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RESEARCH ARTICLE

# VEGETATION COMPOSITION AND REGENERATION STATUS OF OAK DOMINATED FORESTS IN RELATION TO DISTURBANCES IN KUMAUN HIMALAYA, INDIA

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ABSTRACT

Various changes in the Himalayan Forests are appearing in their structure, density, composition and regeneration due to biotic pressure on them namely; uncontrolled lopping and felling of trees for fuel wood, fodder and grazing these biotic pressures play an important role in forest community dynamics and regulate the regeneration ability of a species. The study area is located between 29º22′ and 29º23′ N latitude and 79º 26′ and 79º 28′E longitude between 1800-2300 m elevations in Uttrakhand Himalaya. The present study was conducted in four different sites namely, undisturbed, highly disturbed, moderately disturbed and less disturbed sites in Nainital catchment this chapter mainly concerned with three major forms of activities that have affected the vegetation composition of Western Himalayan oak, grazing, fuel wood and fodder collection.



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## INTRODUCTION

Kumaun region of the Central Himalaya harbors rich biodiversity because of its unique and diverse climate conditions. Composition of the forest is diverse and varies from place to place because of varying topography such as plains, foothills and upper mountains. Several studies have described the vegetation of Kumaun (Osmaston, 1927; Dhar *et al*., 1997; Singh and Singh, 1987; Hussain *et al*., 2008). 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). Several authors have studied the effect of disturbance on Himalayan forests. The effect of anthropogenic disturbance on plant diversity and community structure in the forest of north eastern Himalaya, India was studied by Khan *et al*., (1987); Misra *et al.,* (2004) and Rao *et al*., (1990).

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Various changes in the Himalayan Forests are appearing in their structure, density, composition and regeneration due to anthropogenic pressure (Bargali *et al*., 1998; Kumar *et al.,* 2004). These biotic pressures play an important role in forest community dynamics (Pickett and White, 1985) and regulate the regeneration ability of a species. All of the above studies reported that increased degree of disturbance caused loss of plant diversity and brought about a change in community characteristics. Banj oak *(Quercus leucotrichophora*) and Tilonj oak (*Quercus floribunda*) are the two dominant forest forming species of Central Himalayan occurring between 1800-2300m elevations, both are evergreen species. However depletion of oak forest has contributed to expansion of *pinus roxburghii*. However, the present study deal with the understanding of the relationships between disturbance levels and their impact on vegetation, which provide important basis for predicting species structure and changing vegetation composition.

## MATERIALS AND METHODS

The study area is located between 29º22′ and 29º23′ N latitude and 79º 26′ and 79º 28′E longitude between 1800-2300m elevations in Uttarakhand Himalaya.

The forest were thoroughly surveyed and identified as *Q. leucotrichophora* (Banj-oak) dominated forest and mixed (*Q. leucotrichophora and Q. floribunda*) oak forest. The present study was conducted in four different sites each sites located between 1800 -2300m elevation in Nainital catchment to assess impact of disturbances in plant community. The climate of Nainital is monsoonal. The study was conducted during 2012-14. The minimum temperature in year 2012 ranged from 0.-1.5$^0$C in February to 18.70$^0$C in June, while maximum temperature from 12.5$^0$C in January to 28.4$^0$C in June. The maximum rainfall occurred in July (833.8mm) and lowest in May and October (1mm) .Vegetation analysis was made for all the three layers of forest , i.e. trees, shrubs and herbs, for identification Osmaston (1926) 'Forest Flora of Kumaun' was used.. The size and number of samples were determined following Saxena and Singh (1982). The tree analysis was done by sampling 10x10m quadrates on each site tree considered to be individuals > 30cm cbh (circumference at breast height), saplings 10-30 cm cbh and seedlings <10cm circumference (Saxena and Singh , 1984).

The shrub layer were analysed by sampling quadrates of 5x5m and the herbs layer by placing quadrates of 1x1 m randomly on each site. The vegetational data were calculated for abundance density and frequency (Curtis and Mc Intosh, 1950). Importance Value Index (IVI) for the tree was determined as the sum of relative density, relative frequency and relative dominance (Curtis, 1959). The diversity index for all the three layers at each study site was calculated by using Shannon-Wiener (1963) and Concentration of dominance by using Simpson's (1949) Index. For disturbances analysis the disturbed forest sites were chosen on the basis of their proximity 1-4 km to the village settlements and urban population, where people have easy access to resources. A questionnaire was used to collect basic village information on the communities residing, dependence on the forest for livestock grazing, fuel wood, timber and non -timber forest products. Households were surveyed in these sample villages for natural resources extraction/use pattern.

A random sampling for households with 60% converge was envisaged and actually designed. Primary data were generated using focus group interviews and questionnaires wherever necessary regarding relevant information.

Forest natural resources, such as fuel-wood load, fodder bundles, timber extraction, dry leaves, and their quantities were estimated through interview techniques followed by direct weighing (fresh weight= 3.5x dry weight). Information on fuel resources extraction and usage practices were generated by weighing each head-load during field visits. Information on fodder usage and forest litter was also generated by weighing head-load at the time of extraction. All enumerated resources have been found extracted in each community. The main sources of the resources extraction was *Quercus* forest, adjoining pine forest. Population structure was used to express the regeneration status of individual tree species. Individuals > 30 cm circumference were categorized as trees, 10 to 30 cm as saplings, and < 10 cm as seedlings to determine the regeneration status of tree species in each forest site (Saxena *et al.,* 1984).

# RESULTS

Fuel wood is used for cooking food, heating space and boiling water. The mean amount of fuel consumption at highly disturbed site in a day was 17.54kg $hh^{-1}d^{-1}$ and yearly it was 4156.98kg $hh^{-1}yr^{-1}$ and at moderately disturbed forest site it was 15.85kg $hh^{-1}d^{-1}$ (3106.6kg $hh^{-1}yr^{-1}$ respectively. At less disturbed forest site it was 15.32kg $hh^{-1}d^{-1}$ and 2052.88kg $hh^{-1}yr^{-1}$ respectively. Fodder was traditionally extracted by chopping tree branches and grasses were collected by harvesting with the use of sickles. Fodder collection was high at highly disturbed site 15.12kg $hh^{-1}d^{-1}$, in a day while yearly it was 3628.8kg $hh^{-1}yr^{-1}$ Table-1.

At moderately disturbed forests it was not practiced. Forest floor litter was found to be used for livestock bedding, mulching and composting, etc. The forest floor litter was usually collected during morning /day times. Litter collection was done in once a week and it was 8kg $hh^{-1}d^{-1}$ in a day and 352kg $hh^{-1}yr^{-1}$ yearly at highly disturbed site while at moderate disturbed site it was 6.12kg $hh^{-1}d^{-1}$ in a day and 195.84kg $hh^{-1}yr^{-1}$ yearly Table- 1.

**Impact of anthropogenic pressure in density, regeneration and total basal area**

**Species composition**

On the undisturbed site, the tree density ranged from 15-520 ind./ha. The maximum density was of *Q. leucotrichophora* and minimum of *C. deodara* and *P. pashia* (15 ind./ha). *Q. leucotrichophora* had the maximum total basal are (63.7 $m^2$/ha) on the undisturbed site. The minimum total basal area (0.04$m^2$/ha) was for *C. deodara and C. macropylla. Q. leucotrichophora* was the most important species on undisturbed site (IVI=151.4). On the highly disturbed site *Q. leucotrichophora* had maximum density (400 ind./ha) while *P. pashia* had minimum density (15 ind./ha). Total basal area was maximum (23.608 $m^2$/ha) for *Q. leucotrichophora* while *P. pashia* had minimum (0.191$m^2$/ha) total basal area. *Q. leucotrichophora* was the most important species (IVI= 157.9) for this site Table-2.

On moderately disturbed site *Q. floribunda* had the maximum density (350 ind,/ha) while *A. indica* and *I. odorata* showed minimum density (10 ind./ha). *Q. floribunda* had maximum (37.53 $m^2$/ha) total basal area while total basal area was minimum for *A. indica* (0.071 $m^2$/ha). *Q. floribunda* was the most important (IVI=121.211) species in this aspect. On less disturbed site *Q. floribunda* had the maximum density (575 ind./ha) while minimum was reported for *C. torulosa* .Total basal area was maximum for *Q. floribunda* (25.028 $m^2$/ha) while minimum was found for *C. torulosa* (0.508 $m^2$/ha). *Q. floribunda* was the most important (IVI=210.27) species of this aspect Table-2.

**Shrubs and herbs**

The total shrub density varied from 1420 to 2380 ind./ha it was comparatively higher on disturbed site and decreased towards undisturbed site.

**Table 1. Resource extraction and consumption practices in the sites**

| Site | | UN | HD | | MD | | LD | |
|---|---|---|---|---|---|---|---|---|
| Resource type | Extraction process | * | MC (Kg $hh^{-1}d^{-1}$) | MC (Kg $hh^{-1}yr^{-1}$) | MC (Kg $hh^{-1}d^{-1}$) | MC (Kg $hh^{-1}yr^{-1}$) | MC (Kg $hh^{-1}d^{-1}$) | MC (Kg $hh^{-1}yr^{-1}$) |
| Fuelwood | Felling, lopping, collecting | * | 17.54 | 4156.98 | 15.85 | 3106.6 | 15.32 | 2052.88 |
| Fodder | Chopping, mowing | * | 15.12 | 3628.8 | * | * | * | * |
| Litter | Collecting | * | 8.0 | 352.0 | 6.12 | 195.84 | * | * |

UN= Undisturbed, HD= highly disturbed, MD= moderately disturbed, LD= less disturbed, hh= house hold, d= day, yr= year, *= not practiced

**Table 2. Vegetation parameters for trees in different sites**

| Aspect | Tree species | Density ind/ha | TBA $m^2$/ha | IVI |
|---|---|---|---|---|
| UN | Banj-oak forest | | | |
| | *Q.leucotrichophora* | 520 | 63.7 | 151.4 |
| | *M.esculanta* | 60 | 3.8 | 22.8 |
| | *R.arboreum* | 90 | 7.7 | 30.3 |
| | *C.oblonga* | 60 | 2.2 | 14.75 |
| | *A.oblongum* | 80 | 5.1 | 26.4 |
| | *A.indica* | 60 | 1.6 | 14.15 |
| | *L.umbrosa* | 40 | 0.6 | 10.937 |
| | *C.macropylla* | 15 | 1.2 | 6.02 |
| | *L.ovalifolia* | 20 | 0.4 | 7.058 |
| | *I.depyrena* | 40 | 0.6 | 10.937 |
| | *B.oreintalis* | 15 | 0.4 | 5.078 |
| HD | Banj-oak forest | | | |
| | *Q.leucotrichophora* | 400 | 23.608 | 157.9 |
| | *P.roxburghii* | 160 | 6.14 | 63.6 |
| | *M.esculanta* | 20 | 1.901 | 12.1 |
| | *I.depyrena* | 20 | 0.78 | 12.5 |
| | *P.pashia* | 15 | 0.191 | 6.628 |
| | *A.oblongum* | 40 | 1.194 | 16.9 |
| | *L.ovalifolia* | 20 | 0.672 | 8.6 |
| | *R.arboreum* | 40 | 0.963 | 20.3 |
| MD | Mixed-oak forest | | | |
| | *Q.floribunda* | 350 | 37.53 | 121.211 |
| | *Q.leucotrichophora* | 180 | 16.272 | 67.188 |
| | *E.pendulus* | 15 | 0.47 | 7.2 |
| | *C.deodara* | 130 | 19.422 | 57.625 |
| | *C.torulosa* | 70 | 5.847 | 30.434 |
| | *A.indica* | 10 | 0.071 | 6.047 |
| | *I.odorata* | 10 | 0.137 | 6.129 |
| LD | Tilonj-oak forest | | | |
| | *Q.floribunda* | 575 | 25.028 | 210.27 |
| | *I.dipyrena* | 35 | 1.152 | 23.07 |
| | *Q.leucotrichophora* | 65 | 3.572 | 41.398 |
| | *R.arboreum* | 25 | 0.815 | 15.88 |
| | *C.torulosa* | 20 | 0.508 | 9.38 |

Maximum density 400 ind/ha was observed for *B. albiflora* at undisturbed site and minimum density 20 ind/ha was observed for *W.canescens, S.vaginata* and *A.recemose.* The total herbs density ranged between 861000 ind./ha to1034000 ind./ha and it was comparatively lower on less disturbed site and increased towards undisturbed site. Maximum density 120000 ind/ha was observed for *C.nubigena* at disturbed site and minimum density 2000 ind/ha was observed for *T.foliolosum, R.cordifolia, D.multiflorous* and *G. nepelensis* at undisturbed and disturbed site, respectively (Table-3).

**Diversity**

The species diversity and species richness of different layers are given in Table-4.

Tree, sapling and seedings diversity was maximum in undisturbed site 2.491, 2.807, and 2.609 while shrub diversity was maximum at highly disturbed site 3.880 and herbs diversity was found maximum in moderate disturbed site 4.572.

**Table 3. Shrub density and herb density (ind/ha) in different sites**

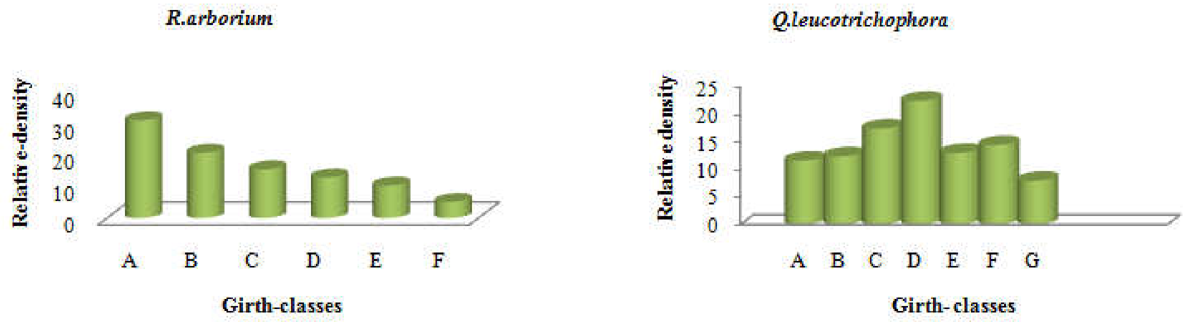
| Shrub Species | D (ind/ha) | D (ind/h) | D (ind/ha) | D (ind/ha) | Herb Species | D (ind/ha) | D (ind/ha) | D (ind/ha) | D (ind/ha) |
|---|---|---|---|---|---|---|---|---|---|
| | UD | HD | MD | LD | | Un | HD | MD | LD |
| B.asiatica | 120 | 100 | 40 | 60 | P.nepalensis | 109000 | 31000 | 15000 | - |
| B.albiflora | 400 | 200 | - | - | C.nubigena | 110000 | 120000 | 104000 | 90000 |
| B.lycium | 40 | 200 | - | - | A.nilgarica | 20000 | 7000 | 39000 | - |
| L.camara | 40 | 80 | - | - | F.indica | 22000 | 5000 | 8000 | - |
| R.ellipticus | 40 | 140 | 40 | 40 | A.thomsonii | 22000 | 3000 | 20000 | 10000 |
| R.tetrasperma | 40 | 100 | 40 | - | C.benghalensis | 50000 | 90000 | - | 90000 |
| D.staminea | 40 | 60 | - | - | O.intermedius | 80000 | 90000 | 50000 | 50000 |
| D.longifolium | 120 | 120 | | 60 | G.ciliata | 20000 | 20000 | - | 18000 |
| H.cernuum | 80 | - | - | - | V.canescens | 20000 | 12000 | 11000 | 4000 |
| I.heterantha | 80 | 360 | - | 80 | N.crispata | 14000 | 14000 | - | 27000 |
| P.crenulata | 100 | 120 | 40 | | O.compositus | 50000 | 104000 | - | 155000 |
| W.canescens | 100 | 60 | 60 | 20 | D.bupleuroides | 24000 | 24000 | - | - |
| H.oblongifolia | 40 | - | - | 40 | O.vulgaris | 12000 | 12000 | 43000 | 5000 |
| C.nepalensis | 80 | - | | | T.royelanam | 28000 | 4000 | - | 22000 |
| S.vaginata | 60 | 40 | - | 20 | J.simplex | 30000 | 60000 | - | - |
| C.microphylla | 40 | 140 | | | T.foliolosum | 2000 | 7000 | - | 14000 |
| S.hookeriana | - | - | 80 | 120 | O.latifolia | 60000 | 40000 | 30000 | - |
| M.pellita | - | 80 | - | - | H.spicatum | 6000 | 6000 | 8000 | - |
| M.africana | - | 200 | 40 | - | R.procera | 12000 | 15000 | 8000 | - |
| D.canabina | - | 240 | 200 | 280 | S.elatus | 16000 | 15000 | 35000 | - |
| A.falacata | - | - | 420 | 600 | A.bidentata | 80000 | 20000 | 40000 | - |
| R.lasiocarpus | 40 | - | 40 | 40 | A.pilosa | 12000 | 11000 | 12000 | 28000 |
| I.geradiana | - | 120 | 180 | 40 | I.scabrida | 60000 | 20000 | 60000 | - |
| R.mochata | - | - | 60 | - | G.nepelensis | 25000 | - | 28000 | 2000 |
| R.veregatus | - | - | 60 | - | R.cordifolia | 2000 | - | | - |
| U.parvifolia | - | - | 120 | - | E.karvinskianus | 40000 | 8000 | 60000 | 8000 |
| H.oblongifolium | - | - | - | 40 | E.annua | 54000 | - | 45000 | - |
| A.recemose | - | - | - | 20 | D.multiflorous | 2000 | - | - | - |
| R.hastatus | - | - | 40 | - | P.polyphylla | 22000 | - | - | 16000 |
| | | | | | P.hirta | 20000 | 6000 | 18000 | 3000 |
| | | | | | P.umbrosa | 40000 | - | - | - |
| | | | | | M.biflora | | 8000 | - | - |
| | | | | | N.calycina | | 14000 | - | 20000 |
| | | | | | O.corniculata | | 21000 | 40000 | 8000 |
| | | | | | G.gossypiana | | 7000 | - | - |
| | | | | | G.rotandifolium | | 24000 | 9000 | - |
| | | | | | S.tetragona | | 16000 | - | - |
| | | | | | S.glauca | | 7000 | - | - |
| | | | | | B.pilosa | | - | 23000 | - |
| | | | | | C.japonica | | - | 90000 | 13000 |
| | | | | | P.critica | | - | 50000 | 8000 |
| | | | | | H.nepelensis | | 6000 | 14000 | - |
| | | | | | P.nepelensis | | 31000 | 15000 | - |
| | | | | | O.cryptogramno | | - | 35000 | 18000 |
| | | | | | V.himalayansis | | - | 16000 | - |
| | | | | | C.campatiens | - | - | 45000 | 24000 |
| | | | | | S.tenuifolium | - | - | - | 20000 |
| | | | | | L.lantana | - | - | - | 20000 |
| | | | | | G.aparine | - | - | - | 12000 |
| | | | | | G.repens | - | - | - | 12000 |
| | | | | | S.angulosa | - | - | - | 44000 |
| | | | | | A.perionoidis | - | - | - | 15000 |
| | | | | | T.repens | - | - | 6000 | - |

**Table 4. Species diversity of different forest sites**

| Aspect | parameters | Tree | Sapling | Seedling | Shrub | Herb |
|---|---|---|---|---|---|---|
| UD | SD | 2.491 | 2.807 | 2.609 | 3.650 | 4.477 |
| | SR | 11 | 9 | 8 | 17 | 31 |
| HD | SD | 1.967 | 2.143 | 1.477 | 3.880 | 4.238 |
| | SR | 8 | 6 | 5 | 17 | 31 |
| MD | SD | 2.032 | 2.423 | 2.037 | 3.371 | 4.572 |
| | SR | 7 | 6 | 6 | 15 | 30 |
| LD | SD | 1.096 | 2.181 | 2.128 | 2.748 | 4.270 |
| | SR | 5 | 5 | 5 | 13 | 28 |

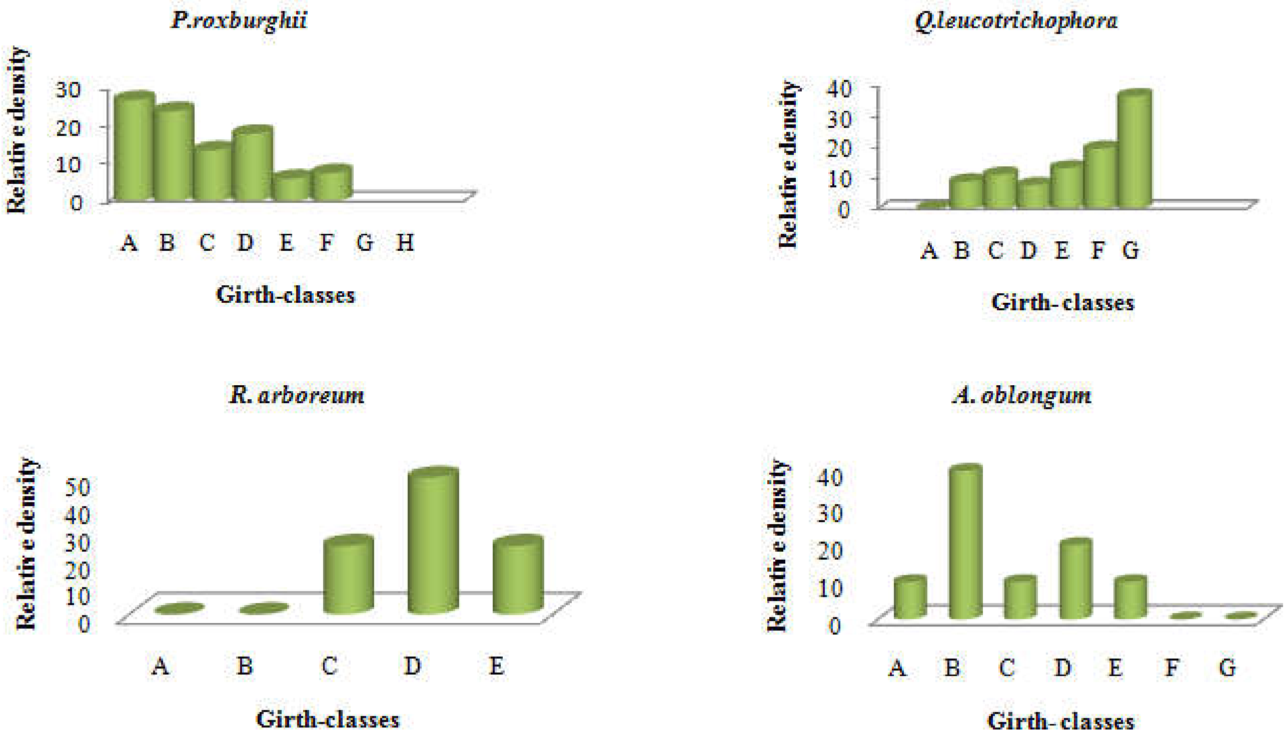
## Population structure and regeneration status

*Q. leucotrichophora* and *Q. floribunda* was the dominant species in all the sites but absence or less number of saplings and seedlings of *Q. leucotrichophora* and increasing number of saplings and seedlings of *P.roxburghii* in highly disturbed site are results of long anthropogenic pressure even less number of saplings and seedlings of *Quercus* species in moderate and less disturbed sites indicates that conversion of seedling into saplings has been absent for a very long time.




A = seedlings, B = saplings and trees: C= 31-60 cm, D= 61-90 cm, E= 91-120 cm F= 121-150 cm, G= 151-180 cm.

**Fig. 1. Population structure of major species *Q. leucotrichophora and R. arboreum on* UD Site**

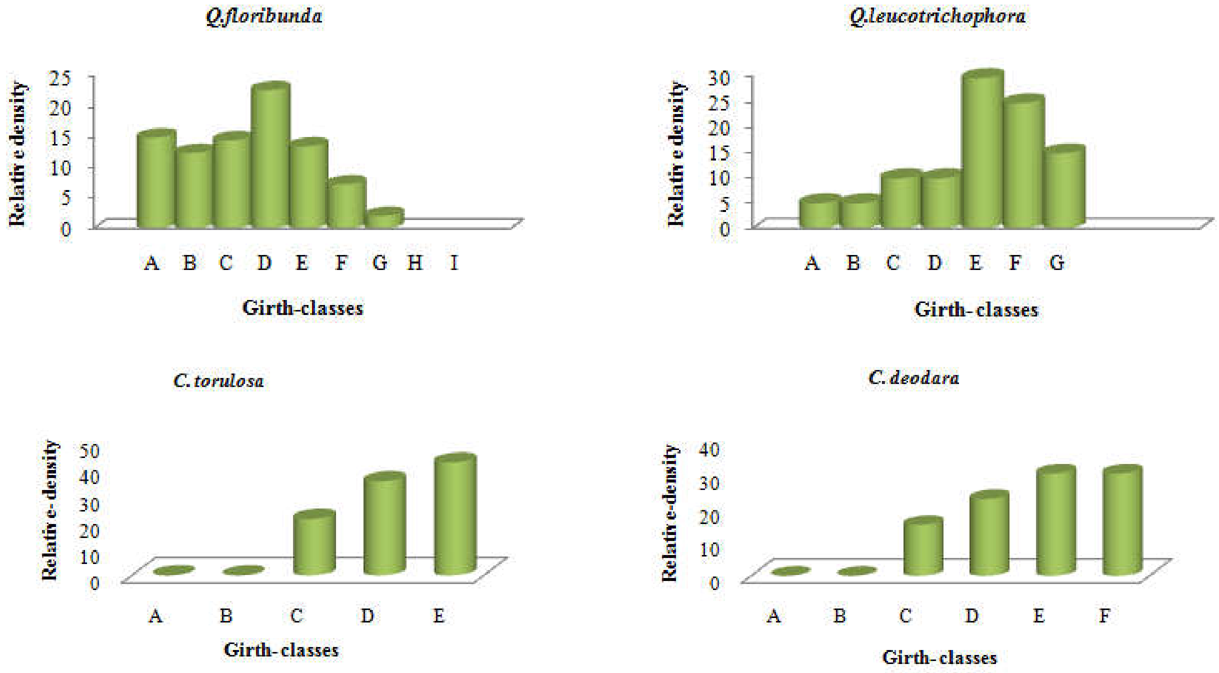



A = seedlings, B = saplings and trees: C= 31-60 cm, D= 61-90 cm, E= 91-120 cm F= 121-150 cm, G= 151-180 cm.

**Fig. 2. Population structure of *P. roxburghii, Q. leucotrichophora, R. arboreum and A. oblongum* on HD Site**

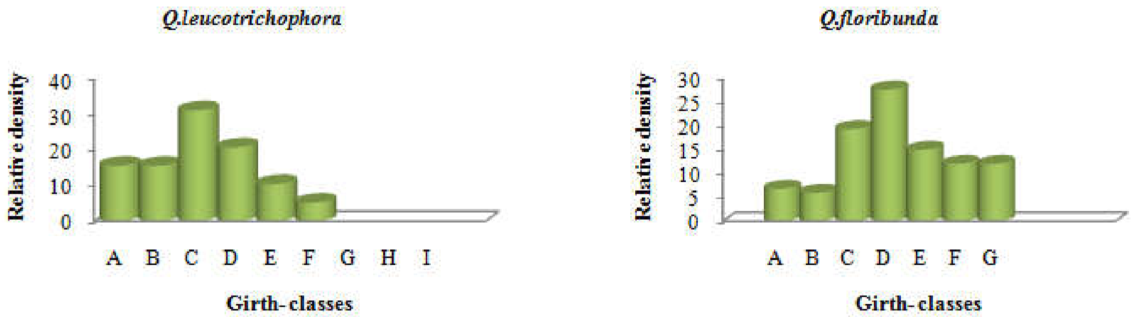
The population structure of tree species were following three types according to the criteria given by Saxena and Singh (1984). *Q. leucotrichophora and R. arboreum* represents frequent reproduction (Knight, 1975) at undisturbed site with higher proportion of individuals in younger girth classes as compared to higher girth classes. The seedling recruitment in undisturbed site for *Q. leucotrichophora* was 11.7% and their conversion into sapling stage was high 12.7% Fig.1.

At highly disturbed site the seedlings and saplings stages for *Q. leucotrichophora and R. arboreum* were less or absent while *P. roxburghii* represents frequent reproduction (Knight, 1975) in this site with higher proportion of individuals in younger girth classes as compared to higher girth classes the seedling recruitment of *P.roxburghii* was 27.28% and their conversion into sapling stage was 24.25% Fig.2. Increasing number of seedlings and saplings of *P. roxburghii* indicating that *Q. leucotrichophora* and *R. arboreum* were not regenerating and may be replaced by *P. roxburghii* in future. At moderately disturbed site *Q. floribunda* represents frequent reproduction and *Q. leucotrichophora,* C. *deodara* and *C. torulosa* represents infrequent reproduction with high density in the intermediate girth classes and decreasing density towards lower and higher girth classes the seedling recruitment in moderately disturbed site for *Q. leucotrichophora* was 11.2% and their conversion into sapling stage was also 11.2% for *Q. floribunda* the relative density of seedlings was 15.06%




A = seedlings, B = saplings and trees: C= 31-60 cm, D= 61-90 cm, E= 91-120 cm F= 121-150 cm, G= 151-180 cm.

**Fig. 3. Population structure of *Q. leucotrichophora, Q. floribunda C. torulosa and C. deodara* on MD Site**




A = seedlings, B = saplings and trees: C= 31-60 cm, D= 61-90 cm, E= 91-120 cm F= 121-150 cm, G= 151-180 cm.

**Fig. 4. Population structure of *Q. leucotrichophora* and *Q. floribunda* on LD Site**

and their conversion into saplings were very low 12.5% Fig.3. At less disturbed site for *Q. leucotrichophora* the seedling recruitment was 15.8 % and their conversion into saplings were also 15.8% for *Q. floribunda* the relative density of seedlings was 6.9% and their conversion into saplings were 6.07% Fig.4.

## DISCUSSION

The broadleaf trees (particularly *Q. leucotrichophora* and *Q. floribunda*) are repeatedly lopped for leaves and firewood, leading to their gradual disappearance. As a result of these activities, the forest sites have been either reduced or dramatically modified and have led to the expansion of xerophytic conditions (Singh and Singh, 1987). The distribution of plant species indicate that the distribution of each species is determined by its own ability to survive, grow and reproduce successfully in different environmental conditions.

In the present study the tree density varied from (715-1000 ind./ha) which were comparatively lower than the value reported by Singh *et.al*. (1994) they have reported tree density values ranging from (250-2070 ind./ha) for different central Himalayan forests. This decline may be due to a gradual and consistent increase in the extraction of fuel wood and fodder as *Q. leucotrichophora* and *Q. floribunda* are the dominant species in these forests which are extensively used as fuel wood and fodder. On the basis of total basal area Upreti (1982) had reported the basal area for disturbed forest generally below (38.7 $m^2$/ha) and the undisturbed forest had relatively higher basal area (33.71 to 74.17 $m^2$/ha) in the present study of these forest the disturbed forest had basal area generally between (31.075-79.7491 $m^2$/ha) and undisturbed forests had basal area generally (87.5 $m^2$/ha) . The seedlings and saplings are less in numbers for disturbed forest compared to undisturbed forest. In general the sapling and seedlings density of dominant tree species was much lower in disturbed forest this could be the attributed to the heavy extraction of dominant tree species for use as fuel and fodder and timber decreased number of sapling and seedling at disturbed forest is another consequence of anthropogenic pressure number of saplings and seedlings of dominant species was lower than the number at undisturbed site in the present study which might be due to the inability of all seedlings to graduate into saplings and saplings into trees the saplings could be cut down for fuel by men and grazed as a fodder by animals and the seedlings could possibly trampled out either by men or by the grazing animals at the disturbed forest further the highly disturbed forest had poor regeneration of dominant tree species due to higher disturbances the soil of the aspect became poorer in moisture and fertility so the moisture observing capacity of the soil become less which led to the other lesser altitudinal forest species *i.e*. *P. roxburghii* to grow, that can grow in very poorer soil and barren areas (Tewari, 1982, Saxena *et al*., 1985) in the present study at highly disturbed site the pine sapling and seedlings increasing in numbers which indicates the impact of disturbances this shows the depletion of oak forest gradually and expansion of pine and other forest species on the other hand. Banj-oak are failing to regenerate adequately over large areas on the other hand Chir pine is regenerating copiously and increasing in numbers (Saxena and Singh, 1984, Singh and Singh, 1985, Rao and Singh 1986).

Similar pattern were observed in the present study. Absence of saplings and seedlings in highly disturbed site and also the conversion of seedlings into saplings of dominant species were low for all the disturbed sites indicate that it may have a significant bearing on the forest structure in coming years. Severe disturbances may reduce vegetation structure by destroying vegetation structure or moving it off site. While mild and moderate severely disturbances may enhance structure complexity by increasing the density of structure type (Franklin, 1992). The diversity and species richness for tree, saplings seedlings, shrubs and herb were decreasing attitudinally. In the present study shrub density was found more at highly disturbed site whereas herb density was observed less at highly disturbed site but found more at moderately disturbed sites. High shrub diversity was observed at highly disturbed forest because high disturbance promotes bushy species to grow while higher herb diversity was found at mid elevation disturbed forest while less herb diversity was found at highly disturbed forest.

This indicates that moderate disturbances maintains high number of herbs by opening the canopy disturbance at moderate level providing favorable conditions for undergrowth to grow , where forest canopy was moderately opened as compared to high and less disturbed forest. This may provide opportunity for invasion of more shrub and herb in the area. According to intermediate disturbance hypothesis (Connell 1978; Huston 1979), with no or little disturbance, only the competitive dominants can survive, while at sufficient high level of disturbance only fugitive species can survive, therefore, the diversity is maximum at the intermediate level of disturbance (Abugov, 1982). The mild disturbance provides greater opportunity for species turnover, colonization and persistence of high species richness (Whittaker, 1975). From the present study it is evident that increasing intensity of anthropogenic pressure on oak- forests leads to depletion of the saplings and seedlings of oak- species which is very important species for the whole region and if the present trend continues these forests of oak will be replaced by other less important species in the next coming year.

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