TEMPORAL CHANGES IN TREE SPECIES COMPOSITION IN DALHOSIE FOREST DIVISION, CHAMBA CIRCLE, HIMACHAL PRADESH

Status Report

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Introduction

The Himalayas cover a vast expanse of 595,000 square kilometres with 2,400 km of parallel mountain ranges encompassing parts of India, Pakistan, Afghanistan, China, Bhutan, Nepal, and Tibet. Situated between 72^0- 91^0 E Longitudes and 27^0-36^0 N Latitudes, the Himalayas separate the alluvial plans of Indian subcontinent on the south from the Plateau of Tibet to the north; and connects the mountains of near East and Central Asia with those in the East Asia. Further, the Himalayan landscape is characterised with a unique geographic and ecological profile, and is home to an array of rivers such as Yangtze Ganga, Brahmaputra, Ganga, Indus, Yarlung, Yangtze, Yellow, Mekong, and Nujiang, which serve as a critical water source for Asian countries.

The Himalayan ecological diversity is altitude dependent where climatic and topographic effects on ecosystems and biota become more pronounced with increasing gradient. Further, there exist stark differences between the eastern and the western Himalayas in altitude, precipitation, and vegetation patterns. The eastern Himalayas are four-times wetter than the western Himalayas with a higher snowline, and a rich biodiversity. Meanwhile, the western Himalayan ranges are farther apart from the plains with precipitous landscape and a colder-drier climate. The altitude gradient and climatic conditions play a decisive role in determining the vegetative pattern in the bio-diverse rich ecology of the Himalayas. At the mountain foothills, there are tropical and sub-tropical broadleaf forests; whereas temperate broadleaf mixed forests with a dominant canopy of oak and maple at the middle; and coniferous, sub-alpine, and alpine vegetation at the higher altitudes adorned with pine, hemlock, spruce, and fir conifers. Areas under inaccessible landscapes are characterised with alpine grasslands, high-altitude meadows, scrubland, which is followed by snowline.

The Indian Himalayan Region

The Indian Himalayan Region (IHR) is home to over 72 million people living in over 10 states covering 95 districts in a total geographic area of 5 laces square km. With its foot-hills in Shivalik at the south, the vast Himalayan region expands to the Tibetan Plateau on the north, thus, serving as a natural northern boundary for India. The region covers three bio-geographic zones – the trans Himalaya (cold deserts of

Ladakh and Kargil in Jammu & Kashmir, Lahaul & Spiti in Himachal Pradesh), the Himalaya (north-west parts of Jammu & Kashmir and Himachal Pradesh and Uttarakhand on west), and Eastern & North-east India (Sikkim, Arunachal Pradesh, and Darjeeling district of West Bengal, Manipur, Meghalaya, Mizoram, Nagaland, Tripura). According to the State of Forest Report, (FSI, 2011), around 42 per cent of the total IHR area is covered under forests (one-third of the total forest area in India) offering invaluable ecological security and resources to the country. Around 22 per cent of India's total geographical area was found to be under forest cover, of which 2.99 per cent was under Very Dense Forest, 9.38 per cent under Moderately Dense Forest, and 9.18 per cent under Open Forest Area. In the Himalayan region, the extent of forest cover varies significantly across the Himalayan states. In terms of percentage of total geographic area under administrative boundary, in North-west region, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand have 10.46%, 27.12%, and 45.43% of total area under forest cover, respectively; in Eastern region, Sikkim and Arunachal Pradesh had 47.14% and 79.96% respectively; and in North-Eastern region, states of Manipur, Meghalaya, Mizoram, Nagaland, Tripura had 77.69%, 76.45%, 86.27%, 75.33%, and 73.68% of their respective geographic area under forest cover (FSI, 2017).

Forests of Himachal Pradesh

Himachal Pradesh is a mountainous state in the northernmost part of India, situated in the western Himalayas between latitude 30º 22' 40" N to 33 º 12' 40" N and longitude 75 º 45' 55" E to 79 º 04' 20" E. The State's geographic landscape is divided into three distinct regions – Shivalik up to 1500m altitude; Mid-Himalayans between 1500-3000m and above 3000m stands the Himadris. Two-thirds of Himachal Pradesh's area (55,673 square km) comes under recorded forest area, however, only 27.12 per cent of this area is accounted under forest and tree cover. One-third of the state's geographic area remains permanently under snow glaciers and inaccessible cold deserts, thus is permanently beyond the tree line. Administratively, the forests are classified as Reserved (5.12 per cent), Protected (89.45 per cent), and Un-classed forest (2.39 per cent), within which certain areas are categorised for specific wildlife, flora, and natural ecosystem protection (HPFD, 2012).

As per Champion and Seth (1968) classifications, Himachal Pradesh Forests are classified under 8 types:

Table 1: Forest Classifications for Himachal Pradesh

Forest Type	Altitude	Mean Annual Temperature / Rainfall	Dominant Forests
Tropical Dry Deciduous Forests	>1000 m above mean sea level	24-27°C 750-1300 mm/annum	*Shorea robusta* and other associates such as *Acacia catechu, Aegle marmelos, Feronia limonia, Anogeissus latifolia, Buchanania lanzan, Woodfordia fruitcosa, Indigofera pulchella, Eulaliopsis binata*
Tropical Moist Deciduous forests	>1000 m above mean sea level	21-26°C 1000-2000mm/annum	*Olea cuspidata, Acacia modesta* and other associates such as *Pyrus pashia, Coriaria nepalensis, Rhus continus, Indigofera gerardiana, Prinsepia utilis*
Subtropical Pine Forests	1000-1800m above mean sea level	15-22°C 1000-3000mm/annum	*Pinus roxburghii* and other associates such as *Terminalia chebula, Mallotus philippensis, Pyrus pashia, Syzygium cumini, Albizzia chinensis, Emblica sp., Acacia catechu, Murraya spp., Rosa moschata*
Himalayan Moist Temperate Forests	1500-3300m above mean sea level	13-16°C 1500-3300mm/annum	Chief Oaks - *Quercus leucotrichophora, Q. dilatata* Other associates such as *Rhododendron, Acer, Aesculus, Cedrus deodara*
Himalayan Dry Temperate Forests	>1,700m above mean sea level	6-17°C 80-800 mm/ annum	Conifers - *Cedrus deodara, Pinus gerardiana, Junipers, Abies, Pinus wallichiana* Broad-leaved – *Acer, Quercus*
Sub-Alpine Forests	2,900-3,500m above mean sea level	2-6°C 10-55mm/annum	Conifers – *Abies pindrow, Pinus wallichiana* Deciduous trees – *Betula utilis, Querus semecarpifola, Rhododendron*
Moist Alpine Scrub	>3,350 m above mean sea level	-	*Betula utilis, Berberis, Salix, Rosa, Aconitum, Lonicera*
Dry Alpine Scrub	>6,000 m above mean sea level	-	*Juniperus, Artemisia, Lonicera, Salix, Myricaria*

Source: (Champion & Seth, 1968)

The forest types are also stratified as per the altitude driven four agro-ecological zones in Himachal Pradesh.

Table 2: Agro-Ecological profile – Himachal Pradesh

	Zone I	Zone II	Zone III	Zone IV
Ecology	Sub Montane & Low Hill Sub-tropical	Mid Hills Sub-humid	High Hills Temperate Wet	High Hill Temperate Dry
Geographic Area (%)	18.43	8.37	16.54	56.61
Altitude (m)	240-1,000	1,001-1,500	1,501-3250	Above 2501
Mean Annual Temp	15 ºC - 23ºC	14ºC - 22ºC	9.1ºC – 20.6ºC	9ºC - 20ºC
Rainfall (mm)	1,100	1,500	1,000	>1,500
Dominant Forest	Tropical mixed deciduous and thorn scrub	Sub-tropical pine forest	Himalayan Moist Temperate forest	Sub-alpine

Native Species	*Acacia catechu, Emblica officinalis, Dalbergia sissoo, Terminalia chebula, Cassia fistula, Anogeissus latifolia, Zizyphus jujuba* Shrubs - *Euphorbia royleana, Adhatoda vasica, Vitex negundo, Woodfordia fruticosa*	*Pinus roxburghii* and its sub-types *Quercus incana, Lannea sp., Lyonia ovalifolia, Rhododendron arboretum, Indigofera sp., Myrsine sp., Rubus sp.* Himalayan Scrub – *Diospyros melanoxylon, Emblica officinalis, Carissa sp., Dodonea viscose, Acacia catechu, Anogeissus sp Lannea sp., Cassia fistula* Dry evergreen bush- *Olea cuspidata, Punica granatum*	Conifers - *Pinus wallichiana, Cedrus deodara, Picea smithiana, Abies pindrow* Broad-leaved – *Quercus incana, Q. semecarpifolia, Q. dilata* *Aesculus indica, Acer caesium, Prunus padus, Populus cilata*	Grass – *Agropyron longeristatum, A.semicostatum, Bracypodium sylvaticum, Bromus asper* Mesophytic Herbs – *Primula, Anemone, Fritillaria, Iris, Gentiana spp.* Other Herbs – *Sedum crassipes, Primula minutissima, Saxifraga imbricate, Potentilla fruticosa* Dwarf shrub – *Juniperus wallichiana, J. communis, Caragana sp.*
Districts	Kangra, Una, Hamirpur, Bilaspur, Solan, and Parts of Chamba, Sirmaur	Parts of Chamba, Kangra, Mandi, Shimla, Sirmaur, Kullu, Kinnaur, Hamirpur, Bilaspur	Shimla, Chamba, Kangra, Mandi, Kullu, Solan, Sirmaur, Kinnaur, Lahaul & Spiti	Kangra, Lahaul & Spiti, Kinnaur, and Parts of Chamba, Mandi, Kullu, Sirmaur, Shimla

Source: Agro-Ecological Zonation of Himachal Pradesh – Agricultural System Information Development at micro-level, Centre of Geo-informatics, CSK Himachal Pradesh Agriculture University, Palampur (Bhagat et al., 2006)

Himachal Pradesh is blessed with a rich biodiversity adorned with diverse natural ecosystems comprising 8 forest types, 38 sub-types, which are home to 3,295 plant species of the 45,000 found in India. 95 per cent of these species are endemic to the state and only 5 per cent known as exotic species have been introduced in the last 150 years. The state's forest ecosystem offers critical ecological, environmental, economic, and social support to the populace serving as a primary source of food, fuel, fodder, timber, and other non-timber forest produce for both urban and rural population. However, these forest resources are currently experiencing greater stress with increasing pressure from burgeoning population, and rising impact of anthropogenic activities. In the western Himalayas, in particular, striking vegetative changes are observed where in various plant species are migrating to higher altitudes owing to warming trends (Padma, 2014), while other remain in danger of extinction. Additionally, the Hindu-Kush-Himalayan region is witnessing early trends of greening while habitat loss of around 30 per cent is expected for Snow Leopards owing to continuous forest losses (Panday & Ghimire, 2012) (Forrest et al., 2012).

To that effect, this temporal study was designed to get a preliminary insight into the current status of vegetation viz. species composition in the Dalhousie forest divisions under the Chamba Forest Circle. The assessment techniques are designed with scalable modalities that can be adapted to other forest circles in the State.

The next section outlines the details on study area and the adopted methodology with information on data sources and applied techniques of assessments. Following which, the section on Results and Findings discusses the outcomes for Dalhousie Forest divisions separately. The report concludes with a categorised and consolidated snapshot of species composition in the Chamba Forest Circle with information on tree community level variation with respect to altitudinal gradients.

Study Area and Methods

District Chamba – A Background

Chamba is bounded on north-west by Jammu and Kashmir, on the north-east and east by Ladakh area of Jammu And Kashmir State and Lahaul and Bara-Bangal area of Himachal Pradesh, on the south-east and south by the District Kangra of Himachal Pradesh and Gurdaspur District of the Punjab.

The Chamba District is situated between north latitude 32° 11′ 30” and 33° 13′ 6” and east longitude 75°49 and 77° 3′ 30”, with an estimated area of 6522 square Kilometers and is surrounded on all sides by lofty hill ranges. The territory is wholly mountainous with altitude ranging from 2,000 to 21,000 feet. Sub-Himalayan range of mountains, full of diverse flora and fauna, make Chamba an exhilarating experience.

Climate:

The variation in the climate is principally due to the altitudinal difference, aspect and disposition in relation to the mountain ranges. The climate though predominantly temperate, there is well marked seasons. In higher reaches chill of winter is felt right from November to March. Temperature gradually increases from April to July. In august and September mainly monsoon season occur. At high altitude, the drop in temperature may result in precipitation taking the form of snow. Bulk of precipitation in lower altitude is received during monsoon

rains. Drought occurs during April, May and June and again during October and November. Prolonged drought adversely affects the plantation and establishment of young regeneration.

Methods

To ascertain the temporal changes in different tree species composition in the Dalhousie forest divisions under the Chamba Forest Circle, two-tier assessment was conducted, covering: *1) tree community based variation; 2) diameter class wise variations in tree composition.*

Dalhousie Forest Division – There are four forest ranges in this division *viz.* Dalhousie, Bakloh, Chowari and Bhattiyat. The total area of these forest ranges is 39951.22 ha (fall under 851.96 ha reserved forest, 38558.69 ha demarcated protected forest area and 540.57ha un-demarcated area) out of which 1624.80 ha was assessed in this study.

Data Sources and Techniques

Working plans from the Himachal Pradesh Forest Department and Compartment History files were consulted and the species composition change during the successive working plans was analyzed for Dalhousie forest the time period for each division is different as per enumerated information available through these working plans.

Working plan is a written scheme of management that aims to ensure continuity of policy action, and controlled treatment of a forest. Within a working plan, Forest Division is the basic unit. This document is utilized to evaluate status of forests and the biodiversity resources within a particular division.

Dalhousie Forest Division: 1969-1992-2012

Respective files were collected from the library of Himachal Pradesh Forest Department, and offices of the three forest divisions and their respective ranges.

Based on the information from the Working Plans for the Dalhousie Forest Circle and information from the Compartment History files, tree communities were identified.

For the assessment purpose, the forests were categorized according to the delineated communities i.e. if for a single species the relative density is more than 50 per cent, then the tree community was identified as ***single species dominant community***. For cases where more than one species collectively accounted for 50 per cent of the relative density, the tree community was referred as ***mixed community***. Species composition was assessed for changes in the tree density, where *individuals per hectare* were calculated and the percentage change was determined for the two time period. The area under the assessed forest compartments for respective divisions was taken to be more than 10 per cent of the total forest area.

The next section elaborates the employed assessment techniques for *1) tree community based variation; 2) diameter class wise variations in tree composition.*

Assessment techniques:

1. Tree Community-based Variations

Each forest division constitutes different tree communities where dominant species is identified based on its relative density *(more than 50 per cent categorised as dominant community; and a collective majority as mixed community*). For each of the identified pure species in Dalhousie forest division variations in density were determined for the two time periods i.e. 1969-70 and 1992-93 and 2013-14.

2. Diameter Class-wise Variations with Altitude Gradient

On the basis of above mentioned altitudinal gradients, the data of different forest compartments were analysed and studied for their density variations in different classes of 10-20cm, 20-30cm, 30-40cm, 40-50cm, 50-60cm, 60-70cm, 70-80cm, 80-90cm, 90-100cm, >100cm. This assessment was conducted individual species for at the three altitude levels. Diameter class wise distribution is analysed to represent the population structure of forests and ascertain the nature of species undergoing variation in different tree communities and altitude gradients.

Key Terminologies

Stand: An aggregation of trees occupying a specific area sufficiently uniform in composition (species), age arrangement, and condition to be distinguishable from the forest on adjoining areas.

Tree community: Group or association of populations of two or more different tree species that occupy the same geographical area at a particular time period

Forest compartment: A section of forest with homogeneous growth conditions and tree species.

Results & Findings

This section presents the findings from the assessment of the tree community composition for Dalhousie forest divisions for their respective species.

Dalhousie Forest Division

Based on the assessment of Working Plans from the Himachal Pradesh Forest Department and Compartment History files from Dalhousie, Bakloh, Chowari and Bhattiyat forest ranges, 5 pure tree communities - *Cedrus deodara* (CD), *Pinus roxburghii* (PR), *Quercus leucotrichophora* (QL, *Abies pindrow*(AP) and *Picea smithiana* (PS) were identified between 1969 and 2013.

The Tree Community based Variations

The following section discusses the tree community based variations in density for the species identified.

S.N.	Communities	No. of Forests/ Compartments	Area (ha)	Density of tree in relative to other species
1	*Cedrus deodara*	14	483.29	Density of *Cedrus deodara* **increased**
2	*Pinus roxburghii*	32	1035.08	Density of *Pinus roxburghii* **increased**
3	*Quercus leucotrichophora*	1	12.5	Density of *Quercus leucotrichophora* **increased**
4	*Abies pindrow*	1	42.9	Density of *Abies pindrow* **decreased**
5	*Picea smithiana*	2	32	Density of *Picea smithiana* **decreased**

Table 3 Details on species community, Forest Compartments and area assessed under Dalhousie Forest Division

1. *Cedrus deodara* community:

Data was collected from 14 forest compartments covering an area of 483.29ha. As illustrated in Figure, in its dominant tree community, density of *Cedrus deodara* increased from 139.47 Ind/ha to 186.05 Ind/ha. In these forest compartments,

representation (density) of other species is as follows – density of *Pinus roxburghii and Quercus leucotrichophora* registered positive variations in respective densities between 1969 and 1994. Meanwhile, density of *Abies pindrow* and *Picea smithiana showed* declined in density.

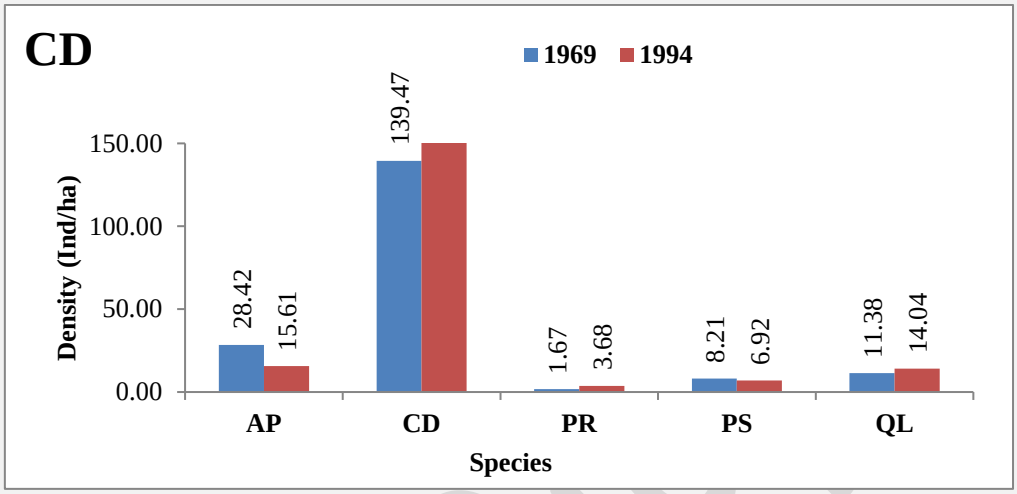

Figure 1 Density Variations in Species Composition in *Cedrus deodara* community, Dalhousie Forest Division, 1969-1994

2. *Pinus roxburghii* community

Data was collected from 32 forest compartments covering an area of 1035.08 ha, for pure *Pinus roxburghii* stands. As illustrated in Figure, in its dominant tree community, density of *Pinus roxburghii* increased from 61.34 Ind/ha to 227.57 Ind/ha between 1969 and 2013. In these forest compartments, representation (density) of other species is as follows – from 1969 to 2013, density of all species increased i.e. Broad-leaved, *Cedrus deodara* and *Quercus floribunda* increased during the study period.

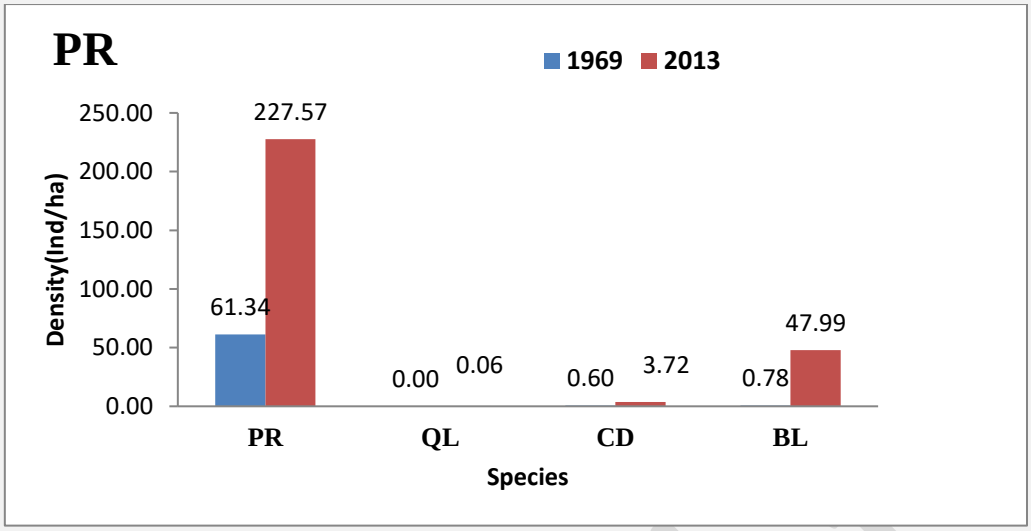

Figure 2 Density Variations in Species Composition in *Pinus roxburghii* community, Dalhouise Forest Division, 1969-2013

3. *Quercus leucotrichophora* community:

Data was collected from 1 forest compartments covering an area of 12.54ha, for pure *Quercus leucotrichophora* stands. As illustrated in Figure 5, in its dominant tree community, density of *Quercus leucotrichophora* increased from 19.86ha to 107.02ha 1969 to 1994. In these forest compartments, for *Cedrus deodara* density also showed in increased density.

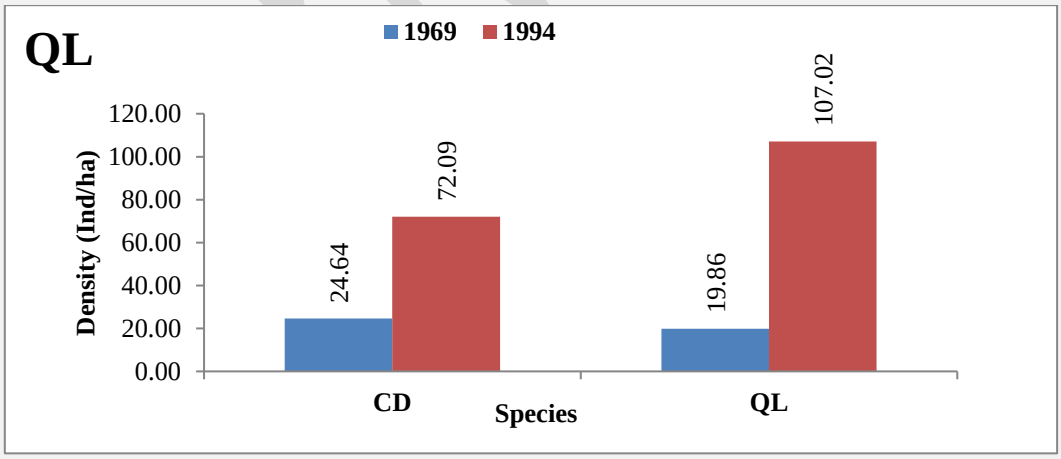

Figure 3 Density Variations in Species Composition in *Quercus leucotrichophora* community, Dalhousie Forest Division, 1969-1994

4. *Abies pindrow* community:

Data was collected from 1 forest compartments covering an area of 42.9ha. As illustrated in Figure 17, in its dominant tree community, density of *Abies pindrow* decreased from 139.77 Ind/ha to 14.97 Ind/ha between 1969 and 1994. In these forest compartments *Abies pindrow* was the pure community.

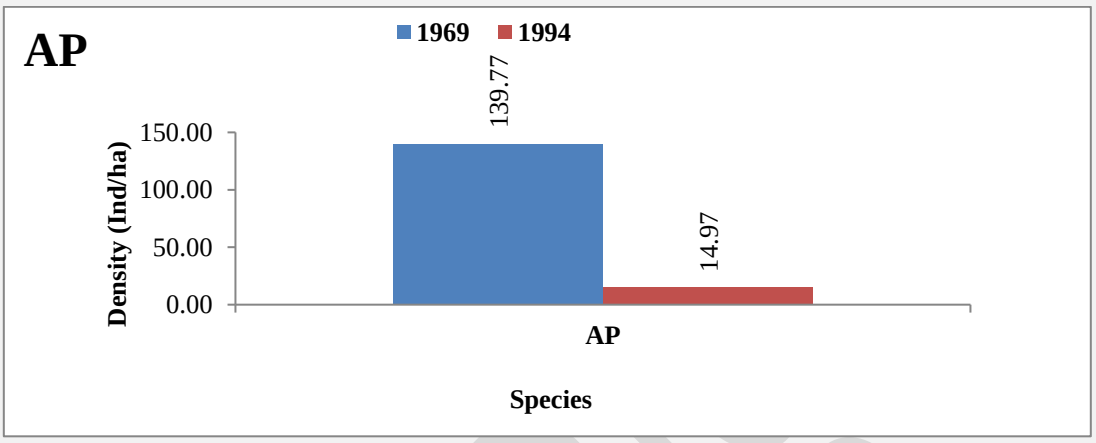

Figure 4 Density Variations in Species Composition in *Abies pindrow* community, Dalhousie Forest Division, 1969-1994

5. *Picea smithiana* community:

Data was collected from 2 forest compartments covering an area of 32ha. As illustrated in Figure, in its dominant tree community, density of *Picea smithiana* decreased from 430.63 Ind/ha to 293 Ind/ha. In these forest compartments, representation (density) of other species *Abies pindrow* and *Quercus leucotrichophora* also showed decreased in density.

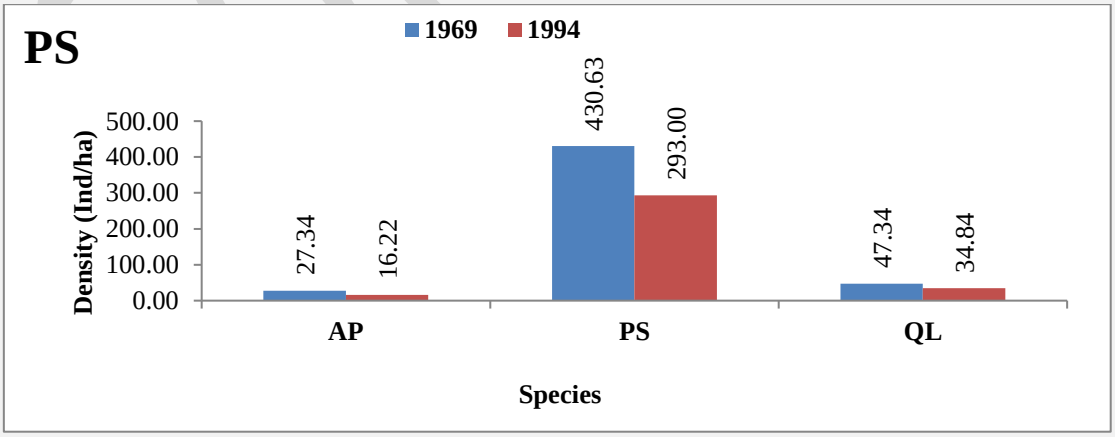

Figure 5 Density Variations in Species Composition in *Picea smithiana* community, Dalhousie Forest Division, 1969-1994.

2. Diameter Class-wise Variations:

Data from different forest compartments was analysed for variation in diameter classes of 10-20cm, 20-30cm, 30-40cm, 40-50cm, 50-60cm, 60-70cm, 70-80cm, 80-90cm, 90-100cm, >100cm for each of the identified species in the Dalhousie Forest Division.

1. *Cedrus deodara:*

Density of *Cedrus deodara* were *decreased* for 20-30 cm categories from 36.86 Ind/ha to 22.68 Ind/ha Figure. Density of trees within rest of diameter classes showed significant increase. This increase in density of younger trees of *Cedrus deodara* signifies the good regeneration and plantation by the forest department of Dalhoisie forest division.

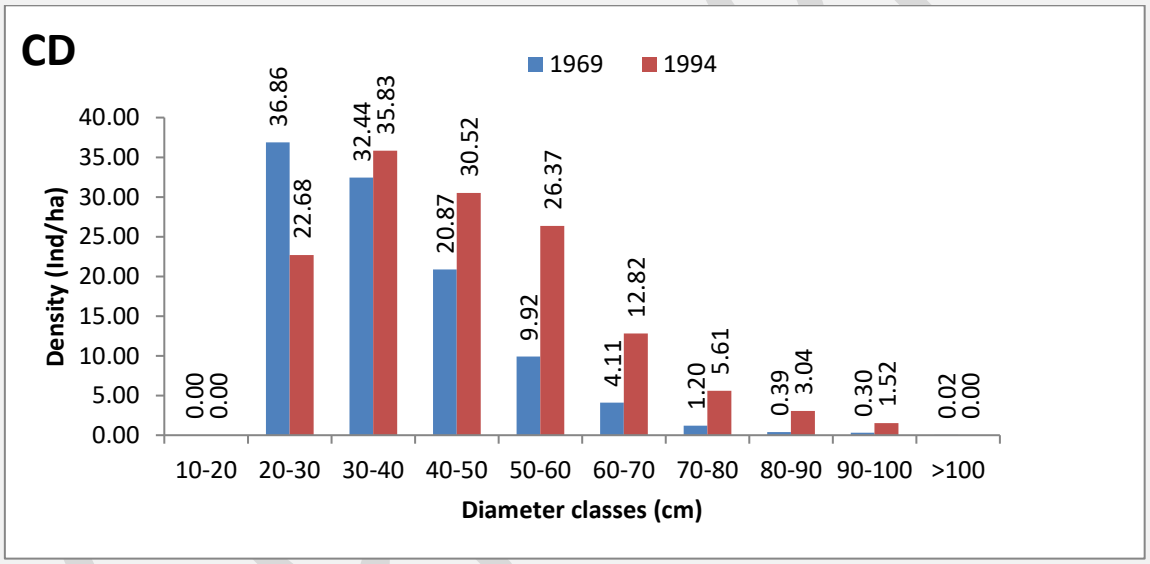

Figure 6 Density Variations in *Cedrus deodara* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-1994

2. *Abies pindrow:*

Abies pindrow community's conducive altitude range is 2100-3300cm, and in Dalhousie Forest Division its density in all diameter classes decreased, specifically of those falling within diameter classes 20-30cm in which density decreased from 8.30 Ind/ha to 2.96 Ind/ha. See Figure

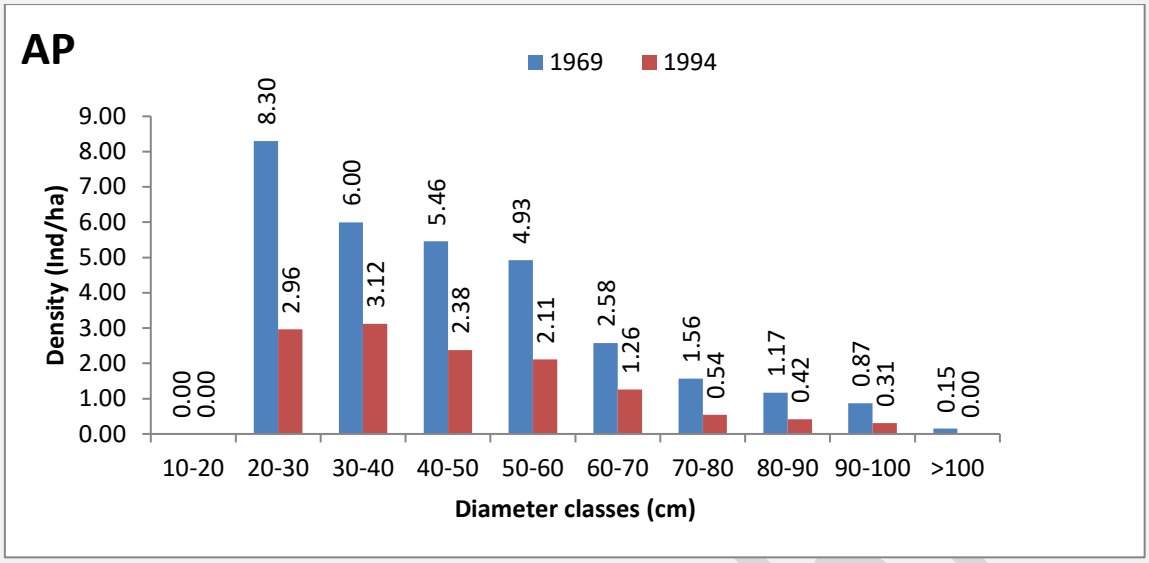

Figure 7 Density Variations in *Abies pindrow* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-1994

3. *Picea smithiana:*

Picea smithiana community thrives at 2000-3600m, and in this forest division density of trees within all diameter classes declined. Maximum sharp decrease occurred in 20-30cm diameter class from 9.02 Ind/ha to 2.61 Ind/ha. This decrease in density is due to low regeneration of *Picea smithiana*.

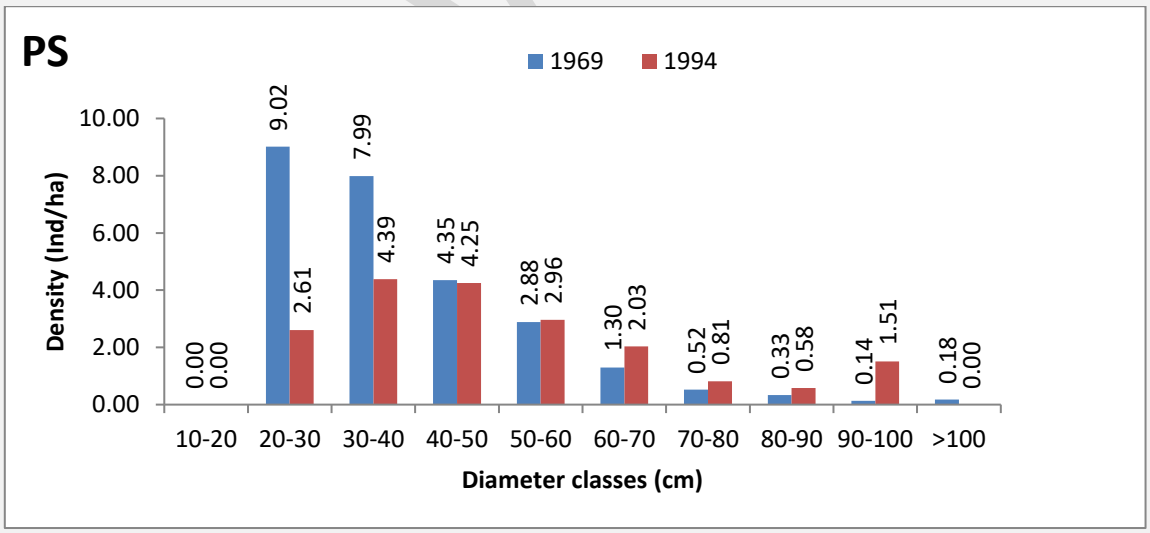

Figure 8 Density Variations in *Picea smithiana* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-1994

4. *Quercus leucotrichophora*

In *Quercus leucotrichophora* community density of trees in 30-40cm, 40-50cm and 50-60cm diameter classes increase 1.52-3.57, 0.63-1.45 and 0.51-0.79. Maximum

tree density occurs in 20-30cm diameter class where the density of tree decreased from 7.37 Ind/ha to 7.30 Ind/ha.

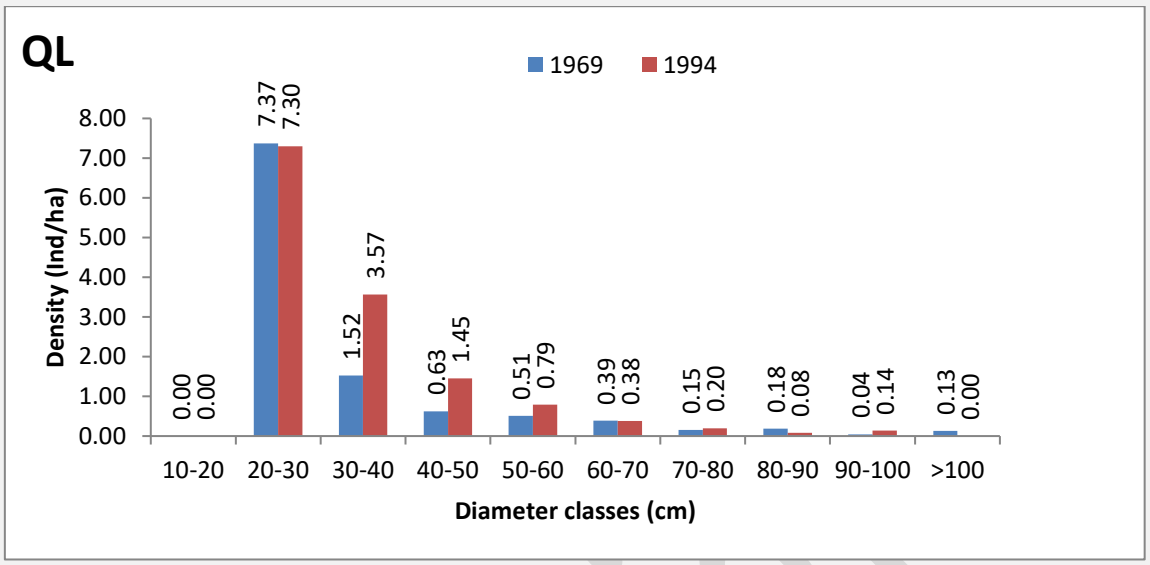

Figure 9 Density Variations in *Quercus leucotrichophora* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-1994

5. *Pinus roxburghii:*

Pinus roxburghii grows at 1000-2000m and in Dalhousie Forest Division its density was observed to increase in all diameter classes between 1969 and 2013. Meanwhile, sharp increase was seen for density of trees within diameter classes 10-20cm, 20-30cm, and 30-40cm, as illustrated in Figure.

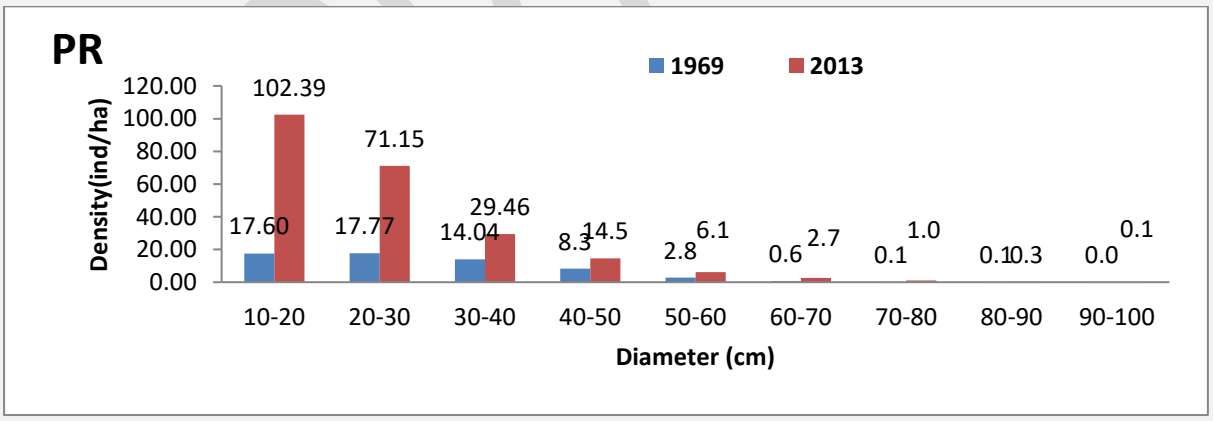

Figure 10 Density Variations in *Pinus roxburghii* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-2013

6. Broad Leaved tree Community:

Broad leaved tree community shows overall in increase their density from 1969 to 2013. Broad leaved community maximum tree density occurs in first three diameter class i.e.10-20cm, 20-30cm and 30-40cm and there is sharp increased in tree density in this diameter class. While in the 70-80cm, 80-90cm and 90-100cm diameter class there is no trees in broad leaved community.

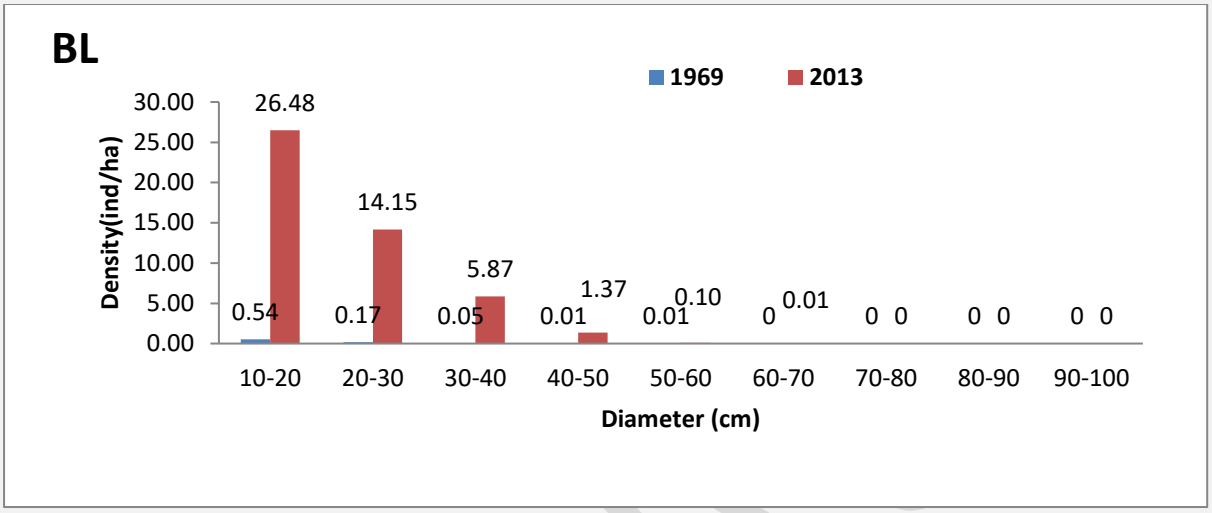

Figure 11 Density Variations in *Broad leaved* community at Different Diameter Classes, Dalhousie Forest Division, and 1969-1994

Conclusion

The temporal study was commission with a view to get a preliminary insight in to the current status of vegetation viz. species composition in the Dalhousie forest divisions. Based on the assessment of Working Plans from the Himachal Pradesh Forest Department and Compartment History files from Dalhousie, Bakloh, Chowari and Bhattiyat forest ranges, 5 pure tree communities - *Cedrus deodara* (CD), *Pinus roxburghii* (PR), *Quercus leucotrichophora* (QL), *Abies pindrow* (AP) and *Picea smithiana* (PS) were identified between 1969 and 2013.

On the bases dominant species community and diameter class wise temporal change in tree species following conclusion can be drawn

1. *Cedrus deodara*: in its dominant tree community, density of *Cedrus deodara* increased from 139.47 Ind/ha to 186.05 Ind/ha. *Cedrus deodara* also showed increase in density in other community of *Pinus roxburghii and Quercus leucotrichophora*. Max. Density of *Cedrus* occurred in 30-40 cm class and minimum in 90-100 cm. Increase in its density is may be due to the plantation activity and enhanced protection measures by the forest department.

2. *Pinus roxburghii:* in its dominant tree community, density of *Pinus roxburghii* increased from 61.34 Ind/ha to 227.57 Ind/ha between 1969 and 2013. It also show increase in *Cedrus deodara* community. *Pinus roxburhii* showed maximum increase in density in all the community in relation to other species, this may due to greater regeneration power and adaptability of *Pinus roxburhii* to different climate. It showed maximum density in 10-20cm diameter class and minimum in 90-100 cm diameter class.

***3. Quercus leucotrichophora*:** its dominant tree community, density of *Quercus leucotrichophora* increased from 19.86ha to 107.02ha 1969 to 1994. It showed increase in all community except *Picea smithiana* where it showed decrease in density from 47.34 Ind/ha to 34.84 Ind/ha. It showed maximum density in 20-30cm diameter class and minimum in 90-100 cm diameter class

4. Abies pindrow: in its dominant tree community, density of *Abies pindrow* decreased from 139.77 Ind/ha to 14.97 Ind/ha between 1969 and 1994. In *Picea smithiana* community it also showed decreased in density from27.34 Ind/ha to 16.22 Ind/ha. It showed maximum density in 30-40cm diameter class and minimum in >100 cm diameter class.

***5. Picea smithiana*:** in its dominant tree community, density of *Picea smithiana* decreased from 430.63 Ind/ha to 293 Ind/ha. *Picea smithiana* also showed decrease in density in other community also. The decrease in density of this may due to its poor regeneration power. It showed maximum density in 30-40cm diameter class and minimum in 80-90 cm diameter class.

In nutshell we can conclude from this study that *Cedrus deodara*, *Pinus roxburghii* and *Quercus leucotrichophora* tree species showed in increase their density by139.47 Ind/ha to 186.05 Ind/ha, 61.34 Ind/ha to 227.57 Ind/ha and19.86ha to 107.02ha respectively from 1969 to 1994. Increase in the respective tree density is due to the plantation activity and enhanced protection measures by the forest department. In case of *Pinus roxburghii* increase in density may due to greater regeneration power and adaptability of *Pinus roxburhii* to different climate.

While in case of *Abies pindrow and Picea smithiana* their density decrease in its pure and other community. In case of *Abies pindrow* abruptly decreased in density from 139.77 Ind/ha to 14.97 Ind/ha between 1969 and 1994. This may be due to the lower regeneration power of these species in relation to the other species to changing climate and due to anthropogenic pressure.