laughingthrush	*Garrulax lineatus*	fgi	r	-	Schedule IV	A-B
		Rufous sibia	*Heterophasia capistrata*	bgi	r	-	Schedule IV	A-B
		Rusty cheeked sumiter babbler	*Pomatorbinus erythrogenys*	bgi	r	-	Schedule IV	B
		Small niltava	*Niltava macgrigoriae*	si	r	-	Schedule IV	B
		Striated babbler	*Turdoides earlei*	bgi	r	-	Schedule IV	C
		Ticklle's leaf warbler	*Phylloscopus affinis*	usi	wv	-	Schedule IV	A-B
		Verditer fly catcher	*Eumyias thalassina*	ai	sv	-	Schedule IV	A-B-C
		Whiskered yuhina	*Yuhina flavicollis*	si	r/am	-	Schedule IV	A-B
		White - tailed rubythroat*	*Luscinia pectoralis*	si	sv	-	Schedule IV	B
		White - throated laughingthrush	*Garrulax albogularis*	gli	r/am	-	Schedule IV	A-B
		White - capped water redstart	*Chaimarrornis leucocephalus*	si	r/am	-	Schedule IV	A-B
		White crested laughingthrush	*Garrulax leucolophus*	fgi	r	-	Schedule IV	A-B
		White - throated fantail	*Rhipidura albicollis*	usi	r/am	-	Schedule IV	A-B
		Yellow - bellied fantail	*Rhipidura hypoxantha*	usi	r/am	-	Schedule IV	A
		Yellowish - bellied bush warbler*	*Cettia acanthizoides*	usi	r	-	Schedule IV	C
25	Nectariniidae	Crimson sunbird	*Aethopyga siparaja*	na	r/am	-	Schedule IV	A-B-C
		Purple sunbird	*Nactarinia asiatica*	nai	sv	-	Schedule IV	A-B-C
26	Oriolidae	Black hooded oriole	*Oriolus xanthornus*	fr	r	-	Schedule IV	C
		Eurasian golden oriole	*Oriolus oriolus*	fse	wv	-	Schedule IV	B-C
		Black - lored tit	*Parus xenthogenys*	usi	r	-	Schedule IV	A-B
		Black - throated tit	*Aegithalos concinnus*	usi	r	-	Schedule IV	A-B
		Great tit	*Parus major*	usi	r	-	Schedule IV	A-B-C
27	Paridae	Green - backed tit	*Parus monticolus*	usi	r	-	Schedule IV	A-B-C
		Grey - crested tit	*Parus dichrous*	usi	r	-	Schedule IV	A
		Rufous - vented tit*	*Parus rubidiventris*	usi	r	-	Schedule IV	A
		Spot - winged tit	*Parus melanolophus*	usi	r	-	Schedule IV	A
28	Passeridae	Baya weaver	*Ploceus philippinus*	gse	r	-	Schedule IV	C
		Chestnut shouldered petronia	*Petronia xanthocollis*	fgi	r	-	Schedule IV	C

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		Common rosefinch	*Carpodacus erythrinus*	gse	wv	-	Schedule IV	A
		House sparrow	*Passer domesticus*	gse	r	-	Schedule IV	A-B-C
		Russet sparrow	*Passer rutilans*	fgsi	am	-	Schedule IV	A-B
		Black francolin	*Francolinus francolinus*	fgsi	r	-	Schedule IV	B
		Cheer pheasant (* Vocal)*	*Catreus wallichii*	fgsi	e	VU	Schedule 1	A
		Common quail	*Coturnix coturnix*	fgsi	r	-	Schedule IV	B-C
29	Phasianidae	Indian peafowl	*Pavo cristatus*	to	r	-	Schedule 1	C
		Kalij pheasant	*Lophura leucomelanos*	fgsi	am	-	Schedule IV	A-B
		Koklass pheasant	*Pucrasia macrolopha*	fgsi	am	-	Schedule IV	A
		Red jungle fowl	*Gallus gallus*	fgsi	r	-	Schedule IV	A-C
		Brown - fronted woodpecker	*Dendrocopos auriceps*	fgi	r/am	-	Schedule IV	A-B
		Brown - capped pygmy woodpecker	*Dendrocopos nanus*	fgi	r	-	Schedule IV	C
		Black - rumped flameback	*Dinopium benghalense*	fgi	r	-	Schedule IV	C
		Yellow- crowned woodpecker	*Dendrocopos mahrattensis*	fgi	sv	-	Schedule IV	C
		Fulvous - breasted woodpecker	*Dendrocopos macei*	fgi	r	-	Schedule IV	A-B-C
		Great slaty woodpecker*	*Mulleripicus pulverulentus*	fgi	r	-	Schedule IV	C
		Greater flameback woodpecker	*Chrysocolaptes lucidus*	fgi	r	-	Schedule IV	B
30	Picidae	Grey - capped pygmy woodpecker	*Dendrocopos canicapillus*	fgi	r	-	Schedule IV	A-B-C
		Grey - headed woodpecker	*Picus canus*	fgi	r	-	Schedule IV	A-B-C
		Himalayan flameback woodpecker	*Dinopium shorii*	fgi	r	-	Schedule IV	A-B-C
		Himalayan woodpecker	*Dendrocopos himalayensis*	fgi	r	-	Schedule IV	A-C
		Lesser yellownape woodpecker	*Picus chlorolophus*	fgi	r	-	Schedule IV	A-B-C
		Rufous - bellied wood pecker	*Dendrocopos hyperythrus*	fgi	r	-	Schedule IV	A-B
		Scaly - bellied woodpecker	*Picus squamatus*	fgi	r	-	Schedule IV	A-B-C
		Speckled piculet	*Picumnus innominatus*	fgi	r	-	Schedule IV	A
		Streak - throated woodpecker*	*Picus xanthopygaeus*	fgi	r	-	Schedule IV	C
		Alexandrine parakeet	*Psittacula eupatria*	fse	r	-	Schedule IV	B-C
31	Psittacidae	Plum - headed parakeet	*Psittacula cyanocephala*	fse	r	-	Schedule IV	B-C
		Rose - ring parakeet	*Psittacula krameri*	fse	r	-	Schedule IV	B-C
		Slaty - headed parakeet	*Psittacula himalayana*	fse	r	-	Schedule IV	A-B
		Black bulbul	*Hypsipetes leucocephalus*	fi	r	-	Schedule IV	A-B
32	Pycnonotidae	Himalayan bulbul	*Pycnonotus leucogenys*	fi	r	-	Schedule IV	A-B-C
		Red - whiskered bulbul	*Pycnonotus jocosus*	fi	r	-	Schedule IV	C
		Red vented bulbul	*Pycnonotus cafer*	fi	r	-	Schedule IV	A-B-C

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33	Sittidae	Chestnut - bellied nuthatch	*Sitta castanea*	bgi	r	-	Schedule IV	A
34	Strigidae	Brown wood owl *	*Strix leptogrammica*	atc	r	-	Schedule IV	A-B
		Jungle owlet	*Glaucidium rodiatum*	atc	r	-	Schedule IV	C
		Spotted owlet	*Athene brama*	atc	r	-	Schedule IV	B
35	Sturnidae	Bank myna	*Acridotheres ginginianus*	to	r	-	Schedule IV	B-C
		Brahminy starling	*Sturnus pagodarum*	to	r	-	Schedule IV	C
		Chestnut-tailed starling	*Sturnus malabarica*	ai	r/am	-	Schedule IV	C
		Common myna	*Acridotheres tristis*	to	r	-	Schedule IV	A-B-C
		Jungle myna	*Acridotheres fuscus*	to	r	-	Schedule IV	B
		Pied myna	*Sturnus contra*	to	r	-	Schedule IV	C
36	Sylviinae	Ashy prinia	*Prinia socialis*	usi	r	-	Schedule IV	B-C
		Jungle prinia	*Prinia sylvatica*	fgi	r	-	Schedule IV	C
		Plain prinia	*Prinia inornata*	gli	r	-	Schedule IV	C
37	Upupidae	Common hoopoe	*Upupa epops*	gli	r/am	-	Schedule IV	B-C
38	Zosteropidae	Oriental white eye	*Zosterops palpebrosus*	usi	r	-	Schedule IV	A-B-C

r = resident, am = altitudinal migratory, sv = summer visitor, wv = winter visitor, vu = vulnerable, e = endemic, cr = critical rare, ai = Aerial insectivore, bgi = Bark gleaning insectivore, fgi = foliage gleaning insectivore, si = sallying insectivore, usi = under-storey insectivore, gli = grass land insectivore, to = terrestrial omnivore, ato = arboreal terrestrial omnivore, gse = granivore seed eater, fgse = frugivore granivore insectivore seed eater, fse = frugivore seed eater, fi = frugivore insectivore, sc = sallying carnivore, atc = arboreal terrestrial carnivore, tc = terrestrial carnivore, wc = wading carnivore, ni = nectarivore insectivore, n = nectarivore, *Rare species of the sites (RA < 0.001), IWPA = Indian wildlife protection Act, IUCN = International Union for Conservation of Nature and Natural resources, A = Nainital, 1900 – 2450m asl, B = Bhowali, 1450 – 1700 m asl, C = Haldwani, 350 to 500 m asl).