Community Structure of Montane forest along the Altitudinal Gradient in Garhwal Himalaya, India

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The present study was done in sub-tropical and temperate Himalayan Forest of Saikot Reserve Forest, Kedarnath forest division in Chamoli district of Uttarakhand to understand the community structure and effect of altitudinal variation on structure and composition of the vegetation and to record the floristic diversity of the plants in the study area. The study area was categorized into four forest types on the basis of vegetation analysis, plant association or plant composition surveys, viz (1) Chir-Pine forest, (2) pine-oak forest (3) oak-pine-forest (4) oak-mixed forest. In the floristic study, a total of 58 species were recorded. Of the 58 plant species, 21 were tree, 11 shrubs and 26 herbs. The Quercus leucotrichophora forest was experiencing serious threat owing to human pressure and severe invasion of Pinus roxburghii which leads to loss of oak forest and development of pine forest.

Key words: Community structure, Saikot Reserve Forest, Garhwal Himalaya, altitudinal gradient, Montane Forest, aspects.

INTRODUCTION

Vegetation is a key factor in determining the structure of any ecosystem (Gaur, 1999; Bhatt and Purohit, 2009). Within a plant community, it determines microclimate, energy budget, photosynthesis, water regimes, surface runoff and soil temperature (Yadav and Gupta, 2006). The plant community of a region is a function of time and altitude. Slope, latitude, aspect, rainfall and humidity also play an important role in the formation of plant communities and their composition (Kharkwal et al., 2005).

The Himalayan vegetation ranges from sub-montane dry-deciduous forest in the foothills to alpine pasture above the timberline (Gaur, 1999; Bhatt and Purohit, 2009). The vegetation of Himalaya was intensively studied by Becking (1954). The literature on quantitative phytosociological work has been published from various parts of world (Cheema and Qadir, 1973; Beg and Khan, 1984; Ahmed et al., 2006; Ahmed et al., 2010; Khan et al., 2010a). Phytosociological characters differ among aspects and position, even in the same vegetation type. However, the different types of forest studies (structural and functional) in Garhwal Himalaya were shown by several workers such as Osmoston (1922), Puri (1960) and Champion and Seth (1968). Oak and other forest of Garhwal Himalaya has been studied for structure and

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succession, and for impact of biotic stress by several workers like Tiwari (1979), Tiwari and Gupta (1982), Agrawal (1985), Rawat and Tiwari (1990), Joshi and Tiwari (1990), Mehta and Tiwari (1992), Bisht and Kusumalata (1993), Gaur and Bartwal (1993), Bhandari et al. (1995), Agarwal (1996), Mehta et al. (1997), Nautiyal et al. (1997), Bhandari et al. (1997), Bhandari and Tiwari (1997), Bhandari et al. (2000) and Bhandari et al. (2003). In Western Himalaya, the formation is represented by *Pinus roxburghii* (Mehta and Bhandari, 1997). But possibly, this is not the potential natural climax forest and its extensive occurrence today would not have been possible, had there not been continuing disturbances such as landslides, burning, deforestations, etc (Champion and Seth, 1968a, b). However, these forests are now stabilized over a large area and are regarded as a permanent feature of the mountains of western Himalaya.

The pine species is the principal tree of the lower and middle region of Garhwal region of western Himalaya (750-2100m asl) and constitutes the main source for fuel and shows a specific impact on the economy and the ecology of this region. Therefore, in the present study, an attempt has been made to quantify the species composition and structure in Saikot forest as very little information exists on this aspect in north western Himalaya.

**MATERIALS AND METHODS**

**Study area**

Geographically, the study area (Saikot Reserve Forest) is between 30° 21' 23.2'' to 30° 22' 47.6'' north latitude and 79° 17' 45.0'' to 79° 17' 44.2'' east longitude while attitudinally, it range from 800 to 2500 m asl and is the part of Gopeshwar range of Kedarnath Wild-life Forest Division of the district Chamoli.

Due to mountainous structure of the study area, it has varying altitude and relief which contribute greatly to variations in climatic condition. Owing to steepness of slopes, there are marked local effects due to differences in isolation. Temperature of the area fluctuates from time to time which makes specific micro-climate of the region. The average annual temperature of the region is 20°C. The maximum temperature is recorded in April to June (35°C) and minimum temperature in the valley recorded in the months of January-December (8-15°C).

The average annual rainfall of the area is 130 mm (based on the data of Gopeshwar Range). The humidity is inversely proportional to temperature. Where the temperature increases, these humidity will decrease. Relative humidity reaches almost the absolute humidity during July and August (80-92%). The minimum relative humidity reduces during the month of January-June and December (25-38%). The average annual relative humidity of study area is 55% which decreases with increase in temperature and altitude.

**Soil**

The soil in a region varies according to altitude, climate and vegetation in its texture and structure, therefore may be categorized into four types viz., hard loamy soil, black loam soil, sandy loamy soil and sandy grey soil. Soil on the slope above 30°, due to erosion and mass wasting processes, are generally shallow and usually have very thin surface horizons. Such soils have medium to coarse texture.

**Methodology**

The vegetation was analyzed by laying the quadrate at different elevation (800 - 2500 m asl) and localities. The woody vegetation analysis was examined by using 10 × 10 m randomly placed quadrates on each sites on each sampling date. In each quadrat, all trees (>31.5cm cbh) and saplings or shrubs (10.50-31.40 cm cbh) were individually measured for circumference at breast height (cbh), that is, 1.37 m from the ground. For recording, the shrubs 5 × 5 m size quadrat were laid while for herbaceous vegetation, 1 × 1 m size quadrates were laid down randomly at each site separately. The vegetation data were analyzed quantitatively for abundance, density and frequency following the methods discussed by Curtis and Cottom (1966); species diversity (*H'* ) was computed by Shannon-Wiener information function (Shannon-Wiener, 1963). Concentration of dominance (Cd) was computed by Simpson's index, (Simpson, 1949). B-Diversity was calculated by following the method of Whittaker (1975), while equitability (Ec) or species per log cycle index was determined following Whittaker (1972) and the community coefficient was calculated following Kulczynski (1927).

**RESULTS AND DISCUSSION**

The present study is based on extensive and intensive field study made during the months of September 2009 to September 2011 at various localities of Saikot Reserve Forest. The vegetation data were quantitatively analyzed for abundance, density and frequency according to the standard formulae.

A total of 58 plant species were recorded from the entire study area (Saikot Reserve Forest area Kedarnath forest division). Of 58 plant species, 21 were trees, 11 were shrubs and 26 were herbs. On the basis of plant association or plant composition surveys, the study area, can be categorized into four forest types viz., (1) Chir-Pine forest, (2) pine-oak forest, (3) oak-mixed forest. The area can also be classified under four altitudinal gradients and aspects that is 800 - 1200 m asl (Site 1) at South-West aspect; 1200 - 1600 m asl (Site 2) at North-West aspect; 1600 - 2000 m asl (Site 3) at South-East aspect and 2000-2500 m asl (Site 4) at North-East aspect. The general features of the area are described in Table 1.

Site-wise (a total of 4 sites were studied in the area) of species distribution is presented in Table 2. Site 4 is relatively species poor than Sites 1 and 2; whereas *Q. leucotrichophora* dominated Sites 3 and 4. Although dominance was shared by number of species, no single species was found to compete with *Q. leucotrichophora* in Sites 3 and 4; a climax species. On the basis of density, basal cover and importance value index (IV), *P. roxburghii* was found to be most important and dominant species in Sites 1 and 2; whereas *Q. leucotrichophora* dominated Sites 3 and 4 (Table 3). However, the presence of *P. roxburghii* in Site 3 is an indication of possible threat to the coexistence of climax and
The range of 27-191.5 m² h⁻¹ and 350 to 1787 plants h⁻¹, Total basal area and density of tree layer was reported in 19427.64 m² h⁻¹ and total density varied between 710. Total basal area of the trees ranged from 1346.59 to roxburghii conditions and invites the invading species like lopping, felling and burning, changes the microclimatic when disturbed severely by human pressure as grazing, and climax species (Table 3). The late successional and associated species (Table 3). The late successional and climax species Q. leucotrichophora in the region when disturbed severely by human pressure as grazing, lopping, felling and burning, changes the microclimatic conditions and invites the invading species like P. roxburghii in the area (Semwal and Mehta, 1996). The total basal area of the trees ranged from 1346.59 to 19427.64 m² h⁻¹ and total density varied between 710 and 1140 h⁻¹ across the Saikot Reserve Forest (Table 3). Total basal area and density of tree layer was reported in the range of 27-191.5 m² h⁻¹ and 350 to 1787 plants h⁻¹, respectively, for various broad leaved, traditional conserved (sacred groove) and protected (Nanda Devi Biosphere Reserve) forests of Kumaun and Garhwal Himalaya (Saxena and Singh, 1982; Singh and Singh, 1987; Bhandari and Tiwari, 1997; Sinha and Maikhuri, 1998; Maikhuri et al., 2000). Higher values of basal cover density and lower values of density suggest that all sites are mature and climax in nature. Low tree density and less number of species in Site 4 reflect the forest is under high biotic pressure coupled with other abiotic factors which are not necessarily conducive for tree growth.

The number (density) of seedlings of any species can be considered as the regeneration potential of that species. From the density values (Table 3), it is concluded that the regeneration of oak (Q. leucotrichophora) in Site 4 is low, as compared to Site 3 and regeneration of P. roxburghii in Site 2 is low, as compared to Site 1, but not in that level of harsh conditions as has been pointed out by other worker in other studied area of Central Himalaya (Saxena et al., 1978; Ralhan et al., 1982; Tiwari and Singh, 1982; Saxena and Singh, 1984; Bankoti et al., 1986). The co-dominance of P. roxburghii with Q. leucotrichophora particularly in Site 3 (Table 3) is an indication that due to various anthropogenic (human) pressures oak regenerates in comparison with pine. Degradation of the oak forest through high anthropogenic pressure will provide appropriate conditions for the pine (an early successional, low nutrient demander and shade intolerant species) to invade, thereby posing a serious threat to the ecological balance of this region (Singh et al., 1984).

In Saikot Reserve Forest, species richness is very high in herb layers (present study) as compared to other broad leaved forests of Garhwal Himalaya (Bhandari and Tiwari, 1997; Bhandari et al., 1998). High species richness in herb layers may be due to relatively less developed canopy in these mature forests which permit sufficient sunlight to reach the ground resulting in the luxuriant growth of herb species (Table 3).

A/F ratio was used to assess the distribution pattern of the species. Vegetation was found in haphazard distribution by most of the species followed by regular distribution. Contagious distribution as observed in the present case has not been reported in tree layers from this part of the Himalaya (Table 4). It is interesting that the distribution pattern of shrub and herbs did not correspond with the distribution pattern of trees. Other workers (Saxena and Singh, 1982; Bhandari and Tiwari, 1997) findings for Central Himalaya are different. Greig-Smith (1957), Kershaw (1973) and Singh and Yadava (1974) have reported contagious distribution in natural vegetation. Preponderance of random distribution in tree and shrubs layers as compared to herbs layer reflects the dimension of biotic interferences in these strata.

In the present study, similarity values have been shown in Table 6. It was interesting to note that Site 1 was completely dissimilar to Site 3 and Site 4. This indicates that there is great influence of site characteristics (microclimatic variations, different aspect, soil composition and

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**Table 1.** Site characteristics in the Saikot reserve forest area of Kedarnath forest division.

| Site          | Altitude (masl) | Slope (°) | Aspect | Forest types                                      |
|---------------|-----------------|-----------|--------|--------------------------------------------------|
| Saikot (Site 1) | 800-1200        | 20        | SW     | Chir-Pine (Pinus roxburghii)                      |
| Tangsa (Site 2) | 1200-1600       | 25        | NW     | Pine-Oak (Pinus roxburghii, Quercus leucotrichophora, Rhododendron arboreum) |
| Devkhal (Site 3)| 1600-2000       | 35        | SE     | Oak-Pine (Pinus roxburghii, Quercus leucotrichophora, Rhododendron arboreum) |
| Bamyala (Site 4)| 2000-2500       | 50        | NE     | Oak-mixed (Quercus leucotrichophora, Q. floribunda, Rhododendron arboreum, Myrica esculenta) |

SW, South-East; NW, North-East; SE, South-East; NE, North East.

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**Table 2.** Distribution of plant species in different sites of the study area.

| Site  | Tree | Shrub | Herb | Total |
|-------|------|-------|------|-------|
| 1     | 7    | 6     | 11   | 24    |
| 2     | 7    | 4     | 7    | 18    |
| 3     | 9    | 3     | 8    | 20    |
| 4     | 6    | 4     | 6    | 16    |
| Total | 21   | 11    | 26   | 58    |
Table 3. Phytosociological analysis of tree vegetation.

| Site          | Botanical name             | F   | A    | D    | TBC  | IVI  | A/F  |
|---------------|---------------------------|-----|------|------|------|------|------|
| Tree          | Pinus roxburghii          | 100 | 4.20 | 4.20 | 10594.97 | 171.40 | 0.0420 |
|               | Bauhinia sema             | 20  | 1.00 | 0.20 | 312.10 | 11.81  | 0.0500 |
|               | Terminalia alata          | 30  | 1.33 | 0.40 | 642.17  | 20.42  | 0.0444 |
|               | Toona ciliata             | 20  | 1.00 | 0.20 | 460.19  | 12.91  | 0.0500 |
|               | Bauhinia variegata        | 50  | 1.00 | 0.50 | 382.32  | 26.56  | 0.0200 |
|               | Emblica officinalis       | 20  | 1.00 | 0.20 | 49.94   | 9.86   | 0.0500  |
|               | Engelharditia spicata     | 60  | 2.33 | 1.40 | 984.90  | 47.05  | 0.0389  |
|               |                           | 300 | 11.87| 7.10 | 13426.59 | 300    |        |
| Sapling       | Pinus roxburghii          | 50  | 3    | 1.5  | 100.44  | 222.67 | 0.06   |
|               | Engelharditia spicata     | 30  | 1.33 | 0.4  | 23.22   | 77.32  | 0.0444 |
|               |                           | 80  | 1.90 | 1.2  | 123.65  |        | 300    |
| Seedling      | Pinus roxburghii          | 50  | 3.2  | 1.6  | 1.15    | 209.27 | 0.064  |
|               | Engelharditia spicata     | 30  | 1    | 0.3  | 0.14    | 54.25  | 0.0333 |
|               |                           | 80  | 2.1  | 1.38 | 110.65  |        | 300    |
| Site 1: Saikot (800-1200) | Shrub           |     |      |      |       |      |      |
|               | Woodfordia fruticosa      | 60  | 2    | 1.2  | 38.22  | 74.149 | 0.0333 |
|               | Barberis asiatica        | 80  | 2.125| 1.7  | 34.65  | 85.914 | 0.0266 |
|               | Rubus ellipticus         | 50  | 1.8  | 0.9  | 10.32  | 40.548 | 0.036  |
|               | Colebrookia oppositifolia| 50  | 1.6  | 0.8  | 6.37   | 35.194 | 0.032  |
|               | Rubus niveus             | 40  | 1    | 0.4  | 3.85   | 22.747 | 0.025  |
|               | Solanum erianthum        | 50  | 1.2  | 0.6  | 17.25  | 41.451 | 0.024  |
|               |                           | 330 | 5.6  | 1.10 | 110.65 |        | 300    |
| Herb          | Cylindrica imperata      | 60  | 3    | 1.8  | 1.29   | 41.927 | 0.05   |
|               | Cymbopogon nardus        | 70  | 5.143| 3.6  | 1.39   | 57.157 | 0.0735 |
|               | Themeda triandra         | 40  | 2.25 | 0.9  | 0.64   | 23.004 | 0.0563 |
|               | Artemisia nilagirica     | 50  | 3.8  | 1.9  | 0.61   | 31.073 | 0.076  |
|               | Heteropogon contortus    | 30  | 6.667| 2    | 0.64   | 28.09  | 0.2222 |
|               | Dicliptera bupleuroides  | 40  | 2.25 | 0.9  | 0.64   | 23.004 | 0.0563 |
|               | Dioscorea bulbifera      | 40  | 2    | 0.8  | 0.25   | 16.95  | 0.05   |
|               | Thysanolaena maxima      | 40  | 2.5  | 1    | 0.32   | 19.147 | 0.0625 |
|               | Coleus froseki           | 30  | 0.667| 0.2  | 0.06   | 8.3192 | 0.0222 |
|               | Poa annua                | 60  | 3    | 1.8  | 1.29   | 41.927 | 0.05   |
|               | Rumex hastatus           | 30  | 1    | 0.3  | 0.10   | 9.4176 | 0.0333 |
|               |                           | 490 | 15.20| 7.23 |        | 300    |

F, Frequency; A, Abundance; D, Density; TBC, Total Basal Cover; IVI, Importance Value Index; A/F, Abundance/Frequency ratio.

variation in altitudinal gradient) on the composition of vegetation. However, Mehta et al. (1997) reported similarity of 9.6 (between burnt grazed and unburnt grazed sites) to 74.9% (between unburnt protected and unburnt grazed sites) for the various forest sites under different management regimes in Garhwal Himalaya. Wikum and Wali (1974) and Saxena and Singh (1982) have pointed out the significant role of the site characteristics in plant distribution and similarity.

The values of diversity are presented in Table 5.
Diversity is a combination of two factors, the number of species present, referred to as species richness and the distribution of individuals among the species, referred to as evenness or equitability. Single species populations are defined as having a diversity of zero, regardless of the index used. Species diversity therefore, refers to the variations that exist among the different forms. In the present study, Shannon-Wiener index of diversity was used. The value of diversity ranged from 0.8098 to 1.3266, 0.6673 to 1.2759 and 0.4377 to 0.5767, respectively, for trees, shrubs and herbs in Saikot Reserve Forest. The range of diversity in the present community forest stands is certainly lower than any other montane forests of Central Himalaya (Ralhan et al., 1982). Moderate amount of anthropogenic pressure on Saikot Reserve Forest is helpful in maintaining the higher species diversity. Such view was also expressed by Thadan and Ashton (1995) and Singh et al. (1997).

The value of beta-diversity ranged from 1.5789 to 2.3333, 1.5384 to 1.8181 and 1.0714 to 2.2916 for trees, shrub and herbs layers, respectively in Saikot Reserve Forest. These values are much lower than those.
Table 3. Contd.

| Site                     | Botanical name          | F  | A  | D  | TBC       | IVI      | A/F  |
|--------------------------|-------------------------|----|----|----|-----------|----------|------|
| Tree                     | Quercus leucotrichophora| 100| 4.6| 4.6| 8912.87   | 111.07   | 0.046|
|                          | Lyonia ovalifolia       | 30 | 1  | 0.3| 731.49    | 13.389   | 0.0333|
|                          | Pyrus pashia            | 100| 2.7| 2.7| 3802.57   | 66.887   | 0.027|
|                          | Myrica esculenta        | 30 | 1  | 0.3| 349.71    | 11.333   | 0.0333|
|                          | Rhododendron arboretum  | 40 | 2.5| 1  | 1494.35   | 25.909   | 0.0625|
|                          | Phoebe lanceolata       | 50 | 2.2| 1.1| 1667.87   | 29.994   | 0.044|
|                          | Quercus floribunda      | 40 | 2  | 0.8| 1494.35   | 25.909   | 0.0625|
|                          | Persea duthiei          | 30 | 1.333| 0.4| 571.85    | 11.333   | 0.0333|
|                          | Phoebe lanceolata       | 50 | 2.2| 1.1| 1667.87   | 29.994   | 0.044|
|                          | Quercus floribunda      | 40 | 2  | 0.8| 1494.35   | 25.909   | 0.0625|
|                          | Persea duthiei          | 30 | 1.333| 0.4| 571.85    | 11.333   | 0.0333|
|                          | Pinus roxburghii        | 20 | 1  | 0.2| 123.31    | 6.9638   | 0.05  |
|                          | Daphne papyracea        | 70 | 2.143| 1.5| 30.57     | 137.23   | 0.0306|
|                          | Pyracantha crenulata    | 40 | 1.75| 0.7| 22.29     | 79.99    | 0.0438|
|                          | Prinsepia utilis        | 60 | 1.167| 0.7| 16.11     | 82.785   | 0.0194|
|                          | Agrostis nervosa        | 100| 5.7 | 5.7| 1.82      | 58.985   | 0.057 |
|                          | Arundinella nepalensis  | 90 | 7.333| 6.6| 2.10      | 63.693   | 0.0815|
|                          | Chrysopogon aciculatus  | 60 | 3.333| 2  | 0.64      | 25.145   | 0.0556|
|                          | Chrysopogon fulus       | 50 | 4.6 | 2.3| 1.65      | 35.081   | 0.092 |
|                          | Hedychium spicatum      | 70 | 3.571| 2.5| 0.80      | 30.538   | 0.051 |
|                          | Polygonum chinensis     | 70 | 4.857| 3.4| 1.08      | 37.032   | 0.0694|
|                          | Polygonum lanigerum     | 60 | 3.333| 2  | 0.64      | 25.145   | 0.0556|
|                          | Achyranthis bidentata   | 60 | 2   | 1.2| 0.86      | 24.359   | 0.0333|

F, Frequency; A, Abundance; D, Density; TBC, Total Basal Cover; IVI, Importance Value Index; A/F, Abundance/Frequency ratio.

reported for oak and chir pine forests of Kumaun (Tewari and Singh, 1985) and Garhwal (Bhandari et al., 1997) Himalaya, respectively. Little difference in the beta-diversity indicates that the growth forms among different stands respond in similar fashion (Adhikari et al., 1991). These values of beta diversity show that the species composition varies across the slopes and aspects.

Values on concentration dominance (Cd) are similar to that reported by Whittaker (1965) and Risser and Rice (1971) ranging from 0.19 to 0.99 for certain temperate vegetation. The values of concentration of dominance (Cd) of the present study ranged from 0.2438 to 0.3993, 0.208 to 0.4789 and 0.1318 to 0.1736, respectively for trees, shrubs and herbs layer for montane forests of
Saikot Reserve Forest. Mean (Cd) values of 0.31 to 0.42 (Mishra et al., 2000) and 0.07 to 0.25 (Shivnath et al., 1993) were reported earlier from other parts of Indian Himalaya. The higher value of Cd in the forest growing on upper altitude was due to lower species richness (Bhatt and Purohit, 2009). According to Baduni and Sharma (1997), the Cd or Simpson’s index was strongly affected by the IVI of the first three relatively important species in a community. Species diversity and dominance (Simpson index) are inversely related to each other (Zobel et al., 1976).

### Table 3. Contd.

| Site           | Botanical name          | F | A  | D  | TBC  | IVI  | A/F  |
|----------------|-------------------------|---|----|----|------|------|------|
| **Tree**       | **Quercus floribunda**  | 40| 3.25| 1.3| 2956.15| 40.97| 0.0813 |
|                | **Q. leucotrichophora** | 80| 3.25| 2.6| 5704.27| 80.77| 0.0406 |
|                | **Neolitsea pallens**   | 100| 3.4 | 3.4| 5770.25| 94.915| 0.034  |
|                | **Acer ceasium**        | 50 | 0.8 | 0.4| 624.20 | 20.921| 0.016  |
|                | **Aesculus indica**     | 60 | 1.833| 1.1| 1390.41| 35.306| 0.0306 |
|                | **Symlocos ramosissima**| 50 | 1.2 | 0.6| 1348.28| 27.118| 0.024  |
|                | **Quercus floribunda**  | 380| 9.40|    | 17793.57|      |       |
| **Sapling**    | **Quercus floribunda**  | 60 | 2   | 1.2| 46.24 | 79.083| 0.0333 |
|                | **Acer ceasium**        | 90 | 1.778| 1.6| 99.87 | 127.38| 0.0198 |
|                | **Aesculus indica**     | 70 | 1.571| 1.1| 73.65 | 93.538| 0.0224 |
|                | **Quercus floribunda**  | 220| 3.90|    | 219.77|      |       |
| **Seedling**   | **Quercus floribunda**  | 80 | 3.25| 2.6| 1.19 | 128.15| 0.0406 |
|                | **Q. leucotrichophora** | 90 | 2.111| 1.9| 1.36 | 125.49| 0.0235 |
|                | **Acer ceasium**        | 30 | 2.667| 0.8| 0.50 | 46.467| 0.0889 |
|                | **Quercus floribunda**  | 200| 5.30| 3.05|     | 251.52| 0.025  |
| **Site 4: Bamyala** (2000-2500) | **Daphne papyracea** | 100| 3.9 | 3.9| 124.20| 171.17| 0.039  |
|                | **Pyracantha crenulata**| 40 | 1.75| 0.7| 37.68 | 47.455| 0.0438 |
|                | **Rosa brunonii**       | 80 | 1.125| 0.9| 18.34 | 55.861| 0.0141 |
|                | **Rosa macrophylla**    | 40 | 1   | 0.4| 6.24 | 25.512| 0.0889 |
|                | **Daphne papyracea** | 260| 5.90|    | 186.46|      |       |
| **Shrub**      | **Arundo donax**        | 90 | 4   | 3.6| 1.79 | 43.621| 0.0444 |
|                | **Agrostis pilosula**   | 90 | 4.111| 3.7| 1.95 | 45.16 | 0.0457 |
|                | **Chrysopogon aciculatus** | 100| 4.7 | 4.7| 3.37 | 61.443| 0.047  |
|                | **Eriophorum comosum**  | 100| 3   | 3   | 2.15 | 45.678| 0.03   |
|                | **Roscoea alpina**      | 90 | 6.222| 5.6| 2.79 | 58.926| 0.0691 |
|                | **Polygonum chinensis** | 90 | 5.111| 4.6| 1.46 | 45.172| 0.0568 |
|                | **Arundo donax**        | 560| 25.2| 13.51|    |      |       |

F, Frequency; A, Abundance; D, Density; TBC, Total Basal Cover; IVI, Importance Value Index; A/F, Abundance/Frequency ratio.

### Conclusion

Generally, *P. roxburghii* forms the climax vegetation at lower altitude and *Q. leucotrichophora* forms at middle altitudes (1500-2000). However, due to the anthropogenic pressure, water table seems to reduce which is providing the suitable condition for *P. roxburghii* invasion at higher elevation and north aspect and this invasion leads to mixed community of oak-pine patches at north aspect and in higher elevation, indicating developmental stage of secondary succession. As a result, it may be
concluded that due to anthropogenic disturbances these forests are in unstable and in degrading stage therefore, immediate steps should be taken to save these ecologically and economically important forests and species. As per the Champion and Seth (1968) classification, the Saikot Forest broadly falls under the Himalayan moist forest category.
Table 6. Community coefficient of different forest sites of Saikot Reserve Forest.

| Site 1 | Site 1 | Site 2 | Site 3 | Site 4 |
|--------|--------|--------|--------|--------|
| Tree   | 100    | 33.52  | Dissimilar | Dissimilar |
| Sapling| 100    | 20.52  | Dissimilar | Dissimilar |
| Seedling| 100  | 41.02  | Dissimilar | Dissimilar |
| Shrub  | 100    | 60.55  | Dissimilar | Dissimilar |
| Herb   | 100    | 13.88  | Dissimilar | Dissimilar |

| Site 2 | Site 2 | Site 3 | Site 4 |
|--------|--------|--------|--------|
| Tree   | 100    | 25     | 26.53  |
| Sapling| 100    | 29.26  | Dissimilar |
| Seedling| 100  | 33.89  | 28.16  |
| Shrub  | 100    | Dissimilar | Dissimilar |
| Herb   | 100    | 17.30  | Dissimilar |

| Site 3 | Site 3 | Site 4 |
|--------|--------|--------|
| Tree   | 100    | 10.57  |
| Sapling| 100    | Dissimilar |
| Seedling| 100  | 51.06  |
| Shrub  | 100    | 50     |
| Herb   | 100    | 21.21  |

| Site 4 | Site 4 |
|--------|--------|
| Tree   | 100    |
| Sapling| 100    |
| Seedling| 100  |
| Shrub  | 100    |
| Herb   | 100    |

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Conflict of Interests

The author(s) have not declared any conflict of interests.

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