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***Research Article***

# COMMUNITY STRUCTURE AND REGENERATION STATUS OF *SCHIMA WALLICHI* (DC) KORTH AND *PINUS ROXBURGHII* SARGENT IN FORESTS OF BANEPA, MIDHILL, CENTRAL NEPAL

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## ABSTRACT
A quantitative vegetation study was undertaken in the southern aspect of the forests of Banepa Municipality (Ward No. 3 and 4) and some VDC of Ravi Opi, and Ugrachandi Nala area in the midhill of Central Nepal. The elevation of the forest ranges between 1400-1844 m at the peak. Community composition (Tree and Shrub) and regeneration of *Schima wallichi* and *Pinus roxburghii* (a planted species) were studied in randomly placed 10m X 10m quadrat (for tree) and 5m X 5m (for sapling, shrub and seedling of tree). All together 39 plant species (19 trees and 20 shrubs) were recorded. The total tree sapling and shrub densities were 1102.5 Pl/ha, 3045 pl/ha and 6530 pl/ha respectively and seedling density was 7775 pl/ha. The size class distribution showed that forest was sustainably regenerating. In case of *Schima wallichi* and *Pinus roxburghii* it showed that *Schima wallichi* had sustainably regeneration. The ratio of seedling to sapling to tree density was 6.06 : 2.4 : 1 for *Schima wallichi* with the tree density 265pl/ha, while the ratio of sapling to tree density was 0.9 : 1 with the sapling density 75 pl/ha for *Pinus roxburghii.*

***Keywords**: Regenration, Seedling , Sapling density, DBH Size-class distribution*

## INTRODUCTION
Natural regeneration is the process of re-growing or reproduction of plants through their juvenile. It is the most important process to maintain and expand the population of plant species in a community with time and space (Bharali *et al.* 2012). The term natural regeneration embraces all methods employed by plants in producing their juvenile. It is important not only for the reproductive role but also for ensuring the replacement of any member of a community that dies off after completing its life cycle (Fatubarin, 1987).
Natural regeneration is important for the maintenance of a stable age structure in the species of plant in a natural community. Natural regeneration is a very slow process. Population structure of a species in a forest can convey its regeneration behavior (Singh and Singh, 1992). Combination of seedling/sapling count and analysis of size-class diagram may give actual situation of reproduction and regeneration pattern . The regenerating and productive character of forest is determined and characterized by the presence of sufficient population of seedlings, saplings and young trees of different age groups from young to old ( Chauhan *et al.*, 2008).
Population of seedlings, saplings and young tree indicates a successful regeneration of forest species (Saxena and Singh, 1984). Regeneration of canopy dominants is commonly assessed by the distribution of size classes measured as diameter at breast height (West *et al*., 1981). This is based on survivorship curve and the density diameter relationships developed by the applied forest scientists (Leak, 1964). Undisturbed old growth forests with sustainable regeneration are found to have reverse J- shaped size class distribution (West *et al*., 1981). A bell shaped size class distribution has been attributed to disturbed forest where regeneration is hampered (Saxena *et al*., 1984).
There may be various factors such as light, water, rainfall, fire, flood, soil physical and chemical properties, aspects, slope etc. which directly or indirectly affect the regeneration behavior of the forest or plant species. In the study area, there was no detailed vegetation study so far carried out. Therefore, this study stands as an inventory documentation concerning the forest ecology and forest regeneration. The study will establish important baseline ecological data and regeneration pattern of forest, which would

assist in subsequent research work and estimating the sustainability of the forest. Study of sustainability of forest outstands as a prime issue in case when the local people are intimately dependent on the forest product.

## MATERIALS AND METHODS

### Study area

The study area lies in the north-west part of the Kavrepalanchowk district of the Central Development Region of Nepal. It lies between $27^0$ 38' 13.6" to $27^0$ 38' 57" N latitude and $85^0$ 31' 13" to $85^0$ 31' 62" E longitude. The forest area is called as Nagi forest. The total area of the forest is 176.24 ha but only 81.79 ha area was studied which lies on the south face of the forest. The elevation ranges between 1400 m to 1844 m at the peak. The forest has the length nearly 1100m east-west and height (vertical distance) is 450 m. Human interference, grazing, fuel wood collection and cut stumps were common in the forest.

*Sampling methods and data analysis*

The total south face forest was divided into 5 equal strata according to equal altitude. Then in each stratum, 8 quadrats of 10 m x10 m size were thrown randomly. The size of quadrats was determined by species area curve method (Mishra, 1968). Then the distance between two quadrats was made at least 50 m. Within each quadrat 4 sub-plots were determined from the centre of the quadrat . The plant species having >10 cm dbh at 1.37 m height were counted and recorded as tree, where as <10 cm dbh and above knee height with woody stem were considered as sapling and rest of tree species were considered as seedling.

The quadrats for sapling and seedling 5m x 5m were laid down in the same quadrats made for the quantitative measurement of tree species. The total 40 quadrats for tree were sampled and 80 quadrats for seedling, sapling and shrubs were laid. From each quadrat, ca. 200 g soil sample was collected from a depth of 15 cm from the center of plot. The soil samples were air dried in shade for week and packed in air tight plastic bags until laboratory analysis.

Specimens of all the tree and shrubs species from the quadrat were collected for identification. Some of the species were identified in the field and their local names were recorded during field visit for easy identification. The unidentified species were collected and tagged. These specimens were identified consulting with related teacher & herbarium in the CDB (TUCH). Correct scientific names and their citation were made with the help of Hara *et al.*(1978), Hara and Williams (1979) and Press *et al.*(2000). Quantitative characters for vegetation sampling such as frequency, density, abundance & their relative values were calculated by using (Zobel *et al.*1987).

Soil moisture and pH were measured in laboratory of Central Department of Botany, Tribhuvan University, Kathmandu. soil moisture, water holding capacity and soil texture were analyzed in laboratory of Central Department of Botany, T.U, Kirtipur and OM, pH, N, P, K were analyzed in soil test section, Department of Agriculture, Hariharbhawan Pulchock, Lalitpur. SPSS (Statistical Package for Social Science) version 16 was used for statistical (correlation) analysis.

### Regeneration status of forest (DBH size-class diagram)

To assess the regeneration status of forest, density of seedling, sapling and tree of each tree species were determined separately following the method described by Zobel *et al.*(1987). Then, life form diagram of dominant and co-dominant tree species (considered based on IVI value) were developed separately by putting tree, sapling and seedling along x-axis and number of individuals (density) along y-axis.

## RESULTS

Altogether 39 plant species (19 tree species with their sapling and 20 species of shrubs) were recorded in the study area Seedling of only 18 species of tree were recorded. *Pinus roxburghii* had no seedlings.

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***Tree layer***

It was found that the total tree density of the forest was 1102.5 pl/ha (Table 2) among which *Schima wallichi* had highest density (265 spl/ha,) followed by *Castanopsis tribuloides* (152.5 pl/ha) and the least density was found for *Rhus wallichi* (7.5 pl/ha). *Schima wallichi* was the most frequent species, with the frequency of 90% followed by *Castanopsis tribuloides* (62.5%), while least frequent species were *Engelhardia spicata* and *Rhus wallichi* each with 7.5% of frequency. The total tree basal area of the forest was found to be 33.849 $m^2$/ha (Table 3) among which *Alnus nepalensis* had highest basal area (9.218 $m^2$/ha) followed by *Schima wallichi* (7.634 $m^2$/ha). While *Rhus wallichi* had lowest basal (0.105 $m^2$/ha). The most abundant tree species of the forest was *Pinus roxburghii*, followed by *Alnus nepalensis* (Table 3) and the lowest abundant species was *Rhus wallichi*. *Schima wallichi* had highest IVI value (63.205) was that followed by *Castanopsis tribuloides* (38.88) while *Rhus wallichi* had the lowest IVI (2.348).

**Table 1: Ecological variables of trees of the study site**

| Name of Species | Density/ha | Basal Area ($m^2$/ha) | Frequency (%) | Abundance | IVI |
|---|---|---|---|---|---|
| *Alnus nepalensis* | 52.5 | 9.218 | 17.5 | 3.000 | 35.631 |
| *Ardisia solanacea* | 52.5 | 0.723 | 37.5 | 1.400 | 13.694 |
| *Castanopsis tribuloides* | 152.5 | 4.587 | 62.5 | 2.440 | 38.885 |
| *Engelhardia spicata* | 15 | 0.219 | 7.5 | 2.000 | 3.370 |
| *Eurya accuminata* | 35 | 0.647 | 27.5 | 1.273 | 10.075 |
| *Lyonia ovalifolia* | 47.5 | 0.595 | 35 | 1.357 | 12.404 |
| *Myrsine capitellata* | 35 | 0.478 | 17.5 | 2.000 | 7.764 |
| *Myrica esculenta* | 107.5 | 3.189 | 57.5 | 1.870 | 29.700 |
| *Pinus roxburghii* | 80 | 1.138 | 20 | 4.000 | 14.280 |
| *Prunus cerasoides* | 20 | 0.722 | 12.5 | 1.600 | 6.238 |
| *Pyrus pashia* | 20 | 0.322 | 15 | 1.333 | 5.485 |
| *Quercus lamellose* | 12.5 | 0.288 | 10 | 1.250 | 3.801 |
| *Q. lanata* | 42.5 | 0.794 | 27.5 | 1.545 | 11.198 |
| *Q.glauca* | 60 | 1.422 | 35 | 1.714 | 16.024 |
| *Rhododendron arboreum aaarboreumarboreum* | 37.5 | 0.712 | 32.5 | 1.154 | 11.399 |
| *Rhus javanica* | 27.5 | 0.498 | 20 | 1.375 | 7.596 |
| *Rhus succedanea* | 32.5 | 0.556 | 22.5 | 1.444 | 8.674 |
| *Rhus wallichi* | 7.5 | 0.105 | 7.5 | 1.000 | 2.348 |
| *Schima wallichi* | 265 | 7.634 | 90 | 2.944 | 63.205 |
| Total | 1102.5 | 33.849 | | 34.700 | |

***Sapling of tree spp.***

The total sapling density of the forest was 3045 pl/ha (Table 2) among which *Schima wallichi* had highest density (635 pl/ha) which was followed by *Castanopsis tribuloides* (395 pl/ha) and the least density was found for *Quercus lamellosa* (30 pl/ha). *Schima wallichi* was the most frequent species with the frequency of 75 % followed by *Castanopsis tribuloides* (55 %), while the least frequent species was *Quercus lamellosa* (5 %).

**Table 2: Ecological variables of sapling of tree species**

| Name of Species | Density (pl/ha) | Basal Area ($m^2$/ha) | Frequency ( % ) | Abundance | IVI |
|---|---|---|---|---|---|
| *Alnus nepalensis* | 55 | 0.256 | 8.750 | 1.571 | 6.281 |
| *Ardesia solanacea* | 255 | 0.985 | 37.500 | 1.700 | 26.435 |
| *Castanopsis tribuloides* | 395 | 1.851 | 55.000 | 1.795 | 43.543 |
| *Engelhardia spicata* | 50 | 0.227 | 8.750 | 1.429 | 5.829 |
| *Eurya accuminata* | 235 | 0.917 | 33.750 | 1.741 | 24.277 |
| *Lyonia ovalifolia* | 205 | 0.817 | 35.000 | 1.464 | 22.562 |
| *Myrsine capitellata* | 125 | 0.600 | 21.250 | 1.471 | 14.756 |
| *Myrica esculenta* | 210 | 0.820 | 33.750 | 1.556 | 22.483 |
| *Pinus roxburghii* | 75 | 0.410 | 12.500 | 1.500 | 9.299 |
| *Prunus cerasoides* | 60 | 0.162 | 8.750 | 1.714 | 5.498 |
| *Pyrus pashia* | 100 | 0.428 | 17.500 | 1.429 | 11.394 |
| *Quercus lamellose* | 30 | 0.121 | 5.000 | 1.500 | 3.287 |
| *Q. lanata* | 70 | 0.298 | 12.500 | 1.400 | 8.015 |
| *Q.glauca* | 190 | 0.721 | 32.500 | 1.462 | 20.556 |
| *Rhododendron arboretum* | 150 | 0.651 | 26.250 | 1.429 | 17.184 |
| *Rhus javanica* | 50 | 0.210 | 7.500 | 1.667 | 5.388 |
| *Rhus succedanea* | 85 | 0.281 | 15.000 | 1.417 | 8.882 |
| *Rhus wallichi* | 70 | 0.268 | 13.750 | 1.273 | 7.981 |
| *Schima wallichi* | 635 | 2.590 | 75.000 | 2.117 | 63.208 |
| Total | 3045 | 12.615 | | | |

The total sapling basal area of the forest was found to be 12.615 $m^2$/ha (Table 2), among which *Schima wallichi* had highest basal area (2.59 $m^2$/ha) which was followed by *Castanopsis tribuloides* (1.851 $m^2$/ha), while *Quercus lamellosa* had lowest basal area (0.121 $m^2$/ha).

The IVI of sapling of different species (Table 2) shows that, *Schima wallichi* was found to be the most important species followed by *Castanopsis tribuloides* with the IVI value of 63.20 and 43.54 respectively, while *Quercus lamellosa* had the lowest IVI value of 3.28

**Seedling**

The total number of seedling of the forest was found to be 7775 pl/ha (Table 3), among which the seedling of *Schima wallichi* had the highest density and frequency (1605 pl/ha and 86.25% respectively) which was followed by the seedling of *Castanopsis tribuloides* with the density of 1150 pl/ha and frequency of 72.5% while *Pinus roxburghii* did not have any seedling.

The IVI of shrubs of different species showed that *Myrsine semiserrata* was found to be the most important species with the value of 40.749 (Table 4) followed by *Phyllanthus parvifolius* with the IVI value of 39.312 While *Hypercium uralum* had the lowest IVI value of 2.813.

***Size class distribution***

The entire tree species were categorized into different dbh size classes at interval of 5 cm. Nine size classes were recognized for the tree species. The size class distribution of the tree species indicated more or less reverse J shaped structure in the study area (Figure 2). The tree to sapling ratio was 1: 2.76, with the sapling density of 3045 pl/ha.

Figure 3 shows the dbh size classes of *Schima wallichi* and *Pinus roxburghii*. Eight size classes were recognized for *Schima wallichi* and nine classes for *Pinus roxburghii* in the forest. The size class distribution of *Schima wallichi* indicated more or less reverse J shaped structure than *Pinus roxburghii*. These results indicate that *Schima wallichi* was fairly regenerating than that of *Pinus roxburghii*. The sapling to tree ratio was 2.4: 1 for *Schima wallichi* while 0.9: 1 for *Pinus roxburghii* which gives the idea that the *Pinus roxburghii* was poor regenerating tree species.

**Table 3: Density and frequency of seedlings of tree species**

| **Name of Species** | **Density pl/ha** | **Frequency (%)** |
|---|---|---|
| *Alnus nepalensis* | 325 | 10 |
| *Ardesia solanacea* | 435 | 48.75 |
| *Castanopsis tribuloides* | 1150 | 72.5 |
| *Engelhardia spicata* | 75 | 7.5 |
| *Eurya accuminata* | 345 | 41.25 |
| *Lyonia ovalifolia* | 270 | 31.25 |
| *Myrsine capitullata* | 160 | 22.5 |
| *Myrica esculentum* | 480 | 45 |
| *Pinus roxburghii* | 0 | 0 |
| *Prunus cerasoides* | 95 | 10 |
| *Pyrus phasia* | 235 | 30 |
| *Quercus lamellosa* | 55 | 5 |
| *Q. lanata* | 160 | 11.25 |
| *Q.glauca* | 585 | 37.5 |
| *Rhododendron arboreum* | 590 | 43.75 |
| *Rhus javanica* | 245 | 15 |
| *Rhus succedanea* | 480 | 30 |
| *Rhus wallichi* | 485 | 27.5 |
| *Schima wallichi* | 1605 | 86.25 |
| **Total** | **7775** | |

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**Table 4: Ecological variables of shrub layer in study site**

| **Name of Species** | **Density pl/ha** | **Frequency ( %)** | **Coverage (%)** | **IVI** |
|---|---|---|---|---|
| *Berberis aristata* | 325 | 33.75 | 7.25 | 19.939 |
| *Camellia kissi* | 355 | 46.25 | 14.44 | 31.314 |
| *Cissus repens* | 215 | 23.75 | 5.82 | 14.669 |
| *Desmodium concinum* | 125 | 16.25 | 0.41 | 5.437 |
| *Desmodium confortum* | 175 | 15.00 | 0.54 | 6.118 |
| *Eschcholzia fruticosa* | 195 | 17.50 | 0.75 | 7.152 |
| *Eupatorium adenophorum* | 580 | 23.75 | 3.69 | 17.723 |
| *Gaultheria fragrantisima* | 505 | 36.25 | 5.5 | 21.074 |
| *Hypercium uralum* | 80 | 7.50 | 0.16 | 2.813 |
| *Melastoma normale* | 350 | 22.50 | 1 | 10.759 |
| *Myrsine semiserrata* | 410 | 57.50 | 19.88 | 40.749 |
| *Osbeckia stellata* | 275 | 18.75 | 1.1 | 9.021 |
| *Oxyspora paniculata* | 310 | 28.75 | 0.88 | 11.166 |
| *Phyllanthus parvifolius* | 1440 | 65.00 | 4.29 | 39.312 |
| *Randia tetrasperma* | 455 | 33.75 | 1.6 | 15.179 |
| *Rubus ellipticus* | 255 | 25.00 | 5.47 | 15.105 |
| *Rubus paniculatus* | 25 | 3.75 | 2.82 | 4.441 |
| *Smilax lanceifolia* | 210 | 23.75 | 1.3 | 9.296 |
| *Viburnum cylindricum* | 85 | 12.50 | 0.32 | 4.011 |
| Unidentified Sp1 | 160 | 23.75 | 6.75 | 14.722 |
| Total | 6530 | | | |

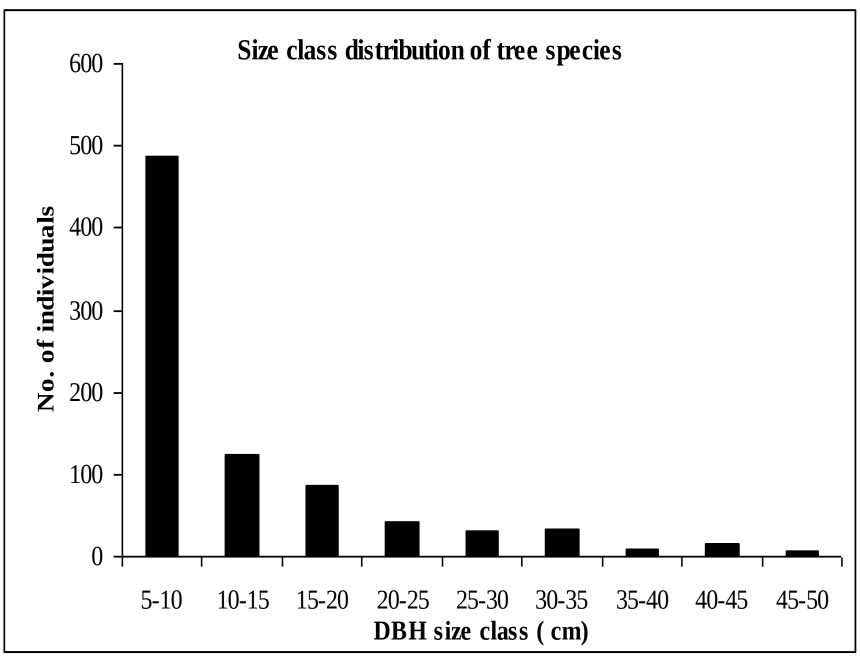


**Figure 2: Size class distributions of all tree species**

***Soil Analysis***

Soil of the forest under study was slightly acidic in nature. The average soil pH of study site was 4.47. Moisture content of soil ranged between 33.11 to 36.16%. Total organic matter in soil ranged between 2.54 to 2.64%. Similarly, nitrogen content, available phosphorus and potassium content in the soil was found between 0.12 to 0.13%, 3.8 to 10.79 kg/ha and 247.9 to 259.73 kg/ha respectively.

The sapling density of *Pinus roxburghii* showed significant positive correlation with organic matter ($p$ = 0.01) (Table 4) and density of *Pinus roxburghii* showed significant positive correlation with phosphorus ($p$ = 0.05 level).

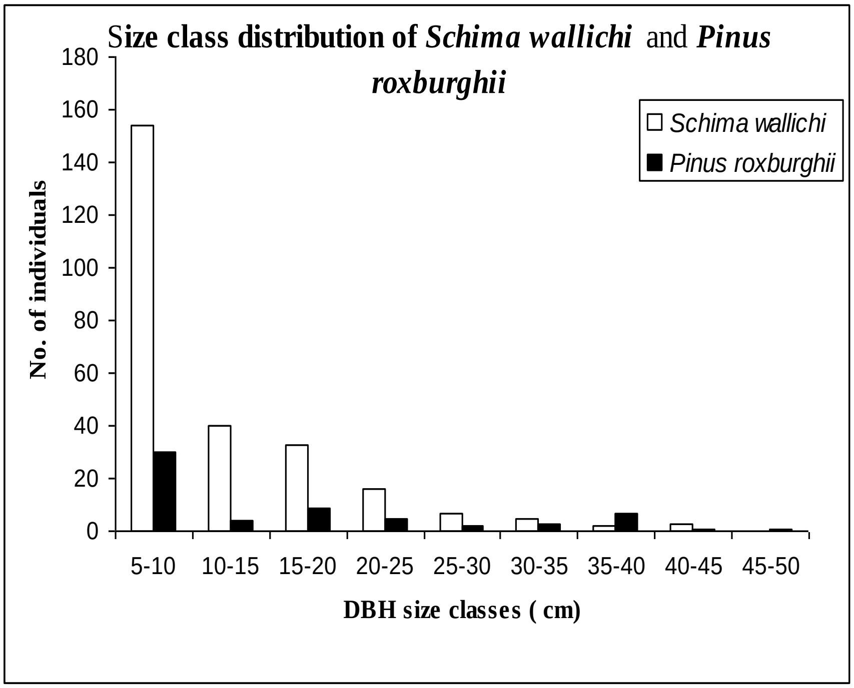


**Figure 3: Size class distribution of *Schima wallichi* and *Pinus roxburghii***

**Table 4. Pearson's Correlation coefficient of different soil and vegetation of *Schima wallichi* and *Pinus roxburghii***

| | PH | OM | N | P | K | WHC | SMOIS | TEM | PPT | SSEE | SSA | SD | PSEE | PSA | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH | 1 | | | | | | | | | | | | | | |
| OM | - | 1 | | | | | | | | | | | | | |
| N | - | 0.285 | 1 | | | | | | | | | | | | |
| P | 0.41 | -0.555 | -0.189 | 1 | | | | | | | | | | | |
| K | - | 0.302 | 0.972 | -0.26 | 1 | | | | | | | | | | |
| WHC | - | 0.498 | 0.237 | 0.356 | 0.09 | 1 | | | | | | | | | |
| SMOIS | 0.21 | -0.663 | 0.457 | 0.604 | 0.37 | 0.013 | 1 | | | | | | | | |
| TEMP | 0.01 | 0.378 | 0.482 | -0.32 | 0.30 | 0.471 | 0.059 | 1 | | | | | | | |
| PPT | 0.31 | -0.447 | -0.516 | -0.35 | - | - | -0.235 | - | 1 | | | | | | |
| SSEED | - | 0.136 | 0.842 | 0.324 | 0.80 | 0.493 | 0.621 | 0.216 | - | 1 | | | | | |
| SSAP | 0.85 | -0.77 | -0.825 | 0.509 | - | -0.372 | 0.112 | - | 0.53 | -0.602 | 1 | | | | |
| SD | - | -0.211 | 0.605 | 0.381 | 0.68 | -0.009 | 0.656 | - | - | 0.805 | - | 1 | | | |
| PSEED | a | a | A | a | a | A | a | a | a | a | a | A | a | | |
| PSAP | 0.80 | 0.975 | -0.297 | 0.586 | - | -0.362 | 0.671 | - | 0.33 | -0.149 | 0.77 | 0.08 | a | 1 | |
| PD | 0.42 | -0.723 | -0.314 | 0.933 | - | 0.017 | 0.577 | - | -0.02 | 0.165 | 0.66 | 0.44 | a | 0.68 | 1 |

**. Correlation is significant at 0.05 level ( two tailed )*
***. Correlation is significant at 0.01 level ( two tailed )*
*a. cannot be computed because at least one of the variables is constant.*

**DISCUSSION**

The floristic data shows that Altogether 39 plant species (19 tree species with their sapling and 20 species of shrubs) were recorded in the study area, seedling of only 18 tree species were recorded. *Pinus roxburghii* had no seedlings. There was absence of *Pinus roxburghii* seedling. Different ecological factors have impact in the variation of species composition concerning the relationship between vegetation and different environmental factors like temperature, precipitation and soil parameter. Various factors like soil, temperature, precipitation, vegetation type and anthropogenic activity influence the density of the forest. The total tree density was 1102.5 pl p/ha in the study area (Table 1). This value was less than the density found by Sigdel (2004) with the value 1413pl/ha to 2670Pl/ha in Shivapuri. It may be due to disturbance anthropogenic disturbance in the study area. This value was close to the value 1200 pl/ha to 1800 Pl/ha reported by Sah *et al.*(1994) Similarly this finding was also close to the value 1193.64 Pl/ ha reported by Gewali (1999) in Biruwa Community Forest. It may be due to same altitudinal range and may be same tree species composition and same tree plantation ie *Pinus* species.

Among the individual tree species, *Schima wallichi* had highest density with the value of 265 pl/ha. This was more than that of the value reported by Shrestha (2005) with the value 84pl/ha to 108pl/ha in Khari and Namjung forests. It may be due to over exploitation at the expense of sal conservation. This value was also more than the value reported by Niroula (2004) in Illam (12.5 pl/ha to 38.46 pl/ha). It may be due to change in climatic condition and aspect. It may be due to co dominance species in that area. This value was close to the value 250 pl/ha as reported by Gautam and Watanable (2005) in Raniban forest. It may be due to same type of species composition in the forest, same aspect or may be due to slight disturbance in the forest.

The density of sapling of tree ranged from 2025 pl/ha to 3350 pl/ha, (Table 2) which is less than the density estimated by Shrestha (1996) in Riyale ranges from 1061.04 Pl/ha to 9726.15 pl/ha and the value estimated by Shrestha (2005) in Khari and Namjung forests (14367 pl/ha and 9285 pl/ha). It may be due to change in altitude and species composition and may be destruction of mature trees by the local. However, more than the density estimated by Gewali (1999) in Kulekhani with the value 977.62 pl/ha. It may be due to less fertile soil cause due to removal of top soil and may be change in aspect. The density value was close as reported by Adhikari *et al.*(1995) in central oak himalayan forest with the value of 1350 Pl/ha to 5280 pl/ha . Similarly, it is closed to the value reported by Shrestha (1997) in natural forest of Chitrepani with the value of 1786 Pl/ha to 5457 pl/ha. It may be due to same altitudinal range and aspect.

Among the individual tree sapling species *Schima wallichi* had highest density with the value of 635 pl/ha. It may be due to dominant tree species and may be production of more seedlings and its maturation. This value was more than value reported by Shrestha (2005) in Namjung and Khari forests (133 pl/ha and 505 pl/harespectively). It may be due to co dominant species in that area. The seedling density ranges from 6450 pl/ha to 9025 pl/ha. Among which *Schima wallichi* had highest seedling with the value 1605 seedling/ha. It may be due to fertile soil and more mature tree with the more production of viable seeds in the study area.

The total density of the shrubs was 6530 pl/ha (Table 8) which was close to the shrub density estimated by Shrestha (1996) with the value 353.68 – 8841.94 pl/ha in Riyale and Shrestha (1997) with the value 96 – 7680 pl/ha in Chitrepani. It may be due to same altitudinal range and may be same climatic factors. But, it was lower than the density estimated by Sah *et al.*(1994) with the value 9560 Pl/ha to 17966 Pl/ha in Himanchal Pradesh and Singh *et al.*(1991) reported 15900-17900 pl / ha in the oak forest , 76-157 per 100 $m^2$ in coniferous forest and 95 -185 per 100 $m^2$ in the mixed oak forest. It may be change in altitudinal range and change in climatic factor and edaphic factor. Among the shrub species *Phyllanthus parvifolius* has highest density with the value 1440 pl/ha. It may due to production of more viable seeds and seeds may germinate in any soil condition. *Myrsine semiserrata* had highest coverage with value 19.88%, which was due to highly branch species. The IVI of shrubs showed that the most important species was

*Myrsine semiserrata* with the value 40.749 which indicated the most dominated shrubs species in the forest. It was due to more coverage value than the other species.

Basal area is an indication of natural fertility of the forest. It is depended with frequency of tree species and the tree age. The total basal area of tree species of the forest was 33.849 $m^2$/ha. It was also closely related with the value 34.20 $m^2$/ha to 36.14 $m^2$/ha reported by Marasini (2003) in Churia forest of Rupendehi district. It may be due same vegetation composition. The value was more than the value 8.62 $m^2$/ha to 15.44 $m^2$/ha as reported by Khadka (2004) in Pisang, Manang and 12.41 $m^2$/ha to 19.56 $m^2$/ha as reported by Nepal (2001) in Ghandruk and 0 $m^2$/ha to 4 $m^2$/ha as reported by Shrestha (1996). It may be due to change in species composition of the forest and with the change in density of the species and with the tree trunk.

Among the basal area *Alnus nepalensis* has the highest basal area with the value 9.218 $m^2$/ha which was mainly due to thick tree trunk volume and due to mature tree. The total basal area of sapling was found 12.615 $m^2$/ha, among which *Schima wallichi* had highest basal area with the value of 2.59 $m^2$/ha. It was due to more density of that species.

The IVI shows a clear picture of the forest as well as of an individual species of tree. The *Schima wallichi* had the highest IVI (63.023%) value with the value (Table 1) indicating the most successful plant species in that area. But the IVI value was less than the value estimated by Gautam and Watanable (2005) in Raiker forest with the value 68.46%. It may be due to well manage forest in that area so it helps to increase the density and frequency of the tree. But IVI value was more than the value reported by Gautam and Watanable (2005) in Raniban forest with the value 32.8%. It may be due to open grazing and collection of the forest product which affect the density frequency of the forest. In case of sapling; also *Schima wallichi* has the highest value of IVI.

For the regeneration study, seedling counts are often taken as regeneration potential. However, it cannot give actual figure of population structure and dynamics. The size class distribution diagram gives a better indication of long term regeneration status of forest than seedling count (Saxena, *et al.*1984; Vetaas, 2000). Nine size classes of tree with 5cm dbh were recognized in the forest. Size class distribution gives a clear picture of the forest state. The size class distribution of the study site showed larger number of tree individual with smaller class dbh size and low number of tree individual with larger dbh class. The decreased of the trees in middle size class may be due to higher mortality rate because of competition for nutrient between sapling and canopy of tree due to which a fairly reverse J shaped graph (Fig.2) which indicates sustainable regeneration (Vetaas, 2000) occurring in the forest.

*Schima wallichi* (Fig.3) is also sustainably regenerating since it has clear reverse J shaped size class distribution. But in case of *Pinus roxburghii*, a rough reverse J shaped pattern was found indicated that *Pinus roxburghii* was disturbed and doesn't properly regenerating as *Schima wallichi*(Rao *et al*., 1990; Vetaas, 2000). The seedling to sapling to tree density was 6.06: 2.4: 1 for *Schima wallichi* with the sapling density of 635 pl/ha. But the sapling to tree density ratio of *Pinus roxburghi i*was 0.9: 1 with the sapling density 75 pl/ha. This indicates that to grow a tree requires 6.06 seedlings.

Large number of fallen logs and lopping of tree was observed during the field visits. People nearby the study area generally preferred timber of *Schima walllichi, Pinus roxburghii* for construction of furniture. High human and other biotic pressure as well as natural disturbance has been reported to be detrimental for population structure and forest regeneration (Singh and Singh, 1992).

## CONCLUSION

The study area was carried out in *Schima wallichi* and *Pinus roxburghii* dominated forest. Highest value of IVI among trees and sapling was found for *S. wallichi*. The result of DBH class analysis indicated that frequent regeneration was going on in the forest. *Schima wallichi* had good regeneration process than *Pinus roxburghii*, (a planted tree), due to less number of sapling density and absent of seedling.

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