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Temporal Changes in Tree Species Composition in Karsog Area of Northwest Himalaya

Harish Bharti*, Pankaj Sharma, Kiran Lata, Abhay Mahajan, Ritesh Kumar, Priyanka Sharma and S. S. Randhawa

Himachal Pradesh Centre on Climate Change (HPCCC), Himachal Pradesh Council for Science Technology and Environment (HIMCOSTE), Vigyan Bhawan Bemloe, Shimla 171 001, Himachal Pradesh, India

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ABSTRACT The forests of Karsog Forest Division in Himachal Pradesh were temporally analyzed for change in tree species composition. These are based on the species composition in different communities and variations along the different altitudinal gradients. The enumeration records were procured from the forest department. Total 143 forest compartments were analyzed to study the change in tree species in thirteen delineated communities, out of which six were pure forest communities and seven were mixed forest communities. The change in density (Ind/ha) in tree species was calculated between two enumeration years, that is 1986 and 2013. Results showed that out of thirteen communities, only three pure communities viz., *Pinus roxburghii, Abies pindrow* and *Quercus leucotrichophora* showed increased density while other pure communities showed decreased density in two enumeration years. Altitudinal based study revealed that the lowest altitudinal gradient (1000-2000 m) showed increase in tree density while in 2000-3000 m zone a gradual fall in tree density was observed temporally.

INTRODUCTION

India is one of the biodiversity rich countries where the forests cover is about 7,08,273 sq km, or 21.54 percent of the country (ISFR 2017). The forest productivity in Indian forests is roughly one tenth of its potential which is due to the growing biotic pressure and inadequate resources for scientific forest management (FAO Report 1997). In the past few decades, a decline in the forest area had sought attention because of the environment impact observed at local, regional and global scales (Cabrera and Vilatta 2013). Thus, reduction in the size of the forests and significant changes in the pattern of the natural landscapes have led to the global climate change (Dale 1997; Watson et al. 2000; Leuzinger et al. 2011; Abdalla et al. 2013). The diversity of tree species is fundamental to total forest biodiversity, because trees provide resources and habitats for almost all other forest species (Huston 1994).

The forests of Himachal Pradesh known for their grandeur and majesty are like a green pearl in the Himalayan crown. Himachal's most important and most voluminous, biological resource is its forest wealth. The forests of Himachal Pradesh play a vital role in the unique Western Himalayan ecosystem by conserving the integrity of the upper watersheds of five major Indian rivers (Chenab, Ravi, Beas, Sutlej and Yamuna), sustaining the agro-pastoral livelihoods of hill peoples and balancing the economy of this small hill state. Out of a total area of 55,673 sq. km. the forests are legally classified into reserved forests (5.12%), demarcated protected forests (30.75%), un-demarcated protected forests (58.48%), unclassed forests (2.63 %), and other forests (3.02%) (H.P. Forest Department).

The wide range of altitudes and climatic conditions in the state sustain a variety of forest types including moist tropical, dry tropical, montane subtropical, montane temperate, sub- alpine and alpine scrub. In general, these categories represent decreasing departmental control and an increase of local rights within them. The richness and diversity of our flora can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the State (Chowdhery and Wadhawa 1984). The forests of Himachal Pradesh are rich in vascular flora, which forms

* *Address for correspondence:*
Mobile: +918894376140, +917018630489
E-mail: harishbharti733@gmail.com

the conspicuous vegetation cover. In view of rich floral diversity of the State and pressures on the forests and subsequently on the lower ecosystems, it seems imperative to study the temporal changes in the tree species, which is hitherto absent. Several studies evaluating the impact of climate change on forest ecosystems in India have been published recently (for example, Chaturvedi et al. 2011; Gopalakrishnan et al. 2011). However, most of these studies lack an assessment of expected development at the local level (Upgupta et al. 2015). Evidence collected at local climate stations in the Himalayas overwhelmingly show a warming trend, albeit at different rates and in different periods depending on specific regional and seasonal circumstances (Gautam et al. 2013).

To observe the temporal change in tree species compositions Forest Working Plans were consulted for the data. Forest division is the basic unit for working plan. Working plan is a document of management aiming at continuity of policy and action and controlling the treatment of a forest. It is essential to periodically update the working plans so that to keep pace with trends emerging out in forest-people interface.

The Mandi forest circle has five forest divisions viz. Joginder Nagar, Mandi, Suket, Nachan and Karsog forest division. But the Karsog area was considered for the study because it has well maintained enumeration records. Therefore, this study was planned to analyze the temporal changes in the species composition based on the data of forest working plans.

Objective

The objective of research is to study the tree species composition which are conifers, oak and broad leaved of Karsog Forest Division. Secondly, this study provides status of forests by analyzing the Karsog's forests temporally and also find out the possible reasons behind the increase or decrease of conifer and oak species.

MATERIAL AND METHODS

Study Area

District Mandi is situated between 31° 13'' to 32° 04' N and 76°37' to 77°23' E in the center of Himachal Pradesh, northwest Himalaya, having total area 3959.604 sq. km. Tehsil Karsog in district Mandi is a beautiful place situated in the lap of Himalayas, near Shimla, at a height of 1,404 m. It lies in the Pir Panjal range of Himalayas bordering Shimla and Kullu districts.

Karsog falls under 'North Western Himalayan Hill Zone', agro-climatic region of India which falls under sub temperate humid region. The soil of the area is mainly sandy loam to silty clay loam. The depth of the soil is shallow to moderate deep. The topography of area is moderate to steep having slope of 15-60 percent (Project Report 2011).

Methods

Enumeration records of various tree species (in two different years 1986-87 and 2013-14) were taken from working plans and compartment history files and analyzed for species composition and density change. There are total four forest ranges in Karsog Forest Division viz., Karsog, Pangna, Seri and Magroo (Fig. 1 and Table 1). The various forest compartments were polled together and different communities were delineated as per 2013-14 enumeration records. If more than 50 percent representation of a single tree species, then we categorized it as single species dominant pure community and if more than one species is contributing to make 50 percent of the relative density, then it is delineated as a mixed community (Rana and Samant 2009). Furthermore, the forests were classified into four different altitudinal zones viz. 1000-1500 m, 1500-2000 m, 2000-2500 m and 2500-3000 m. The Karsog Forests Division has total forest cover under 22,365.9 hectares area (Table 1) distributed in four forest ranges out of which 6,547 hectares area (Table 2) was used to study the community-based variation. Only 29 percent of area of total forest were accessed as sample in the study because of data unavailability and change in the enumeration methods of forests in subsequent years. For altitudinal variations in tree species composition only 6,318.31-hectare area (Table 3) was used which was not same as area taken to study the tree communities. Because three compartments were lacking the altitudinal information so they were not included in the study.

The temporal data was collected from working plans and compartment history files which were procured from the library of the HP Forest department and from the Karsog Forest Divi-

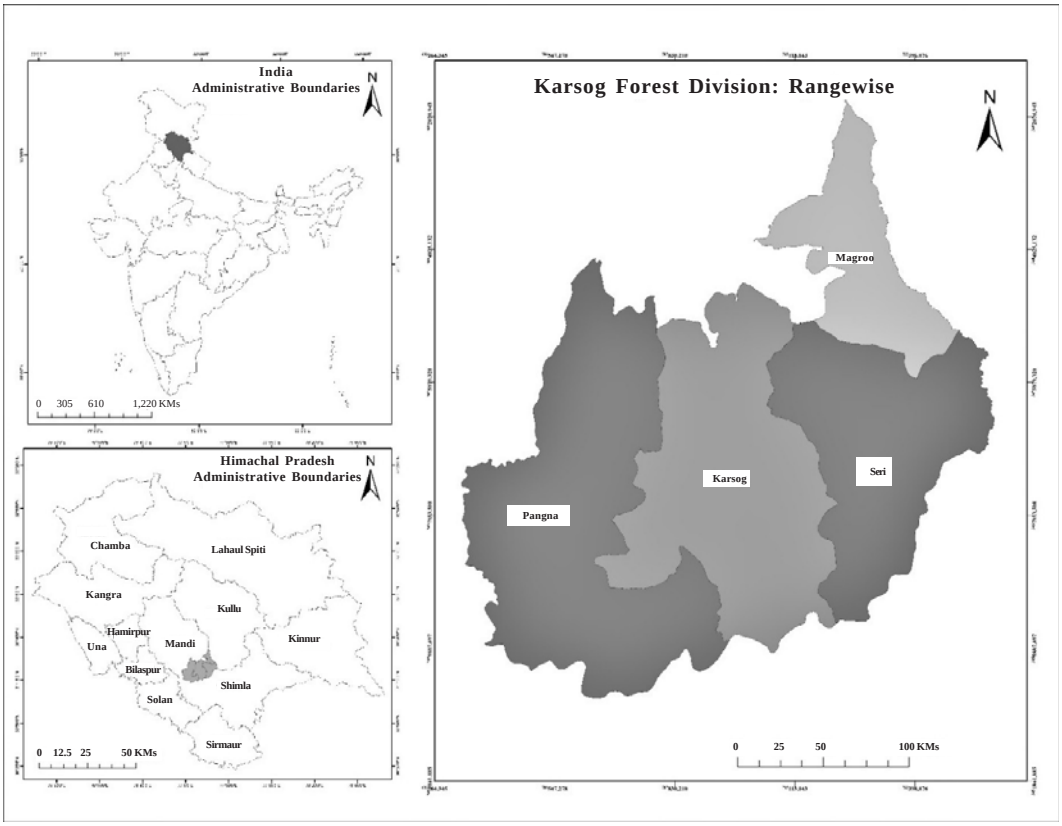

Fig.1. Map showing locations of different forest ranges of Karsog Forest Division, Himachal Pradesh
Source: Forest Department of Himachal Pradesh

sion and its respective ranges. The change in the density of trees (Individuals/ha) in subsequent years was analyzed. However, the enumeration results of working plan comprise of only major economically important tree species of the region, therefore the density calculated and compared will be of individuals species and not the total of the community. The present study was aimed to find changing species density in different communities or altitudinal gradients during last 27 years.

Table 1: Status of Karsog Forest Division (As per Working plan oldest; 1986-1987 and latest; 2013-2014) showing Forest ranges, locations, number of compartments and total area of ranges

S. No.	*Forest range*	*Location under forest range*	*No. of forest/comp.*	*Total area (ha)*
1	Karsog Forest Range	Tehsil Karsog	47	6565.16
2	Pangna Forest	Sub Tehsil Nihri	8	1593.67
	Range	Tehsil Karsog	45	5028.2
3	Seri Forest Range	Tehsil Karsog	25	5565.37
4	Magroo Forest	Karsog Tehsil	5	1503.9
	Range	Thunag Tehsil	20	2109.6
	Total 4 Ranges	Total	150	22365.9

RESULTS

The enumeration records of the total 143 forests having area of 6,547 ha were analyzed in two different years.

Community Based Studies

The forests of Karsog Forest Division were delineated into thirteen different communities. There were six pure communities that is *Pinus roxburghii, Pinus wallichiana, Cedrus deodara, Picea smithiana, Abies pindrow, Quercus leucotrichophora* community and seven mixed communities viz. *Pinus roxburghii-Pinus wallichiana, Pinus roxburghii*-Broad leaved, *Pinus wallichiana-Quercus leucotrichophora, Quercus leucotrichophora*-Broad leaved, *Cedrus deodara*-Broad leaved, *Cedrus deodara-Pinus wallichiana* and *Pinus wallichiana*-Broad leaved mixed community. All the details of no. of compartments, altitude range, area, forest ranges and total density (Ind/ha) and change in the communities are mentioned (Table 2).

Pure Communities

The Karsog forest division is having *Pinus roxburghii* as the dominant community represented by total 86 forest compartments, covering total area of 3973.9 ha (61% of total) and having a wide altitudinal range varying from 800-2420 m. The community covers all the four forest ranges viz., Karsog, Pangna, Seri and Magroo. The total density of the enumerated trees of the community increased by 91 Ind/ha wherein it changed from 265 Ind/ha to 356 Ind/ha in the two subsequent years (Table 2). Most significant change in this community was in the density of *Pinus roxburghii* which increased from 209 to 321 Ind/ha. The density of *Quercus leucotrichophora* drastically decreased from 27 to 7 Ind/ha (Fig. 2).

Pinus wallichiana community has 11 forest compartments having an area of 394.96 ha and distributed from 1500 to 2284m altitudinal range. The community was represented in only two forest ranges (Seri and Magroo). The total density of this community decreases from 172 to

Table 2: Communities showing compartments, altitudinal range, area, Periodic Blocks, ranges and temporal changes in density

	Tree communities							
S. No.	*Communities*	*No. of compartments*	*Altitudinal range (m)*	*Area (ha)*	*Forest ranges*	*Density 1986*	*Density (Ind/ha) 2013*	*Change in density (Ind/ha)*
1	*Pinus roxburghii*	86	800-2420	3973.9	Karsog, Pangna, Seri, Magroo	265	356	+91
2	*Pinus wallichiana*	11	1500-2284	394.96	Seri, Magroo	172	103	-69
3	*Cedrus deodara*	19	1460-2834	902.33	Karsog, Pangna, Seri, Magroo	443	263	-180
4	*Picea smithiana*	5	1828-3090	300.02	Magroo	353	108	-245
5	*Abies pindrow*	4	1960-2980	152.38	Magroo	218	414	+196
6	*Quercus leucotrichophora*	3	1180-2140	168.95	Karsog, Seri	165	102	-63
7	*Pinus roxburghii -Pinus wallichiana*	5	1360-2112	336.55	Karsog, Pangna, Seri, Magroo	124	254	+130
8	*Pinus roxburghii* -Broad leaved	2	1360-1800	45.17	Karsog, Seri	344	630	+286
9	*Pinus wallichiana- Quercus leucotrichophora*	1	2160-2330	38.52	Magroo	132	625	+493
10	*Quercus leucotrichophora* - Broad leaved	1	2160-2500	27.37	Magroo	559	401	-158
11	*Cedrus deodara*-Broad leaved	1	1828-2499	44.15	Magroo	799	493	-306
12	*Cedrus deodara -Pinus wallichiana*	4	1768-2560	131.02	Magroo	266	275	+9
13	*Pinus wallichiana*- Broad leaved	1	1860-2200	31.19	Magroo	309	496	+187
	Total	143		6547	4			

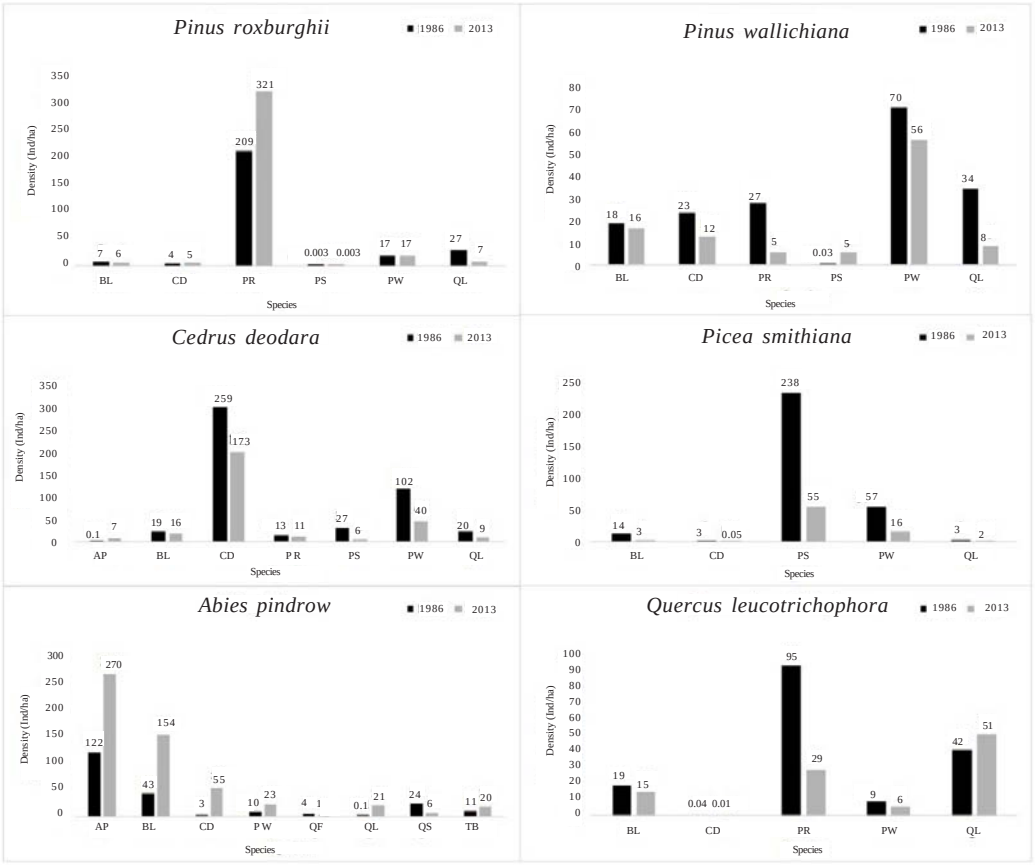

Fig. 2. Community wise change in species composition within six pure communities showing density (Ind/ha)

Abbreviations used: AP= *Abies pindrow*; BL= Broad leaved; CD=*Cedrus deodara*; PS=*Picea smithiana*; PR=*Pinus roxburghii*; PW=*Pinus wallichiana*; QF= *Quercus floribunda*; QL= *Quercus leucotrichophora*; QS= *Quercus semecarpifolia*; TB=*Taxus baccata*

103 Ind/ha (Table 2) in two respective years that is 1986 and 2013. *Pinus wallichiana* density decreased to 56 Ind/ha from 70 Ind/ha in last 27 years (Fig. 2).

Cedrus deodara community comprising of 19 forests compartments covering the total area of 902.33 ha having all the four forest ranges of the division were representing nearly 14 percent of the total area. The altitudinal range of this community varies from 1460-2834 m. The total density of enumerated species in the community was decreased from 443 to 263 Ind/ha in the two respective years. A marked difference was observed in the fir and spruce dominant communities wherein the density of spruce was profoundly decreased and that of fir increased.

Spruce (*Picea smithiana*) community has 5 forest compartments (area 300.2 ha) which falls only under Magroo forest range of the division having altitudinal range of 1828-3090 m. The total density of the community substantially decreased from 353 to 108 Ind/ha where the major contributor for this decline was *Picea smithiana* wherein its density changed from 238 to 55 Ind/ha in last 27 years (Table 2 and Fig. 2).

Fir (*Abies pindrow*) community on the other hand has 4 forests compartments covering 152.38 ha area distributed in Magroo forest range at an

altitudinal range of 1960-2980 m. The total density of enumerated species in the community was appreciably increased from 293 to 550 Ind/ha. The density of *Abies pindrow* has increased from 122 to 270 Ind/ha in the two assessment years (Table 2 and Fig. 2). Besides increasing the density of dominant species, the other species in this community for example like *Cedrus deodara, Pinus wallichiana* and *Taxus baccata* also showed increased densities. While density of *Quercus floribunda* and *Quercus semecarpifolia* decreased.

Quercus leucotrichophora community was represented by 3 compartments covering an area of 168.95 ha. The altitudinal range was from 1180-2140 m which falls in Karsog and Seri forest ranges. The total enumerated species density of the community changed from 165 to 102 Ind/ha. The density of *Pinus roxburghii, Pinus wallichiana* and broad-leaved species decreased substantially while a slight increase was observed in *Quercus leucotrichophora*, that is from 42 to 51 Ind/ha. Since, *Pinus roxburghii* was the dominant tree community in 1986 but its density decreases temporally from 95 to 29 Ind/ha and in recent enumeration *Quercus leucotrichophora* become the dominant (Fig. 2).

Mixed Communities

There were total seven mixed forest communities which have been delineated in the Karsog forest division, comprising of 15 forest compartments (654 ha). Out of these seven mixed communities only two communities that is *Pinus roxburghii-Pinus wallichiana* and *Cedrus deodara-Pinus wallichiana* have both dominated and co-dominated conifer species, the remaining 5 communities are composed of conifer and broad-leaved species in mixed form. The *Pinus roxburghii-Pinus wallichiana* mixed tree community have an area of 336.55 ha (Table 2) of five different compartments falling in Karsog Seri, Pangna and Magroo forest ranges. *Cedrus deodara-Pinus wallichiana* mixed communities have an area of 131.02 ha (Table 2) and have four compartments occurs only in Magroo forest range. The total density of *Pinus roxburghii-Pinus wallichiana* mixed community was increased from 124 to 254 Ind/ha (Table 2) and all the species that is Broad-leaved, *Cedrus deodara* and *Quercus leucotrichophora* showed increased density (Fig. 3). While, the total density of *Cedrus deodara-Pinus wallichiana* mixed tree community was increased from 266 to 275 Ind/ha (Table 2) and all species in this community showed increased density except *Abies pindrow* and *Cedrus deodara* (Fig. 3) community showed increased density except *Abies pindrow* and *Cedrus deodara* (Fig. 3). The remaining 5 mixed communities has conifer and broad-leaved combinations except one community that is *Quercus leucotrichophora*-Broad leaved, where both species were broad leaved. Mixed communities are represented by very smaller number of forest compartments due to the unique and isolated ecology of Magroo forest range except *Pinus roxburghii*-Broad leaved of Karsog and Seri forest range (Table 2 and Fig. 3). *Pinus roxburghii*-Broad leaved mixed community has only 2 compartments (area 45.17 ha) having an altitudinal range from 1360 to 1800 m, comprising of five species which showed increased density. The overall increase in enumerated species density was from 344 to 630 Ind/ha in two years of enumeration. The mixed communities of *Pinus wallichiana-Quercus leucotrichophora, Quercus leucotrichophora*-Broad leaved, *Cedrus deodara*-Broad leaved and *Pinus wallichiana*-Broad leaved consists of only one forest compartment in each mixed community, each falling in Magroo forest range wherein altitude varies from 1828-2560 m (Table 2 and Fig. 3).

Species Wise Temporal Changes in Different Altitudinal Gradients

The forests of Karsog forest division were categorized in four altitudinal zones that is 1000-1500 m, 1500-2000 m, 2000-2500 m and 2500-3000 m (Table 3). The value of altitudinal zones of compartments were normalized to their average values and placed in above mentioned zones.

Altitudinal range 1000-1500 m has total 14 forest/compartments and comprising of 496.21-hectare area falling in three forest ranges viz. Seri, Karsog and Pangna. Ecologically, this altitude is suitable for *Pinus roxburghii* showing its dominance in almost all forest compartments. The density of *Pinus roxburghii* was increased from 143.6 to 217.4 Ind/ha (1986-2013 respectively) while that of *Pinus wallichiana* decreased

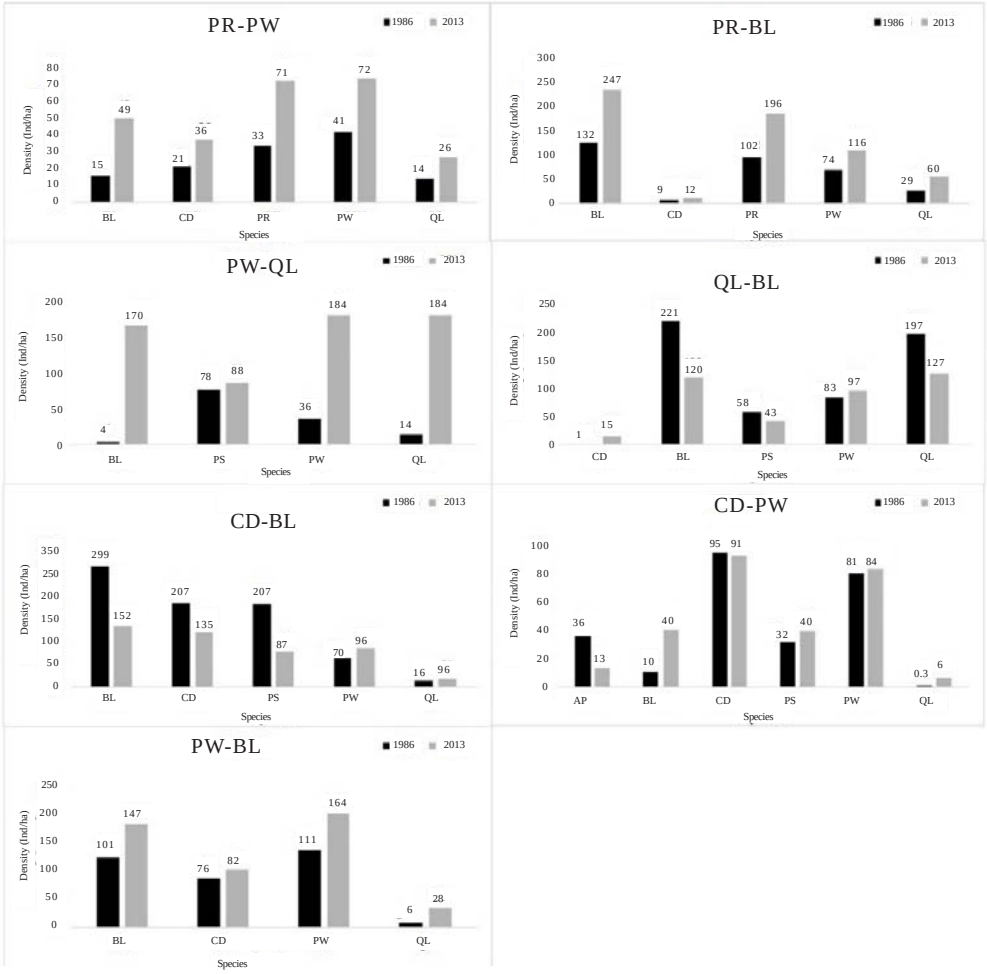

Fig. 3. Community wise change in species composition in 7 mixed communities
Abbreviations used: PR= *Pinus roxburghii*, PW=*Pinus wallichiana*, CD=*Cedrus deodara*, PS=*Picea smithiana*, AP=*Abies pindrow*, QL=*Quercus leucotrichophora* and BL=Broad leaved.

substantially and other species doesn't show significant change but the overall density of all species was increased (Fig. 4). In 1500-2000 m, altitudinal zone has 88 compartments which cover nearly 65 percent area. The density of *Pinus roxburghii* was 184 Ind/ha in year 1986 which

Table 3: Different altitudinal gradients showing Forest ranges, number of compartments, total area

S. No.	*Altitudinal ranges*	*No. of forest/comp.*	*Total area*	*Forest ranges*
1	1000-1500m	14	496.21	Seri, Karsog, Pangna
2	1500-2000m	88	4099.39	Seri, Karsog, Pangna, Magroo
3	2000-2500m	31	1353.23	Seri, Karsog, Pangna, Magroo
4	2500-3000m	7	369.48	Magroo
	Grand Total	140	6318.31	4

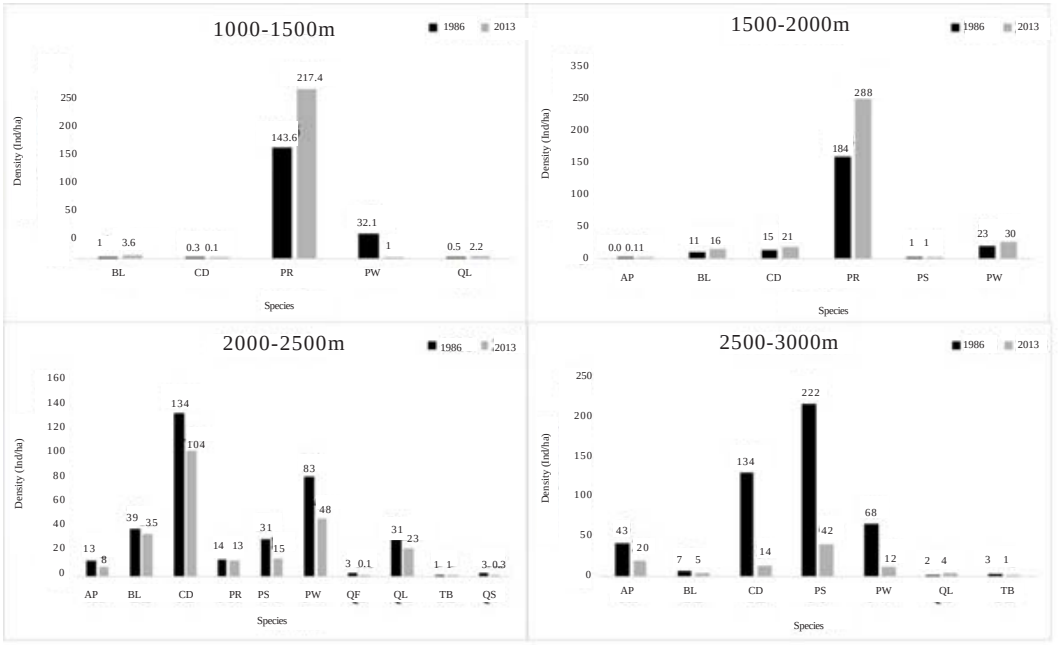

Fig. 4. Altitudinal gradient wise temporal change in species density
Abbreviations used: PR= *Pinus roxburghii*, PW=*Pinus wallichiana*, CD=*Cedrus deodara*, PS=*Picea smithiana*, AP=*Abies pindrow*, QL=*Quercus leucotrichophora*, QS=*Quercus semecarpifolia*, QF=*Quercus floribunda*, TB=*Taxus baccata* and BL=Broad leaved.

increased to 288 Ind/ha in year 2013. Other species like *Abies pindrow*, *Cedrus deodara* and *Pinus wallichiana* and other broad leaved showed its presence in this zone with slight increase in density (Fig. 4). Altitudinal gradient, 2000-2500 m has 31 compartments with an area of 1353.23 ha which covers nearly 21.5 percent area. Total 10 species have been enumerated in this gradient. All species in this range showed a decreased density in the two respective years of enumerations. The 2500-3000 m altitudinal zone has 7 forest compartments covering 369.48-hectare area and all the compartments are from Magroo forest range. All species viz. *Abies pindrow*, *Cedrus deodara*, *Picea smithiana*, *Taxus baccata*, *Pinus wallichiana* and Broad-leaved (except *Quercus leucotrichophora*) of this altitudinal gradient showed a significant decrease in density in two assessment years.

DISCUSSION

The present study was done to analyze the temporal change in tree species composition of Karsog Forest Division based on the enumerations as per forest working plans (systematically enumerates only major tree species). The study revealed the status of change in tree species present in different delineated communities and also the variations along altitudinal gradients.

The number of individuals of *Abies pindrow* in its own pure community showed a significant increase as they were nearly doubled. The community has decent altitudinal variations from 1960 to 2980 m which fall under Magroo range. The significant increase in *Abies pindrow* species might be due to the good regeneration, habitat suitability and less anthropogenic pressure. The other reason of its increased density might be due to behind its safeness in the forest due the less dependency of the local stakeholders. *Cedrus deodara* in this community, was also increased from 3 to 55 Ind/ha which might be due to the extensive plantation measures by forest department of Himachal Pradesh as this is one of the key target species of the department. While the broad-leaved species composition in this tree

community has increased due to the less dependency of local stakeholders and suitable moisture regime for growth and regeneration. However, *Abies pindrow* species in mixed community of *Cedrus deodara-Pinus wallichiana* showed sharp decrease from 36 to 13 Ind/ha. A decrease was observed in *Cedrus deodara* from 259-173 Ind/ha (from year 1986 to 2013) in its own community which contributes more to overall decrease in density of community. This decrease might be due the extensive use of this for timber by the local stakeholders, unregulated felling during the timber distribution and encroachment. In pure community of *Abies pindrow* and mixed community of *Pinus wallichiana-Quercus leucotrichophora, Cedrus deodara* showing visible increase in population that was 3-55 Ind/ha and 4-170 Ind/ha respectively due to less anthropogenic pressure. The reason behind the increase in the mixed community was because combination of different life forms such as conifer and broad-leaved trees were widely observed throughout the northern Hemisphere (Braun 1964; Pastor and Mladenoff 1992) and also seen in this part of Himalaya.

Temporal change of *Pinus roxburghii* in its pure community showed significant increase from 209 to 321 Ind/ha (from year 1986 to 2013 respectively). This increase was due to the habitat suitability, hardiness, high adaptability and high regeneration capacity of this species. Another reason of its increase are extensive plantation measures taken up by the government, for pine resin extraction to generate revenue income (as per H.P. govt. report *Pinus roxburghii* resin extraction for year 2016 was 5931 quintals in Karsog forest division). Status of this species in other pure communities showed a little decrease in population while in mixed communities it increased substantially. Forests of Karsog division experience forest fires every year in summers with great loss of biodiversity and *Pinus roxburghii* in particular, was acutely affected and targeted. Besides these factors and others like overexploitation by the local stakeholders, it successfully acclimatizes itself with nature's unfavorable conditions and maintains its existence in the forest.

The number of *Picea smithiana* in its dominant pure community was significantly decreased while in *Pinus wallichiana-Quercus leucotrichophora* and *Cedrus deodara-Pinus wallichiana* mixed community showed a visible increase in population (Fig. 3). One of the possible reasons behind its sharp decline might be due to attack of insect viz, *Euzophera cedrella, Laspeyresia ethelinda* to cones and seeds and *Eucosma hypsidryas* to damages buds (Kulkarni and Joshi 1998). If its reproductive part like cones and buds get affected or attacked it is difficult to maintain the existence in next generation. Magroo forest range of Karsog Forest Division occupy most of the area of this species which is considered to be suitable for apple orchard growing consequently, people encroach these forests resulting in declining its population.

The *Pinus wallichiana* forests are extensively located in Seri and Magroo ranges of the division. The total density of *Pinus wallichiana* community decreases from 172 to 103 Ind/ha in two respective years that is 1986 and 2013 while *Pinus wallichiana* species density decreased to 56 Ind/ha from 70 Ind/ha in last 27 years (Table 2 and Fig. 2). Seri and Magroo forest ranges of Karsog forest division have good moisture regime and ecology which is suitable for horticulture crops and exclusively recommended for apple orchard. Therefore, unregulated felling, heavy encroachment and dependency of local stakeholder for fuel and timber might be resulting in declining its population. Other species of this community are also severely affected by the anthropogenic pressure, people depends upon other broad-leaved species like *Quercus leucotrichophora* for fuel, fodder and timber etc. consequently heavily reducing the population. The *Quercus leucotrichophora* community was showing marginal increase in density that is 42 to 51 Ind/ha but the overall density of community was declining. In other pure communities *Quercus leucotrichophora* showing a negative trend. The forest fire was the main reason for its decline because of its mosaic occurrence in *Pinus roxburghii* and *Pinus wallichiana* forests which affects this species most. While the viability of this species after forest fire was very low (due to its sensitiveness and susceptibility to temperature) as compared to other broad-leaved species.

The species densities were also compared along the altitudinal gradients in the division to assess the temporal change in population. The density of *Pinus roxburghii* in altitude gradient

1000-1500 m in year 1986, was 143.6 Ind/ha which increased to 217.4 Ind/ha in 2013. Above this range that is 1500-2000 m this species was still in good number, while the other species in these two altitudinal ranges were very less in number. This was due to the fact that the forests are pine dominant forest. Moreover, the government of Himachal Pradesh to promote its plantations to strengthen the revenue as its demand for timber, fuelwood, for resin extractions as already discussed. The next species in this gradient was *Pinus wallichiana* which has 32 Ind/ha, now was reduced to only one individual per hectare which might be due to forest fires and timber dependency of local stakeholders since, this altitudinal range was having maximum villages. The density of *Pinus roxburghii* was increasing in 1500-2000 m altitudinal zone while covering maximum number of the forest compartments that was 88. Reasons being the same that is, due to the significant recruitment measures by the forest department and its high regeneration rate and resilience.

Most of the species in this altitudinal range are small trees (0 to 30 years) and large trees (above 120 years) as mentioned in the data collected from the forest department. In this altitudinal gradient other species like *Abies pindrow*, *Cedrus deodara* and *Pinus wallichiana* showed insignificant increase in density. Ten tree species have been enumerated in the altitudinal gradient of 2000 to 2500 m owing to its suitable ecology. There was a decline in the total density of the species (from 351 to 249 Ind/ha from year 1986 to 2013 respectively). Therefore, species richness and diversity patterns on elevation gradients are, however, little understood and have only been documented recently (Wang et al. 2002; Bhattarai and Vetaas 2003). The variation in species diversity patterns can be caused by many factors, such as climate, productivity, anthropogenic influences and biotic interactions, for example competition (Sanders and Rahbek 2012; Pausas and Austin 2001). The forests of Karsog Forest Division are managed forests by different management measures of state forest department. Well-preserved forests are resilient (Noss 2001; Drever et al. 2006) owing to their high native biodiversity, complex structure and absence of anthropogenic pressures (Thompson et al. 2009). Comparatively, disturbed forests have lower resilience due to factors such as forest fragmentation, poor regeneration and adverse impact of invasive species, and are therefore inherently more vulnerable (Kant and Wu 2012). This altitude range has good moisture regime, hence recommended for apple orchards in the region, therefore unregulated felling or encroachment might have resulted in the change in land use pattern. Moreover, heavy dependency of local stakeholders for fuel, fodder and timber has also contributed towards declining forests densities in this zone. However, favorable climatic conditions provide the most available primary productivity in the mountain ecosystem and support the survival of more species (Bhattarai et al. 2004; Kluge et al. 2006). In 2500-3000m altitudinal zone, overall density has drastically reduced owing to enormous decrease in population of tree species. The four species viz. *Abies pindrow*, *Cedrus deodara*, *Picea smithiana* and *Pinus wallichiana* had respectable population in 1986 but in year 2013 these species showed a significant decrease. However, the harsh climate conditions, for example, strong wind, intense solar radiation, and low fertility of soil, may prevent the appearance of some species at high altitude, while inter-specific competition may eliminate other species (Körner 2007).

CONCLUSION

In Karsog Forest Division the temporal change in species composition among different communities' results increased number of *Pinus roxburghii*, *Abies pindrow* and *Quercus leucotrichophora* individuals whereas the population density of *Cedrus deodara*, *Pinus wallichiana* and *Picea smithiana* decreased. The local people and stakeholders of Karsog Forest Division are directly dependent in these species and its great demand in the market. Other reasons behind its decline population are over exploitations, habitat destructions, forest fire, encroachment (for agriculture and horticulture) and natural calamities. State Government and other non-governmental organizations (NGO's) are doing number of initiatives and awareness program to conserve the forest flora and wildlife. These initiatives are successful in saving the forest flora of Himachal Pradesh that enable the sustainable use of the resources making its availability in the present as well as in the future.

RECOMMENDATIONS

This study provides a region-specific information about forests, tree species composition, status and temporal change. Such kind of research can be of more helpful if we get the data up to the species level of different life forms and can also be linked with current and future climate scenario. This type of information would undoubtedly improve the management practices, future scenarios and conservation measures. Therefore, it will provide us the possible vulnerability of forests and associated communities and will help the policymaker to develop necessary adaptation strategies.

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