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Role of protected areas in conservation of shrub biodiversity in Kashmir Himalaya

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Abstract
The present investigation entitled "Role of protected areas in conservation of shrub biodiversity in Kashmir Himalaya" was carried out during the year 2014-15 & 2015-16, in two protected areas viz., Dachigam National Park (DNP) and Overa-Aru Wildlife Sanctuary (OAWS) along with their adjoining unprotected areas in Srinagar and Anantnag districts of Kashmir valley respectively. Each protected and unprotected area were divided was into north and south aspects. Each aspect was then further sub divided into three different altitudinal ranges viz. A_1 (1600-2100m), A_2 (2100-2600m) and A_3 (2600-3100m) covering different forests of protected as well as unprotected areas. Random sample plots of size 5x5m were laid in each altitudinal range on different aspects of protected and unprotected areas to study the structural and functional parameters of shrubs. One time sampling was done to assess the shrub phytosociology. The results revealed that density (tillers/m^2), basal area (cm^2/m^2) and frequency (%) shrub vegetation in each protected and unprotected areas was maximum at middle altitude and south aspect exhibited the highest values among different altitudinal ranges and aspects, respectively. A total of (17) shrub species were recorded during the entire study period. Among the shrubs, *Berberis aristata*, *Daphne mucronata*, *Gualtheris tricophyla*, *Parroptios jacquemontii* and *Rosa webbiana* were recorded with maximum findings (8), followed by *Berberis lyceum* and *Cotoneaster acuminatus* (5) sites. *Lonicera quinquelocularis* was the least recorded shrub specie with only one representation across the 12 forest sites of protected and unprotected areas of Dachigam National Park and Overa-Aru Wildlife Sanctuary.

Keywords: protected, dachigam, overa-aru, *berberis*, sanctuary.

Introduction
Protected areas are assumed to arrest the forest vagaries and protect forest from changes and are traditionally managed to support and maintain carbon sinks, protect biodiversity, and to help stabilize global climate (Munroe *et al.* 2007) [23]. Protected areas have been the primary defense of habitat, and they surely will continue to play a role and make efforts to conserve biological diversity, particularly for conserving populations of threatened species (Gaston *et al.* 2008) [11]. Protected areas are the priority centers of biodiversity and wildlife conservation. It is therefore vital to understand the contribution which this system actually makes to biological conservation. They are renowned for their ability to act as refuges for species and ecological processes that cannot persist in intensely managed landscapes as well as for their ability to provide space for natural evolution and potential ecological restoration (Dudley *et al.* 2010) [10]. In most cases, they are the only remaining natural or semi natural areas in whole regions and significant numbers of species are found nowhere else (Ricketts *et al.* 2005) [25]. Conservation of biodiversity and therefore bringing more and more area under forest cover as well as preserving the existing green cover has been added to the priority list of many countries. Keeping protected areas connected in a network is increasingly recognized as a conservation priority in the current era of rapid climate change (Belote *et al.* 2016) [3].
Two key measures of protected areas contribution to conservation are extent of coverage and effectiveness at conserving biodiversity. Evaluating the effectiveness of protected area is difficult, especially given the poor availability of data on ecological and social conditions and their change over time. Two components of the ecological effectiveness of protected areas are typically differentiated. The first, representation or inventory, concerns the capture by protected areas of biodiversity features, especially those which are rare or threatened. The second component of the ecological effectiveness of protected areas, persistence or condition, concerns how well these areas maintain the biodiversity features which occur and the ecological/evolutionary processes which take place within their bounds. It seeks to explore comparisons by pairing protected and unprotected locations that are similar in their landscape characteristics. Matching can evaluate impacts within the boundaries of protection as well as assess outside impact (Kent, 2012) [17].

Data collected according to accepted quantitative methods, can be used to give detailed information about plant species abundance and description of the structure of vegetation. Such data can also be used for gradient analyses, measuring plant species diversity, the study of succession changes and measuring plant production of different ecosystems. When the expansion of conservation areas is considered, the results of phytosociological studies should be used to assist with planning of these expansions to guide conservation decisions about important, scarce or rare plant communities. (Kent, 2012) [17]. although this approach to ecosystem management is not without its shortcomings, it provides ecologists with a sensible, tangible tool and first approximation for the management of ecosystem patterns and processes.

There are numerous ways to study the biodiversity; these include inventory and documentation, diversity assessment, population status and ecology, management and threat. Along with vegetation type distribution, topographic variability, climatic gradients and biotic pressure, criteria of biodiversity inventory also forms the cornerstone in conservation planning and strategies. Apart from such advantages these areas can be helpful in representing can be effective at representing additional aspects of biodiversity, such as ecological uniqueness, species distributions, species diversity and contiguous intact natural habitats (Wessels *et al.* 1999) [31]. The essential attributes of of forest ecosystem like, species composition, structure and function are reflected in response to environmental as well anthropogenic variables (Shaheen *et al.* 2012; Bisht and Bhat, 2013) [27, 5]. Protected areas are answer to the overall biodiversity loss (Jenkins and Joppa 2009) [16].

Material and Method

The present investigation was carried out during the years 2014-15 and 2015-16. The physical and environmental attributes of study area, materials used and methodology adopted for the study are given below:

Study area

The study was conducted in two protected areas viz. Dachigam National Park and Overa-Aru Wildlife Sanctuary. Dachigam National Park lies between 34º 05′ N-34º 11′ N longitude and 74º 54′ E-75º 09′ E latitude and the area comes under the civil jurisdictions of Srinagar, Anantnag and Pulwama districts. Its area comes in 2.38.12 (Himalayan Highlands) bio geographical province, and 2A Bio-geographic zone. It is 21 km north east to Srinagar, the summer capital of Jammu and Kashmir State situated in Zabarwan mountain range of Great Himalayas. The total area of Dachigam national Park is 141 sq. km. Dachigam National Park is divided in two zones Lower and Upper Dachigam. Dachigam National Park is known world-wide because it holds one of the best populations of Asiatic black bear in Asia and the red deer sub species Hangul. Dachigam occupies almost half of the catchment zone of the famous Dal Lake and is the main source of water for the Srinagar city. The park is foster mother nurturing rich assets of threatened as well as rare flora and fauna. Dachigam national park with adjacent conservation reserves and wildlife Sanctuaries makes Greater Dachigam Landscape which harbors high level of biodiversity. The natural boundaries to the park are two steep mountain ridges, one originating from Harwan water reservoir on the south west side of the park and the other originating from Dara/Khimber side with an elevation gradient of 2,600 to 3,000m. Dachigam is bounded by Sindh valley to the north east, Tarsar, Lidderwath, Kolhai of Lidder Valley and Overa-Aru Wildlife Sanctuary in the East, Tral range in the south east and Harwan, Brain and Nishat in the west and south-west (Kurt, 1978) [19]. As per revised Champion and Seth (1968) [7], the vegetation of Dachigam National Park is typically Himalayan moist temperate forest, sub-alpine forest and alpine forest type and can be classified into following forest types:

- Moist temperate deciduous forest
- *Parrotia* (pohu) scrub forest
- West Himalayan low level blue pine forest
- Western mixed coniferous forest
- Deciduous alpine scrub

Keeping in view floral diversity among protected, the present study was undertaken to throw light on floristic variation in two different aspects along altitudinal gradient by investigating forests (Champion and Seth, 1968) [7] located at different elevations as follows (Table 1).

Table 1: Forest area selected for vegetation and carbon stock estimation analysis

S. No.	Protected/Unprotected area	District	Aspect	Altitudinal ranges (m) in each aspect
1	Dachigam National Park (DNP)	Srinagar Anantnag Pulwama	North and South	A_1=1600-2100 A_2=2100-2600 A_3=2600-3100
2	Adjacent unprotected area Dachigam National Park (UDNP)	Srinagar Anantnag Pulwama	North and South	A_1=1600-2100 A_2=2100-2600 A_3=2600-3100

Vegetation analysis

The shrub characteristics in each forest were studied by laying out five random sample plots of size 5x5m. The shrub vegetation from each sample plot was segregated species wise and identified. The herbarium in the university, experts, FRI Dehradun herbarium, journals and research books were taken to identify them. Density, basal area and frequency of shrub species were computed using following methodologies:

Observations recorded

Density (D)

It represents the population of a species in the community and was calculated by counting number of each species in the sample plot/quadrat.

Frequency

It is the indicator of number of samples in which the given species occurs, thus expresses the distribution of various species in the community, Frequency was calculated by using the formula following:

$$\text{Frequency (\%)} = \frac{\text{No. of sample in which the species occurred}}{\text{No. of sampling units studied}} \times 100$$

Basal area

The cross sectional area of shrubs falling in the recording unit was determined by the formulae as:

$$\text{Basal area} = \pi \frac{d^2}{4}$$

Where,
d = Diameter in linear units
One time sampling procedure was followed to study the different parameters of shrub species.

Statistical analysis
The data was analyzed by using analysis of variance-two way classification (Gupta, 1983) [13].

Experimental Results
Floristic composition of shrub vegetation in protected and unprotected sites
North aspect
Protected and unprotected areas of Dachigam National Park revealed a uniform distribution with each altitudinal range in both protected and unprotected sites consisting of (6) different species. However, protected and unprotected sites of Overa-Aru Wildlife Sanctuary showed an irregular trend with Altitudinal range of A_2 consisting maximum (9) number of species in both the protected and unprotected sites, respectively. Barring altitudinal ranges of A_1, A_2 and A_3 in protected sites of Overa-Aru Wildlife Santuary and A_2 of unprotected sites of Overa-Aru Wildlife Sanctuary, all other sites of protected and unprotected forests consisted of equal number (6) of species which was also the least number of species of shrubs represented across the sites (Table 2).

South aspect
Shrub species composition along the three altitudinal gradients across protected and unprotected areas of Dachigam National Park on south aspect revealed dominant distribution with altitudinal range of A_2 consisting of (9) species in both protected and unprotected sites. Least number of species (4) was present in altitudinal range of A_3 of unprotected site.
Protected and unprotected sites of Overa-Aru Wildlife Sanctuary showed altitudinal range of A_2 consisting of maximum number of species (11) in the protected sites. The lower number of species (4) was found in A_3 range of unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary (Table 3).

Table 2: Shrub species composition on north aspect

S. No.	Name	Protected (DNP)			Unprotected (DNP)			Protected (OAWS)			Unprotected (OAWS)		
		A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
1	*Berberis aristata*	-	-	-	-	+	+	-	+	+	-	+	+
2	*Berberis lyceum*	-	-	-	+	+	-	+	+	-	+	+	-
3	*Cotoneaster acuminatus*	+	+	+	+	-	-	+	-	-	+	-	-
4	*Daphne mucronata*	-	-	-	-	+	+	-	+	+	-	+	+
5	*Gualtheris tricophyla*	-	-	-	-	-	+	-	+	+	-	+	+
6	*Indigofera heterantha*	+	+	+	+	-	-	+	-	-	+	-	-
8	*Lonicera quinquelocularis*	-	-	-	-	-	+	-	-	+	-	-	+
9	*Parroptios jacquemontii*	+	+	+	+	+	-	+	+	-	+	+	-
10	*Rhododendron arboretum*	-	-	-	-	-	+	-	-	+	-	-	+
11	*Rosa macrophylla*	-	-	-	-	+	-	-	+	-	-	+	-
12	*Rosa moschata*	-	-	-	-	+	-	-	+	+	+	+	-
13	*Rosa webbiana*	+	+	+	+	-	+	+	-	-	-	+	-
14	*Rubus ellipticus*	-	-	-	-	-	-	-	+	-	-	+	+
15	*Sorbaria tomentosa*	-	-	-	-	-	-	-	+	+	+	-	-
16	*Viburnum grandiflorum*	+	+	+	+	-	-	+	-	-	+	-	-
17	*Zizyphus mauritiana*	+	+	+	-	-	-	+	-	-	+	-	-
Sub total		06	06	06	06	06	06	07	09	07	08	09	06
Total		18			18			23			23		

* Where (+) = Present (-) = Absent

Table 3: Shrub species composition on south aspect

S. No.	Name	Protected (DNP)			Unprotected (DNP)			Protected (OAWS)			Unprotected (OAWS)		
		A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
1	*Berberis aristata*	-	+	+	-	+	+	-	+	+	-	+	+
2	*Berberis lyceum*	+	-	+	-	-	-	-	+	+	+	-	-
3	*Cotoneaster acuminatus*	+	-	+	-	-	-	-	+	+	+	-	-
4	*Daphne mucronata*	-	+	+	-	+	+	-	+	+	-	+	+
5	*Gualtheris tricophyla*	-	+	+	-	+	+	-	+	+	-	+	+
6	*Indigofera heterantha*	+	-	-	+	-	-	+	-	-	+	-	-
8	*Lonicera quinquelocularis*	-	-	+	-	-	-	-	-	-	-	-	-
9	*Parroptios jacquemontii*	+	+	-	+	+	-	+	+	-	+	+	-
10	*Rhododendron arboreum*	-	-	+	-	-	+	-	-	+	+	-	-
11	*Rosa macrophylla*	-	+	-	-	+	-	-	+	-	-	-	+
12	*Rosa moschata*	-	+	-	-	+	-	-	+	-	-	+	-
13	*Rosa webbiana*	+	+	-	+	+	-	+	+	-	+	+	-
14	*Rubus ellipticus*	-	+	-	-	+	-	-	+	-	-	+	-
15	*Sorbaria tomentosa*	-	+	-	-	+	-	-	+	-	-	+	-
16	*Viburnum grandiflorum*	+	-	-	+	-	-	+	-	-	+	-	-
17	*Zizyphus mauritiana*	+	-	-	+	-	-	+	-	-	+	-	-
Sub total		07	09	07	05	09	04	05	11	06	08	08	04
Total		23			18			23			20		

* Where (+) = Present (-) = Absent

Overall, in protected and unprotected sites of Dachigam National Park (DNP) and Overa-Aru Wildlife Sanctuary (OAWS) along the three altitudinal ranges, a total of 16 Shrub species were recorded. Among the shrubs *Berberis aristata*, *Daphne mucronata*, *Gualtheris tricophylla*, *Parroptiosis jacquemontii* and *Rosa webbiana* were recorded with maximum occurrence on eight sites followed by *Berberis lyceum* and *cotoneaster acuminatus* on five sites. *Parroptiosis jacquemontii* recorded the maximum (9) occurrence on north aspect of both protected and unprotected sitres of Dachigam National Park and Overa-Aru Wildlife Sanctuary.

Summary of floristic composition of shrub community

In protected and unprotected sites of Dachigam National Park (DNP) and Overa-Aru Wildlife Sanctuary (OAWS) forest along the three altitudinal ranges, a total of 12 different forest sites represented the shrub flora during the study. A total of (17) shrub species were recorded. Among the shrubs, *Berberis aristata*, *Daphne mucronata*, *Gualtheris tricophyla*, *Parroptios jacquemontii* and *Rosa webbiana* were recorded with maximum findings (8), followed by *Berberis lyceum* and *Cotoneaster acuminatus* (5) sites. However, representation of shrub species (9) was found uniformly across the four forest sites. *Rubus ellipticus*, *Sorbaria tomentosa*, *Viburnum grandiflorum*, *Zizyphus mauritiana*, *Rhododendron arboretum*, *Rosa macrophylla*, *Rosa moschata* and *Indigofera heterantha* were found along these four sites. *Lonicera quinquelocularis* was the least recorded shrub specie with only one representation across the 12 forest sites of protected and unprotected areas of Dachigam National Park and Overa-Aru Wildlife Sanctuary. *Berberis aristata* was recorded on six sites on north aspect, while as it occurred on eight sites on south aspect (Table 4).

Table 4: Representation of Floristic composition of shrub community

S. No.	Name	Protected (DNP)			Unprotected (DNP)			Protected (OAWS)			Unprotected (OAWS)			Total
		A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	
North aspect														
1	*Berberis aristata*	-	-	-	-	+	+	-	+	+	-	+	+	6
2	*Berberis lyceum*	-	-	-	+	+	-	+	+	-	+	+	-	6
3	*Cotoneaster acuminatus*	+	+	+	+	-	-	+	-	-	+	-	-	6
4	*Daphne mucronata*	-	-	-	-	+	+	-	+	+	-	+	+	6
5	*Gualtheris tricophyla*	-	-	-	-	-	+	-	+	+	-	+	+	5
6	*Indigofera heterantha*	+	+	+	+	-	-	+	-	-	+	-	-	6
8	*Lonicera quinquelocularis*	-	-	-	-	-	+	-	-	+	-	-	+	3
9	*Parroptios jacquemontii*	+	+	+	+	+	-	+	+	-	+	+	-	9
10	*Rhododendron arboreum*	-	-	-	-	-	+	-	-	+	-	-	+	3
11	*Rosa macrophylla*	-	-	-	-	+	-	-	+	-	-	+	-	3
12	*Rosa moschata*	-	-	-	-	+	-	-	+	+	+	+	-	5
13	*Rosa webbiana*	+	+	+	+	-	+	+	-	-	-	+	-	7
14	*Rubus ellipticus*	-	-	-	-	-	-	-	+	-	-	+	+	3
15	*Sorbaria tomentosa*	-	-	-	-	-	-	-	+	+	+	-	-	3
16	*Viburnum grandiflorum*	+	+	+	+	-	-	+	-	-	+	-	-	6
17	*Zizyphus mauritiana*	+	+	+	-	-	-	+	-	-	+	-	-	5
S. No.	**Name**		**Protected (DNP)**		**Unprotected (DNP)**			**Protected (OAWS)**			**Unprotected (OAWS)**			**Total**
			A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	
South aspect															
1	*Berberis aristata*		-	+	+	-	+	+	-	+	+	-	+	+	8
2	*Berberis lyceum*		+	-	+	-	-	-	-	+	+	+	-	-	5
3	*Cotoneaster acuminatus*		+	-	+	-	-	-	-	+	+	+	-	-	5
4	*Daphne mucronata*		-	+	+	-	+	+	-	+	+	-	+	+	8
5	*Gualtheris tricophyla*		-	+	+	-	+	+	-	+	+	-	+	+	8
6	*Indigofera heterantha*		+	-	-	+	-	-	+	-	-	+	-	-	4
8	*Lonicera quinquelocularis*		-	-	+	-	-	-	-	-	-	-	-	-	1
9	*Parroptios jacquemontii*		+	+	-	+	+	-	+	+	-	+	+	-	8
10	*Rhododendron arboreum*		-	-	+	-	-	+	-	-	+	+	-	-	4
11	*Rosa macrophylla*		-	+	-	-	+	-	-	+	-	-	-	+	4
12	*Rosa moschata*		-	+	-	-	+	-	-	+	-	-	+	-	4
13	*Rosa webbiana*		+	+	-	+	+	-	+	+	-	+	+	-	8
14	*Rubus ellipticus*		-	+	-	-	+	-	-	+	-	-	+	-	4
15	*Sorbaria tomentosa*		-	+	-	-	+	-	-	+	-	-	+	-	4
16	*Viburnum grandiflorum*		+	-	-	+	-	-	+	-	-	+	-	-	4
17	*Zizyphus mauritiana*		+	-	-	+	-	-	+	-	-	+	-	-	4

* Where (+) = Present (-) = Absent

Density (tillers/ha) of shrub vegetation

Data pertaining to mean density of shrub vegetation in different forests of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary depicted maximum (6232.00) density in protected sites of Dachigam National Park at A_2 on south aspect followed by (6208.00) at A_2 on north aspect of unprotected site of Dachigam National Park. The lowest (1712.00) density were for found in unprotected sites of Dachigam National Park at upper altitude (A_3) on south aspect followed by (1735.00) in unprotected sites of Overa-Aru Wildlife Sanctuary at upper altitude (A_3) on south aspect.

The density for north aspect of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (5840.00) and minimum (1864.00). Similarly, values for south aspect of protected and

unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (6220.00) and minimum (1768.00).

Among protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary the data revealed maximum value (3933.33) in protected sites and minimum value (3897.25) in unprotected sites, respectively. The density for data pertaining to altitude revealed maximum (5866.00) density for A_2 followed by A_1 (3981.00) and A_3 (1898.97) (Table 5).

Table 5: Density (N/ha) of shrub vegetation

Districts / Sites	D_1							D_2							Overall Mean	Factor Mean
	A_1		A_2		A_3		Sub-mean	A_1		A_2		A_3		Sub-mean		
	N	S	N	S	N	S		N	S	N	S	N	S			
P_1	3544.00	4416.00	5848.00	6232.00	2192.00	1824.00	4009.33	4368.00	4024.00	5496.00	5480.00	1904.00	1872.00	3857.33	3933.33	A_1=3981.00
P_2	3272.00	4112.00	5480.00	6208.00	2128.00	1712.00	3818.67	4240.00	3872.00	6184.00	6000.00	1824.00		3975.83	3897.25	A_2=5866.00
Overall Mean	3408.00	4264.00	5664.00	6220.00	2160.00	1768.00	3914.00	4304.00	3948.00	5840.00	5740.00	1864.00	1803.50	3916.58	3915.29	A_3=1898.97
CD (5%)																
Districts (D)	NS		Aspects (a)		NS		D×A×a	339.12		A×P		239.79		D×a×P		NS
Altitudes (A)	169.56		D×a		195.79		Sites (P)	NS		D×A×P		339.12		A×a×P		NS
D×A	239.80		A×a		239.79		D×P	195.79		a×P		NS		D×A×a×P		NS

Basal area (m^2/ha) of shrub vegetation

Data pertaining to mean basal area of shrub vegetation in different forests of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (0.92) basal area in protected site of Dachigam National Park at A_1 on north aspect followed by (0.77) at A_2 on north aspect of protected site of Dachigam National Park. The lowest (0.12), basal area were for found in unprotected sites of Dachigam National Park & Overa-Aru Wildlife Sanctuary at lower altitude (A_1) on south aspect followed by (0.13) in unprotected sites of Dachigam National Park at lower altitude (A_1) on south aspect The basal area for north aspect of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (0.61) and minimum (0.14), respectively. Similarly, basal area for south aspect of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (0.50) and minimum (0.13).

Among protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary the data revealed maximum (2.40) in protected sites and minimum (0.27) in unprotected sites, respectively. The basal area for data pertaining to altitude revealed maximum (0.49) at A_2 followed (0.31) at A_1 and (0.22) at A_3, respectively (Table 6).

Frequency (%) of shrub vegetation

Data pertaining to mean frquency of shrub vegetation in different forests of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (11.00) frequency in unprotected sites of Dachigam National Park at A_2 on north aspect followed by (10.80) at A_2 on north aspect aspect of protected site of Dachigam National Park. The lowest (5.40) frequency were found in both protected and unprotected sites of Dachigam National Park as well as Overa-Aru Wildlife Sanctuary at upper altitude (A_3) on south aspect followed by unprotected sites of Overa-Aru Wildlife Sanctuary at upper altitude (A_3) on north aspect (5.40).

Table 6: Basal area (m^2/ha) of shrub vegetation

Districts / Sites	D_1							D_2							Overall Mean	Factor Mean
	A_1		A_2		A_3		Sub-mean	A_1		A_2		A_3		Sub-mean		
	N	S	N	S	N	S		N	S	N	S	N	S			
P_1	0.92	024	0.77	0.55	0.61	0.19	4.51	0.35	0.36	0.48	0.32	0.13	0.13	0.30	2.40	A_1=0.31
P_2	0.12	0.13	0.46	0.45	0.37	0.12	0.28	0.26	0.12	0.51	0.43	0.14	0.12	0.26	0.27	A_2=0.49
Overall Mean	0.52	12.065	0.615	0.5	0.49	0.155	2.39	0.31	0.24	0.50	0.38	0.14	0.13	0.28	1.34	A_3=0.22
CD (5%)																
Districts (D)	0.05		Aspects (a)		0.05		D×A×a	0.12		A×P		0.09		D×a×P		0.10
Altitudes (A)	0.06		D×a		0.07		Sites (P)	0.05		D×A×P		NS		A×a×P		NS
D×A	NS		A×a		NS		D×P	0.07		a×P		0.07		D×A×a×P		0.18

The frequency for north aspect of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary revealed maximum (10.70) minimum (5.60) frequency. Similarly, values for south aspect of protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary depicted maximum (10.50) and minimum (5.40). Among protected and unprotected sites of Dachigam National Park and Overa-Aru Wildlife Sanctuary the data depicted maximum (7.77) in unprotected sites and minimum (7.70) in protected sites, respectively. The frequency for data pertaining to altitude revealed maximum values for A_2 (10.45), followed by A_1 (7.00) and A_3 (5.75) (Table 7).

Table 7: Frequency (%) of shrub vegetation

Districts / Sites	D_1							D_2							Overall Mean	Factor Mean
	A_1		A_2		A_3		Sub-mean	A_1		A_2		A_3		Sub-mean		
	N	S	N	S	N	S		N	S	N	S	N	S			
P_1	7.00	7.00	10.20	10.00	6.60	5.40	7.70	7.00	7.00	10.80	10.40	5.60	5.40	7.70	7.70	A_1=7.00
P_2	7.00	7.00	10.20	11.00	6.60	5.40	7.87	7.00	7.00	10.60	10.40	5.60	5.40	7.67	7.77	A_2=10.45
Overall Mean	7.00	7.00	10.20	10.50	6.60	5.40	7.78	7.00	7.00	10.70	10.40	5.60	5.40	7.68	7.73	A_3=5.75
CD (5%)																

Districts (D)	NS	Aspects (a)	0.18	D×A×a	0.44	A×P	NS	D×a×P	NS
Altitudes (A)	0.22	D×a	NS	Sites (P)	NS	D×A×P	NS	A×a×P	NS
D×A	0.31	A×a	0.31	D×P	NS	a×P	NS	D×A×a×P	NS

Discussion

The forests under study differed in plant species composition, with protected site, middle elevations (2100-2600m) and south aspect having highest number of species while, unprotected sites, lower (1600-2100m) and upper (2600-3100m) elevations, andnorth aspect recording the least plant species numbers (Table 1 & 2). The relationship between environmental variables like elevation with species composition, diversity and distribution, has been a subject to extensive research (Miehe, 1989, 1997; Schickhof, 2005 and Tambe and Rawat, 2010) [20, 26, 30]. The decrease in number of species with increasing altitude for various Himalayan ranges is a recognized pattern with certain variations in species composition (Korner, 2003) [18]. The species richness can change monotonically with an elevational gradient or form a hump shaped pattern (Grytnes and Vetaas, 2002; Bhattarai *et al.* 2004) [12, 4].

The number of shrub species in these forests ranged from 6 (north aspect) to11 (South aspect). The south aspects tend to be relatively hotter, which makes it a good size for broad leaved species, which in turn nurture higher number of shrub species (Chavez and Macdonald, 2010) [8] thus high number of shrubs, might have occurred in south aspect. Also, higher tree layer diversity enhance shrub layer diversity either by increasing environmental heterogeneity or by creating environmental conditions which are favourable to a greater number of species (Beatty, 2003) [2] that might have encouraged the shrub composition in forests of unprotected sites. Low number of shrub species in higher altitude forests has been recorded by Dangwal *et al.* (2012) [9] for Kashmir forests and Siddiqui *et al.* (2009) [29] for Pakistan forests. Shrub species recorded in Fir-Spruce forest are similar to the findings of Gupta (2007) [14, 15] for Northwest Himalaya forests in Himachal Pradesh. Muller (2003) [22] and Neufeld & Young (2003) [24] opined that overstorey species enhance spatial heterogeneity of soil fertility resulting in change in shrub dynamics. The distribution of species is also regulated by altitude and physiographic regimes (Sharma *et al.* 2010) [28] and edaphic conditions, slope, aspect and moisture regime (Adhikari *et al.* 2009) [1].

In unprotected sites less number of floral diversity may primarily be triggered by ill managed activities like land sales to cattle ranchers and the exhaustion of high-value timber because of poor management practices, in addition to human colonization. By contrast, the protected areas that show high diversity are protected by remoteness, as are the uninhabited protected areas, or their high economic value to the government and local people. In addition to colonization, other drivers of less diversity include pre-existing land claims, and illegal activities along the protected area borders. Thus as a probable consequence of these drivers, and logistic regression also advocates that management status (inhabited buffer zone, multiple-use zone, inhabited protected areas, and recently inhabited community concessions) were related to less diversity among these areas (Bray, 2004) [6]. These findings merit further exploration of other contextual factors that likely influence the outcomes in these cases. Least number of species in unprotected sites may also be due to pine needle-litter deposition on the forest floor which might have restricted germination of herbaceous flora (Gupta *et al.* 2007) [14, 15], which is in line with findings of species composition in conifer forests in Himalaya by Mukhia (2011) [21] and Dangwal *et al.* (2012) [9].

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