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Vegetational Parameters in Different Disturbance Regimes in Corbett National Park

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ABSTRACT:

Himalayan vegetation is subjected to various types of disturbances and most of them are either geological or anthropogenic or both. Biodiversity at all hierarchical levels is impacted upon by disturbance of an ecosystem in terms of maintenance and restoration. Protected Areas are forests that have as their primary function the protection of people or assets against the impacts of natural hazards. The main 'product' of these forests are standing trees which act as obstacles to down slope mass movements such as rock falls, snow avalanches, erosion, landslides, debris flows, and floods. The study area is located between 29^0 24' and 29^0 27' N latitude and 78^0 52' and 78^0 59' E longitude between 280 and 370 m elevation in Uttarakhand Himalaya. In this study, an attempt was made to study the vegetational parameters of floral biodiversity under different disturbance regimes of protected area i.e Corbett National Park (CNP). Overall species richness of the study area was 60, out of which 17 were trees, 12 shrubs and 31 herbs. (Table 2). Tree richness varied from 8 to 11, shrubs richness from 8 to 9 and herbs richness varied from 16 to 19, it was maximum in Protected Area and minimum in disturbed forest. In sum, these results suggest that over a quarter of a century, protected areas have been proven to be quite effective in the protection and proliferation of plant species as a vital ecosystem function, in terms of the two key components of ecological effectiveness, their representation of this function and its persistence through time.

KEYWORDS: *Himalaya, Disturbance, Protected areas, Vegetation.*

INTRODUCTION

Himalayan vegetation is subjected to various types of disturbances and most of them are

either geological or anthropogenic or both. The geological disturbances are natural and include landslides, soil erosion and earthquakes whereas the anthropogenic disturbances include deforestation, grazing, lopping of tree branches for fodder and fuel wood, removal of leaf and wood litter from the forest floor and frequent fires. Both types of disturbances affect ecosystem stability and retard the succession process (Kumar and Ram 2005). Anthropogenic disturbance can occur in a chronic form. Removal of just a small amount of biomass at any given time can continuously affect the ecosystem without any respite or recovery (Singh 1998). Biodiversity is the totality of genes, species and ecosystem in a region. 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 (Gurarni et al 2010). Biodiversity is not distributed evenly on earth. It is consistently richer in the tropics and in other localized regions. Flora and fauna diversity depends on climate, altitude, soils and the presence of other species. In the year 2006, large numbers of the earth's species are formally classified as rare or endangered or threatened species; moreover, most scientists estimate that there are millions more species actually endangered which have not yet been formally recognized.

Biodiversity at all hierarchical levels is impacted upon by disturbance of an ecosystem in terms of maintenance and restoration (McNaughton, 1989; Walker, 1989; Pickett and Parker, 1994). Changes, such as, of land use, in resource use, increased biotic invasions, reduction in species number and creation of stress, have a direct impact on biodiversity through habitat destruction and resource over exploitation and indirect impact through their effect on the composition of the atmosphere and the climate (Heywood 1995). In areas influenced by humans many species have been purged (Chapin III *et al.* 2000). Factors, such as, the available pool of species, the physical characteristics of the land, soil fertility, climate and disturbance regime characteristics, control the vegetation dynamics of forests system (Gauthier *et al.* 2000). The chronic disturbances and fragmentation, both natural and manmade, are major threats to biodiversity in the Himalayan region (Singh, 1998).

Protected Areas are forests that have as their primary function the protection of people or assets against the impacts of natural hazards. The main 'product' of these forests are standing

trees which act as obstacles to down slope mass movements such as rock falls, snow avalanches, erosion, landslides, debris flows, and floods. The protective effect of these forests is ensured only if the silvicultural system used and any natural disturbances that occur leave a sufficient amount of forest cover (Brang et al 2006). Protected areas indicate the rich biodiversity that occurs along the altitudinal gradient. While the Protected areas located in the bhabar and foothills such as Corbett Tiger Reserve are famous for large mammals including flagship species like Tiger and Elephant. (Semwal et al. 2008).

In this study, an attempt was made to study the vegetational parameters of floral biodiversity under different disturbance regimes of protected area i.e Corbett National Park (CNP). Sites were selected within and outside CNP to assess the importance of affording protection to forests in conserving plant diversity in two different zones i.e buffer (outside CNP) having human inhabitations in its vicinity and core (inside CNP) having no human inhabitation and least disturbance due to more protection.

MATERIALS AND METHODS

Site Description: The study area is located between *29^0 24' and 29^0 27' N latitude and 78^0 52' and 78^0 59' E longitude* between 280 and 370 m elevation in Uttarakhand Himalaya. The sites were categorized as disturbed and least disturbed on the basis of the following parameters i.e. cutting of tree branches, Canopy cover, cattle dung and forest fire. (Table1). The study sites were located within 10-15 km distance from one-another.

Table1. *Average of Disturbance parameters recorded at the studied sites for categorization into disturbed and least disturbed sites:*

Site	Canopy Cover (%)	Lopping Intensity (%)	Cattle dung (*d/ha)	Fire scars on trees (d/ha)
Disturbed forest area	34	62	82	54
Protected Area area	66	14	14	4.4

*D= dung piles per ha.

After through reconnaissance of the southern boundary of CNP, a total of two forests were selected for detailed Vegetational analysis of tree, shrub and herb layers. One site within the protected area (Jhirna Area i.e Core) where human interference is low and other site outside the protected area (Dhela Area i.e Buffer) where human interference is considerably very high, were selected for study. All the three vegetation layers i.e. tree, shrubs and herbs were analyzed for each site. Tree layer was analyzed in ten, 10×10 m quadrates, shrubs were analyzed by placing ten, 5×5 m quadrates and herbs by ten, 1×1 m quadrates, randomly. The vegetational parameters were analyzed during peak growing season (October). Circumference at breast height (cbh 1.37 m) was taken to determine the tree basal area as, $c^2/4$. The vegetation data were quantitatively analyzed for abundance, density and frequency (Curtis and McIntosh 1950). The distribution pattern of different species was studied using the ratio of abundance to frequency (Whitford 1949). The importance value index (IVI) of trees was analyzed as the sum of relative frequency, relative density and relative dominance (Phillips 1959), in case of Shrubs and Herbs, IVI is expressed as a sum of relative frequency and relative density (Prasad, 2010).

Species diversity was measured using Shannon-wiener information index (Shannon and Weaver, 1963):

$$H=-\sum (ni/n) \log 2 (ni/n),$$

Where, ni = the number of individual of a species

n= total number of individual of all species in that stand

Concentration of Dominance (CD) was calculated by Simpson's index (simpson 1949),

$$CD = \sum (\frac{ni}{n})^2$$

Where, ni and n were the same as for Shannon-wiener index.

Data were analyzed using SPSS ver 12.0 program (SPSS 2003). Least significant difference (LSD) was also determined to differentiate density and basal area among disturbance.

RESULTS

Overall species richness of the study area was 60, out of which 17 were trees, 12 shrubs and 31 herbs (Table 2). Tree richness varied from 8 to 11, shrubs richness from 8 to 9 and herbs richness varied from 16 to 19, it was maximum in Protected Area and minimum in disturbed forest. In Protected Area, total species richness was 39 and in disturbed forest it was 32 (Table 2). *Aegle marmelos* and *Diospyros melonoxylon*, were common tree species in both while *Clerodendrum infortunatum*, *Flemingia strobilifera*, *Glycosmis pentaphylla*, *Lantana camara* and *Murraya coenigii* were the common species in shrub layer and Cassia tora, *Chloris dolichostachya*, *Cyperus kalling* and *Desmostachya bipinnata* herbs were common in both forests (Table 2).

Table 2 *Presence (+) and absence (-) of different species in disturbed and least disturbed forest.*

Species	**Highly disturbed site (Dhela i.e buffer zone)**	**Least disturbed site (Jhirna i.e core zone)**
TREE		
Acacia catechu	-	+
Adina cordifolia	-	+
Aegle marmelos	+	+
Anogeissus latifolia	-	+
Butea monosperma	+	-
Cassia fistula	-	+
Cordia dichotoma	+	-
Dalbergia sissoo	+	-
Diospyros melonoxylon	+	+
Garuga pinnata	-	+
Holarrhena Antidysenterica	-	+
Hymenodictyon excelsum	-	+
Lagerstroemia parviflora	+	-
Lannea coromandelica	-	+
Mallotus philippinensis	+	-

Schleichera oleosa	-	+
Shorea robusta	+	-
Total	**08**	**11**
SHRUB		
Clerodendrum infortunatum	+	+
Flemingia strobilifera	+	+
Glycosmis pentaphylla	+	+
Helicteres isora		+
Lantana camara	+	+
Murraya koenigii	+	+
Pogostemon benghalensis		+
Sida cordifolia	+	
Sida rombhifolia	+	
Solanum indicum		+
Ziziphus mauritiana	+	
Zizyphus xylopyrus		+
Total	**08**	**09**
HERB		
Ageratum conizoides	+	
Alteranthera sessilis	+	
Achyranthus aspera		+
Adiantum capillus-veneris		+
Apluda mutica		+
Borreria articularis		+
Cassia tora	+	+
Cheilanthus ferinosa		+
Chloris dolichostachya	+	+
Chrysopogon fulvus		+
Cyanodon dactylon		+
Cyperus kallinga	+	+

Desmostachya bipinnata	+	+
Dicanthum annulatum	+	
Dicliptera bupleuroides		+
Eleusine indica	+	
Eulaliopsis binnata		+
Euphorbia hirta	+	
Euphorbia Lypercifolia	+	
Evolvulus alysinoides		+
Gomphorena sessilis		+
Ichnocarpus frutescens	+	
Imperata cylindrica	+	
Justicia procumbens		+
Neyraudia arundinacea		+
Oplisemanus compositus		+
Oxalis corniculata	+	
Polygonum barbatum	+	
Rungia pectinata		+
Sporobolus coromandelianus	+	
Vetiveria zizinoides	+	
	16	**19**

Effect of disturbance on Vegetation parameters

Total tree density ranged from 250.3-340 trees/ha and total basal area from 18.1-76.15 m^2/ha in the two sites, which was higher for Protected Area and lower for disturbed forest. Total shrub density ranged from 3500-6790 shrubs/ha in two sites, which was higher for disturbed forest and lower for Protected Area. Herb density raged between 60.1 and 63.6 herbs/sq m, which was higher in disturbed forest and lower in Protected Area.

Effect of disturbance on Shrub layer:

In disturbed forest (Dhela) individual shrub density ranged from 20-1840 shrubs/ha, it was maximum for *Flemingia strobilifera* and minimum for *Ziziphus mauritiana. Clerodendrum infortunatum, Flemingia strobilifera, Glycosmis pentaphylla*, *Lantana camara* and *Murraya coenigii* were the common species in shrub layer , showing higher density in disturbed forest as compared to Protected Area. *Helicteres isora* and *Pogostemon benghalensis* are the species found in Protected Area with high density whereas *Glycosmis pentaphylla, Sida cordifolia, Sida rombhifolia and Ziziphus mauritiana* are only present in disturbed forest. *Ziziphus mauritiana* and *Lantana camara* showed greater abundance in disturbed forest whereas *Zizyphus xylopyra* and *Solenum indicum* were abundant in Protected Area. *Flemingia strobilifera* was the dominant shrub in disturbed habitat whereas *Helicteres isora* was dominant in protected area (Table 3).

Effect of disturbance on herb layer:

In disturbed forest (dhela area i.e buffer zone), individual herb density ranged from 0.7-15.3 herbs/Sq. m , it was maximum for *Chloris dolichostachya* and minimum for *Euphorbia lypersifplia* and *Euphorfia hirta.* In disturbed forest, *Chloris dolichostachya* was the dominanting herb whereas *Chrysopogon fulvus* was dominant in Protected Area. In least disturbed Protected Area (Jhirna area i.e core zone), individual herb density ranged from 0.3-14.5 herbs/sq. m, it was maximum for *Chrysopogon fulvus* and minimum for *Evolvulus alysinoides.* The species like *Ageratum conizoides, Alteranthera sessilis, Dicanthum annulatum* **,** *Eleusine indica, Euphorbia hirta, Euphorbia Lypercifolia, Ichnocarpus frutescens, Imperata cylindrical, Oxalis corniculata* **,** *Polygonum barbatum* **,** *Sporobolus coromandelianus* **,** *Vetiveria zizinoides* are species present only in disturbed forest whereas *Achyranthus aspera, Adiantum capillus-veneris, Apluda mutica, Borreria articularis , Cheilanthus ferinosa, Chrysopogon fulvus, Cyanodon dactylon, Dicliptera bupleuroides, Eulaliopsis binnata, Evolvulus alysinoides, Gomphorena sessilis, Justicia procumbens , Neyraudia arundinacea, Oplisemanus compositus* and *Rungia pectinata* are the species found in Protected Area (Table 4).

A total of 32 species were found in disturbed forest whereas 39 were in Protected Area. Tree and herb diversity was higher in Protected Area as compared to disturbed forest, reverse pattern was shown by shrubs (Table 5). ANOVA indicated that tree richness, Density, Basal area and Shrub density was significantly different among forests (Table 6).

Table 3. Vegetational parameters of shrub layer in disturbed and least disturbed site.

	Disturbed Site (Buffer)				**Least Disturbed Site (Core)**			
Species (Botanical name)	**Density (D)/ha**	**Frequency (F)**	**A / F**	**Prominance value**	**Density (D)/ha**	**Frequency (F)**	**A / F**	**Prominance value**
Clerodendrum infortunatum	1590	60	0.44	36.18	40	10	0.40	3.18
Flemingia strobilifera	1840	80	0.29	44.12	530	60	0.15	27.39
Glycosmis pentaphylla	600	50	0.24	19.47	20	10	0.20	2.61
Helicteres isora	-	-	-	-	1300	90	0.16	55.51
Lantana camara	270	90	0.03	23.13	210	100	0.02	26.41
Murraya koenigii	1650	90	0.20	43.45	900	100	0.09	46.12
Pogostemon benghalensis	-	-	-	-	440	80	0.07	28.90
Sida cordifolia	380	20	0.95	9.85	-	-	-	-
Sida rombhifolia	440	70	0.09	21.37	-	-	-	-
Solanum indicum	-	-	-	-	30	20	0.08	4.94
Ziziphus mauritiana	20	10	0.20	2.42	-	-	-	-

Zizyphus xylopyrus	-	-	-	-	30	20	0.08	4.94
	6790	**470**	**2.45**	**200.00**	**3500**	**490**	**1.24**	**200.00**

Table 4. Vegetational parameters of Herb layer in disturbed and least disturbed site

	Disturbed Site (Buffer)				**Least Disturbed Site (Core)**			
Species (Botanical name)	**Density (D)/sq.m**	**Frequency (F)%**	**A / F**	**PV**	**Density (D)/sq.m**	**Frequency (F)%**	**A / F**	**PV**
Ageratum conizoides	3.7	70	0.08	18.32				
Alteranthera sessilis	1	40	0.06	8.72				
Achyranthus aspera					1.4	40	0.09	9.47
Adiantum capillus-veneris					0.7	30	0.08	6.52
Apluda mutica					6.5	20	1.63	14.39
Borreria articularis					0.6	30	0.07	6.36
Cassia tora	1	20	0.25	5.14	1.2	40	0.08	9.14
Cheilanthus ferinosa					1.8	40	0.11	10.14
Chloris dolichostachya	15.3	50	0.61	32.99	12.9	50	0.52	30.39
Chrysopogon fulvus					14.5	60	0.40	34.84
Cyanodon dactylon					2	10	2.00	5.11
cyperus kallinga	3.8	30	0.42	11.33	2.5	20	0.63	7.73
Desmostachya bipinnata	6.3	40	0.39	17.05	2.2	10	2.20	5.45
Dicanthum annulatum	1	10	1.00	3.36				
Dicliptera					1.2	40	0.08	9.14

bupleuroides								
Eleusine indica	3.5	10	3.50	7.29				
Euphorbia hirta	0.7	20	0.18	4.67				
Eulaliopsis binnata					2	10	2.00	5.11
Euphorbia Lypercifolia	0.7	30	0.08	6.46				
Evolvulus alysinoides					0.3	10	0.30	2.28
Gomphorena sessilis					1.9	60	0.05	13.88
Ichnocarpus frutescens	1.1	50	0.04	10.66				
Imperata cylindrica	9	60	0.25	24.87				
Justicia procumbens					0.7	30	0.08	6.52
Neyraudia arundinacea					4	20	1.00	10.23
Oxalis corniculata	2.8	50	0.11	13.33				
Oplisemanus compositus					3	10	3.00	6.78
Polygonum barbatum	1.2	40	0.08	9.03				
Rungia pectinata					0.7	30	0.08	6.52
Sporobolus coromandelianus	2	10	2.00	4.93				
Vetiveria zizinoides	10.5	30	1.17	21.87				
	63.6	**560**	**10.22**	**200.00**	**60.1**	**560**	**14.37**	**200.00**

Table 5. Species Diversity and Dominance in both disturbed and Protected Area:

Name of area	**TREE**			**SHRUBS**			**HERBS**		
	Richness	**Diversity**	**CD**	**Richness**	**Diversity**	**CD**	**Richness**	**Diversity**	**CD**

Disturbed forest	8	2.53	0.23	8	2.5	0.2	16	3.36	0.13
Protected Area	11	3.02	0.16	9	2.3	0.25	19	3.48	0.13

Table 6. ANOVA table showing difference in the vegetational parameters.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Disturbance	Tree Richness	5.000	1	5.000	8.036	.011*
	Tree density	4.050	1	4.050	4.893	.040*
	Basal Area	168.914	1	168.914	14.873	.001*
	Shrub Richness	.200	1	.200	.133	.719NS
	Shrub Density	5412.050	1	5412.050	7.466	.014*
	Herb Richness	.000	1	.000	.000	1.000NS
	Herb Density	61.250	1	61.250	.158	.696NS

*Significant at 5%

NS: Not Significant

DISCUSSION

The forest ecosystems in the Himalaya are severely threatened by natural (landslide, landslip, cloudburst, torrent rains, etc.) and anthropogenic forces. Forest diversity is the main livelihood source for the people living in the state of Uttarakhand. The increasing population over the last few decades and consequent dependence on plant products has led to over exploitation of natural flora and fauna of this region (Ram et al. 2004). The forest biomass is

removed through grazing, lopping and surface burning year round and plants often do not get enough time to recover (Singh 1998). These anthropogenic disturbances not only influence the soil, nutrient and water conditions but also influence microenvironment of the area. The biodiversity of these forests is indeed under great anthropogenic pressure (Pokhriyal et al 2012). Human technological and scientific advances have caused environmental changes that are impossible to evaluate and fully comprehend. Our ability to change the environment has increased faster than the ability to predict the effect of that change. Pollution of the environment is one of the major effects of human technological advancement. It results when a change in the environment harmfully affects the quality of human life including effects on animals, microorganisms and plants as well as soil ecosystem. (Marinescu et al., 2010).

The continuous anthropogenic disturbances are responsible for creating gaps of various sizes in forest canopies. The creation of gaps, both directly and indirectly, influence species richness and other Vegetational parameters of a forest. Our study indicated that tree density was high in least disturbed forest, it 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 climatic factors (Samant et al. 2002, Joshi 2002). The lowest species number (32) was recorded in disturbed forest while Protected Area contained greatest richness (39). Nath *et al.* (2005) reported that tree and shrub richness decreased from low to high disturbance regimes while medium disturbance favouring high herb richness, but overall species richness was greater in low disturbances in a tropical wet evergreen forest and reverse was reported in subtropical and temperate forests of Uttaranchal. Pant and Samant (2007) reported high shrub richness may be due to diverse habitats and suitable edaphic and climatic factors supporting growth and survival of the species.

The total basal area was high in Protected Area and indicated that most of the environmental factors support radial growth of the tree. Present study indicated that tree and herb diversity was higher in Protected Area and shrub in disturbed forest forest. Greater diversity in a closed canopy has also been observed by Moral, 1972 and Zobel et al. 1976. Shrub diversity was comparatively higher where disturbances are present (Kharakwal et al. 2007). This may

provide opportunity for the invasion of more shrub in the area. Whittaker (1972) stated that the dominance of one stratum may affect the diversity of another stratum. Concentration of dominance for tree ranged from 0.16-0.23, shrubs 0.22-0.24 and herbs 0.15-0.23. Concentration of dominance reported by Adhikari (1992) and Srivastava (2002) was 0.20 to 0.89 for trees, 0.12 to 0.89 for shrub layer and 0.04 to 0.73 for herb layer in the central Himalayan forests. CD ranging from 0.56 to 3.36 for tree layer, 0.17 to 0.62 for shrubs and 0.06 to 0.44 for herb layer has been reported by Kharakwal et al. (2007). CD of trees ranges from 0.06-0.49, shrubs from 0.03-1.00 and herbs from 0.01-0.52 (Pant and Samant 2007).

Anthropogenic activities in forests such as logging and plantation establishment cause a reduction in species richness and density (Struhsaker, 1997, Bobo et al. 2006 and Turyahabwe and Tweheyo 2010). Therefore, degradation of unprotected forest fragments is expected to result in low species diversity. Nevertheless, expected tree species density in riverine patches in Bulindi (53 species ha – 1) was similar to densities reported from 1-ha plots in main forests elsewhere in Uganda (Eilu et al. 2004). Concentration of dominance for tree raged from 0.16-0.23, Concentration of dominance reported by Risser and Rice (1971) for tree layer ranges from 0.10 to 0.9 for temperate forests. Adhikari (1992) and Srivastava (2002) reported the value ranging from 0.20 to 0.89 for trees, 0.12 to 0.89 for shrub layer and 0.04 to 0.73 for herb layer in the central Himalayan forests. CD ranging from 0.56 to 3.36 for tree layer, 0.17 to 0.62 for shrubs and 0.06 to 0.44 for herb layer has been reported by Kharakwal et al. (2007).

Maithani et al.1986 has reported that the low intensity surface fires in the forest can allow herbs to dominate while Sal recruits get badly affected. Local residents also burn the forest for the profuse growth of grasses (Dinerstein, 1979) which allows herbs along with grasses to grow. In the disturbed ecosystem of Kumaon Himalayas, the increase in species diversity has been reported by many workers (Pandey and Singh, 1985). Disturbance in terms of grazing by wild animals also helps in seed dispersal of species. Janzen (1986) suggested that grazing mammals may have been the common dispersers of many plants which were earlier thought to be wind dispersed. The interesting phenomenon observed in the study is that least disturbed site showed higher herb species richness.

The highly disturbed areas (buffer zone) get invasion of more shrubby and herbaceous flora because of more openings in the area due to severe anthropogenic pressures while least disturbed areas (core zone) with less openings due to less human pressure and more protection allows species richness to be higher and comparatively less density of herbs and shrubs. The shrubby weed i.e *Lantana camara* is spreading fast everywhere in CNP but the higher density of it was noticed in highly disturbed Dhela (buffer) area which needs immediate attention of park administration.

CONCLUSION

Thus, it is concluded that the least disturbed areas (core zone) are important for ecosystem as a whole while highly disturbed areas (buffer zone) need constant protection, lessening of anthropogenic pressures through the active involvement of community and more silvicultural inputs by the department. In sum, these results suggest that over a quarter of a century, protected areas have been proven to be quite effective in the protection and proliferation of plant species as a vital ecosystem function, in terms of the two key components of ecological effectiveness, their representation of this function and its persistence through time.

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