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Natural regeneration status of *Betula utilis* in Sangla valley of Indian Himalayas

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Abstract
The present investigation entitled, "Natural regeneration status of *Betula utilis* in Sangla valley of Indian Himalayas.". The study area was divided into three horizontal (lower, middle and upper) elevations. To carry out this study five quadrates of 10 x 100m were laid down for the study of trees and shrubs, whereas, twenty quadrates of 2 x 2m were layed per main plot to study the regeneration parameters. The recruits, unestablished and established plants of *Betula utilis* and associated species decreased with the increase in elevation. Similarly, the regeneration success decreased with increase in elevation. The maximum total weighted average height, total established index, total stocking index and total establishment stocking per cent were recorded at lower elevation. Simple correlation reveal that regeneration of *B. utilis* had a positive and significant correlation with soil organic carbon, pH, organic matter layer and solar influx, soil moisture and soil nutrients.

Keywords: *Betula utilis,* regeneration, elevation, stocking index and correlation

Introduction
Betula utilis D. Don., commonly known as birch in English and Bhojpattar in Hindi belongs to family Betulaceae. It is a moderate sized deciduous tree up to 20 m tall or often mere shrub on higher elevations forming the upper most limit and successional climax of the vegetation in tree line. The bark is smooth, reddish brown with whitish, linear, horizontal, lenticles, which was used as paper in China. Leaves are stalked, 5 to10 cm long, ovate, unequally serrate, acute, slightly hairy along the mid ribs. The tree is found in higher reaches of the inner Himalayas starting from Bhutan westwards, chiefly at an altitude between 3,000 to 4,500 m amsl. But sometimes it descends sporadically as low as 2,500 m and even 2,000 m in the Kishenganga valley of Kashmir (Troup, 1921) [17]. Northwards, it extends to China and western Tibet. It is usually found associated with *Abies pindrow, Quercus semecarpifolia, Pyrus lanat* and *P. foliolosa*. It has a gregarious growth nature and makes the upper limit of tree vegetation on the uplands of the inner western Himalayas below the snow line begins. The birch forests occur on open exposed tracts which are under snow throughout the greater part of the winter. It is the only broadleaved angiosperm tree species in the Himalayas which dominates an extensive area at subalpine altitudes (Zobel and Singh, 1997) [20]. *Betula* spp. possess high freezing tolerance (Sakai and Larcher, 1987) which enables them to form tree line in the Himalayas (Zobel and Singh, 1997 and TISC, 2002) [20, 16] as well as in the Scandinavian region (Cairns and Moen, 2004) [3]. The tree is a strong light demander. The young crops spring upon bare ground exposed by the scouring of snow or on the accumulation of earth and rock debris. The birch forests themselves are subjected to constant erosion and scouring by snow and the upper reaches of the snow-fed torrents are often piled up with the white trunks of the birch trees, which have been swept down by the sliding and melting snow. In some localities extensive damage is done to the birch forests by nomadic graziers and local residents, who lop and fell the tree for fodder and fuelwood and have been responsible for the clearance of large tracts of forests. The excessive striping of the bark for decorative paper making and other purposes also accounts for the death of many trees.

The Betula has poor survival due to biotic interference like grazing, and trampling, infrequent seed years, accumulation of humus and weed growth, etc. Furthermore, the slow initial growth hampers its establishment and development in the natural habitat, threatening the very existence of species in this country. Management and improvement of the existing stock thus requires the knowledge of population structure, composition and regeneration potential of species for its overall growth and development.

Biodiversity has become more and more popular topic within the discussion of sustainability in the last decade, though the maintenance of diversity of forest ecosystems requires many years, especially stressed upon even in the Rio declaration and renewed by the Lisbon conference in 1998. Biodiversity is the sum total of plants, animals and microorganisms existing as an interacting system in a given habitat. It exists on earth in eight broad realms with 193 biogeographical provinces (Udvardy, 1984) [18]. Each geographical province is composed of ecosystems which are constituted by communities of living specks existing in an ecological region. At the global level about 16, 04,000 species of plants, animals and microorganisms have been described so far. However, it is estimated that there are around 17, 98,000 species (WCMC, 1992) [19]. These species exist on land, fresh water and in marine habitats or occur as symbionts in mutualistic and in parasitic state with other organisms. Biodiversity can be assessed at three broad levels, viz., genetic variation with in species (number of individuals with in a species), the variety of species with in a habitat and the variety of habitats on ecosystems or planet (Flint, 1991) [9].

Methods and Materials

Study Area

Present study was carried in the Sangla valley which is nested in the Kinnaur district of Himachal Pradesh located between latitude 31^{0}06' N to 31^{0}30' N and longitude 78^{0}10'E to 79^{0}00' E (FSI, Map sheet Number 53I7). The study was mainly confined to *Betula utilis* bearing forests within the elevation range from 3,000 m to 3,900 m msl distributed mainly in west Himalayan sub-alpine birch/fir forests (14/C_1), Birch-Rhododendron scrub forests (15/C_1) and Deciduous alpine scrub (15/C_2) forest types as per Champion and Seth (1968) [5]. The valley comprises a number of small watersheds which find their way into the Baspa River. The hamlets are scattered all along the valley. The strips of cultivable lands in valley vary from a few hectares to a few kilometers. The upper most part of the mountain peaks are usually covered by perpetual snow cover. A major part of the valley remains cut-off from other parts of the state due to heavy snowfall during winter period. The rocks in the valley varied in age from Precambrian to perm carboniferous. Schists, gneisses, granites, quartzites, phyllites, conglongrates, quartzites slate, dolomite and limestone are the major rock types. Rocks have been highly exposed along the Karchham-Sangla road. Soil type is sandy to sandy loam and is highly fragile (Fig. 1).

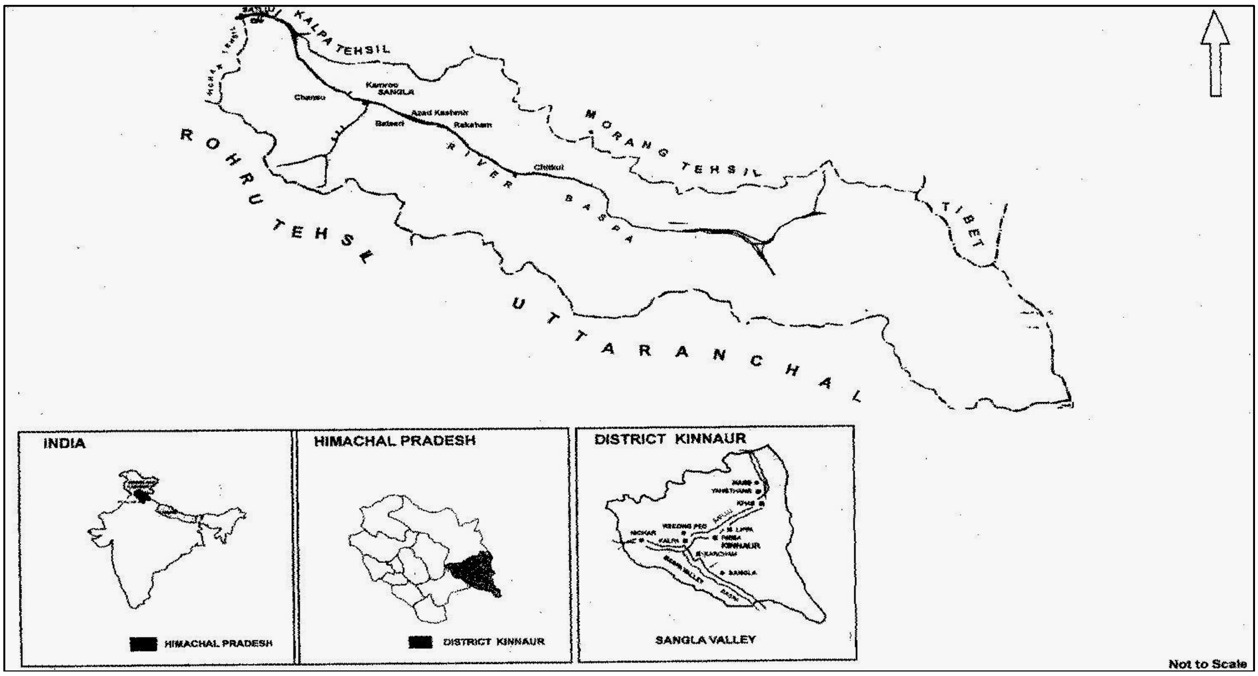


Fig 1: Map depicting location of HP, Kinnaur, Sangla valley and study site.

Climate

There are four major seasons, viz., spring starts from middle of March and lasts till mid-May, summer from mid-May to mid-September, autumn from mid-September to November and winter season from December to March. Summer is quite mild and with the onset of monsoon rains, there is a gradual decline in atmospheric temperature. After the receding of monsoon, the mercury drops further thus winter sets in. The period from November to March is the coldest.

Site Selection

The selection of the site was carried out on the basis of presence of *Betula utilis stands* for the study purpose. The study area selected ranged between 3,000 to 3,900 m msl. Since the terrain was highly undulating and it was not possible to cline at many places. Thus the complete area was horizontal (H) divided into three elevations, viz., lower zone (3,000 to 3,300 m), middle zone (3,300 to 3,600 m) and upper zone (3,600 to 3,900 m). These three horizontal (H) zones were further divided into five vertical (V) zones as depicted below. Thus 15 compartments were marked. Sampling was carried out in each compartment as depicted below.

	V1	V2	V3	V4	V5
H3 Upper Elevation (3,600-3,900 m)	Q11	Q12	Q13	Q14	Q15
H2 Middle Elevation (3,300-3,600 m)	Q6	Q7	Q8	Q9	Q10
H1 Lower Elevation (3,000-3,300 m)	Q1	Q2	Q3	Q4	Q5

The regeneration survey was carried out in all the sample plots in all the selected sites at each elevation. In each major sample plot (10x100 m), twenty quadrates of size 2 x 2m were laid down. A number of 2,500 established plant per hectare was considered to express satisfactory regeneration. Similarly, the quadrate was considered fully stocked when it contained at least one established plant (Chacko, 1965) [4]. The survey was conducted for recruits (defined as current years seedlings), unestablished regeneration (seedling other than recruits which has not yet established and the height was less than 2 m); here four unestablished plants were taken equivalent to one established plant and established regeneration having height of more than 2 m. The regeneration data for *Betula utilis* and associated species was collected on the basis of number of individuals occurring at seedling, sapling and pole stage in each quadrate. The height of unestablished plants was also measured for the assessment of regeneration (Champion, 1935) [6].

Regeneration Assessment

The data thus collected was analyzed using the formulae given by Chacko (1965) [4] as

$$\text{Recruits (r) /ha} = 2500 \sum_{i=1}^{n} ri / m$$

$$\text{Unestablished regeneration (u)/ha} = 2500 \sum_{i=1}^{n} ui / m$$

$$\text{Established regeneration (e)/ha} = 2500 \sum_{i=1}^{n} ei / m$$

Where, n = Number of sampling units

m = Total number of recording units in survey

ri =Total number of recruits in each sampling unit

ui = Total number of unestablished plants in each sampling unit

ei = Total number of established plants in each sampling unit

$$\text{Weighted Average Height (m)} = \frac{\text{Total height of unestablished regeneration + (Number of established plants x establishment height)}}{\text{Total unestablished plants + total established plants}}$$

On the basis of above estimates following indices were calculated:

$$\text{Establishment Index } (I_1) = \frac{\text{Weighted average height}}{\text{Establishment height}}$$

$$\text{Established Stocking (\%)} = 100\ (I_1 \times I_2)$$

$$\text{Regeneration Success (\%)} = \text{Stocking index } (I_2) \times 100$$

$$\text{Stocking Index } (I_2) = 1/2500 \times \frac{\text{Unestablished regeneration/ha}}{4} + \text{Established regeneration/ ha}$$

Results

The present investigations for regeneration studies were carried out on recruits, unestablished, established and regeneration success in Betula forests of Sangla valley in Himachal Pradesh. The data on various regeneration parameters is described as under.

Regeneration Status at Different Elevations

Lower Elevation

The pooled data for different elevations (lower, middle and upper) depicted that the regeneration status of *Betula utilis* and its associated species in Sangla valley of H.P. and the results revealed that maximum number of recruits 1044.00/ha (36.17%) were recorded for *Betula utilis* followed by *Pinus wallichiana* and *Picea smithiana* with numbers 862.00/ha (29.89%) and 488.00/ha (16.91%), respectively. Whereas, the minimum number was reported for *Juniper macropoda* with number of 50.00 /ha (1.73%). Similarly, the maximum number of unestablished plants were found maximum 354.00/ha (36.80%) in case of *B. utilis*, followed by *P. wallichiana* and *P. smithiana* with numbers 292.00 (30.35%) and 164.00 (17.05%), respectively. However minimum number of unestablished plants were found minimum 8.00 /ha (0.83%) for Juniper macropoda. Also the maximum established plants of 150.00/ha (44.12%) were recorded for *B. utilis* followed by *P. wallichiana* with 126.00/ha (37.06%) plants while, not a single established plant was observed for *Juniper macropoda* (Table 01).

Middle Elevation

The maximum number of recruits, unestablished and established plants were observed in case of *Betula utilis* with numbers 902.00/ha (36.70%), 334.00/ha (41.85%) and 112.00/ha (48.69%), followed by *Pinus wallichiana* with numbers 764.00/ha (31.31%), 292.00/ha (36.59%) and 80.00/ha (34.78%), respectively. The minimum numbers were recorded in case of *Abies pindrow* with numbers 356.00/ha (14.59%), 82.00/ha (10.28%) and 18.00/ha (7.83%) plants, respectively (Table 01).

Upper elevation

The data in Table 01 revealed that in upper elevation, the maximum number of recruits, unestablished and established plants was found for *Betula utilis* with values of 608.00/ha (35.51%), 168.00/ha (39.62%) and 64.00/ha (45.07%), which were followed by *Pinus wallichiana* with values of 500.00/ha (29.21%), 120.00/ha (28.30%) and 46.00/ha (32.39%), respectively. However, the minimum numbers for recruits and unestablished plants were recorded for *Picea smithiana* with values of 278.00/ha (16.24%) and 66.00/ha (15.36%), respectively and for established plants minimum of 14.00/ha (9.86%) was recorded for *Abies pindrow* (Table 01).

Regeneration Establishment and Stocking

Lower Elevation

Persual of data in Table 02 represents the regeneration establishment and stocking data for different tree species in Betula forest of Sangla valley. The data reveals that the maximum weighted average height for *Picea smithiana* (96.85 cm), followed by *Beutla utilis* (79.99 cm) and *Pinus wallichiana* (76.95 cm), respectively. While minimum was reported for *Juniper macropoda* (15.00 cm). The establishment index was found maximum (0.48) for *P. smithiana*, followed by *B. utilis* (0.40) and *P. wallichiana* (0.39), respectively, whereas minimum establishment index was reported for *Juniper macropoda* (0.07). The maximum stocking index was reported for *B. utilis* (0.095), followed by *P. smithiana* (0.079) and *P. wallichiana* (0.030), respectively, while the minimum was recorded for *B. utilis* (0.0008). The maximum establishment stocking per cent was observed in case of *Picea smithiana* (3.85), closely followed by *Betula utilis* (3.81) and *Abies pindrow* (0.98), respectively whereas minimum establishment stocking per cent was recorded for *Juniper macropoda* (0.006) as depicted in Table 02.

Middle Elevation

The regeneration establishment and stocking data for different tree species at middle elevation presented in Table 02 reveals that the maximum weighted average height was recorded for *Pinus wallichiana* (82.97 cm) followed by *Abies pindrow* (79.85 cm) and *Betula utilis* (73.35 cm). Whereas, the minimum weighted average height was observed for *Picea smithiana* (72.37 cm). The maximum establishment index (0.41) was observed for *P. wallichiana* followed by *A. pindrow* (0.39) and least for *B. utilis* (0.36) and *P. smithiana*. The stocking index was found maximum in case of *B. utilis* (0.07) followed by *P. wallichiana* (0.06) and the minimum stocking index (0.015) was recorded for *A. pindrow*. The maximum establishment stocking per cent (2.86) was recorded for *B. utilis* followed by *P. wallichiana* (2.53) and *Abies pindrow* (0.61), whereas, the minimum establishment stocking per cent (0.61) for *P. smithiana* (Table 02).

Upper Elevation

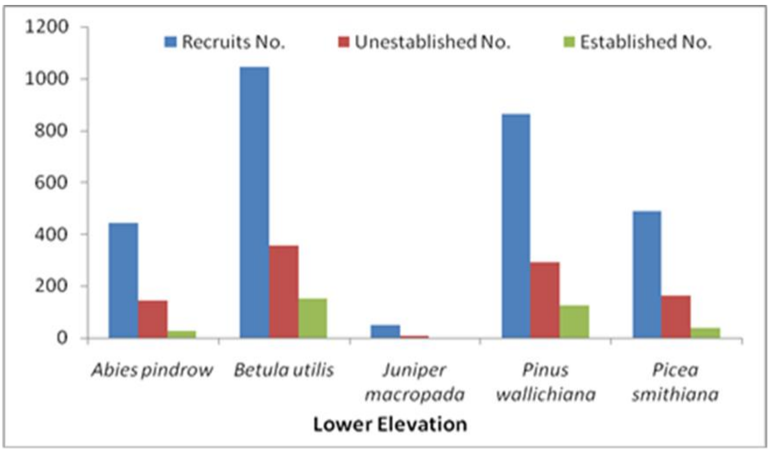
The perusal of data reveals that maximum weighted average height (86.76 cm) was observed for *Pinus wallichiana* followed by *Picea smithiana* (81.71 cm) and *Abies pindrow* (78.07 cm), respectively. Whereas, minimum weight average height (77.32 cm) was recorded for *Betula utilis.* Similarly, maximum establishment index (0.43) was observed for *P. wallichiana* followed by *P. smithiana* (0.40). The minimum establishment index (0.38) was recorded for *B. utilis*. However, the maximum stocking index (0.042) was observed for *B. utilis*, followed by *P. wallichiana* (0.030) and *P. smithiana* (0.013) and the minimum stocking index is observed for *A. pindrow (0.012).* The maximum establishment stocking per cent (1.64) was observed for *B. utilis*, followed by *P. wallichiana* (1.31) and *P. smithiana* (0.56) while *A. pindrow* (0.49) depicted the minimum value (Table 02).

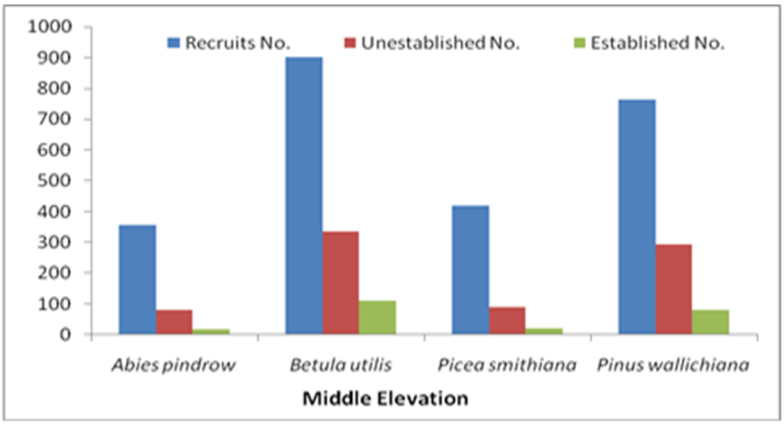
Discussion

The results on regeneration studies depicted that recruits, unestablished and established plants of *Betula utilis* and associated species decreased with the increase in elevation (Fig. 02). This can be attributed to better edaphic and atmospheric parameters. Moreover when the snow melts the seeds (which are very small in size) are slowly washed and they reach the lower elevation, higher values of available nitrogen, phosphorus and potassium, photosynthetic rate, transpiration, water use efficiency at lower elevation. The results are thus in accordance with Ali *et al.* (2009) [2] and Rikhari *et al.* (2000) where they had reported similar results in Taxus species. Similarly, the regeneration success of *B. utilis* and associated species decreased with increase in elevation (Table 02). The maximum total weighted average height (347.34 cm), total established index (1.74); total stocking index (0.2322) and total establishment stocking per cent (9.87) were recorded at lower elevation (Fig. 03). In the present study, it was observed that the regeneration success of *B. utilis* decreased from lower (9.54 %) to upper (4.24 %) elevation (Table 02). Agarwal and Patil (1956) [1] and Sharma (2006) [14] also reported similar results while working on fir and spruce forests. Similar trend was also observed for their associated species. This trend of better regeneration in lower elevation can be attributed to better soil depth, higher moisture contents, higher soil temperature, more of soil nutrients and longer growing period. The present results from *Betula utilis* also draw support from work of Colaona and Giannini (1971) [7], Singh (1983) [15] and Pengshalin *et al*. (2006), where they have reported that depth of organic matter has indirect relationship with regeneration success. Similar finding also have been reported by Gorden (1970) [10] in *Abies pindrow*, Ram Prakesh (1991) [12] in *Cedrus deodara* and Zu Yuan Gang *et al*. (2006) [21] in *Taxus baccata* (Fig. 03). Simple correlation coefficient (Table 03) reveal that regeneration of *B. utilis* has a positive and significant correlation with soil organic carbon, pH, organic matter layer and solar influx, soil moisture, nitrogen, phosphorus and potassium. The results are thus in conformity with the finding of Filipiak and Komisaraek (2005) [8] who reported potassium content and organic carbon in soil has positive effect on the regeneration of Silver fir.

Conclusion

The recruits, unestablished and established plants of *Betula utilis* and associated species decreased with the increase in elevation at Sangla valley. Similarly, the regeneration success of *B. utilis* and associated species decreased with increase in elevation (Table 01). The maximum total weighted average height (347.34 cm), total established index (1.74), total stocking index (0.2322) and total establishment stocking per cent (9.87) were recorded at lower elevation. The regeneration success of *B. utilis* was also observed to decrease from lower (9.54 %) to (4.24%) upper elevation (Table 02). Simple correlation coefficient reveal that regeneration of *B. utilis* had a positive and significant correlation with soil organic carbon, pH, organic matter layer and solar influx, soil moisture and soil nutrients, viz. nitrogen, phosphorus and potassium availability (Table 03)





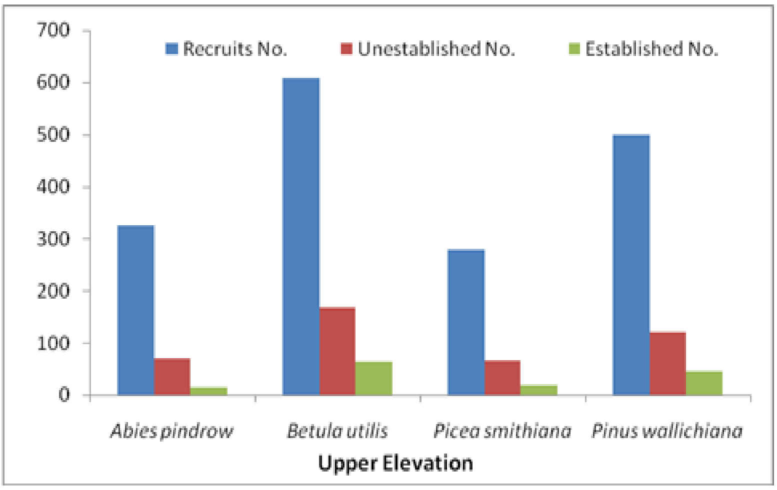


Fig 2: Distribution of recruits, unestablished and established tree species at different elevations in the study area

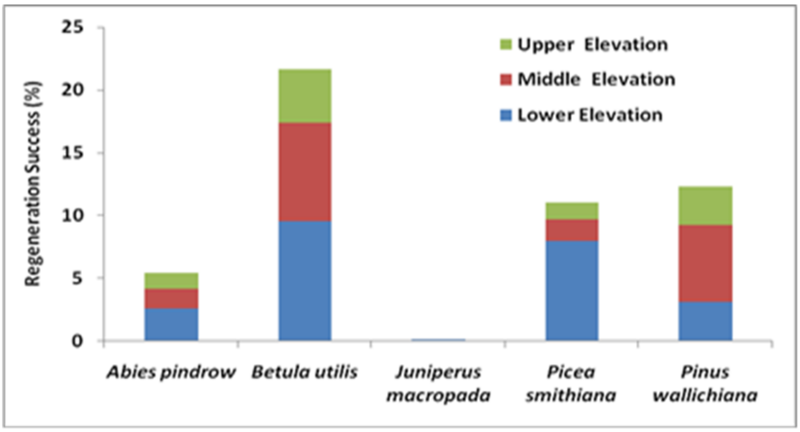
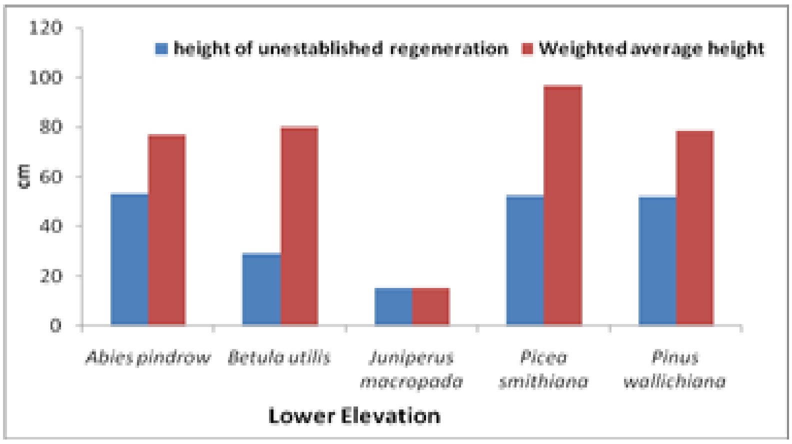
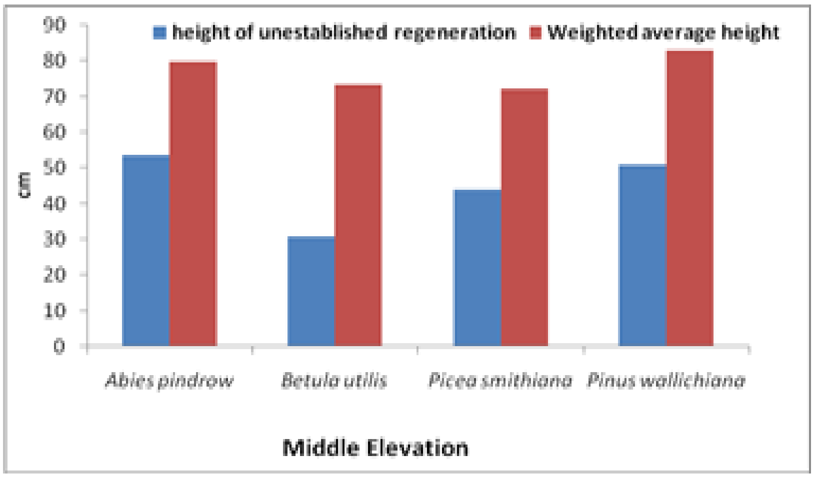


Fig 3: Depicting the regeneration success of tree species at different elevations in the study area





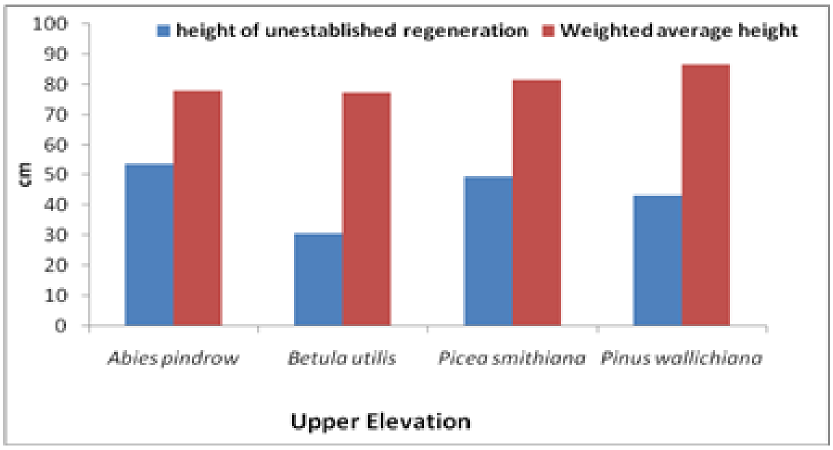


Fig 4: Depicting height of unestablished regeneration and weighted average height in the study area.

Table 1: Regeneration status of different tree species in study area at different elevations

S. No	Species	Recruits No. (%)	Unestablished No. (%)	Established No. (%)
	Lower			
1	*Abies pindrow*	442.00 (15.32)	144.00 (14.97)	28.00 (8.24)
2	*Betula utilis*	1044.00 (36.17)	354.00 (36.80)	150.00 (44.12)
3	*Juniperus macropoda*	50.00 (1.73)	8.00 (0.83)	0.00 (0.00)
4	*Pinus wallichiana*	862.00 (29.89)	292.00 (30.35)	126.00 (37.06)
5	*Picea smithiana*	488.00 (16.91)	164.00 (17.05)	36.00 (10.59)
	Total	2886.00	962.00	340.00
	Middle			
1	*Abies pindrow*	356.00 (14.59)	82.00 (10.28)	18.00 (7.83)
2	*Betula utilis*	902.00 (36.70)	334.00 (41.85)	112.00 (48.69)
3	*Picea smithiana*	418.00 (17.13)	90.00 (11.28)	20.00 (8.69)
4	*Pinus wallichiana*	764.00 (31.31)	292.00 (36.59)	80.00 (34.78)
	Total	2440.00	798.00	230.00
	Upper			
1	*Abies pindrow*	326.00 (19.04)	70.00 (16.50)	14.00 (9.86)
2	*Betula utilis*	608.00 (35.51)	168.00 (39.62)	64.00 (45.07)
3	*Picea smithiana*	278.00 (16.24)	66.00 (15.56)	18.00 (12.68)
4	*Pinus wallichiana*	500.00 (29.21)	120.00 (28.30)	46.00 (32.39)
	Total	1721.00	424.00	142.00
	$CD_{0.05}$	163.49	90.72	38.24

Where figures in parenthesis are percentage values

Table 2: Establishment and stocking data for different tree species in Betula forests at different elevations

S. No	Species	Ht. of unestablished regeneration	Weighted average height	Establishment index	Stocking index	Establishment stocking (%)	Regeneration Success (%)
	Lower Elevation						
1	*Abies pindrow*	53.03	76.95	0.38	0.0256	0.98	2.56
2	*Betula utilis*	29.14	79.99	0.39	0.0954	3.81	9.54
3	*Juniperus macropoda*	15.00	15.00	0.07	0.0008	0.006	0.08

4	*Picea smithiana*	52.34	96.85	0.48	0.0796	3.85	7.96
5	*Pinus wallichiana*	51.88	78.54	0.39	0.0308	1.20	3.08
	Total		347.34	1.73	0.2322	9.87	
Middle Elevation							
1	*Abies pindrow*	53.48	79.85	0.39	0.0154	0.61	1.54
2	*Betula utilis*	30.88	73.35	0.36	0.0782	2.86	7.82
3	*Picea smithiana*	44.00	72.37	0.36	0.0170	0.61	1.70
4	*Pinus wallichiana*	50.91	82.97	0.41	0.0612	2.53	6.12
	Total		308.55	1.54	0.1718	6.63	
Upper Elevation							
1	*Abies pindrow*	53.68	78.07	0.39	0.0126	0.49	1.26
2	*Betula utilis*	30.59	77.32	0.38	0.0424	1.64	4.24
3	*Picea smithiana*	49.45	81.71	0.40	0.0138	0.56	1.38
4	*Pinus wallichiana*	43.35	86.76	0.433	0.0304	1.31	3.04
	Total		323.86	1.62	0.0992	4.01	

Table 3: Simple correlation between regeneration success of *Betula utilis* and different site characteristics.

Parameters	Regeneration of *Betula utilis*
Regeneration of *Betula utilis*	1
Percent Soil moisture (%)	0.7456*
Percent organic carbon	0.8652**
Nitrogen (kg/h)	0.6741*
Phosphorus (kg/h)	0.8455*
Potassium (kg/h)	0.7626*
pH value	-0.8765**
Bulk Density	0.5428
Porosity (%)	0.5874
Organic matter depth (cm)	-0.9235**
Solar influx (%)	0.9452**

* Significant at 5% level ** Significant at 1% level

References

1. Agarwal SC, Patil BD. Problems of fir (*Abies pindrow*, *A. spectabilis*) and spruce (*Picea morinda*) regeneration. Indian Forester. 1956; 82(7):382-386.
2. Ali Aasif, Shamet GS Shamet, Kumar Raj. Evaluation of natural regeneration status and site quality characteristics of *Taxus wallichiana* forests in Himachal Pradesh. *Annals of Biology*. 2009; 25(2):159-162.
3. Cairns DM, Moen J. Herbivory influences treeline. Journal of Ecology. 2004; 92:1019-1024.
4. Chacko VJ. A Manual of Sampling Technique for Forest Surveys. Manager Publications, Delhi, 1965, 172.
5. Champion HG, Seth SK. A Revised Survey of Forests Types of India. Manager publication Delhi, 1968,404.
6. Champion HG. Silvicultural Research Manual for use in India. Vol. I. The Experimental Manual. Government of India. Press Delhi, 1935, 110.
7. Colaona M, Giannini R. Seed germination and early growth of *Abies alba, Epilobium angustifolium* and *Rubus hirtus* as influenced by various natural seed beds. Annals Accademia Italiana di scienze forestali. 1971; 20:227-258.
8. Filipiak M, Komisarek J. Regeneration of the European silver fir (*Abies alba* Mill) in the sudety mountains on soils with different physico-chemical properties. Dendrobiology 2005; 53:17-25.
9. Flint M. Biological diversity and developing countries: Issues and options-A synthesis paper. ODA. 1991, 50.
10. Gordon DT. Natural regeneration of white and red fir. U.S. For. Res. Pap. Paaf. 5th West For. Range Exp. Sta. NO. PSW. 1970; 58:32.
11. Pengshalin, Wang Chang Wei, Liming Guang, LI Wenjain Faliang, Chen Weimin. Major ecological factors affecting growth of Taxus spp. Acta Scientiarum Naturalium Universitatis Sunyatsani. 2006; 45(3):65-69.
12. Ram Prakash. Propagation Practices of Important Indian Trees. International Book Distributors, Rajpur Road, Dehradun. India. 1991; 165-166.
13. Sakai A, Larcher W. Frost Survival of Plants: Response and Adapta- tion to Freezing Stress. Ecological Studies 62. Berlin, Germany: Springer, 1987.
14. Sharma Yashpal. Studies on stand parameters and natural regeneration status of silver fir and spruce in Himachal Pradesh. M.Sc. Thesis, Dr. Y.S. Parmar UHF, Solan (H.P). 2006, 84.
15. Singh Gurbakash. Status of natural regeneration of fir forest in Jammu and Kashmir state. Indian Journal of Forestry. 1983; 6(2): 132-136.
16. TISC [Tree Improvement and Silviculture Component]. Forest and Vegetation Types of Nepal. TISC Document Series 105. Kathmandu, Nepal: Department of Forest, 2002.
17. Troup RS. The Silviculture of Indian Trees. Vol. III. Clarendon Press, Oxford. 1921, 1090-1093.
18. Udvardy MDF. Classification of the Biogeographical Provinces of the world. IUCN, Grassland Switzerland, 1984.
19. WCMC (World Conservation Monitoring Centre). Global biodiversity: Status of earth living resources. World Conservation Monitoring Centre, Cambridge, Chapman and Holl, London, UK, 1992.
20. Zobel DB, Singh SP. Himalayan forests and ecological generalizations. Bioscience. 1997; 47:735-745.
21. Zu Yuman Gang, Chen Hua Feng, Wang Wenjie, Nie Shao Quan. Population structure and distribution pattern of Taxus cuspidate in Muling region of Heilongjiang Province, China. Journal of Forestry Research. 2006; 17(1):80-82.