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FOREST STRUCTURE AND REGENERATION PATTERN OF *BETULA UTILIS* D. DON IN MANASLU CONSERVATION AREA, NEPAL

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ABSTRACT

Forest structure and regeneration of *Betula utilis* (D. Don) was studied in birch forest located in Samagaun valley (3500 – 4000 m) of Manaslu Conservation Area. Vegetation sampling was done by quadrat method. Altogether 40 quadrats were sampled to determine the Importance Value Index (IVI) of tree species, and distribution pattern of seedlings and saplings. Regeneration was assessed by density - diameter curve. Four tree species were recorded from the forest. *Betula utilis* was the dominant tree species with the highest Importance Value Index (173.22) in mixed *Betula* forest and 262.96 in pure *Betula* forest and *Abies spectabilis* was the co – dominant species (65.95) in mixed *Betula* forest while *Rhododendron campanulatum* was the co-dominant species (37.03) in pure *Betula* forest. Density of *Betula utilis* increased with increase in elevation where as density of other tree species decreased with increase in elevation. Mixed *Betula* forest at lower elevation was young. The density diameter curve of the tree population of *Betula utilis*, both on mixed and pure forests, deviated slightly from the typical reverse J shaped structure and hence did not show the sustainable regeneration. The sapling density was higher than seedling density. The distribution of seedlings and saplings were not uniform among the sampling plots.

Key words: *Abies spectabilis*, density-diameter curve, Samagaun, saplings and seedlings.

INTRODUCTION

Betula utilis D. Don (Bhojpatra) forms tree line vegetation all along the Nepal Himalayas and extensive stands of this species can be found on northern shady slopes and ravine areas (TISC 2002). It is the only broadleaved angiosperm tree species in the Himalayas which dominates an extensive area at subalpine altitudes (Zobel and Singh 1997). *Betula* spp. show a high freezing tolerance (Sakai and Larcher 1987) which enables them to form a tree line in the Himalayas as well as in the Scandinavian region (Cairns and Moen 2004). It is a moderate-sized tree that grows up to 20 m in height. The bark is shining, reddish white or white, with white horizontals smooth lenticels which was observed in present study too.

High elevation ecosystems of Himalayan region are the most vulnerable geographic regions of the world and are important regions for detecting the patterns of climate change on regional scale. There is a phenomenal increase in temperature as a result of global warming during the past few decades. In Nepal, between 1975 and 2005, mean annual temperature increased at a rate of 0.04ºC/year with a higher rate of increase at high altitudes (Baidya *et al*. 2007) which in turn has an influence in the distribution and regeneration of tree-line species. The regeneration of *Betula utilis* (tree line birch) is very low compared to *Abies spectabilis* (Talispatra) dominant tree – line species.

Betula tree line is slowing and being invaded by *Abies* tree – line. Regeneration of *Betula utilis* forest and spatial patterns of seedling distribution in the Manaslu area have not been studied in detail. So this study was undertaken with following specific objectives: 1) to document the community structure of *Betula utilis* forest, and 2) to study the regeneration pattern.

MATERIALS AND METHODS

Study site

The study area was Samagaun valley which lies inside Manaslu Conservation Area, Gorkha district, Central Nepal. The study area (28°34'58.6"N, 84°38'28.2"E, elevation 3500 – 4000 m) lies on north facing slope with average inclination of 34°. The mean annual monsoon precipitation is 190 ml and mean annual temperature is 6 to 10°C. Samagaun is surrounded by high mountain and traversed by Budhi Gandaki river. Snow melt water is the main source of soil moisture for forest growth.

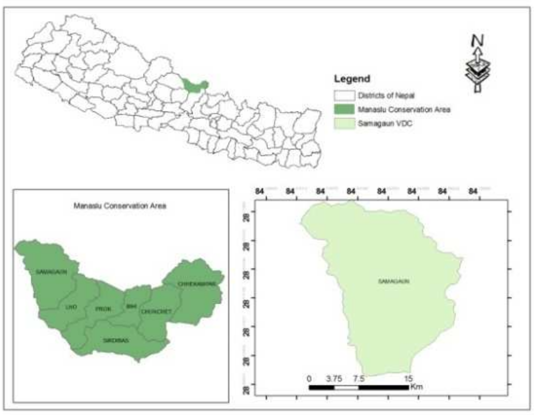

Fig. 1. Map showing study area.

Sampling

The study site was divided into 5 vertical transects, each representing both mixed and pure forests. In each transect, paired quadrats (10 m × 10 m) spaced horizontally about 100 m apart was sampled at every 100 m elevation increment from 3500 m up to 4000 m. Altogether 40 quadrats were sampled. In each square quadrat (10 m × 10 m), number of individuals of each species in tree stage were counted and diameter at breast height (DBH, measured at 137 cm above the ground) of each tree measured. Individuals of tree species were divided into three growth stages: trees (DBH>10 cm), saplings (DBH<10 cm, height > 30 cm) and seedling (height < 30 cm) (Sundryal and Sharma 1996). All shrub species present in the quadrat were recorded. Seedlings and saplings present inside the quadrat was counted within 10 × 10 m^2 since they were scattered. In each sampling plot, the number of trees, sapling, and seedlings were counted for each tree species. Diameter at breast height and height of trees were measured. All the tree species were divided into different size classes based on DBH of 5 cm difference and the size class diagram was developed to analyze regeneration pattern.

Analysis

The field data were used to calculate frequency, density, basal area and importance value index of tree species following the method described by Zobel *et al*. (1987) with some modifications. For some of the pairs of variables, scatter diagrams were prepared.

RESULTS AND DISCUSSION

Community Structure

The forest is clearly differentiated into two stands. Lower belt (3500 – 3800 m) is mixed *Betula* forest whereas upper belt shows the pure *Betula* forest. *Betula utilis* was the dominant tree species with the highest important value index 173.32 in mixed forest and 262.96 in pure forest. *Abies spectabilis* was the co-dominant tree species with IVI 65.95 in mixed forest and *Rhododendron* *campanulatum* with 38.06 in pure forest. *Abies spectabilis* and *Larix himalaica* were present up to 3800 m only. *Rhododendron campanulatum* were present above 3700 m. Tree species richness was very low, only four tree species in mixed forest and two in pure forest (Table 1). In pure *Betula utilis* forest, *Rhododendron campanulatum* was present only in 20% of the sampling plots.

Present studied tree species richness (four species) is equitable to the tree species richness (three species) at tree line in Manang area of Trans-Himalayan dry valley in Central Nepal reported by Shrestha *et al.* (2007). The observation of various forests of the subalpine region of Manang revealed that the tree species such as *Betula utilis* generally preferred moist northern slope. In present study also, forest of *Betula utilis* was found only in the north facing slope. Distribution of *Betula utilis* up to higher altitude is seen in Himalaya as it is adapted well in cold climate. Lower belt of the forest was occupied by *Abies spectabilis* and *Larix himalaica* in our study site but in the dry Manang valley, central Nepal, lower belt was dominated by *Abies spectabilis* and *Pinus wallichiana* (Ghimire and Lekhak 2007, Shrestha *et al*. 2007). In a study, Gaire *et al.* (2010) recorded six tree species from treeline ecotone of Langtang National Park, which is greater than our observation from Himalayan treeline.

Total tree density was more in mixed forest than in pure forest (2054 stems/ha in mixed forest and 1707 stems/ha in pure forest). The total basal area of mixed forest was high (76.55 m^2/ha) than in pure forest 71.00 m^2/ha). But the basal area of *Betula utilis* was found to be less in mixed *Betula* forest (55.65 m^2/ha) than in pure *Betula* forest (64.67 m^2/ha) (Table 1). Tree density in present study was higher than the tree density observed by Shrestha *et al.* (2007) in Manang area and Bhuju *et al.* (2010) from treeline of Sagarmatha National Park. Bhuju *et al*. (2010) recorded total basal area of 11.2 m^2/ha and a density of 445 stems/ha, from treeline and basal area of 18.6 m^2/ha and a density of 1,034 stems/ha from timberline region. The tree basal areas of *Betula utilis* increased from 3500 m to 3800 m and then get decreased above 3800 m. Similarly the tree basal area of *Abies spectabilis* and *Larix himalaica* also get decreased with increase in elevation. *Betula utilis* in lower altitude (3500 – 3600 m) were small with lower basal area than in other elevation (Fig. 2).

Density of *Betula utilis* increased with increase in elevation where as density of other tree species decreased with increase in elevation (Fig. 3). The most densely populated plots were between 3700 – 3800 m and above 4000 m. The density of *Abies spectabilis* and *Larix himalaica* was highest between 3500 m – 3600 m. *Rhododendron campanulatum* was found more in between the elevation of 3700 m – 3800 m. This study observed decrease of total tree density with increase in elevation which is similar to the observation of Shrestha *et al*. (2007) in the trans-Himalayan treeline.

Table 1. Structural parameters of tree species.

SN	Plant Species	Mixed *Betula* Forest (3500-3800 m)			Pure *Betula* Forest (3800-4000 m)		
		D (stem/ha)	BA (m^2/ha)	IVI	D (stem/ha)	BA (m^2/ha)	IVI
1.	*Betula utilis*	1384	55.65	173.22	1654	64.67	262.96
2.	*Abies spectabilis*	412	11.64	65.95			
3.	*Larix himalaica*	226	7.84	51.12			
4.	*Rhododendron campanulatum*	32	1.42	10.12	53	6.33	37.03
	Total	2054	76.55		1707	71.00	

Note: D = Density, BA= Basal Area, IVI= Importance Value Index

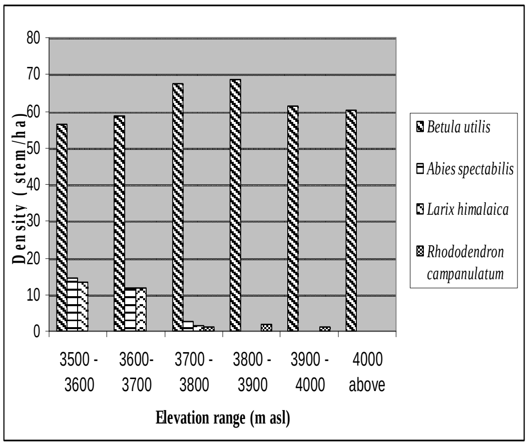

Fig. 2. Basal area of tree species.

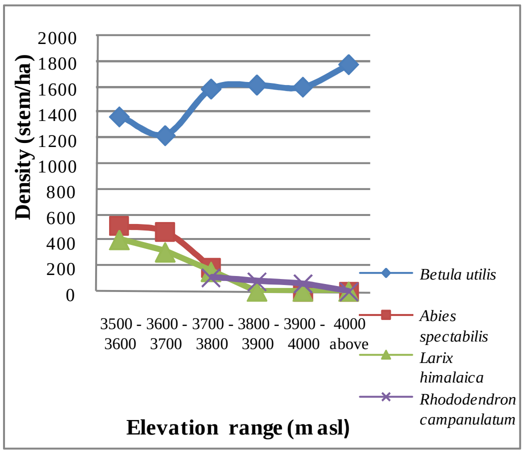

Fig. 3. Density of tree species.

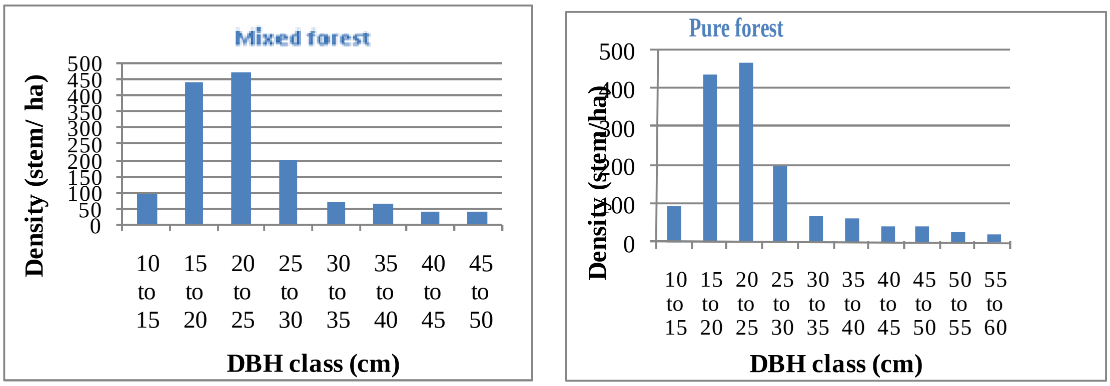

Fig. 4. Density – diameter curve of *Betula utilis* in MCA.

Regeneration and Size Class Distribution

The density diameter curve of the tree population of *Betula utilis* both on mixed and pure forests deviated slightly from the typical reverse J shaped structure (Fig. 4) which is the indication of regeneration (Vetaas 2002). The size class 15–20 cm consists of maximum number of individuals and class 10–15 cm consists of fewer individuals in mixed forest while in pure forest density of trees with DBH 20–25 cm were highest. Only eight size classes were found in mixed *Betula* forest while ten size classes were found in pure *Betula* forest. Trees were smaller in the mixed forest (DBH 10-50 cm) than in pure forest (DBH 10-60 cm). This indicates that the trees in mixed forest are younger than in pure forest as in the *Betula* forest of dry valley of central Nepal. Absence of higher girth class of *Betula utilis* trees (above 50 cm diameter) in mixed forest might be due to the cutting of larger tress for firewood. The regeneration potential of mixed *Betula* forest was higher than that of pure *Betula* forest. An open canopy caused by mild disturbance to the forest allows the growth of seedlings and saplings, which ensures sustainable regeneration (Koirala 2004).

Vegetation in Shrub Layer

Six species were recorded in shrub layer. Among them *Rhododendron anthopogon* was the most frequent (50%). Others shrubs present in mixed forest of *Betula utilis* are *Rhododendron lepidotum*, *Berberis aristata*, *Arudinaria* spp. and *Sorbus microphylla*.

Seedlings and Saplings Density

The distribution of saplings and seedlings was not uniform among the sampling plots. There were no saplings in 25% of the plots and seedlings in 60%. The sapling density in mixed forest was 1136 stems per ha and that in pure forest were 147 stems per ha. The seedling density was 156 stems per ha in mixed forest while that in pure forest was 33 stems per ha.

The sapling density of *Abies spectabilis* was 648 stems per ha and that of *Larix himalaica* was 416 stems per ha. The sapling density of both species declined with increase in elevation. The sapling density of *Betula utilis* was highest at 3500–3600 m and lowest at 4000 m. The sapling density of *Betula utilis* decreases with increase in elevation (Fig. 5).

The seedling density of *Abies spectabilis* and *Larix himalaica* was found to be greater than that of *Betula utilis* in mixed forest and that of *Rhododendron campanulatum* was also more than that of *Betula utilis* in pure forest (Fig. 6).

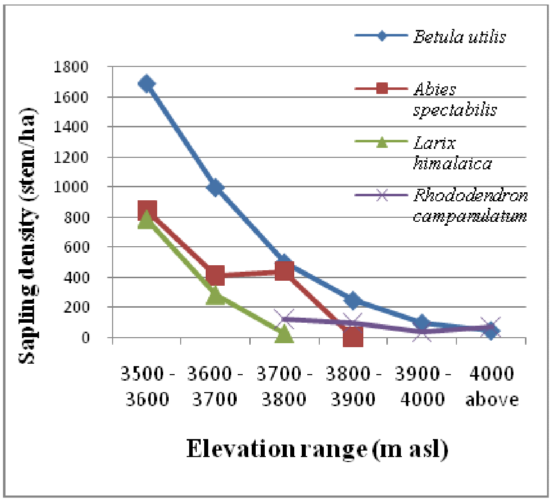

Fig. 5. Density of saplings.

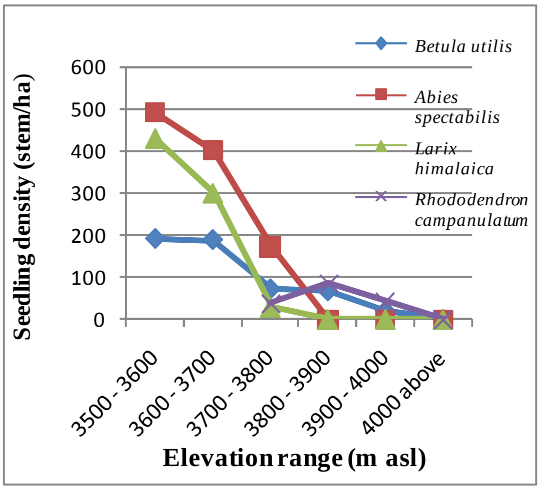

Fig. 6. Density of seedlings.

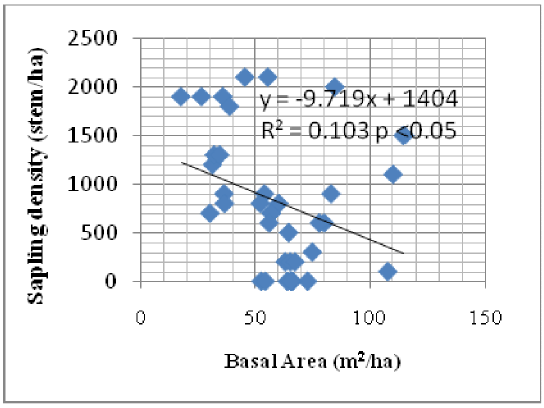

Fig. 7. Scatter diagram showing variation of sapling density with basal area.

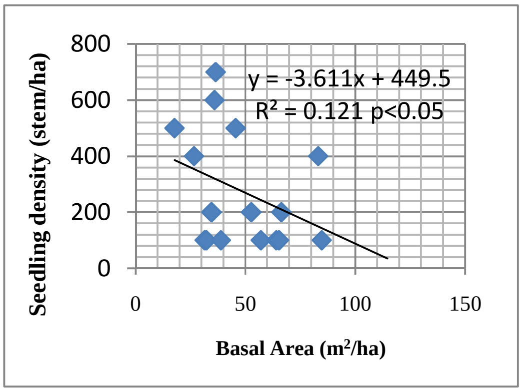

Fig. 8. Scatter diagram showing variationof seedling density with basal area.

The density of *Betula utilis* seedlings was highest at the lowest elevation, but it was absent above 4000 m. Both seedling and sapling density decreases with increase in tree density and basal area. Similar type of results was also seen in the *Betula* forest of Manang done by Shrestha *et al*. (2007).

Sapling and seedling distribution of *Betula utilis* was spatially heterogeneous, which may be relatively common under natural conditions. Spatial heterogeneity in sapling and seedling distribution appeared to be determined by light availability caused by variation in canopy cover. The stands with the highest sapling and seedling densities have low basal area (Figs. 7 and 8). According to Carlton and Bazzaz (1998) lack of birch regeneration can be attributable to poor seedling growth and survival rather than inadequate seed dispersal. Low light and thick litter may be the major constraints for seedling establishment of *Betula utilis* under its own canopy.

Density of seedlings should be greater than the density of saplings for a normal demographic development (West *et al*. 1981) but in our present study, sapling density was found to be greater than seedling density. Seedlings of the *Abies spectabilis* and *Larix himalaica* were more in number than that of *Betula utilis* in the lower elevation (below 3800 m). Seedlings of *Abies spectabilis* were most abundant and were growing under deep shade. Similarly in high elevation (>3900 m), the seedling and sapling density of *Rhododendron campanulatum* were higher than that of *Betula utilis*.

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