

Temporal Change in Tree Species Composition in Solan Forest Division of Nahan Circle, Himachal Pradesh

Status Report

02-Sep-19

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Introduction

The Himalayas cover a vast expanse of 595,000 square kilometers with 2,400 km of parallel mountain ranges encompassing parts of India, Pakistan, Afghanistan, China, Bhutan, Nepal, and Tibet. Situated between 72°- 91° E Longitudes and 27°- 36° N Latitudes, the Himalayas separate the alluvial plains 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 characterized with a unique geographic and ecological profile and serves as a 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 higher snowline, and rich biodiversity. Meanwhile, the western Himalayan ranges are farther apart from the plains with precipitous landscape and 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; 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 characterized with alpine grasslands, high-altitude meadows, scrubland which is followed by snowline.

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 lacs 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. According to the State Forest Report, 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. As per the State of Forest Report 2017, 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.

Forests of Himachal Pradesh

Himachal Pradesh is a mountainous state in the northernmost part of India, situated in the western Himalayas between latitude 30° 22' 40" N to 33° 12' 40" N and longitude 75° 45' 55" E to 79° 04' 20" E. 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 (5.13 per cent), Protected (89.46 per cent), and Un-classed forest (5.41 per cent), within which certain areas are categorized for specific wildlife, flora, and natural ecosystem protection.

Table 1: Forest Classifications for Himachal Pradesh

Forest Type	Altitude	Rainfall	Dominant Forests
Tropical Dry Deciduous Forests	>1000 m above mean sea level	100-150 cm/annum	<i>Shorea robusta</i> and other associates such as <i>Acacia catechu</i> , <i>Aegle marmelos</i> , <i>Feronia limonia</i> , <i>Anogeissus latifolia</i> , <i>Buchanania lanzan</i> , <i>Woodfordia fruitcosa</i> , <i>Indigofera pulchella</i> , <i>Eulaliopsis binata</i>
Tropical Moist Deciduous forests	>1000 m above mean sea level	100-200 cm/annum	<i>Olea cuspidate</i> , <i>Acacia modesta</i> and other associates such as <i>Pyrus pashia</i> , <i>Coriaria nepalensis</i> , <i>Rhus continus</i> , <i>Indigofera gerardiana</i> , <i>Prinsepia utilis</i>

Subtropical Pine Forests	1000-1800m above mean sea level	90-250 cm/annum	<i>Pinus roxburghii</i> and other associates such as <i>Terminalia chebula</i> , <i>Mallotus philippensis</i> , <i>Pyrus pashia</i> , <i>Syzygium cumini</i> , <i>Albizia chinensis</i> , <i>Emblica sp.</i> , <i>Acacia catechu</i> , <i>Murraya spp.</i> , <i>Rosa moschata</i>
Himalayan Moist Temperate Forests	1500-3300m above mean sea level	150-250 cm/annum	Chief Oaks - <i>Quercus leucotrichophora</i> , <i>Q. dilatata</i> other associates such as <i>Rhododendron</i> , <i>Acer</i> , <i>Aesculus</i> , <i>Cedrus deodara</i>
Himalayan Dry Temperate Forests	>1,700m above mean sea level	< 100 cm/annum	<i>Conifers</i> - <i>Cedrus deodara</i> , <i>Pinus gerardiana</i> , <i>Junipers</i> , <i>Abies</i> , <i>Pinus wallichiana</i> . <i>Broad-leaved</i> – <i>Acer</i> , <i>Quercus</i>
Sub-Alpine Forests	2,900-3,500m above mean sea level		<i>Conifers</i> – <i>Abies</i> , <i>Pinus wallichiana</i> , <i>Deciduous trees</i> – <i>Betula utilis</i> , <i>Quercus semecarpifolia</i> , <i>Rhododendron</i>
Moist Alpine Scrub	>3,350 m above mean sea level		<i>Betula utilis</i> , <i>Berberis</i> , <i>Salix</i> , <i>Rosa</i> , <i>Aconitum</i> , <i>Lonicera</i>
Dry Alpine Scrub	>6,000 m above mean sea level		<i>Juniperus</i> , <i>Artemisia</i> , <i>Lonicera</i> , <i>Salix</i> , <i>Myricaria</i>

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. This temporal study was designed to get a preliminary insight into the current status of vegetation viz. species composition in Solan Forest Division under the Nahar Forest Circle.

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 Solan Forest division. The report concludes with a categorized and consolidated snapshot of species composition in the Solan Forest Division with information on Working Circle level variation.

Study area and method

District Solan - A Background

The District is bounded by Shimla district in the North and by Ropar District of Punjab and Ambala district of Harayana in the south, by Sirmaur District in the east and by Bilaspur district in the west. Mandi District touches the boundary of Solan district in north-east. The shape of the district is rectangular with slight bulge on the northern side intruding towards Mandi district. It is located between the longitudes 76.42 and 77.20 degree and latitudes 30.05 and 31.15 degree north. The elevation of the district ranges from 300 to 3,000 meters above seas level. The mountain ranges lie in the outer Himalayas and are a part of Shivalik ranges. The mountains of lower elevation are found in western-southern parts of the district comprising of Nalagarh and Arki tehsil while higher ranges start from central region and extend upto north-estern corner of the District comprising Solan tehsil and parts of Arki tehsil, Kasauli tehsil and Kandaghat tehsil which are located in north-eastern direction of the district and are having the highest ranges of the District.

Solan Forest Division-

The Solan division lies between longitudes 76⁰56' and 77⁰12' East and latitudes 30⁰46' and 31⁰ 10' North. The geographical area of the division is 721.30 Sq. Kms. It is bounded on the North by the Shimla Forest Division, by the Rajgarh Forest Division in the East, on the West by Kunihar Forest Division and on the South by boundary of Haryana State. The whole area of the division is a compact block except for Rugra block of Subathu Range, access to which can be had either by crossing Kunihar or via Ghanahatti near Shimla. It can be appropriate to mention here that there are no Reserved or Protected forests falling under this block.

The entire track is hilly starting from outer Shiwalik to Middle Himalayas and covering the forests, which lies between the altitudes of 500 meters to the 2500 meters.

Soil:

All over the track soil is sandy loam. Soil is fairly deep in the areas having good vegetative cover and is shallow in the naked areas. In the regions above 1500 meters it is deep and contains a thick layer of humus or leaf mould in Ban Oak and Chil Forests. Soil is dry on the Alobra-Sairighat ridge, although plantation has been raised in the past. The soil is friable and dry in Ajmergarh, Parwanoo and Lugon areas also. Loose boundary soil that is highly susceptible to soil erosion is very common in the southern aspect on lower reaches.

Climate:

In the lower reaches the climate is sub-tropical and moist temperature in the upper reaches, especially in some parts of the Kandaghat and Solan ranges. The seasons are well marked and there are distinct summer, rainy, autumn and winter seasons.

Precipitation is received both during the rainy and winter seasons, but the bulk of it is received during rainy season from the southeast monsoon. The rainy season commences from the first week of July and continues up to the last week of August but sometime extends up to mid of September. Winter rains generally commence from the last week of December and continue up to end of February. April, May, October and November are relatively dry months. Precipitation in the form of snow is received during January, February mainly around Karol but occasionally does come down to lower reaches.

Due to variation in altitude in this Division, the temperature also varies considerably. Minimum temperature goes down below 0°C in high reaches during winter season and maximum temperature exceeds 40°C in lower reaches during the summer season.

Forests:

The forests of Solan forest division vary from the scrub and bamboo forests that are confined to lower elevations to the chil forests and ban oak forests in the upper reaches of the reaches of the division. Conifer forests i.e. Chir pine occurs mostly in pure form as also the ban oak forests. In transitional area (i.e. ecotones), chil and broad leaved species are found together in various proportions. Chil is the only main conifer species occurring with a few deodar patches of planting origin in the oak areas. Densely stocked blocks of forests are absent and since the area has reasonable population density, the forests are generally scattered and honeycombed by habitations and agriculture fields.

The chir pine forests have been by and large reverted to an irregular state as due to the ban on green felling the forests could not be worked during the last working plan. There is a general predominance of younger age classes as in almost all forests the chil regeneration in sapling to pole stage has sprung up in blanks and where ever sufficient gap have been created in the canopy due to salvage removals or for meeting right holder remands.

Sr. No. 1	Total geographical area of the division 571.58 Km ²		
2.	Division is bounded between: a) Longitudes 76 ⁰ 56' & 77 ⁰ 12' b) Latitudes 30 ⁰ 46' & 31 ⁰ 10'		
3.	Land Use Classification	Area (ha)	% of Geographical area
	(i) Forest area	11743.80	20.5
	(ii) Net cultivable area	3156.38	55.2
	(iii) Common land vested with Govt.	9723.42	17.0
	(iv) Ghasanis, Wasteland, Nalas etc.	4130.33	7.2
4.	Per capita forest area of the division	0.096 ha or 0.1 ha	
5.	Category wise area of Forest (ha)		
	Reserve Forest		4372.50
	Demarcated Protected Forests		7220.30
	Un-demarcated Protected Forest		151.00

Table 2 Forest details (category and area) and Land use classification of Solan Forest Division

Methods

To ascertain the temporal changes in different tree species composition in Solan Forest Division of Nahan Forest Circle, tree community based variation has been studied. Most of the forests of Solan Forest Division are pure forests i.e. composed of one species only however some forests are composed of more than one species known as mixed forest.

Solan Forest Division – There are five forest ranges in this division viz., kandaghat, Solan, Subathu, Dharampur and Parwanoo. The total area of these forest ranges are 11743.8 ha out of which 2061.5 ha were assessed in the study.

Sr. No.	Name of Range	Reserved Forests (in ha)	Demarcated Protected Forests (in ha)	Un-demarcated Protected Forests (in ha)	Total (in ha)
1.	Kandaghat	366.0	420.4	-	786.4
2.	Solan	406.8	998.6	26.0	1431.4
3.	Subathu	16.0	821.8	125.0	962.8
4.	Dharampur	1970.1	1896.3	-	3866.4
5.	Parwanoo	1613.6	3083.2	-	4696.8
		4372.5	7220.3	151.0	11743.8

Table 3 Category wise distribution of forest area (ha) for different forest ranges of Solan Forest Division

Broadly the following forests are met with in the division, as we ascend from an altitude of 600 m to the highest point of 2250 meters.

1. Scrub forests:

These are confined to the lower reaches of Parwanoo, Dharampur and Subathu ranges and do not contain species of much commercial importance, the most common species found here are Jhingan, Chhalm, Pula, Kainth, Amaltas, Kamal, Amla etc.

2. Bamboo Forests:

These are restricted to only the lower reaches of two ranges i.e. Parwanoo and Dharampur and are restricted to area along the Kaushalya River, tributaries of Ghaggar River and along the Haryana border around Parwanoo township. These occurs either in pure patches or are generally interspersed with miscellaneous broad-leaved.

3. Chir Forests:

These are found in all ranges of the division and occur mostly in pure form, through a fair proportion of broad leaved species in the lower elevations and ban oak in the higher reaches is found intermixed with it. Chil has been exploited for timber, resin in the past and it is the mainstay of tomato and vegetable farming, in Solan district, as its twigs are favoured as stakes for the vegetable plant.

4. Oak Forests:

Only ban oak is found as compact forests in this division and the forests are confined to the Solan and Kandaghat ranges. A few patches are seen in the Dharampur range as well. Ban oak has been exploited for fuelwood and charcoal in the past, but subsequently this has been stopped due to the ban on the felling of oaks.

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 the said forest division.

**Solan Forest Division: 1983-84 to 1997-98
and 2002-03 to 2016-17**

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.

Respective files were collected from the Library of Himachal Pradesh Forest Department. Based on the information from the Working Plans for the Solan Forest, tree communities were identified however, the forests/compartments under particular working circles are pure forests (composed of one species e.g. Chil working circle). For every forests density (Ind/ha) were calculated for *Pinus roxburghii* and Broad Leaved to observe the change between different years of enumeration (1984 to 2017)

S.N.	Tree species community	No. of Forest/Compartment	Area (ha)	Forest Ranges
1	<i>Pinus roxburghii</i>	70	1677.9	Solan, Subathu and Dharampur
2	Broad Leaved	7	383.6	Dharampur
	Total	77	2061.5	3

Table 4 Detail on species community Forest Compartments and area assessed under Solan Forest Division

Assessment techniques

Tree Community-based Variations

The forest division constitutes different tree communities where dominant species is identified based on its relative density (more than 50 per cent categorized as dominant community). However, most of the forests of Solan forest division consist of pure communities where single species is dominant. For each of the identified pure species in Solan Forest Division, variations in density were determined for the two time periods i.e. 1983 and 2017.

Key Terminologies

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 and species composition for Solan Forest Divisions.

Pinus roxburghii Tree Community:

Available data showed that there are seventy compartments which are purely dominant (composed of *Pinus roxburghii*) having forest area of 1677.9 ha in Solan, Subathu and Dharampur forest range of Solan forest division. Finding revealed that the density of *Pinus roxburghii* was increased from 129 Ind/ha to 359 Ind/ha (from enumeration year 1983-84 and 2016-17 respectively) in Figure 1. Diameter class wise variations showed that saplings were increased from diameter class 10-20 cm to 30-40 cm (in Figure 2) which indicate that *Pinus* rejuvenation/regeneration power is great in the selected forests on comparing 1983 to 2017.

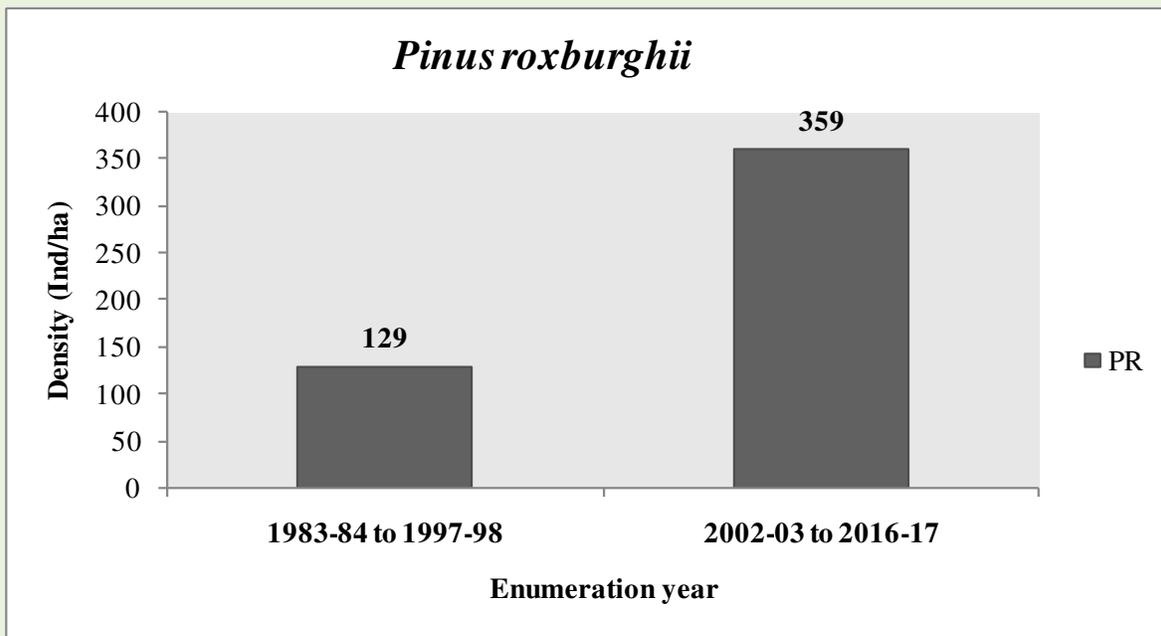


Figure 1 Density Variations in *Pinus roxburghii* community, Solan Forest Division, 1983-2017

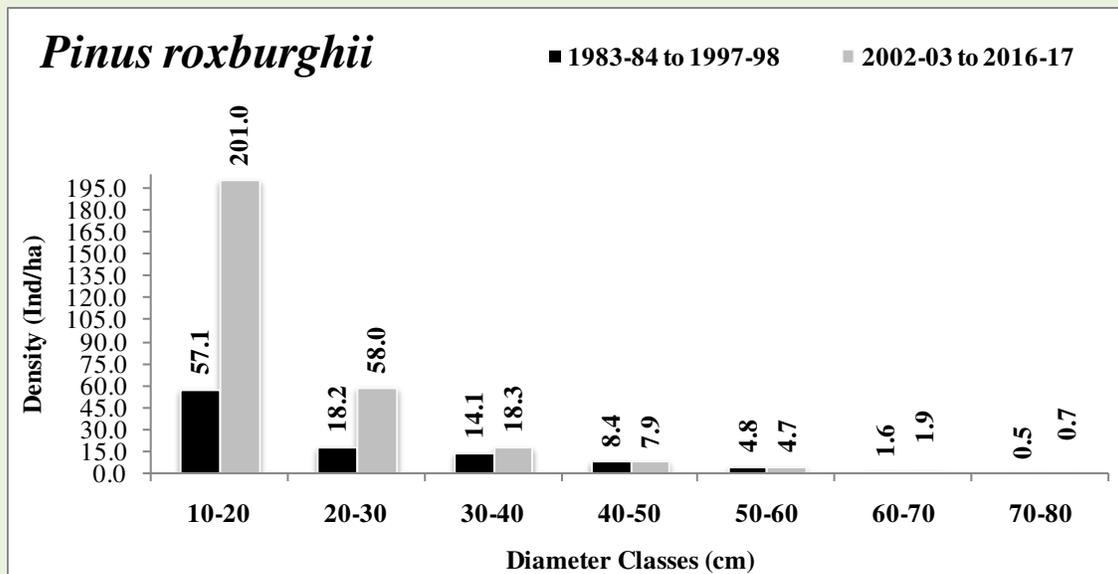


Figure 2 Diameter class wise variations in density of *Pinus roxburghii* of Solan Forest Division, 1983-2017

Broad Leaved Tree Community:

There are seven compartments of Dharampur forest range (with an area of 383.6 ha) which showed that the density of broad leaved increased from 118 Ind/ha to 144 Ind/ha in enumeration year 1983 to 2017 respectively (Figure 3). However the diameter class showed slight increase from 10-20cm to 20-30cm and above diameter classes showed negligible change in density (Figure 4).

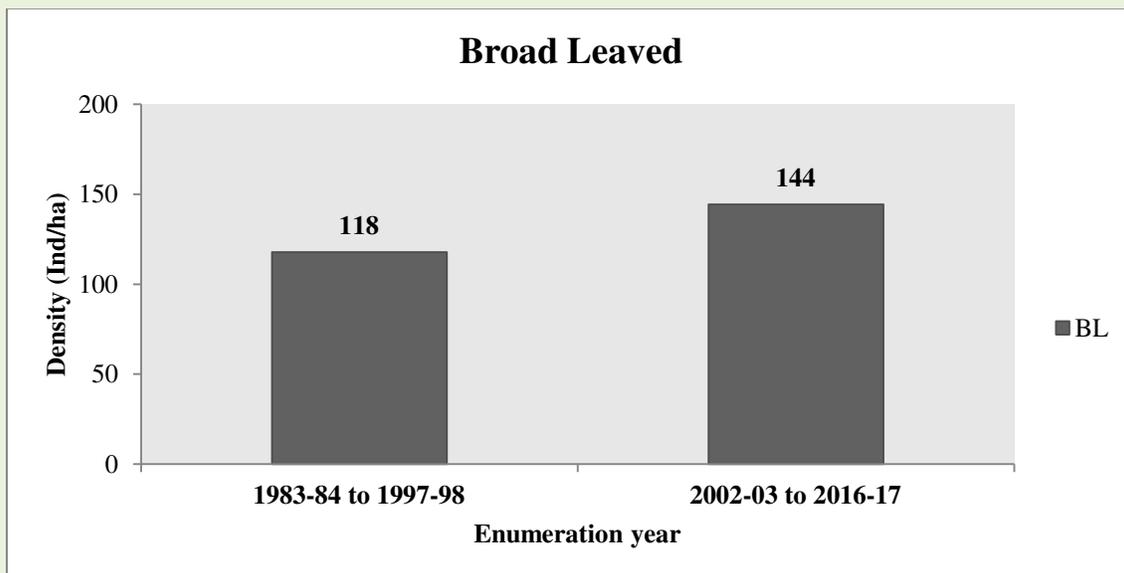


Figure 3 Density Variations in Broad Leaved community, Solan Forest Division, 1983-2017

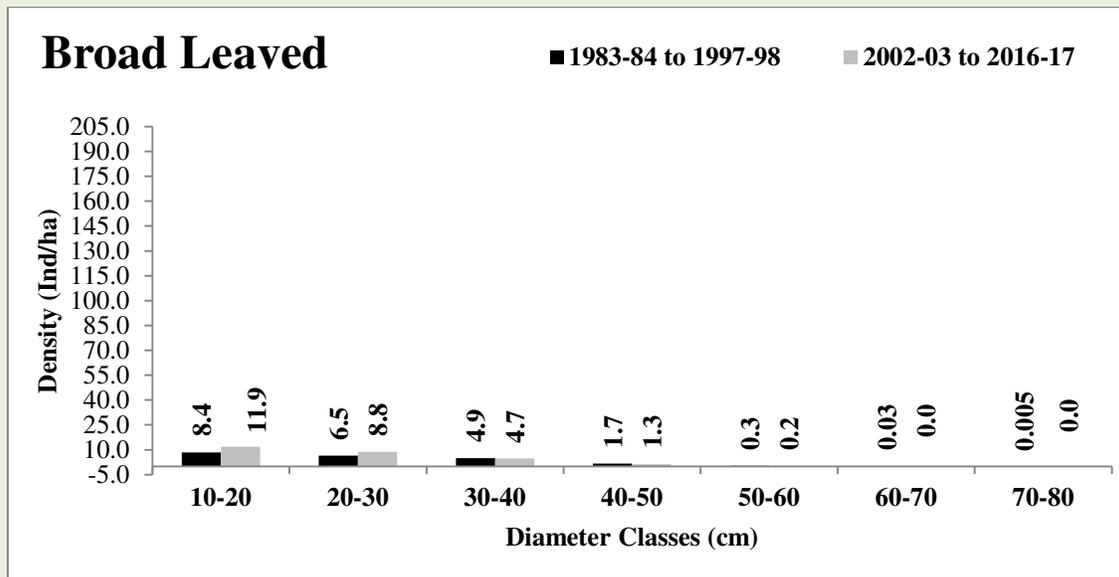


Figure 4 Diameter class wise variations in density of Broad Leaved of Solan Forest Division, 1983-2017

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 Solan Forest Division under the Nahar Forest Circle. To ascertain the temporal changes in different tree species composition, tree community based variation has been took place.

There were only two pure tree communities' *viz.* *Pinus roxburghii* and Broad leaved in Solan forest division as per the data analyzed in 77 forest compartments from enumeration year 1983-84 to 2016-17. Finding revealed that density of both species i.e. *Pinus roxburghii* and Broad leaved were increased from 129 Ind/ha to 359 Ind/ha and 118 Ind/ha to 144 Ind/ha respectively.

As Chil (*Pinus roxburghii*) has been exploited for timber, resin in the past and is the mainstay of Tomato and vegetable farming, in Solan district, as its twigs are favoured as stake for the vegetable plant. However the broad leaved plant has been exploited for fuelwood, fodder and other socio-economic uses. Beside the great demand of these species

among public domain and anthropogenic activities these species showed great adaptation/regeneration power in the forests as well.