

## QUANTITATIVE DESCRIPTION AND ENVIRONMENTAL RELATIONS OF PINE COMMUNITIES OF SHANGLA DISTRICT OF KP, PAKISTAN

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### Abstract

The study was carried out in forty stands of conifer dominating forests in Shangla District to evaluate the quantitative vegetation composition and community structure. Sampling was carried out by Point Centered Quadrant (PCQ) method. Five conifer species were dominating the forest namely, *Pinus wallichiana*, *Abies pindrow*, *Picea smithiana*, *Cedrus deodara*, and *Pinus roxburghii*. On the basis of importance value five communities were identified i.e. *Abies pindrow* - *Picea smithiana* Community, *Pinus wallichiana* - *Abies pindrow* community, *Pinus wallichiana* - *Quercus baloot* community, *Cedrus deodara*, and *Pinus wallichiana* community, *Picea smithiana* - *Pinus wallichiana*. Four monospecific stands of *Pinus wallichiana*, *Abies pindrow*, *Cedrus deodara*, and *Pinus roxburghii*, were also recognized. Among these, *Pinus wallichiana* exhibited the highest mean density 296 ha<sup>-1</sup> with 80 m<sup>2</sup> ha<sup>-1</sup> mean basal area occurring in 32 stands followed by *Abies pindrow* which was recorded in 9 stands with mean density of 223 ha<sup>-1</sup> and about 85 m<sup>2</sup> ha<sup>-1</sup> basal area, exhibiting the second highest importance value. *Picea smithiana* attained low quantitative values recorded from 3 sites. By studying the current forest structure, it can be concluded that the population of young stands exhibited higher density while the population of old trees is at risk of elimination. Therefore it is necessary that proper attention should be needed to these ecologically important forests zone that contributes a diverse range of biodiversity with a number of conifers that are seemingly close to elimination. Hence, proper conservation approaches should be applied to retain forests in the future.

**Key words:** Pine forests, Shangla, Point centered quarter method, Density, Basal area, Population, Community.

### Introduction

Pakistan is rich in biodiversity, having an enormous range of fauna, and flora, and is also composed of different climatic zones. According to Nasir & Ali (1972), approximately 6000 plant species of different medicinal and commercial importance are found in Pakistan. Plants play important role in the social and economic well-being of a nation. Besides, making a pleasant environment they reduce soil erosion, hold carbon stalk, regulate biogeochemical cycles, and act as a storehouse of genetic resource that contributes to evolutionary mechanism leading to an increase in biodiversity. The demand for plants has increased worldwide as the forest area reduces so it is of utmost importance to assess the present forest that highlights the threats and to improve their management. With the passage of time, plant diversity is deteriorating due to anthropogenic disturbances that lead to vanish a huge number of species (Parveen & Hussain, 2007). Biodiversity is considered an important approach for evaluating the forest ecosystem. According to Dewwanthi, (2008) factors that determine species composition remain unknown without the identification of plant communities, dynamics, and characteristics. Pakistan has five important ranges of mountains i.e. Western Himalayas range, the Karakoram Range, the Hindukush range, the Suleiman range, and the Khirthar range (Khan, 2011). Razaq & Ahmed (2019). Investigated Mountain of Pakistan and conifer forests quantitatively. Most of the areas of Shangla District lie in a moist temperate area of the Himalayan

Range of Khyber Pakhtunkhwa province of Pakistan. Champion *et al.*, (1965) observed different forests in Pakistan and find out that these dry and moist temperate areas show high species diversity as well as the diversity of plant communities. However, no quantitative or phytosociological work was presented in this area. Therefore an attempt has been made to identify phytosociological aspects of the forest vegetation of District Shangla. The investigations may be useful for the conservation and management perspective. The main objective of this study is to provide a detailed description of the plant communities and their relation to edaphic factors.

### Materials and Methods

Sampling was carried out in conifer-dominating forests, throughout their geographical limits in Shangla Mountains during the summer seasons of 2013 and 2014. Only mature and least disturbed forests were selected for quantitative sampling. Point Centered Quarter (PCQ) method of Cottam & Curtis (1956), was followed for quantitative sampling. In each forest (stand) 20 points were taken at 10-meter intervals following Ahmed & Shaukat (2012). Ground flora was also recorded by using a circular plot of 2.5 meters at each point. Phytosociological attributes (relative density, relative frequency, and relative basal area) and absolute values (density ha<sup>-1</sup> and basal area m<sup>2</sup> ha<sup>-1</sup>) were calculated by following the method of Mueller-Dombois & Ellenberg (1974) and Ahmed & Shaukat (2012). The slope angle was recorded by using a

slope meter. Global positioning system (GPS) was used to obtain geographical coordinates, i.e. elevation, Latitude and Longitude. The Importance Value Index (Brown & Curtis, 1952) was used to rank each plant species, and the species with the highest importance value in each stand were considered the first dominant species. Soil samples were also collected from the surface to 6" depth and subsurface 6" to 12" depth from each stand. Each plant community was then given a name on the basis of the first two dominant species. Unknown plant species were collected from each stand and then identified with the help of the flora of Pakistan (Nasir & Ali, 1972, 1980-1989 and Ali & Qaiser, 1995-2008).

## Results

**Description of communities:** Phytosociological analysis of 40 stands of different conifer-dominating tree species is described. Phytosociological attributes and absolute values (density  $\text{ha}^{-1}$  and basal area  $\text{m}^2 \text{ha}^{-1}$ ) are given in Table 1. The Mean values of phytosociological attributes of six dominant tree species are presented in Table 2, while stands included in each community and range of elevation, slope, and aspect are shown in Table 3. The results show four monospecific pure stands and five communities on the basis of importance value index (IVI) and floristic composition. Locations of 40 forest stands are shown in Fig. 1. Quantitative description of each community and the pure forest are explained as follows:

***Abies pindrow* – *Picea smithiana* community:** *Abies pindrow*, *Picea smithiana* community was recorded from two sites Mann Sar (stand 14) and Safaray Karaall (stand 15) areas. The elevation ranges from 2620 to 2780m with  $40^\circ$  and  $45^\circ$  steep slopes on East and West facing aspects (Table 3). Each stand had an open canopy. The importance values of *Abies pindrow* were 63.36 % and 80.74 % and *Picea smithiana* attained 19.2 and 36.6 %. Densities of *Abies pindrow* in both stands were 242 to 290  $\text{ha}^{-1}$  with 74.72 to 108.9 basal area  $\text{m}^2 \text{ha}^{-1}$  while *Picea smithiana* attained 60.5 to 61.5 density  $\text{ha}^{-1}$  with 32.1 to 43.2 basal area  $\text{m}^2 \text{ha}^{-1}$ . A few signs of land sliding and soil erosion was observed. Understory vegetation was disturbed by overgrazing. Few stumps of pine trees were also present in the area, due to anthropogenic disturbance. A total of 13 species from ground flora were recorded under this community. Six species were frequently distributed in both stands i.e. *Abies pindrow* seedlings, *Ajuga parviflora*, *Ammannia baccifera*, *Cenchrus penusaliformis*, *Fragaria orientalis*, *Rubus fruticosus*, while other species i.e. *Anaphalis scopulosa*, *Artimisa griffithiana*, *Cannabis sativa*, *Picea smithiana* seedlings, *Morchella esculenta*, *Trillium govanianum*, and *Urtica dioica* occurred in single stands.

***Pinus wallichiana* – *Abies pindrow* community:** This community was recorded from four different locations of sampling area i.e. stands no 23, 27, 30 and 32. Elevation range was from 2120m to 2223m above sea level with  $30^\circ$  to  $40^\circ$  slope angles at N/W and W/S aspects. Dominant species *Pinus wallichiana* contained 42 to 95% importance value while co-dominant *Abies pindrow*

showed 5.2 to 53.5% IVI. Density range was from 170 to 367  $\text{ha}^{-1}$  with 53.4 to 109 basal area  $\text{m}^2 \text{ha}^{-1}$  of *Pinus wallichiana* while co-dominant *Abies pindrow* attained 19.30 to 184 density  $\text{ha}^{-1}$  with 5.3 to 94.01 basal area  $\text{m}^2 \text{ha}^{-1}$  respectively. *Quercus baloot* was the associated species in this community and was present in stand no 32 with a very low quantity. Like other stands, the ground flora showed poor floristic composition. *Anaphalis scopulosa* with 17.3% relative frequency was the highest value among all other species of ground flora. Many species were observed with low frequency in each stand. These are *Adiantum venustum*, *Achyranthus aspera*, *Asplenium ceterach*, *Artimisa griffithiana*, *Anaphalis scopulosa*, *Berberis lycium*, *Artimisa griffithiana*, *Cannabis sativa*, *Conyza bonarensis*, *Elaengnus anguspifolia*, *Geranium wallichianum*, *Hedera nepalensis*, *Impatiense bracylcenera*, *Indigofera gerardiana*, *Launaea procum*, *Persicana punctata*, *Leucus notans*, *Mentha spicalinn*, *Morchella esculenta*, *Panicum milaceum*, *Pteridium aquilinum*, *Phragmites karka*, *Rubus fruticosus*, *Rumex dentatus*, *Spodiopogon cortolifer*, *Skimmia laureolia*, *Tagetis minuta* and *Urtica dioica*. *Conyza bonarensis*, *Hedera nepalensis* with 4.5% relative frequency and *Skimmia laureolia* with 4.6% relative frequency were found in this community.

***Pinus wallichiana* – *Quercus baloot* community:** *Pinus wallichiana* and *Quercus baloot* community was observed in two stands (stand 31 and 33) on North and North-East facing aspects respectively. Slope angle was  $25^\circ$  and  $28^\circ$  with 2223 and 2103m elevations respectively. Dominant species *Pinus wallichiana* attained 88% importance value, while *Quercus baloot* was presented with 12% importance value. Canopy of both stands was open due to illegal cutting and human disturbances. Understory vegetation and seedling of trees were highly disturbed. Dominant species *Pinus wallichiana* density was 268 to 300  $\text{ha}^{-1}$  with 50 to 53 basal area  $\text{m}^2 \text{ha}^{-1}$  while *Quercus baloot* attained low density 52 to 65  $\text{ha}^{-1}$  with 4.9 to 6.8 basal area  $\text{m}^2 \text{ha}^{-1}$ . Ground flora was diverse and the community showed poor floristic composition. A total of 21 species found in both stands in which *Hedera nepalensis* and *Conyza bonarensis* were found as common species with 9.7-13.2 and 8.1-9.4% relative frequencies respectively. Other species *Adiantum venustum*, *Ammannia baccifera*, *Rubus fruticosus*, *Berberis parkeriana*, *Bistorta amplexicula*, *Corbichonia decumbers*, *Dicliptera bupleuroides*, *Elaengnus anguspifolia*, *Indigofera gerardiana*, *Mentha spicalinn*, *Morus nigra*, *Ocimum bacilicum*, *Panicum milaceum*, *Pinus roxberghii* seedlings, *Polygonatum multiflorum*, *Solanum nigrum* and *Verbascum thapsus* were observed in single stand.

***Cedrus deodara* - *Pinus wallichiana* community:** This community was identified after sampling from two different locations (stands 35 and 37) at the elevation from 2014 and 2089m while degree of slope was between  $33^\circ$  and  $35^\circ$  respectively. Canopy was open in both stands because of anthropogenic disturbances i.e. cutting, animal grazing. Ground flora was rich. Soil erosion and land sliding were also observed. The soil collected from these stands was hard, muddy and composed of sedimentary rocks. *Cedrus deodara* was

the dominant species with IVI 44-88%, a density of 109 and 295 ha<sup>-1</sup>, while basal area 32 and 100 m<sup>2</sup> ha<sup>-1</sup>. Co-dominant species *Pinus wallichiana* was distributed with 12 to 45% IVI, density 63 to 145 ha<sup>-1</sup>, and 6 to 18 m<sup>2</sup> ha<sup>-1</sup> basal areas. The associated species *Quercus baloot* was observed with low density and basal area. The ground flora in these two stands was composed of 11 species. *Conyza bonarensis* and *Juglans regia* were found in both stands with 9.4-14.8 and 6.3-6.6% relative frequency respectively. *Leucus notans* were recorded with 13.1% relative frequency, while the lowest relative frequency was observed for *Portulaca oleracea*, *Tagatis minuta*, and *Plygonatum multiflorum* with 4.9% relative frequency in both stands. Other species *Amaranthus tricolor*, *Ammannia baccifera*, *Berberis parkeriana*, *Cicota virosa*, *Hedera nepalensis*, *Impaliense bracylcenera*, *Indigofera gerardiana*, *Nasturtium officinale*, *Panicum milaceum*, *Solanum nigrum*, *Strobilanthus asropurporus*, *Verbascum thapsus*, and *Xanthium stramonium* were found as rare species with lower relative frequencies.

***Picea smithiana* - *Pinus wallichiana* community:** This community was sampled from Jabba (stand 40) occurred on North-East facing with a 28° steep slope, while the elevation was 2374 m above sea level. Canopy was open at this stand because of the illegal cutting of old and mature trees and overgrazing. Soil erosion and land sliding were also observed. *Picea smithiana* the leading dominant species showed 83% importance value with a density of 246 ha<sup>-1</sup> and 97 m<sup>2</sup> ha<sup>-1</sup> basal area. Co-dominant *Pinus wallichiana* occurred with 17% importance value having 57 stem ha<sup>-1</sup> and 15 m<sup>2</sup> ha<sup>-1</sup> basal area. Most of the conifers species are a great threat in the whole district. Seedlings and saplings of *Pinus wallichiana* and *Picea smithiana* were present with the understorey vegetation in low numbers. The ground surface was full of bushes and herbs. Associated understorey species were *Adiantum capillsveneris*, *Amaranthus tricolor*, *Asplenium ceterach*, *Berberis lycium*, *Cenchrus penusaliformis*, *Fragaria nubicola*, *Fragaria orientalis*, *Impaliense bracylcenera*, *Morchella esculenta*, *Paeonia emodi*, *Picea smithiana*, *Solanum nigrum* and *Verbascum Thapsus*.

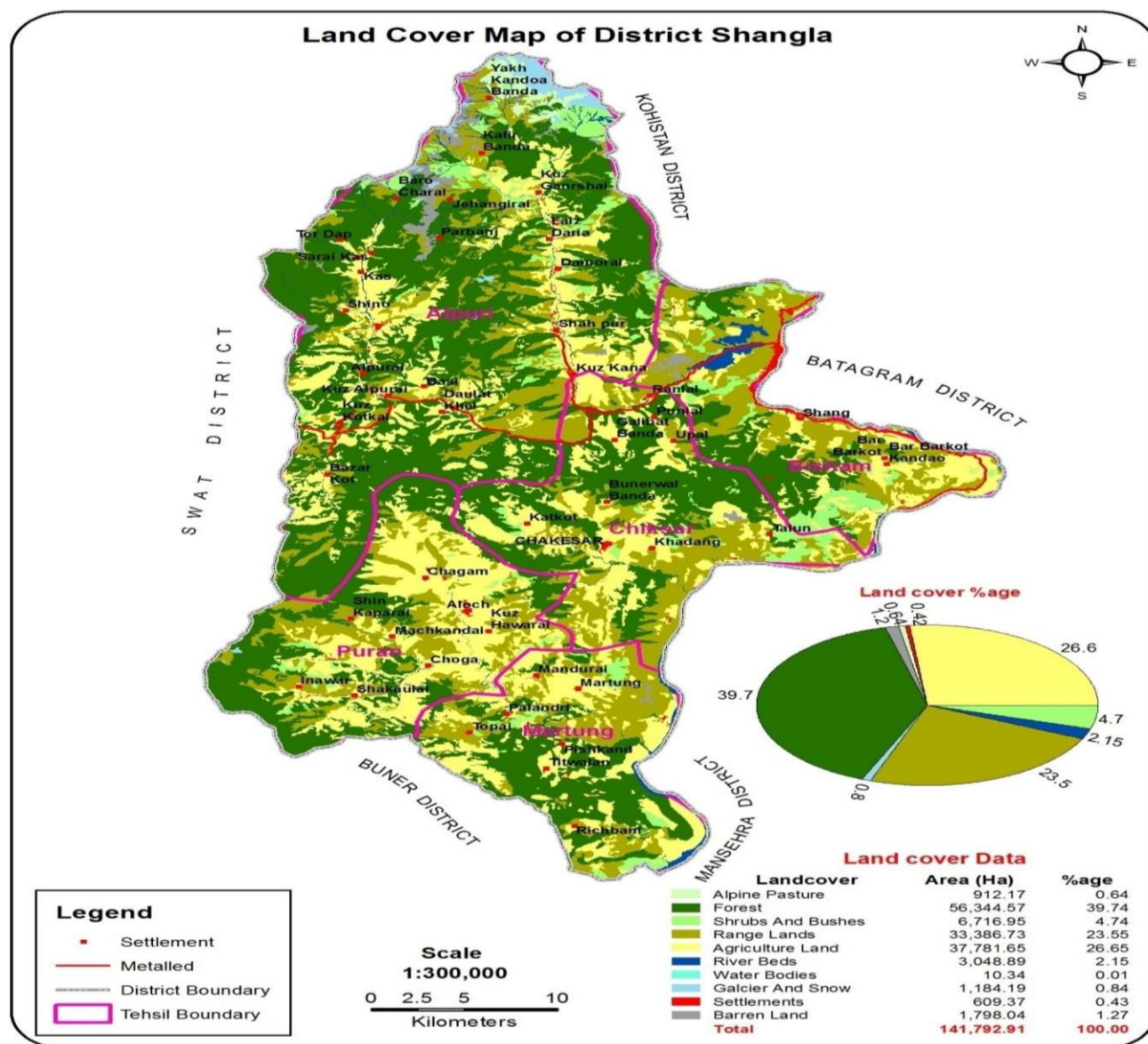


Fig. 1. Study area map of Shangla District, showing locations of Stands.

Table 1. Phytosociological Attributes and absolute values of tree species in forty stands from Shangla District of KPK, Pakistan.

	Main locations and sites	Name of species	Phytosociological attributes				Absolute values		
			R.F	R.B.A	R.D	IVI	Rank	D/ha <sup>-1</sup>	B.A m <sup>2</sup> ha <sup>-1</sup>
1.	Mangarkot (Shangla Top)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	55.61	14.5
2.	Rehman Abad	<i>Pinus wallichiana</i>	100	100	100	100	Pure	353	71.04
3.	Picho Banda (Dawlat Kaly)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	242.81	64.7
4.	Matta Karin	<i>Pinus wallichiana</i>	100	100	100	100	Pure	317.46	53.4
5.	Wachobi Card (Rahim Abad)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	313.81	68.56
6.	Kawaro (Alpurai)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	295.43	52.85
7.	N.G.Machhaar	<i>Pinus wallichiana</i>	100	100	100	100	Pure	298.29	126.9
8.	M.M.Machhaar	<i>Pinus wallichiana</i>	100	100	100	100	Pure	371.61	91.5
9.	Kotkay 1	<i>Pinus wallichiana</i>	100	100	100	100	Pure	298.04	40.5
10.	Kotkay 2	<i>Pinus wallichiana</i>	100	100	100	100	Pure	375.58	71.3
11.	Kandao (Ajmeer)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	379.2	139.4
12.	Kandao (P.K)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	293.46	141.1
13.	Bahadar Sar	<i>Pinus wallichiana</i>	100	100	100	100	Pure	383.71	145.4
14.	Mann Sar	<i>Abies pindrow</i>	80	80	63.36	74.45	1 <sup>st</sup>	242.18	74.7
		<i>Picea smithiana</i>	20	20	36.64	25.55	2 <sup>nd</sup>	60.54	43.2
15.	Safaray	<i>Abies pindrow</i>	82.5	82.5	77.21	80.74	1 <sup>st</sup>	60.54	108.9
		<i>Picea smithiana</i>	17.5	17.5	22.8	19.26	2 <sup>nd</sup>	289.8	32.1
16.	Nakhtar Nao	<i>Pinus wallichiana</i>	100	100	100	100	Pure	372.7	75.5
17.	Board Kotkay	<i>Pinus wallichiana</i>	100	100	100	100	Pure	390.96	62.4
18.	Shangla Top 1	<i>Pinus wallichiana</i>	100	100	100	100	Pure	345.17	103.7
19.	Shangla Top 2	<i>Pinus wallichiana</i>	100	100	100	100	Pure	289.98	109.6
20.	Alpurai Dipu	<i>Pinus wallichiana</i>	100	100	100	100	Pure	354.33	84.1
21.	Lilownai (P.L)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	335.75	65.9
22.	Poran Hill (Y.T)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	409.36	132.1
23.	Yakh Tangay 1	<i>Pinus wallichiana</i>	95	95	94.5	94.8	1 <sup>st</sup>	366.68	91.1
		<i>Abies pindrow</i>	5	5	5.52	5.17	2 <sup>nd</sup>	19.3	5.3
24.	Chakat (Karora)	<i>Pinus wallichiana</i>	100	100	100	100	Pure	327.3	94.3
25.	Goli butt	<i>Pinus wallichiana</i>	100	100	100	100	Pure	396.03	87.5
26.	Yakh Tangay 2	<i>Pinus wallichiana</i>	100	100	100	100	Pure	346.8	158.8
27.	Yakh Tangay 3	<i>Pinus wallichiana</i>	85	85	89.28	86.43	1 <sup>st</sup>	280.2	109.4
		<i>Abies pindrow</i>	15	15	10.72	13.57	2 <sup>nd</sup>	49.45	13.1
28.	Yakh Tangay 4	<i>Pinus wallichiana</i>	100	100	100	100	Pure	392.12	158.8
29.	Yakh Tangay 5	<i>Pinus wallichiana</i>	100	100	100	100	Pure	381.47	115.4
30.	Acharo (Y.T)	<i>Pinus wallichiana</i>	75	75	65.47	72.07	1 <sup>st</sup>	278.97	92.6
		<i>Abies pindrow</i>	25	25	34.53	27.95	2 <sup>nd</sup>	92.99	48.8
31.	Chakesar (Kandao)	<i>Pinus wallichiana</i>	83.75	91.1	83.75	86.2	1 <sup>st</sup>	92.9	50.4
		<i>Quercus baloot</i>	16.25	8.9	16.25	13.8	2 <sup>nd</sup>	268.82	4.93
		<i>Abies pindrow</i>	48.75	63.17	48.75	53.55	1 <sup>st</sup>	183.81	94.01
32.	Bakht Banda (Kandao)	<i>Pinus wallichiana</i>	45	35.92	6.25	41.97	2 <sup>nd</sup>	169.67	53.45
		<i>Quercus baloot</i>	6.25	0.91		4.48	3 <sup>rd</sup>	23.56	1.36
		<i>Pinus wallichiana</i>	80	99.93	80	88.31	1 <sup>st</sup>	299.88	74.4
33.	Poran Towa	<i>Quercus baloot</i>	20	0.07	20	11.69	2 <sup>nd</sup>	74.97	6.80
		<i>Pinus wallichiana</i>	100	100	100	100	Pure	224.7	20.3
34.	Sanela Poran	<i>Pinus wallichiana</i>	50	33.94	50	44.64	1 <sup>st</sup>	144.85	20.3
		<i>Cedrus deodara</i>	37.5	59.68	37.5	44.9	2 <sup>nd</sup>	108.65	18.1
35.	Bund Dherai	<i>Quercus baloot</i>	12.5	6.38	12.5	10.46	3 <sup>rd</sup>	36.22	31.8
		<i>Pinus roxburghii</i>	100	100	100	100	Pure	224.7	20.3
36.	Pitao (Dherai)	<i>Cedrus deodara</i>	82.5	99.94	82.5	88.3	1 <sup>st</sup>	295.51	100.4
37.	Chaat (Kandao)	<i>Pinus wallichiana</i>	17.5	0.06	17.5	11.7	2 <sup>nd</sup>	62.68	5.7
		<i>Cedrus deodara</i>	100	100	100	100	Pure	334.3	94.6
38.	Nala (Opal)	<i>Abies pindrow</i>	100	100	100	100	Pure	371.4	142.7
39.	Shalkho	<i>Picea smithiana</i>	81.25	86.42	81.3	83	1 <sup>st</sup>	246.5	97.2
		<i>Pinus wallichiana</i>	18.75	13.58	18.7	17	2 <sup>nd</sup>	56.9	15.3

**Key to abbreviations:** RF = Relative frequency, RBA = Relative basal area, RD = Relative density, D/ha<sup>-1</sup>= Density per hectare, Ba m<sup>2</sup> ha<sup>-1</sup> = Basal area m<sup>2</sup> ha<sup>-1</sup>, IVI = Importance value index, Y.T = Yakh tangay

**Table 2. Summary of Mean tree values of six dominant species of study area.**

S. No.	Name of species	PNST	Mean IVI	Mean D. ha <sup>-1</sup>	Mean B.A m <sup>2</sup> ha <sup>-1</sup>	Dominant		
						1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
1.	<i>Pinus wallichiana</i>	32	88.8 ± 4.3	296.4 ± 17.35	79.8 ± 7.01	29	3	-
2.	<i>Abies pindrow</i>	9	61.7 ± 12.7	223.5 ± 48.2	85.8 ± 18.06	6	3	-
3.	<i>Picea smithiana</i>	3	42.6 ± 20.3	122.8 ± 61.8	57.5 ± 20.10	1	2	-
4.	<i>Cedrus deodara</i>	3	77.7 ± 16.8	246.2 ± 69.7	75.6 ± 21.9	2	1	-
5.	<i>Pinus roxburghii</i>	2	100 ± 100	273.2 ± 48.5	26.9 ± 6.5	2	-	-
6.	<i>Quercus baloot</i>	4	10.10 ± 1.99	46.7 ± 11.08	4.12 ± 1.15	-	2	2

**Key to abbreviation:** PNST = Presence in a number of stands, D = Density, B.A = BASAL area, ± Standard error, IVI = Importance value index

**Table 3. Communities stand numbers and topographic attributes of communities are listed below.**

S. No.	Name of community	Stand No.	Elevation	Slope	Aspect
			Range	(o)	
1.	<i>Pinus wallichiana</i> (Pure)	1 to 10 12, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 28, 29	1490—2620	30—50	NW, N, NE, W, SW, S
2.	<i>Abies pindrow</i> (Pure)	11,13,39	2556—2810	26—45	SW,S,R.top
3.	<i>Pinus roxburghii</i> (Pure)	34,36	1298—1451	30—40	NE.
4.	<i>Cedrus deodara</i> (Pure)	38	2094	50	S.
5.	<i>Abies pindrow</i> / <i>Picea smithiana</i> .	14, 15	2620—2780	40—45	E,W.
6.	<i>Pinus wallichiana</i> / <i>Abies pindrow</i> .	23, 27,30,32	2120—2240	30—40	NW,W.
7.	<i>Pinus wallichiana</i> / <i>Quercus baloot</i>	31,33	2103—2223	25—28	SE,NE.
8.	<i>Cedrus deodara</i> / <i>Pinus wallichiana</i>	35,37	2014—2089	33—35	W,N.
9.	<i>Picea smitiana</i> / <i>Pinus wallichiana</i>	40	2374	28	NE.

### Monospecific stands

***Pinus wallichiana*:** *Pinus wallichiana* monospecific stands were found at 23 different locations in Shangla District from 1490 to 2620m elevation. The degree of the slope was from 30° to 50° (Table 1). This species was widely distributed in all over Shangla District. Canopy was mostly open in these stands because of illegal cutting and human disturbances. The ground surface was mostly full of litter, grasses, bushes, and boulders. Various cut stems were also seen at these sites. In these monospecific stands *Pinus wallichiana* density ranged from 55 to 409 ha<sup>-1</sup> with 14.47 to 132.11 basal area m<sup>2</sup> ha<sup>-1</sup>. Lichens of different colors and shapes were seen thriving on the bark of trees and dead stems. The soil was mostly soft and loamy but in some stands, it was hard and dry composed of pebbles, gravels, and sedimentary materials, and in some places brown in color. In these forests ground flora was found in diverse shapes among which *Asplenium ceterach* was found as the dominant species in 14 sites with 6.5 to 18.4% relative frequency, *Hedera nepalensis* was found in 13 stands with 5.8 to 21%, *Berberis lycium* with 5.8 to 13% relative frequency. Other species were occasional like *Achyranthus aspera*, *Adiantum venustum*, *Amaranthus tricolor*, *Anaphalis scopulosa*, *Artimesa griffithiana*, *Artemisia maritima*, *Bistorta amplixicula*, *Cannabis sativa*, *Carpesium nepalense*, *Cenchrus penusaliformis* *cicota virosa*, *Conyza bonarensis*, *Corbichonia decumbers*, *Delphinium lacosti*, *Dicliptera bupleuroides*, *Digiteria sanguinalis*, *Drypteris stewartii*, *Echinopes*, *Elaengnus angusipifolia*, *Ficus palmate*, *Fragaria orientalis*, *Fragaria nubicola*, *Geranium Wallichianum*, *Impaliense bracycenera*, *Indigofera gerardiana*, *Juglans regia*, *Launaea procum*, *Leptorhabdo spariflora*, *Mentha longifolia*, *Ocimum bacilicum*, *Panicum milaceum*, *Persicana punctata*, *Pinus wallichiana* seedlings, *Pinus roxburghii* seedlings, *Pteridium aquilinum*, *Phragmites*

*karka*, *Punica granatum*, *Quercus baloot* seedlings, *Ricinis communis*, *Rubus fruticosus*, *Rumex hastatus*, *Solanum nigrum*, *Spodiopogan cortolifer*, *Strobilanthus asropurporus* *Tagetis minuta*, *Urtica dioica*, *Verbascum thapsus* *Viola canescens*, and *Xanthium stramonium*.

***Abies pindrow*:** At three locations, *Abies pindrow* was sampled as a single dominating species. These stands were present at the elevation from 2556 to 2810 meters above mean sea level with 26° and 45° steep slopes. In these monospecific stands, density ranged from 371 to 384 ha<sup>-1</sup> with 139.38 to 145.37 basal area m<sup>2</sup> ha<sup>-1</sup> Table 1. The canopy was moderately closed. As these forests are present at high elevations and far away from the local community so these forests are least disturbed than other. Surface of the soil was mostly brown and full of rich ground flora. Lichens of different colors and sizes were seen on exposed rocks and on the bark of trees. In these forests *Asplenium ceterach* was found in all three sites with 9.3 to 10.1% relative frequency while *Adiantum capillsveneris*, *Allium sativum*, *Alisma plantago aquatica*, *Artemisia maritima*, *Berberis lycium*, *Cannabis sativa*, *Conyza bonarensis*, *Corbichonia decumbers*, *Digiteria sanguinalis*, *Dicliptera bupleuroides*, *Drypteris stewartii*, *Fragaria nubicola*, *Hedera nepalensis*, *Launaea procum*, *Mentha longifolia*, *Morchella esculenta*, *Ocimum bacilicum*, *Paeonia emodi*, *Phragmites karka*, *Polygonatum multiflorum* *Ricinis communis*, *Solanum nigrum*, *Tagetis minuta*, *Urtica dioica*, and *Viola canescens* were distributed, with low frequency.

***Pinus roxburghii*:** *Pinus roxburghii* monospecific stands were distributed at the elevation of 1298 and 1451m above sea level at two different locations stand no 34 Poran side, and stand no 36 Dherai Ghurband side. The density range was from 225 to 322 h<sup>-1</sup> with 20.36 to 33.38 basal area m<sup>2</sup> ha<sup>-1</sup>, Slope angle was from 30° to 40°. In

these stands, the canopy was open because it was a young forest and the sign of disturbance were also seen. Soil erosion was also observed. The soil was soft and clay-type in both stands. Due to illegal cutting and animal grazing highly disturbed *Pinus roxburghii* is present in the lower level of the district. From these two stands, *Ammannia baccifera*, *Bistorta amplixicula*, *Cicota virosa*, *Hedera nepalensis*, *Morus nigra*, *Pinus roxburghii* seedlings, and *Verbascum thapsus* was found in both sites in which *Verbascum thapsus* contained 4.8 frequency in stand 36 and highest (16.4%) relative frequency in stand 34, while *Asplenium ceterach*, *Berberis lycium*, *Conyza bonarensis*, *Geranium Wallichianum*, *Portulaca oleracea*, and *Nasturtim officinale* were found in a single site.

***Cedrus deodara*:** *Cedrus deodara* monospecific pure forest was situated only in one stand (38) at Nala area near Karora at the elevation of 2094m above sea level. Density was 334 ha<sup>-1</sup> on a 50° slope angle. The canopy was a moderate type. Some old and huge trees were present in this stand. Seedlings of *Cedrus deodara* were observed on the forest floor. Ground flora was dominated by *Polygonatum multiflorum* with 14% relative frequency followed by *Hedera nepalensis* and *Panicum milaceum* with 12.3% relative frequency. *Berberis parkeriana* and *Impaliense brachycenera* were with 7% relative frequency, while other species in this forest were *Poligonatum verticelatum*, *Rubus fruticosus*, *Solanum nigrum*, *Tagetis minuta* and *Ocimum bacilicum* with low frequency.

Table 2 shows the mean values of six dominant tree species of the study area while Table 3 postulate the number of stands, elevation range, slope angles, and aspects occupied by different tree communities in Shangla District. *Pinus wallichiana*, *Abies pindrow*, *Pinus roxburghii*, and *Cedrus deodara* showed the highest possible (100%) relative phytosociological attributes due to the pure stands. In dominant tree species *Pinus wallichiana* occupied the highest (296) mean density ha<sup>-1</sup> while the highest basal area (86 m<sup>2</sup> ha<sup>-1</sup>) was shown by *Abies pindrow*. *Pinus roxburghii* attained highest IVI (100%) and contained a considerably low mean (27) basal area with 2<sup>nd</sup> larger density (273 ha<sup>-1</sup>). Highest basal area species *Abies pindrow* showed 4<sup>th</sup> position in density ha<sup>-1</sup>. Table 3 indicated that *Cedrus deodara* pure stand was distributed in the South, *Pinus roxburghii* on North-East and *Picea-Pinus wallichiana* community was restricted to North-East aspects. *Pinus wallichiana* was distributed in the thirty-two stands while *Abies pindrow* was recorded from 9 stands. Other tree species showing limited distribution i.e. present in 2 to 4 stands.

The vegetation of the forest contributed a stronger correlation with *A. pindrow* in the pure vegetation group and in a combination with *P. wallichiana*. Although, *P. wallichiana* is represented in a greater number of stands as a single-dominated species occupying a greater area but *A. pindrow* showed a stronger bonding with the environment that indicated its propagation in the future. In contrast, the basal area of the conifers was poorly variant among conifers with a non-significant difference. However, *P. roxburghii* possessed a larger basal area ha<sup>-1</sup> with a sharp gradually declining trend Fig. 2.

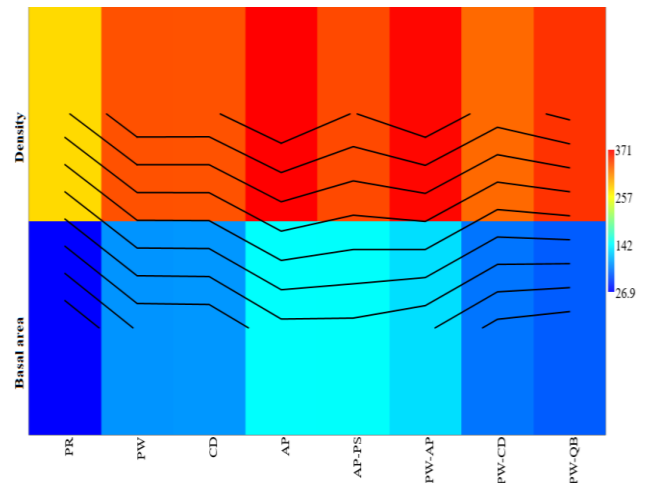


Fig. 2. Colorogram showing community trend on the basis of density and basal area of conifer-dominated vegetative groups.

## Discussion

In this study, four monospecific pure stands and five communities were recorded from Shangla District. Among these forty stands *Pinus wallichiana* was present as the leading dominant species in the whole study area while *Cedrus deodara* and *Picea smithiana* occurred with low density. *Pinus wallichiana*, the leading dominant species occurred in 32 stands, while in twenty-three stands it was present as monospecific species and it was found first dominant in 29 stands, while in three stands it was present as the second dominant species with other conifer species. Champion *et al.*, (1965) observed *Pinus wallichiana* from different sites of moist temperate areas and they declared that this species requires more moistened conditions than other species of dry temperate zones. Beg *et al.*, (1975) recognized *Pinus wallichiana* in Blue-pine forests as a dry temperate zone species. Ahmed *et al.*, (2006) recorded *Pinus wallichiana* pure stands from Nalter (Gilgit-Baltistan) on South facing aspects at about 2770m altitude and from Takht-e-Suleiman Balochistan at 3100 m elevation (both areas are dry temperate). They also recorded *Pinus wallichiana* from moist temperate mixed forests of Murree and Lower Topa, Jhika Gali, associated with *Quercus incana* at about 1970 to 2250m elevations (Khan *et al.*, 2020). According to Khan (2021) and Ahmed *et al.*, (2006), this species has a wide ecological amplitude distributed from moist temperate to dry temperate areas and up to timberline. Iqbal *et al.*, (2022) evaluated four vegetation groups in the Shangla district, quantitatively i.e., *Pinus wallichiana* associated with *Abies pindrow*, *Abies pindrow*, and *Picea smithiana* group, *Cedrus deodara* associated with the *Pinus wallichiana*, *Abies pindrow*, and *Picea smithiana* association. They observed that environmental characteristics, soil physical properties, and soil nutrients) are the key controlling factors for each community. Wahab *et al.*, (2011) observed *Pinus wallichiana* monospecific pure forest from Batharae, Tormang dara at about 1875 m elevation. Density was 43 stems ha<sup>-1</sup> with 39.63 basal area m<sup>2</sup> ha<sup>-1</sup>. Akbar *et al.*, (2011) recorded *Pinus wallichiana* stands from 10 different locations of Skardu and Astore Districts of Gilgit-Baltistan. The range of density of these stands was 92 to 180 ha<sup>-1</sup> with 8.72 to

36.02 basal area  $\text{m}^2 \text{ha}^{-1}$ . Siddiqui *et al.*, (2013) recorded *Pinus wallichiana* monospecific forest from two different places *i.e.*, Chikar, Azad Kashmir and Patriata, Murre. *Pinus wallichiana* was also present as dominating species associated with seven non-conifer understorey species. Rahman *et al.*, (2020) recorded *P. wallichiana*-dominated vegetation groups, which exhibited significant floristic variation and complex relationships with the surrounding environment. *Pinus wallichiana* and *Abies pindrow* community was observed by Khan, (2011) reported this community from Chitral District at about 2775m elevation with a closed canopy. Khan *et al.*, (2016) investigated *Pinus wallichiana*-*Abies pindrow* community at six different locations of Indus Kohistan in a dry temperate region. Siddiqui, (2011) and Bokhari (2011) analyzed this community in moist temperate areas from Suddhan Gali, Azad Kashmir. Wahab (2011) observed community of *Pinus wallichiana*-*Quercus baloot* from Bhagam in Nehag Dara forests of District Dir at about 2190 m elevation. They also recorded eleven understorey species in which *Indigofera gerardiana* and *Rubus fruticosus* were distributed, both these species are also present in our study area under this community which shows wide ecological distribution in these forests. Iqbal *et al.*, (2014) investigated *Abies pindrow* from seven different locations in his preliminary studies. According to Ahmed *et al.*, (2006) *Abies pindrow* preferred dry temperate areas of Pakistan but also reported from moist temperate areas showing wide ecological amplitude. Wahab *et al.*, (2008) observed *Abies pindrow* pure stands from Satto Khwar in Usherie Valley at about 2670 m elevation. The density of this pure species was  $123 \text{ha}^{-1}$  with  $24.6 \text{m}^2 \text{ha}^{-1}$  basal area. Akbar *et al.*, (2011) reported this species as a pure stand from District Astore at about 3464 m altitude. They calculated *Abies pindrow* density as  $107 \text{trees ha}^{-1}$  with  $7.87 \text{m}^2 \text{ha}^{-1}$  basal area. Siddiqui *et al.*, (2013) investigate *Abies pindrow* monospecific forest from Lalazar, (Naran, Kaghan valley) at 3000m elevation. The density was  $189 \text{trees ha}^{-1}$  with  $109 \text{m}^2 \text{ha}^{-1}$  basal area. They also observed that this area was extensively disturbed due to human interferences that's why very few understorey species were recorded from the area. Ali *et al.* 2014, concluded that *Abies pindrow* won't go extinct in the region, but its existing habitat and population density will be adversely impacted. As a result, the sub-flora that depends on *Abies pindrow* will either disappear or relocate with the overstorey trees.

*Abies pindrow* and *Picea smithiana* community was recorded from two sites in Shangla Districts. A similar type of community were also recorded by Wahab (2011) from District Dir, Siddiqui *et al.*, (2013; 2015) from moist temperate areas of Sri, Shogran and Malam Jabba forests while Khan *et al.*, (2016) from Indus Kohistan District of Khyber Pakhtunkhwa. *Pinus roxburghii* species were also present at other locations with low numbers. According to Ahmed *et al.*, (2019), *Pinus roxburghii* species mostly prefer to grow in lower elevations and gentle slopes of subtropical zones of Pakistan. Due to human interference, these gentle slopes are mostly converted to the human population and cultivated lands. Champion *et al.*, (1965) described *Cedrus deodara* under a moist temperate forest. Siddiqui *et al.*, (2013) observed two monospecific forests of *Cedrus deodara* from Naran and Kaghan valley, which are moist temperate areas. These stands were located at the

elevation of 1650 m and 2500 m respectively. The density range of these pure stands was 284 to  $410 \text{ha}^{-1}$  with 36 to  $50 \text{m}^2 \text{ha}^{-1}$  basal area. The presence of these species in moist temperate areas indicates the wide ecological amplitude of this species. Wahab *et al.*, (2008) investigated *Cedrus deodara* from a dry temperate zone. Ahmed *et al.*, (2006) recorded this species from Astore District (sub-alpine area). Wahab *et al.*, (2008) recorded *Cedrus deodara* pure stands from Afghanistan at Surgulo sar. All the trees were young. Ahmed *et al.*, (2010) sampled *Cedrus deodara* monospecific forest from twelve different locations in Northern areas of Pakistan. The elevation range was from 1650 to 2770 m. In this monospecific deodar, forest density was ranged from 99 to  $457 \text{trees ha}^{-1}$  with 6.35 to  $115 \text{m}^2 \text{ha}^{-1}$  basal area. They concluded that most deodar is found in dry temperate areas; while in moist temperate areas, few pure stands were also present. Khan *et al.*, (2011) observed *Cedrus deodara* monospecific forest from three locations of District Chitral. These single dominating species were present at about 2125 to 2900 m elevation above mean sea level. The density of these monospecific tree stands was from 100 to  $322 \text{ha}^{-1}$  with 7.84 to  $76.45 \text{m}^2 \text{ha}^{-1}$ . As *Cedrus deodara* was present in very few stands of the study area indicates the great threat to this species if the government and local forest department do not take prompt action for the conservation of this species it may vanish very soon. Ahmed *et al.*, (2010) also reported *Cedrus deodara*-*Pinus wallichiana* community from 22 different locations of moist temperate areas of Himalayan range of Pakistan from 1950m elevation to 2700m elevation.

The *Picea smithiana* community was observed by Wahab *et al.*, (2008) from Sheshan, Afghanistan. *Picea smithiana* trees were mostly large in size with the lowest density of ( $35 \text{trees h}^{-1}$ ) with a basal area of  $15.9 \text{m}^2 \text{ha}^{-1}$ . They also observe that this species is also present in nearby areas of Pakistan with high values of density and basal area. *Picea smithiana* - *Pinus wallichiana* community was recorded by Hussain (2013) from three locations of Central Karakoram National Park, Northern areas of Gilgit-Baltistan with 3110 to 3512m elevation. They recorded 42 species of ground flora from these areas. Wahab (2011), sampled *Picea*-*Pinus wallichiana* community from District Dir. Ahmed *et al.*, (2006) reported *Picea*-*Pinus wallichiana* community from dry temperate areas of the Astore District of Gilgit-Baltistan with 3300m elevation. Akbar, (2013) also recognized this community from the Rama and Mushken forests of Gilgit-Baltistan with elevations ranging from 2719 to 3275m. They observed *Fragaria nubicola* understorey species with 5 % relative frequency which is also present in our study area showing wide ecological amplitude in these areas. Khan *et al.*, (2010a & b) recorded *Quercus baloot* species from different locations in Dir and Chitral Districts. A quantitative description of various conifer forests in Pakistan was presented by Ahmed *et al.*, (2019). Like other studies in Pakistan, the present investigation also suggested that these pine tree species are distributed either in pure form or forming communities with other pine or broad-leaved species. Then numerical values or phytosociological attributes are depended on the degree of disturbance and their values are within the range of other studies in different areas of Pakistan.

The present investigation showed that the study area (Shangla District) supported similar communities, monospecific forests, or tree floristic compositions to other subtropical, moist, or dry temperate areas of Pakistan. Phytosociological attributes and absolute values of tree species are within the range of other studies in the country. The area also faced similar anthropogenic disturbances i.e. illegal cutting, overgrazing, picking of medicinal plants and timber for construction, etc. The area is potentially suitable for the forest which offers a habitat for wildlife, medicinal plants, and other tree communities. However, it needs ecological exertion for its restoration, improvement, and proper management to reduce pressure on forest resources.

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