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Community composition, population structure and regeneration potential of tree species in Oak-dominated mixed forests of Rajouri district in Jammu and Kashmir, India.

Composición de la comunidad, estructura de la población y potencial de regeneración de especies arbóreas en bosques mixtos dominados por robles del distrito de Rajouri en Jammu y Cachemira, India.

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ABSTRACT

The study was carried out to explore the diversity and regeneration potential of trees species in mixed Oak forest of Rajouri district of Jammu and Kashmir (India). A total of 20 tree species were recorded from the area dominated by various species of oak particularly *Quercus leuchotrichophora. Quercus leuchotrichophora* shows maximum values of density, basal cover and IVI. In different localities, it has different groups of associates like *Q. floribunda, Q. semecarpifolia, Q. glauca, Buxux wallichiana, Pinus roxburghii, Aesculus indica, Rhododendron arboreum*, etc. Majority of the species show very poor regeneration, which is a matter of concern and demands for proper conservation strategies.

Keyword: forest, regeneration, oak, ecology, population dynamics.

RESUMEN

El estudio se llevó a cabo para explorar la diversidad y el potencial de regeneración de especies de árboles en el bosque mixto de robles del distrito de Rajouri de Jammu y Cachemira (India). Se registraron un total de 20 especies de árboles de la zona dominada por varias especies de roble, en particular *Quercus leuchotrichophora*. *Quercus leuchotrichophora* muestra valores máximos de densidad, cobertura basal e IVI. En diferentes localidades tiene diferentes grupos de asociados como *Q. floribunda, Q. semecarpifolia, Q. glauca, Buxux wallichiana, Pinus roxburghii, Aesculus indica, Rhododendron arboreum*, etc. La mayoría de

las especies presentan muy poca regeneración, lo cual es un asunto preocupaciones y demandas de estrategias de conservación adecuadas.

Palabra clave: bosque, regeneración, roble, ecología, dinámica de poblaciones.

INTRODUCTION

Trees provide the overall physical structure of habitat in a forest ecosystem (Singh, et al, 2016; Malik et al 2016). A forest crop, majorly represented by its tree species, continues its growth and rejuvenation through the addition of newer individuals. Every living organism tends to expand its population and thus continues its existence through its succeeding generations. Population refers to the number of individuals of a species in an area at a specific point of time. The ratio of various age groups in a population determines its reproductive status and indicates its future course (Odum, 1971). Plant species maintain and increase their populations through the process of regeneration which is the key ecological phenomenon in any community. Natural regeneration is an essential process for preservation of biodiversity and good health of an ecosystem.

Natural regeneration of tree species depends mainly on the production and germination of seeds and the establishment of new recruits that is seedlings and saplings (Rao, 2008). It is affected by environmental factors and anthropogenic pressures prevalent in a region. Demographic variables such as the recruitment, mortality and growth rates of individuals describe the population dynamics of a plant community (Watkinson, 1997) and determine its regeneration potential. Presence of sufficient number of seedlings and saplings indicates good regeneration behavior of a particular species. Inadequate number of young trees, saplings and seedlings in a population depicts poor regeneration whereas complete absence of seedlings and saplings indicates no regeneration. Regeneration potential of various woody species decides the future composition of a forest in space and time (Henle *et al.*, 2004). Reliable information on regeneration trends of woody species in a plant community not only helps in predicting the future composition of a crop but also provides basis for effective forest management and conservation.

Oak-dominated forests form an important group of vegetation in the Himalayas. Besides their huge ecological significance, they are also found closely associated with the socio-economy of the locals. However, under the influence of increased anthropogenic pressure and possible climate change-related stresses, these forests are fast shrinking in terms of area, density and diversity.

Although sufficient literature exists on ecological attributes including population dynamics of various types of vegetation in other parts of the Himalayas, little or no such information is available for Oak-dominated mixed forests of Jammu and Kashmir. Various species of oak and its associate tree species abundantly grow on the southern slope of the Pir Panjal Himalayan range in Jammu and Kashmir. They form an important group of vegetation and represent temperate broadleaved forests in the state. Like most of mountain forest ecosystems (Krauchii *et al* 2000), these forests also have a major problem of poor regeneration. The present study was undertaken with an aim to explore and describe the population structure

and regeneration potential of major tree species in Oak-dominated plantations of Rajouri forest division (which forms part the Pir Panjal range) in Jammu and Kashmir.

MATERIAL AND METHODS

Study area: Rajouri district of Jammu and Kashmir in India forms part of the mighty Pir Panjal Himalayan range. It lies between 30° 50′N and 33° 30′N latitude and 70° E and 74° 10′E longitude with an altitudinal range from 370-6000 m above sea level spreading over an area of 2630 sq km. Topography of the district varies from plains or gentle slopes to hilly and very hilly (Fig 1). The region is drained by numerous perennial rivers originating from northern snow-capped mountains. Main soil types present in the area include Utisols, Sub-Mountainous Soil (Alfisols) and Bhabar Soil (Entisols). Climate is generally mild with warmer in lower plains and harsher and cold with heavy snowfall on in upper mountainous part. Average annual rainfall is 1150 mm and average temperature varies from 7.42 to 37.4 degree Celsius. Higher reaches support characteristic alpine vegetation whereas lower slopes exhibit rich coniferous and broadleaved forests between 1000 m to 3000 m elevations. The district has 48.48% of its geographic area under forest cover (Anonymous, 2009) that supports a good deal of biodiversity including several endemic plant and animal species.

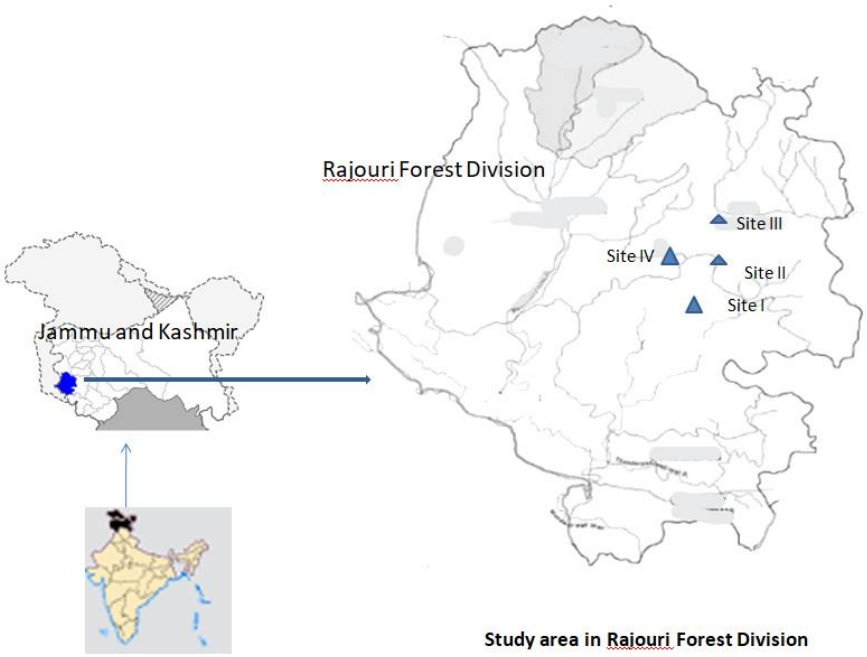

Fig 1. Map of studied site.

From Forest Management point of view district Rajouri falls under the Western Circle and is divided into two divisions namely Nowshera Forest Division and Rajouri Forest Division. Rajouri Forst Division, where this study was undertaken, comprises of three territorial ranges viz., Kalakote Forest Range, Rajouri Forest

Range and Kandi Forest Range. About 14% of total Rajouri Forest Division is comprised of broadleaved forests with Oak as the principal species (Anand, 2014).

Sampling: After the preliminary survey during 2018-19, four forest sites representing all the three territorial ranges of Rajouri forest division, were selected for data collection (Table 1). Plots of 10 ha (1000 m x 1000 m) in size, visually representatives of overall vegetation of the area, were delineated for detailed study. 20 quadrats of 20 m x 20 m size were laid randomly at each forest site for analysis of the vegetation. Nested quadrats of 1 m x 1 m and 5 m x 5 m were used for seedlings and saplings respectively. Circumference at breast height (CBH =1.37 m) was taken for the determination of tree basal area. Plants with circumference less than 10 cm, 10-30 cm and above 30 cm were considered seedlings, saplings and trees respectively.

Vegetation Analysis: The dominance of the plant species was determined by the Importance Value Index (IVI) of species. The value of IVI was computed by summation of the values of the relative frequency, relative density and relative dominance (Curtis and McIntosh, 1950; Mishra, 1968). Basal cover is considered as the portion of ground surface occupied by a species (Greig–Smith, 1983) and it was calculated by using the following formula: Tree basal area = $(G)^2/ \pi$; Where, G is girth of tree at 1.37 m π is equal to 3.14; Total basal cover= Density x Tree basal area.

Regeneration Status: Regeneration status of individual tree species was determined on the basis of their quantitative potential at different age classes in the following manner:

- Good regeneration, if seedlings> saplings >adults;
- Fair regeneration, if seedlings >or < saplings < adults;
- Poor regeneration, if the species survives only at sapling stage, but no seedlings (saplings may be>, < or = adults).
- No regeneration, if a species is present only in adult form.
- New regeneration, if the species has no adults but only seedlings or saplings.

RESULTS AND DISCUSSION

Community composition: A total of 20 tree species were recorded from the study area (Table 1). *Quercus leuchotrichophora* was the main dominant species. It showed highest values of frequency (100%), density (420 to 560 trees/ha, excluding seedlings) basal cover (55.61 m²/ha to 87.49/ha m²) and IVI (148.410 to 167.248). Other species of Oak present in the region were *Quercus floribunda*, *Quercus semecarpifolia* and *Quercus glauaca*. *Buxus wallichiana* Baill, *Quercus floribunda* and *Quercus semecarpifolia* followed in terms of IVI at various sites. Total density ranged from 770 to 975 individuals/ha whereas total basal area was between 88.84 and 133 m²/ha.

Table 1 General profile of study sites

Study site	Forest Range	Longitude/latitude	Aspect	Slope/ terrain	Anthropogenic interference
I. Gadyog, Khawas	Kalakote	74°33'E / 33°18' N	South western	Gentle	Least disturbed
II. Perinar (Jaglanoo)	Kandi	74°32'E / 33°20' N	South eastern	Steep	Moderately disturbed
III. Badhal Mahl	Kandi	74°33'E / 33°20' N	Western	Gentle	Disturbed
IV. Rehan	Rajouri	74°28'E / 33°23' N	South eastern	Gentle	Disturbed

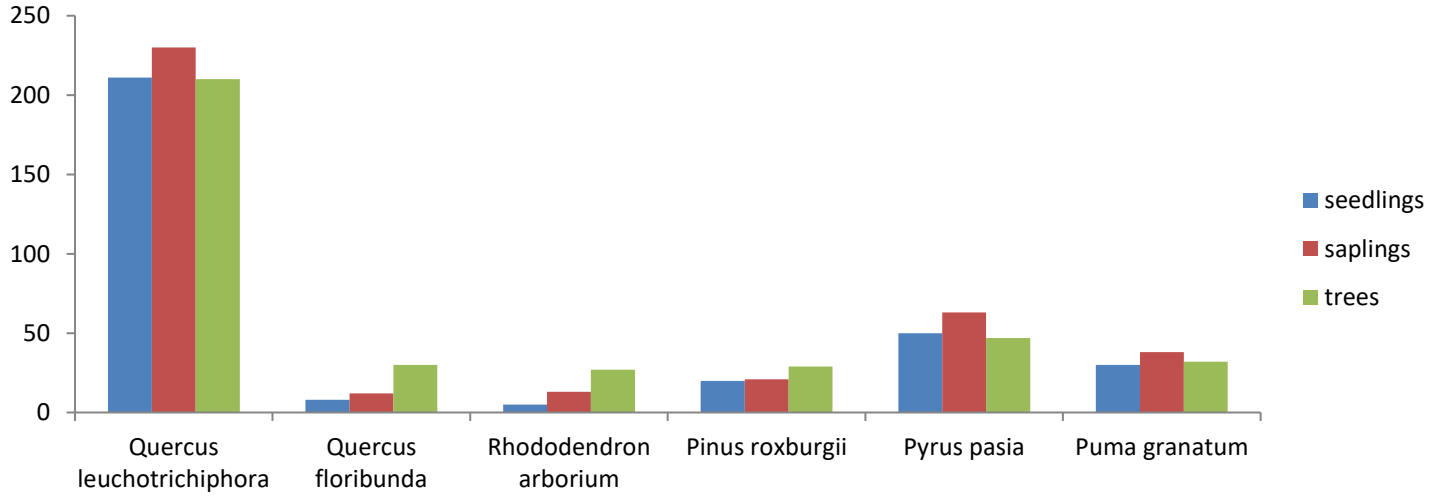

Figure 2 Proportion of seedlings, saplings and trees of various species at Site I

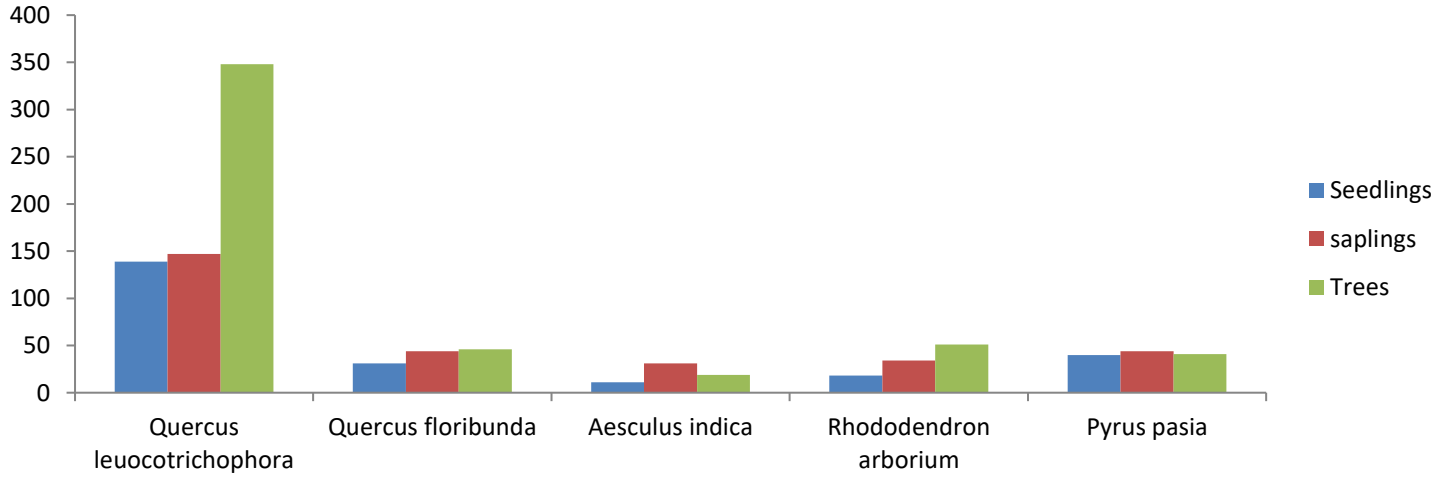

Figure 3 Proportion of seedlings, saplings and trees of various species at Site II

Quercus leuchotrichophora was dominant in the entire study area but has different groups of associates in different localities like *Pinus roxburghii* (IVI= 11.941), *Xanthoxylum aratum* (IVI=9.004), *Morus alba* (IVI=10.772), etc. at site I, *Quercus floridunda* (IVI=39.216), *Lyonia ovalifolia* (IVI=9.108), *Aeseculus indica* (22.882) at site II, *Quercus semecarpifolia* (IVI= 11.924), *Quercus floribunda* (IVI=54.399), *Buxus wallichiana* (IVI=31.210), etc. at site III and *Quercus glauca, Pinus roxburghii* etc., at site IV. Several trees like *Rhododendron arboreum, and Pyrus pashia* etc. were present almost ubiquitously in the entire region.

Community structure, floral composition, diversity and other ecological attributes of vegetation in a region are mainly determined by its geographic location, climate, soil conditions and other environmental factors. Floral composition of the studied area is similar as reported by other workers for temperate moist forests of the western Himalayas (Singh, et al, 2016, Malik, et al, 2014, 2016). Forest area is dominated by various species of Oak, particularly *Quercus leuchotrichophora,* which is believed to be the climax species of the mid altitudes in the western Himalayas (Singh and Rawat, 2012; Troup, 1921).

Population structure and regeneration potential: Population structure of major trees species (with higher IVI) is summarized in Table 2. At Site I. *Quercus leuchotrichophora* showed almost an equal number of trees (210) and seedlings (211) but slightly higher number of saplings (230). *Pyrus pashia* showed a higher number of seedlings (50) and saplings (63) than trees (47). *Rhododendron arboreum* and *Quercus floribunda*, however, had very low number of seedlings and saplings (Figure 1). At site II all tree species except *Pyrus pashia* had very low number of seedlings and saplings in comparison to adult trees (Figure 2). *Quercus leuchotrichophora* had 139 seedlings and 147 saplings against 348 adult trees. *Quercus floribunda* also showed lower density of seedlings (31) and saplings (44) than its adult trees (46). *Aesculus indica* had 11 seedlings, 31 saplings against 19 trees. *Rhododendron arboreum* has highest number of trees (51) followed by saplings (34) and seedlings (18), which shows extremely poor regeneration behavior. *Pyrus pashia*, however, had almost equal number of seedlings (40), saplings (44) and trees (41).

A comparatively better density of saplings (287) and seedlings (205) was observed for *Quercus leuchotrichophora* against its adult trees (233) at site III (Figure 3). *Buxus wallichiana* showed a density of 63 seedlings and 75 saplings against 40 trees. *Quercus floribunda*, however, had 32 seedlings, 59 saplings and 61 trees. At Site IV all the species except *Pyrus pashia* and *Pinus roxburghii* showed poor seedling density *Quercus leuchotrichophora* had 121 seedlings, 298 saplings and 262 trees (Figure 4).

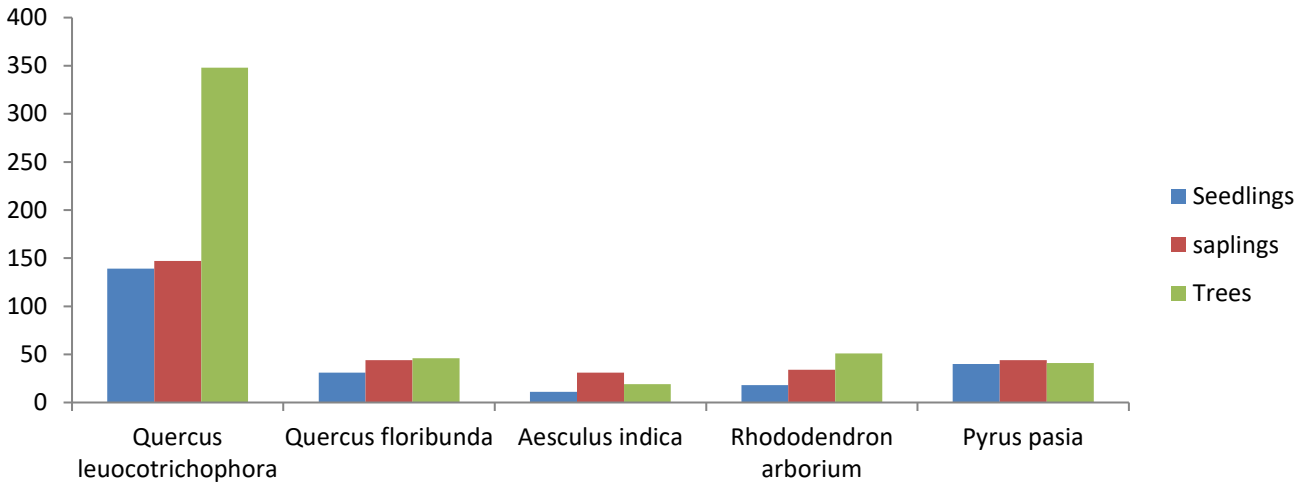

Figure 4 Proportion of seedlings, saplings and trees of various species at Site III

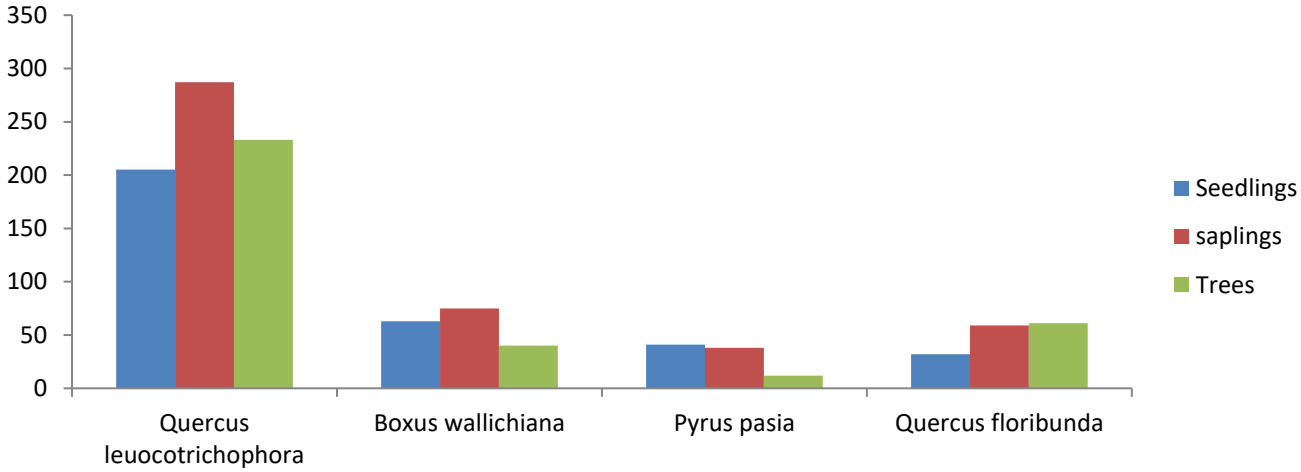

Figure 5 Proportion of seedlings, saplings and trees of various species at Site IV

Table 2. Phytosociological characteristics of study area

Species	Site I			Site II			Site III			Site IV		
	Density (per ha)	Basal cover (m^2/ha)	IVI	Density (per ha)	Basal cover (m^2/ha)	IVI	Density (per ha)	Basal cover (m^2/ha)	IVI	Density (per ha)	Basal cover (m^2/ha)	IVI
Quercus leuocotrichophora	440	55.617	148.410	495	87.496	167.248	420	75.239	162.868	560	53.949	178.340
Quercus floribunda	40	4.212	16.470	90	15.274	39.216	120	16.647	54.399	-	-	-
Q. semecarpifolia	-	-	-	-		-	25	1.274	11.924	-	-	-
Aesculus indica	-	-	-	-	-	-	20	1.997	11.996	11	1.099	6.837
Lyonia ovalifolia	-	-	-	-	-	-	15	2.616	8.259	-	-	-
Pyrus pashia	110	1.696	27.495	95	2.723	26.122	55	1.095	19.345	53	1.141	21.845
Pinus roxburghii	50	1.248	11.941	-	-	-	-	-	-	112	11.386	44.652
Punica granatum	70	0.321	15.146									
Ficus palmata	60	1.342	13.103	-	-	-	-	-	-	-	-	-
Zanthoxylum armatum	35	0.285	9.004	-	-	-	-	-	-	-	-	-
Celtis australis	35	0.642	10.772	-	-	-	-	-	-	-	-	-
Species		Site I			Site II			Site III			Site IV	

	Density (per ha)	Basal cover (m²/ha)	IVI	Density (per ha)		Density (per ha)	Basal cover (m²/ha)	IVI	Density (per ha)		Density (per ha)	Basal cover (m²/ha)
Morus alba	10	0.103	3.676	-	-	-	-	-	-	-	-	-
Melia azaderachta	20	0.382	7.607	-	-	-	-	-	-	21	1.354	14.441
Ulmus wallichiana	20	0.464	6.476	-	-	-	-	-	-	-	-	-
Buxux wallichiana	-	-	-	-	-	-	115	1.465	31.210	-	-	-
Quercus glauca	-	-	-	-	-	-	-	-	-	115	1.465	23.174
Acacia catechu	-	-	-	-	-	-	-	-	-	13	2.267	10.712
Rhododendron arboreum	40	1.561	16.369	85	16.681	35.423	-	-	-	-	-	-
Bombax ceiba	20	0.536	5.329	-	-	-	-	-	-	-	-	-
Grevia optiva	25	0.440	8.203	-	-	-	-	-	-			
Total	975	68.84		840	133.04		770	100.33		885	72.66	

Table 3 Density of seedlings, saplings and trees of major species

Species	Site I			Site II			Site III			Site IV		
	Seedlings	Saplings	Trees	Seedlings	Saplings	Trees	Seedlings	Saplings	Trees	Seedlings	Saplings	Trees
Quercus leuchotrichiphora	211	230	210	139	147	348	205	287	233	121	298	262
Quercus floribunda	8	12	30	31	44	46	32	59	61	-	-	-
Quercus glauca	-	-	-	-	-	-	-	-	-	11	39	76
Pinus roxburghii	20	21	29	-	-	-	-	-	-	56	61	51
Pyrus pashia	50	63	47	40	44	41	41	38	12	32	35	28
Punica granatum	30	38	32	-	-	-	-	-	-	-	-	-
Aesculus indica	-	-	-	11	31	19	-	-	-	-	-	-
Buxus wallichiana	-	-	-	-	-	-	63	75	40			
Rhododendron arboreum	5	13	27	18	34	51	-	-	-	-	-	-

Analysis of population structure of various species indicates poor or average regeneration behaviour for majority of the tree species. *Quercus leuchotrichophora* showed poor regeneration at all sites. *Rhododendron arboreum* and *Quercus floribunda* which were present at three out of four sites also showed very poor regeneration. *Pyrus pashia* and *Pinus roxburgii*, however, showed a better density of seedlings and saplings and this indicated their good regeneration potential. *Buxus wallichiana*, an endemic species with very restricted distribution in the Pir Panjal region, present at one site (Site III), showed good regeneration behavior. Bhat (2012), Ballabha et al. (2013) and Singh et al. (2016) observed much better trends of regeneration for similar forests in some other parts of the Himalayas. Poor regeneration of majority of the tree species including *Quercus leuchotrichophora* can be attributed to various natural as well anthropogenic factors. Among natural factors species fecundity, site conditions, climatic change etc., are very important determinants that affect seed production and dispersal of seeds as well as germination, growth and survival of the seedlings. Biotic interference like deforestation, grazing, lopping, forest fires, etc. also affect forest regeneration. The locals in the entire Pir Panjal belt heavily rely on nearby forests and thus exert tremendous pressure on them. Oak, for its multiple uses including as fodder, fuel wood, timber, etc., face serious threats in the area.

The species showing poor or no regeneration are actually at high risk of depletion even if they are dominant at present (Nowacki and Abrams, 2008; Malik and Bhatt, 2016). The situation, thus, demands for an immediate and appropriate management and conservation strategy for the Oak-dominated forests of Jammu and Kashmir.

As conclusion, the area is rich in woody vegetation with Oak dominating the canopy. However, most of the tree species show very poor regeneration behaviour, which is a matter of great concern and demands immediate attention for implementation of appropriate conservation and management strategies.

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