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# Influence of canopy cover on vegetation in *P. roxburghii* sarg (chir-pine) dominated forests in Uttarakhand Himalaya, India.

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**Abstract:** Increasing anthropogenic pressure and dependence on plant products have led to widespread exploitation of natural forests in the Uttaranchal Himalaya. The present study was carried out to study the influence of canopy cover on tree, shrub and herb vegetation. For this three different canopy types, open canopy (<30%, cover), moderate canopy (30-60%, cover) and close canopy (>60%, cover) were identified in *Pinus roxburghii* (chir-pine) dominated forests. The study area is located between 29$^0$ 20'and 29$^0$ 30' N latitude and 79$^0$ 23' and 79$^0$ 42' E longitude between 1350-2000m elevations in Uttarakhand a newly created hill state. Total tree density was high in close canopy sites basal area was greater in open canopy sites. Total shrub density varied from 26107 to 28560 shrub/ha. It was maximum for open canopy sites and minimum for moderate canopy sites. Total shrubs cover varied from 45.8 to 50.6%. Shrubs cover was maximum for moderate canopy sites and minimum for open canopy sites. Herbs density was greater in open canopy and total herbs cover was greater in close canopy. Tree and shrub diversity was high in close canopy sites and herbs diversity in open canopy sites.

**Key words:** Disturbance; Diversity and Canopy

## Introduction

The Himalayan vegetation ranges from tropical deciduous forest in the foot hills to alpine meadows above treeline (Singh and Singh 1992 and Ram *et al.,* 2004). Increasing anthropogenic pressure on forest over the few decades has led to vast exploitation of natural flora of Uttarakhand Himalaya. The Himalaya is rich in biodiversity due to its geographical latitudinal ecosystem and habitat diversity (Singh and Singh 1992). Vegetation in mountain area is affected by several factors of which altitude, aspect, slope, soil, canopy cover and microclimate are predominant as they modify regimes of moisture and exposure to sun. Bormann *et al.,* (1970) revealed that along an altitudinal gradient, the total basal area, and basal area per tree, deciduousness and productivity decreased with increasing elevation, while density and species diversity increase. Vegetation within forest is greatly affected by differences in the microclimate, aspect and altitude (Pande *et al.,* 1996).

The formation of the gaps following the death of one or more canopy trees is a common disturbance in many forest types (Whitmore 1978, Runkle 1982, Yamamoto 1996 and 2000). Gap formation and closure result in a dynamic canopy state that profoundly affects the dynamics of both communities and population within a forest (Gray and Spies 1996, Runkle 1998, 2000 and Miura *et al.,* 2001). In the hilly regions of Uttarakhand disturbance in the form of lopping for fodder and fuel wood is pronounces people depend heavily on forest resources for their daily subsistence. The continued disturbance may be responsible for opening of the canopy, decrease in regeneration and survival of species and favor regeneration of disturbance resistant species as well as understory growth.

Disturbances impact most ecological communities by causing extinction and opening up space for immigration, as well as it mediates coexistence and community dynamic (Denslow 1985, Petraitis *et al.,* 1989, Gibson and Brown 1991, Glenn and Collins 1992). Disturbance of land surface due to mining activities results in the loss of soil (Soulliere and Toy 1986), poor water holding capacity, inadequate supplies of plant nutrients (Doubledey and Jones 1977), high surface temperature and low moisture (Richardson 1958, Richardson and Greenwood 1967), and impoverishes the system both nutritionally and microbiologically (Visser *et al.,* 1979 and Bradshaw 1983).

The objective of the present study was (i) to study influence of disturbance on species diversity (ii) to observe variation in different community characteristics in relation to disturbance.

## Materials and Methods

The study area is located between 29$^0$ 20' and 29$^0$ 30' N latitude and 79$^0$ 23' and 79$^0$ 42' E longitude between elevation of about 1300 and 2000 m in Uttarakhand Himalaya. The study site was dominated by *Pinus roxburghii* sarg. and intermixed with *Quercus leucotrichophora* A. camus towards upper limit forest (a mixed broadleaf species). The study sites were located within 2-10 Km from each other. Monsoon rainfall pattern influences the climate of the area. Year to year variation in total annual rainfall exist. In 2004 the total rainfall was 148.6 cm and 221.3 cm in 2006. 80% of the rainfall occurred during July to

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September and the remaining 20% as winter rains between December to February. During the study period the mean maximum temperature varied from 12.5ºC in January to 24.9ºC in June. Winters are cold with mean minimum temperature ranged from 5.0ºC in January to 17.4ºC in June.The rocks of the study area are mainly sand, stones, conglomeration, lime stone, quartzite, schist's and granites (Valdiya 1980).

A total of 36 sites were selected in the study with 12 sites each in open canopy (<30%), moderate canopy (30-60%) and close canopy (>60%). All the three layers of forest vegetation i.e. trees, shrubs and herbs were analyzed for detailed vegetation parameters. The size and number of the samples were determined according to Saxena and Singh (1982). The trees were sampled as above 30cm CBH (circumference at breast height). Circumferences at breast height (1.37m) were taken for tree to determine the basal area. 20 quadrats of 10x10m were randomly placed for analysis of tree vegetation while shrubs were studied in 20, 5x5m quadrats. Similarly, herbs were studied in 20, 1x1m quadrats at each site. The vegetational parameters were quantitatively analyzed for density (Curtis and Mc Intosh 1950). Tree basal area was estimated using the formula:

$$\text{Basal area} = C^2/4\pi$$

Where 'C' is the circumference at breast height.

The cover of shrubs was measured by taking line transect of 5m. Herb cover was determined by placing a transects of 1m on the ground and percent ground cover occupied by each herb species was noted avoiding overlapping (Mishra 1968).

Species diversity was calculated on the basis of IVI using Shannon- Wiener information index (Shannon and Weaver 1963).

$$H = -\sum (Ni/N) \log 2 (Ni/N),$$

Where, Ni is the number of individual of a species and N is the total number of individual of all species in that stand.

Concentration of dominance was measured by Simpson's index (Simpson 1949),

$$C D = \sum (Ni/N)^2$$

Where, Ni is the number of individual of a species and N is the total number of individuals of all species.

Data were analyzed using SPSS Ver 12.0 program (SPSS 2003). Variation in vegetation for canopy gaps was analyzed using GLM univariate ANOVA program. Mean density and total basal area were analyzed for each canopy cover.

## Results

**Tree layer:** Total tree density was maximum (376.50 trees/ha) for close canopy sites and minimum (307.80 trees/ha) for open canopy sites. Moderate canopy had the maximum total basal area (35.10 $m^2$/ha) and minimum total basal area (28.40 $m^2$/ha) was in open canopy sites. Tree diversity ranged between 2.06 and 2.23. It was maximum for close canopy and minimum for moderate canopy sites (Table 1).

ANOVA indicated that mean tree density and total basal area varied significantly ($p<0.01$) from one canopy cover to another (Table 2).

**Shrub layer:** Total shrub density varied from 26107-28546 shrubs/ha. Density was maximum in open canopy sites and minimum in moderate canopy sites. Total shrub cover was maximum (50.60%) in moderate canopy and minimum (45.8%) in open canopy. Shrub diversity ranged between 4.51 and 4.61. It was maximum in close canopy and minimum in open canopy. (Table 1).

**Table 1:** The values are means of sites under each treatment (open canopy, moderate canopy and close canopy)

| Parameters | Open canopy | Moderate canopy | Close canopy |
|---|---|---|---|
| **Tree layer** | | | |
| Density (Trees/ha) | 307.80 | 327.50 | 376.50 |
| Total basal area ($m^2$/ha) | 28.40 | 35.10 | 33.20 |
| Diversity (H) | 2.09 | 2.06 | 2.23 |
| CD | 0.40 | 0.43 | 0.38 |
| **Shrub layer** | | | |
| Density (Shrubs/ha) | 28546 | 26107 | 26803 |
| Total cover (%) | 45.80 | 50.60 | 47.80 |
| Diversity (H) | 4.51 | 4.59 | 4.61 |
| CD | 0.06 | 0.05 | 0.04 |
| **Herb layer** | | | |
| Density (Herbs/ha) | $9.4x10^5$ | $8.1x10^5$ | $8.5 x10^5$ |
| Total cover (%) | 14.3 | 11.9 | 14.2 |
| Diversity (H) | 2.74 | 2.84 | 2.53 |
| CD | 0.08 | 0.07 | 0.06 |

ANOVA indicated that mean shrub density did not vary significant by one canopy cover to another while shrub cover varied significantly ($p<0.01$) from one canopy cover to another (Table 2).

**Table 2:** ANOVA for the values are means of sites under each treatment (open, moderate and close canopy)

| Source | Mean square | df | F | Sig (p<) |
|---|---|---|---|---|
| **Tree density** | | | | |
| Cover | 60.4 | 2 | 14.8 | 0.01 |
| **Tree basal area** | | | | |
| Cover | 5476.1 | 2 | 5.7 | 0.01 |
| **Shrub density** | | | | |
| Cover | 5095.0 | 2 | 2.0 | NS |
| **Shrub cover** | | | | |
| Cover | 3141.0 | 2 | 2.9 | 0.01 |
| **Herb density** | | | | |
| Cover | 8574.5 | 2 | 1.9 | NS |
| **Herb cover** | | | | |
| Cover | 11030.2 | 2 | 22.7 | 0.01 |

**Herb layer:** Total herb density, total cover and concentration of dominance were maximum for open canopy sites compared to moderate and close canopy sites, while herb diversity was maximum for moderate canopy sites (Table 1).

ANOVA indicated that herb density varied significantly from one canopy cover to another (Table 2).

## Discussion

The present study indicated that tree density was high in close canopy while shrub and herb density was greater in open canopy sites. The high density of trees may be due to low disturbance which provide opportunity for formation of seeds, seed germination and seedling growth. However, establishment and survival of all the seedlings also depends upon several other factors like drought (Samant *et al.,* 2002 and Joshi 2002). The shrub density was not significantly different along the canopy gap but relatively high in open canopy. Herb density however, was significantly high in open canopy sites. It indicates that the shrubs and herbs required abundant light for their growth and development apart from other resources. Nath *et al.,* (2005) have reported that the low density of herbs in the moderately disturbed stands is due to low insulation on the forest floor owing to close canopy cover. The total tree basal area was high in moderate and close canopy indicating that the tree size is not much influenced by opening of space. The shrub cover was high in moderate canopy highlighting the fact that the open canopy provides better growing condition for the shrubs. Total herbs density and total cover was maximum in the rainy season and minimum in summer season. The rainy season is the most favorable period for the recruitment of herbs.

Species diversity across the canopy cover ranged from 2.06-2.33 for tree layer, 4.51-4.61 for shrub layer and 2.28-2.47 for herb layer during rainy season. Whittaker (1972) stated that the dominance of one stratum may affect the diversity of another stratum. Tree and shrub diversity was high in close canopy and herbs diversity in open canopy sites. Greater diversity or shrubs in a close canopy has also been observed by Moral (1972) and Zobel *et al.,* (1976). Herbaceous diversity was comparatively high where forest was open (Kharakwal *et al.,* 2007). Better light condition in open canopy sites and availability of water from small rain storms (which is generally not available to plants growing under dense canopies because of canopy interception) provides opportunity for the invasion of more herbs in open canopy.

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