STUDIES ON PLANT BIODIVERSITY OF PURE *Pinus Roxburghii* Sarg. FOREST AND MIXED PINE-OAK FOREST IN UTTARAKHAND HIMALAYA

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ABSTRACT: The present study was carried out on two forest types were identified along an elevational gradient in Uttarakhand Himalaya. The dominant tree species were *Pinus roxburghii* Sarg. followed by *Quercus leucotrichophora, Rhodendron arborium, Cedrus deodara and Myrica esculenta*. *Berbaris asiatica* was the shrub present in all the forest. Tree and herb species richness, density, total basal area and diversity were high in pine-oak forest. Shrub richness was maximum in *Pinus roxburghii* forest and shrub density, total cover and diversity were maximum in pine-oak forest. [New York Science Journal 2010;3(8):1-5]. (ISSN: 1554-0200).

Key words: Biodiversity, Conservation, Disturbance, Diversity, forest

INTRODUCTION

Himalayan forest ecosystem has a major contribution to the mega-biodiversity of India. Therefore, the conservation and scientific management of this biodiversity for socioeconomic development, betterment of soil, live-stock and human assumes a great significance. Various aspect of biodiversity of these forests has been studied by (Dhar et at. 1997, Silori 2001, Kumar 2000 and Khera et al. 2001). The Himalayan vegetation ranges from tropical dry deciduous forests in the foothill to alpine meadow above tree line (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 in Uttrakhand Himalaya. Anthropogenic disturbances play an important role in change, loss or maintenance of plant biodiversity and more recent phenomenon of climate change will also be responsible for the change in species composition and other ecosystem activities (Ram et al. 2005). Tree of *Pinus roxburghii*, the dominant species from low to mid elevation were harvested on a large scale in 1960 s for timber and other industrial raw material and thereafter the continued disturbances either geological or anthropogenic is severely threatening the biological diversity. The anthropogenic disturbances occur in form of grazing, browsing, lopping of tree for fuel wood and fodder, fire, deforestation etc. Both natural and human caused disturbances are considered since vegetation responses do not distinguish between natural and human activities (Oliver and Larson 1990). Disturbance is a key component of all ecosystems. Its affects every level of biological organization and spans a broad range of spatial and temporal scales. With origins that can be either natural or anthropogenic, and either endogenous or exogenous, disturbances are inherently diverse (White 1979 and White and Jentseh 2001). In the Himalayan region the biotic disturbances occurs in the chronic form in which people remove only at a given time. The problem with the chronic form of forest disturbances in the plans or ecosystems often donot get time to recover adequately because human onslaught never stops (Singh 1998).

Biodiversity is the variety and variability of plant and animal species including microorganism on our planet. It also includes the genes they contain and the ecosystems they form. It represents the very foundation of human existence. Yet by our heedless action we are eroding this biological capital at an alarming rate. The word “Biodiversity” was coined by E.O.Wilson to express total variation of life as a contraction of biological diversity (Prance 1993). Hunter (1990) has defined biodiversity as the diversity of life in all its forms and all its levels of organization. Biological diversity has long been of interest to biologist (Margalef 1958, Pielou 1975 and Margurran 1988) as is evident from the explosion and proliferation of literature as the topic over the past century from clement and Gleasen’s early interest in its spatial and temporal patterns (Clements 1916 and Gleason 1917) to the incorporation of formal mathematical concept to the study (Margalef 1958, McIntosh 1967, Pielou

1975, Margurran 1988 and Orloei 1975, 1991). Global biodiversity is being lost at an unprecedented rate, as a consequence of human induced environmental change (Pimm et al. 1995). Species richness, species relative abundance and heterogeneity of their spatial and temporal distribution in a given area are the central subject of community ecology (He and Legendre 2002). In last several decades, however, several authors have recognized that disturbance may increase species richness (Connell 1978, Grime 1979, Huston 1979, Nauch & Whittaker 1979, Sausa 1984, and Petraits et al. 1989). Species richness is a simple and easily interpretable indicator of biological diversity (Hurlbert 1971, Peet 1974 and Whittaker 1977).

MATERIAL AND METHOD

The study area is located between 29º 29´ and 29º 58´N latitude and 79º 25´ and 80º 59´E longitude between 1700-2200m elevations in Uttarakhand Himalaya. The forest were thoroughly surveyed and identified as *P. roxburghii* (chir-pine) dominated forest and mixed pine-oak forest. After thoroughly reconnaissance, tree, shrub and herb species were listed from all the forests. Species richness was determined as the number of species perunit area (Whittaker 1972 and 1975). 10 plots of 10x10m were randomly established in each forest for determination of species richness and other vegetation parameters. Three vegetation layers that are trees, shrubs and herbs were analyzed for species richness, density and diversity of tree species in different forests. Tree were analyzed in 10x10m, shrub in 5x5m (Curtis and Mc Intosh 1950 and Phillips 1959) and herb were analyzed in 10, 1x1m within each plot. Circumference at breast height (cbh) was taken for the determination of tree basal area and calculated as πr^2, where r is the radius. Tree basal area of a species was the multiple of mean tree basal area and density while total cover of a shrubs and herbs species was the multiple of mean cover and density. Total basal area/cover was the sum of basal area/cover of all species present in the forest. Density and basal area were converted to per hectare (ha), shrub and herb cover were given as percent for vegetational parameters. Tree basal area was used to determine the relative dominance of a species while cover was used for shrubs and herbs. Importance Value Index (IVI) was the sum of relative density, relative frequency and relative dominance (Phillips 1959).
Species diversity was calculated using Shannon-wiener information index (Shannon and Weaver 1963) as:

$$\mathbf{H = - \Sigma (ni/n) \log 2 (ni/n)}$$

Where, ni is the IVI of a species and n the total IVI of all species in that forest.

RESULT

Species richness and species diversity

A total of 27 species were recorded from study area out of which 5 were trees, 11 shrubs and 11 herbs. Total species richness was greater in mixed pine-oak forest. Greater number of tree and herb species were present in mixed pine-oak forest in contrast to this shrub in pine dominated forest (Table 1).

Table 1. Species richness in different sites

Species	Site 1		Site 2	
Trees	**Pine dominated forest**	**Pine-Oak forest**	**Pine dominated forest**	**Pine-Oak forest**
Cedrus deodara	+	+	-	-
Myrica esculenta	-	-	-	+
Pinus roxburghii	+	+	+	+
Quercus leucotrichophora	-	+	+	+
Rhododendron arborium	+	+	-	+
Total (5)	**3**	**4**	**1**	**4**
Shrubs				
Asparagus recmosus	+	+	+	-
Berbaris asiatica	+	+	+	+
Boennghausenia albiflora	-	+	+	-
Dephene cannabina	-	-	+	-
Flemengera bractata	-	-	+	+
Inulla cuspidate	-	+	-	-
Pyracantha crenulata	-	+	+	+
Randia tetrasperma	-	+	+	+
Rubus ellepticus	+	+	-	-
Rumex hastatus	+	-	-	-
Urtica dioca	+	-	-	-
Total (11)	**5**	**6**	**7**	**4**

Herbs				
Anaphalis controta	-	-	+	+
Apluda mutica	+	-	+	-
Artemisia nilagarica	+	+	-	+
Carex nubigena	+	+	-	-
Geranium nepalensis	-	-	+	+
Justicea simplex	+	+	+	+
Micromeria biflora	-	-	+	+
Nepta leucophylla	-	+	+	-
Oxalis corniculata	-	-	+	+
Rubia cordifolia	-	+	-	-
Thalactrum japonica	-	+	-	-
Total (11)	**4**	**6**	**7**	**6**

Total tree diversity ranged from 0.52-1.26 and herb diversity from 2.25-2.45. It was maximum in mixed pine-oak forest compared to pine dominated forest. Shrub diversity ranged from 2.15-2.42. It was maximum in pine dominated forest compared to mixed pine-oak forest (Table 2).

COMMUNITY STRUCTURE

Total tree density varied from 485-1000 tree /ha and total basal area 12.65-14.55 m²/ha. It was maximum in mixed pine-oak forest compared to pine dominated forest. In shrub, total density ranged between 1460 and 1660 shrub/ha and total cover 4.02 and 4.69%. It was maximum in mixed pine-oak forest compared to pine dominated forest. In herb, total herb density varied from 47000-51400 herb/ha and total cover from 10.63-12.10%. It was maximum in pine dominated forest compared to mixed pine-oak forest.

Table 2. Species richness, Diversity and Important vegetational parameters of different forest.

Parameter	Pine dominated forest	Pine-oak forest
Tree		
Density (tree/ha)	485	1000
T.B.A (m²/ha)	12.65	14.55
Diversity	0.52	1.26
Richness	3	4
Shrub		
Density (shrub/ha)	1460	1660
Total cover (%)	4.02	4.69
Diversity	2.15	2.42
Richness	10	8
Herb		
Density (herb/ha)	47000	51400
Total cover (%)	10.63	12.10
Diversity	2.25	2.45
Richness	9	10

DISCUSSION

The Himalayan biodiversity is severely threatened by natural and anthropogenic disturbances. One of the foundations for conservation of biological diversity in forest landscapes is understanding and managing the disturbance regimes of landscape under past-natural and natural conditions (Spies and Turner 1990). Conservation biologists worn that 25% of all species could become extinct during the next 20 to 30 years. The causes for the loss of species and fragmentation of natural habitats. In the present study, plant biodiversity is assessed by quantitative analysis of forest vegetation in different forest including various disturbances do not provide time for the ecosystem recovery and widen the forest gap and fragmentation of the land in the region.

The mixed pine-oak forest showed highest species richness followed by chir-pine forest. The chir-pine forest was characterized by low species richness. Chir-pine forest showed greater variation in shrub and herb species richness. The decrease in species richness may be due to increased biotic pressure and opening of the tree canopy which arrest

the regeneration of some tree species. The opening of canopy increase the number of shrub species in the high disturbed forest. Rathore (1993) noticed high species richness and diversity in the *P. roxburghii*-mixed broadleaf forests. Singh et al. (1994) stated the *P. roxburghii*-mixed broadleaf forests had the highest richness. Burns (1995) and Austin et al. (1996) have analyzed association between species richness and climate, slope position and soil nutrient status. Both studies found that total species richness was greater at low elevation, warm site with moderate rainfall and intermediate to high nutrient level.

Total tree density varied from 485-1000 tree/ha. Singh et al. (1994) have reported density value ranging from 250-2070 tree/ha for different Central Himalayan forests. The shrub density was observed between 1460-1660 shrubs/ha and herb density ranged between 47000-51400 herbs/ha. Greater variation in tree density was in chir-pine forest compared to mixed pine-oak forest. Similarly, shrub and herb density varied in chir-pine forest. The pure chir-pine forest may favour the growth of herbaceous vegetation with decreasing richness and density of other woody vegetations.

In the present study, the value of total basal area of \different forest was 12.65-14.55 m^2/ha, which were slightly higher than that reported by Singh et al. (1994). The shrub cover of the forest ranged between 4.02-4.69%, whereas, the herb cover was observed between 10.63-12.1%.

Shannon-weiner index ranged between 0.52 and 1.26 in different forests. The shrub diversity ranged between 2.15 and 2.42, while the herb layer diversity ranged between 2.25 and 2.45. The tree diversity index analyzed for the forest was lower than that reported (2.85) by the earlier workers (Uperti et al. 1985). The diversity was lowest for the pine forest and highest for pine-oak forest. The increased disturbance intensity may favour the invasion of herb while moderate disturbances in pine forest favour the shrub. Anthropogenic disturbance first decreases the tree diversity with increasing intensity of disturbance decreased trees and shrubs diversity and increased herb diversity. The diversity of disturbances decreased the overall richness and diversity of the ecosystem.

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