EFFECTS OF DEFORESTATION ON SPECIES COMPOSITION OF GROUND VEGETATION IN KUMAUN HIMALAYA, INDIA

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ABSTRACT

The present study highlights effects of deforestation on species composition of forest floor vegetation between the elevations of 1850-2000 m in Kumaun Himalaya. The species composition changed from forested site to totally deforested site. The moderate level of disturbance increased the species richness (25 to 31 species) but severe disturbance caused a drastic reduction (12 species). Species diversity decreased with increasing level of disturbance (3.82 in forested site to 1. 51 in deforested site). Erect forbs were the dominant growth forms in forested site and grasses and sedges showed dominance in partly deforested and totally deforested sites.

***Keywords*: Deforestation, growth forms, forbs, grasses, species richness.**

INTRODUCTION

The unprecedented increase in human population during recent years has brought excessive land under agriculture, housing, roads, etc., and increased biotic pressure on native forests. The uncontrolled felling and lopping of trees for firewood and leaf fodder, firing of ground vegetation for domestication of animals, livestock grazing and harvesting of ground vegetation for forage are some of the factors responsible for the exploitation of forests and emergence of disturbed forests and open grasslands in Kumaun Himalaya. The elevational belt of 1200-2000m in Central Himalaya roughly corresponds with banj oak (*Quercus leucotrichophora* A. Camus)-chir pine (*Pinus roxburghii* Sarg.) forest zone. Because of close relationship between forests and man's subsistence economy (Singh and Singh, 1991), these forests particularly of banj oak have been severely degraded. Towards a village area of gradient of decreasing tree cover or of increasing degree of deforestation, starting from forested site through sites with various stages of deforestation to totally deforested site can be observed. Such gradient provides an opportunity to examine the pattern of changes in species composition of ground vegetation in response to change in extent of deforestation. So far, no quantitative study on the changes of ground vegetation in response to change in the level of deforestation is available for this zone.

This study is an attempt to describe the changes in species composition under different growth forms of ground vegetation in response to change in the level of deforestation in Kumaun Himalaya.

Study Sites

The present study was carried out between the elevations of 1850-2000 m in Kumaun Himalayan region, which covers 21033 km^2. The maximum extent on the east-west axis is about 155 km and along the north-south axis, it is about 235 km (Joshi et al., 1983). With respect to the extent of

deforestation, three representative sites located one after another were selected within banj oak-chir pine forest zone viz., forested site (*Quercus leucotrichophora*), partly deforested site (*Quercus leucotrichophora–Pinus roxburghii* forest) and totally deforested site (open grassland). The total basal area, sectional area of stems at breast height, of the forested site (53 m^2 ha^{-1}) was comparable with that of other similar forests of the region (Singh and Singh, 1987). The total basal area at partly deforested site was 30 m^2 ha^{-1}. In addition to lower basal area, the branches of most of oak trees had been cut by local people for firewood and tree fodder. Further, a number of chir-pine (*P. roxburghii*) tree had been established subsequent to cutting of oak trees. The totally deforested site was a treeless grassland.

METHODS

For the analysis of herbaceous vegetation each tiller of a grass plant was considered as one individual plant (Singh, 1967). In case of other forms any unit of the plant having functional roots was considered as one plant (Singh, 1969, Saxena and Singh, 1980). Ground vegetation was sampled using 20, 1x1 m quadrats. The sampling was done when the herbaceous vegetation was at its peak i.e., September. The various species encountered were categorized into growth forms following the characteristics given in Table 1.

The vegetational data were quantitatively analysed following Curtis and McIntosh (1950), Phillips (1959) and Curtis (1959). The species richness was the number of species per unit area (Whittaker, 1972; 1975). The species diversity (H) was calculated by using Shannon and Wiener information function (Shannon and Wiener, 1963) as: $H = -\sum (Ni/N) \log_2 (Ni/N)$, where, Ni is the density of each species and N is the total density of all the species in a stand. Dominance-diversity curves were drawn following Whittaker (1965).

The plant species were identified with the existed voucher specimens collected in the Department of Botany, Kumaun University, Nainital.

Table1: Growth form characteristics

Growth Form	*Plant Characteristics*
Erect forbs	Erect herbaceous non-grass
Cushion forming and spreading forbs	Prostrate herbaceous non-grass
Grasses and sedge	Grass-like plants including sedges

RESULTS AND DISCUSSION

The various species categorized by growth forms are listed in Table. 2. A total of 44 herb species were recorded from study sites of which 25 were forbs, 6 cushion forming and spreading forbs and 13 grasses and sedges. Six species, comprising 5 forbs and 1 grass were recorded in all the three sites (Table 2).

There were 25 species in forested site, 31 in partly deforested site and 12 in totally deforested site (Table 3). The density of individual species (individuals m^{-2}) ranged from 1.2 (*Hedychium spicatum*) to 49.5 (*Mondo intermedium*) in forested site, 0.8 (*Polygonum capitatum*) to 580.0 (*Cymbopogon distans*) in partly deforested site, and 0.8 (*Swertia cordata*) to 665.0 (*C. distans*) in totally deforested site. The total density (individuals m^{-2}) was higher in partly deforested site (1284.80) compared to forested site (199.2) and totally deforested site (1234.6).

Unregulated harvest of biomass, grazing, burning and concomitant degradation of soil and changes in light and temperature regimes have brought about marked changes in the composition of the original herbaceous vegetation of the forest. From forested site through partly deforested site to totally deforested site, not only was the scale of disturbance increased, but the duration of disturbance was also longer. The moderate level of disturbance somewhat increased the herb species richness, but severe disturbances (totally deforested site) caused a drastic reduction. A pattern of species richness peaking in the middle part of gradient of disturbance is consistent with observations of Connell (1978) for tropical rain forest and coral reefs, Pandey and Singh (1991) for tropical savanna vegetation and Rikhari et al (1993) for an alpine meadow.

In terms of importance value index (IVI), *M. intermedium* was dominant in forested site (IVI=41.9), *C. distans* in partly deforested site (IVI=84.3) and totally deforested site (IVI=103.4). Among the growth forms, in terms of species richness forbs were more represented than others in forested site and forbs and grasses in partly deforested and totally deforested sites (Table 3). However, in terms of IVI the herb layer was dominated by erect forbs in forested site and by grasses and sedges in partly deforested and deforested sites (Table 3). Across the sites, IVI of grasses and sedges increased from forested site to totally deforested site while forbs showed a reverse trend (Table 3).

Dominance diversity curves (Figure 1) also indicated changes in diversity due to deforestation. Thus, the three sites were distinct from one another in regard to herbs in spite of the fact that one was located next to another and originally had some forest type. Grasses and sedges in which leaves emerge right from the base and grow much in horizontal space were not well represented in forested site. A dense over story discourages the growth of graminoids and encourages adaptations to low intensities, such as large leaf areas, thin cuticles, cell walls and stems that make plants particularly susceptible to trampling damage (Cole, 1987). Competition for light is a selective pressure on height where leaves are placed in the shade of under canopy environment, especially during rainy season where herbaceous cover is greatest. Competition for light favours increased leaf height which prevents overtopping. Plants should grow latter until the likely photosynthesis advantage of being taller than an opponent is balanced structural cost (stem for raising leaves to greater height) of decreased proportions of energy allocated to leaves (Givnish, 1987).

Table 2: Density (m^{-2}) and importance value index (IVI) of different growth forms on different sites

Growth form/ species	*Family*	*Forested site*		*Partly deforested site*		*Totally deforested site*	
		Density	IVI	Density	IVI	Density	IVI
Erect Forbs							
Arisaema tortuosum (Wallich) Schott.	Araceae	2.0	2.28	-	-	-	-
Bidens biternata(Laur.) Merrill & Sherff	Asteraceae	1.6	3.40	1.2	1.87	-	-
Craniotome furcata(Link) Kuntze	Lamiaceae	3.6	7.85	1.6	5.58	1.6	8.13
Cyanotis vega (Lour.) J. A. & J. H. Schulters	Commelianceae	12.8	13.61	7.6	6.49	-	-
Dicliptera roxburghiana Nees	Acanthaceae	5.6	15.45	4.0	6.21	2.8	13.5
Dipsacus mitis L.	Dipsacaceae	11.2	15.72	-	-	-	-
Erigeron bonariensis L.	Asteraceae	3.2	5.95	-	-	-	-
Galium aparine L.	Rubiaceae	4.8	7.21	4.8	4.86	-	-
Gnaphalium hypoleucum DC.	Asteraceae	1.6	3.61	4.4	5.75	2.4	8.98
Goldfusia dalhausiana Nees	Acanthaceae	8.8	20.50	-	-	-	-
Hedychium spicatum Buch.-Ham. ex J.E. Smith	Zingiberaceae	1.2	4.34	-	-	-	-
Impatiens scabrida DC.	Balsaminaceae	3.2	7.01	-	-	-	-
Micromeria biflora Buch.-Ham. ex D. Don) Benth.	Lamiaceae	5.6	9.68	6.4	8.9	11.2	14.95
Nepeta leucophylla Benth	Lamiaceae	-	-	3.2	4.73	-	-
Oldenlandia diffusa (Willd.) Roxb.	Rubiaceae	32.0	29.18	-	-	-	-
Paris pollyphylla J.E. Smith	Liliaceae	1.6	4.11	-	-	-	-
Pedicularis pectinata Wall ex. Benth.	Scrophulariaceae	-	-	5.2	6.54	-	-
Polygonum nepalense Meisn.	Polygonaceae	6.4	19.45	6.8	8.06	-	-
Reinwardtia indica Dumortier	Malpighiaceae	4.0	13.46	-	-	2.0	10.68
Roscoea procera Wallich	Zingiberaceae	6.0	15.47	-	-	-	-
Rumex hastatus D. Don	Polygonaceae	-	-	3.2	7.49	-	-
Scutellaria angulosa Benth.	Lamiaceae	7.2	15.88	6.0	8.09	6.0	12.57
Siegesbckia chinensis L.	Asteraceae	-	-	1.2	0.98	-	-
Swertia cordata (G. Don) C. B. Clarke	Gentianaceae	-	-	-	-	0.8	8.65
Teucrium royleanum Wallich ex Benth.	Plantaginaceae	-	-	3.6	4.41	-	-
Cushion forming and spreading forbs							
Circium argyracanthus L.	Asteraceae	2.0	4.95	3.6	4.03	-	-
Fragaria vesca L.	Rosaceae	4.0	5.09	-	-	-	-
Oxalis corniculata L.	Oxalidaceae	-	-	2.8	3.70	2.0	7.75

Parietaria debilis Forst. f.	Urticaceae	2.0	10.92	6.0	14.44	-	-
Polygonum capitatum Buch.-Ham. ex D. Don	Polygonaceae	-	-	0.8	1.56	-	-
Trollis japonica (Hoult) DC.	Ranunculaceae	-	-	2.0	3.34	-	-
Grasses and sedges							
Apluda mutica L.	Poaceae	-	-	1.6	1.86	-	-
Arthraxon lanceolatus (Roxb.) Hochst.	Poaceae	-	-	10.8	5.44	68.8	21.38
Arundinella nepalensis Trinius	Poaceae	17.2	14.11	312.0	31.81	16.8	10.53
Carex cruciata Wahlenberg	Cyperaceae	2.0	5.89	10.0	5.70	-	-
Chrysopogon serrulatus Trinius	Poaceae	-	-	242.0	40.34	456.0	79.24
Cymbopogon distans Nees ex Steudel) W. Watson	Poaceae	-	-	580	84.33	664.0	103.39
Cynodon dactylon (L.) persoon	Poaceae	-	-	16.0	19.31	-	-
Cyperus compressus L.	Cyperaceae	-	-	2.4	2.75	-	-
Dicanthium annulatum (Forsk.) Stapf	Poaceae	-	-	15.6	4.85	-	-
Fimbristylis dichotoma (L.) Vahl	Cyperaceae	-	-	8.0	1.86	-	-
Imperata cylindrical (L.) P. Beauv	Poaceae	-	-	10.0	1.72		
Mondo intermedium (D.Don) Baily	Poaceae	49.6	41.88	-	-	-	-
Setaria glauca (L.) P. Beauv	Poaceae	-	-	2.0	2.63	-	-

Table 3: Species richness, diversity (H), concentration of dominance (CD) of herbs by growth forms (values in the parenthesis indicate importance value index (IVI)

Categories	*Forested site*	*Partly deforested site*	*Totally deforested site*
Growth forms			
Erect Forbs	19 (217.1)	14 (80.0)	7 (77.43)
Cushion forming and spreading forbs	3 (21.1)	5 (27.4)	1 (7.8)
Grasses and sedges	3 (61.9)	12 (192.6)	4 (214.5)
Diversity (H')	3.817	2.344	1.514

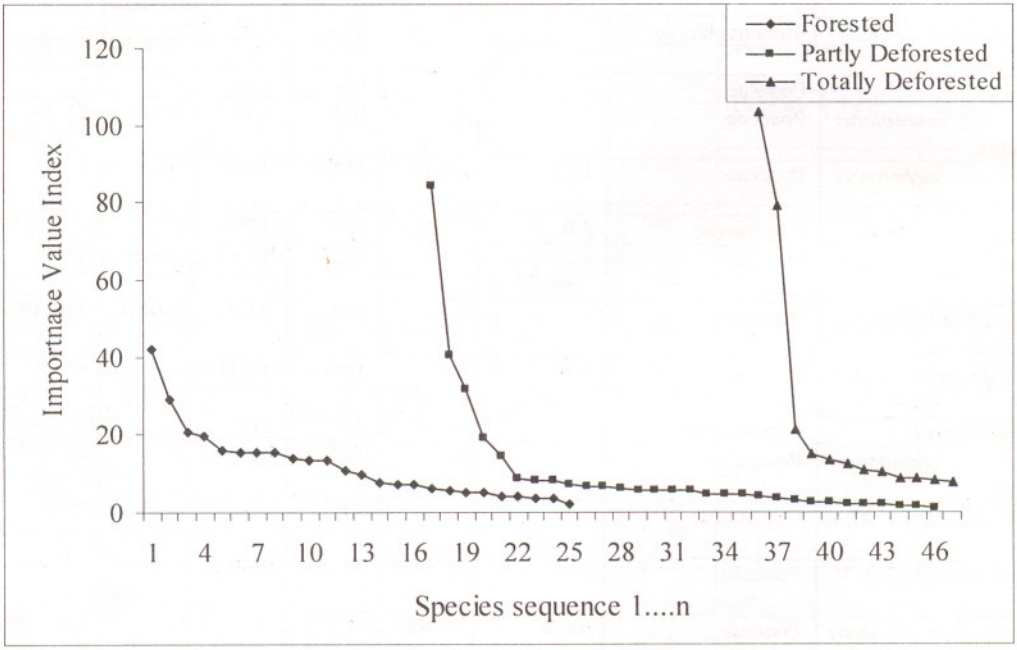

Figure 1: Dominance –diversity curve for three sites

CONCLUSION

To conclude, findings of the present study suggest that ecosystem properties that develop subsequent to loss of canopy species bring about marked changes in species composition of ground vegetation of original forest. The moderate level of disturbance somewhat increased species richness but severe disturbance causes a drastic reduction in species richness and diversity. Erect forbs in particular are more vulnerable to loss of species due to loss of overstory tree cover.

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