# Community Structure and Regeneration Potential of *Shorea robusta* Forest in Subtropical Submontane Zone of Garhwal Himalaya, India

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**Abstract:** This paper reports the regeneration potential and community structure of *Shorea robusta* forest in subtropical submontane zone of Garhwal Himalaya, India. 22 tree species, 15 sapling species and 16 seedling species were recorded from the site. Among the trees, *Shorea robusta* was the dominant and *Mallotus philippensis* was found co-dominant species. The highest tree density was reported for *Shorea robusta* (610 tree/ha) while least number was recorded for *Gardenia turgida* (1 tree/ha). In tree layer, most of the species (86.36%) were distributed contagiously and few (4.45%) were distributed randomly. Very few species showed regular distribution. In sapling layer *Shorea robusta* was the dominant species (1576 tree/ha) and *Gardenia turgida* (98 tree/ha) was the least dominant. In seedling layer again *Shorea robusta* (2681 tree/ha) had the dominance while *Acacia catechu* and *Gardenia turgida* were the least dominant (285 tree/ha). Most of the species of sapling layer (77.77%) and seedling layer (86.66%) were distributed contagiously. In the seedling stage, maximum number was observed for *Shorea robusta* (2681 seedling/ha) followed by *Mallotus philippensis* and *Terminalia tomentosa* (2098 seedling/ha). As far as the regeneration status was concerned, 81.8% species showed good regeneration, 9.09% species were facing problem of poor regeneration and 9.09% species were not regenerating [Nature and Science. 2010;8(1):70-74]. (ISSN: 1545-0740).

**Keywords:** Environmental regeneration potential, *Shorea robusta*, Species diversity, Submontane, Subtropical.

## 1. Introduction

Variation in species diversity along environmental gradient is a major topic of ecological investigation and has been explained by reference to climate, productivity, biotic interaction, habitat heterogeneity, and history (Givnish, 1999; Currie and Francis, 2004; Gonzalez-Espinosa *et al.,* 2004). The elevational range of 300-2200 m asl in the Garhwal Himalaya reflects three vegetation zones, viz., *Shorea robusta* in sub-montane zone (upto 1000m) *Quercus leucotrichophora* (>1500) in the low montane to mid-montane zones while *Pinus roxburghii* regime in between the first two zones. Vegetation between 2200 and 2800 m exhibits a dense canopy of *Quercus floribunda* at moist situations and occupies an intermediate range between *Q. leucotrichophora* and *Q. semicarpifolia*. Above 2800 m oak-conifer association occurs where, *Q. semicarpifolia*, *Abies pindrow*, *Rhododendron barbatum*, *Taxus wallichiana* and species of *Viburnum* are the dominant forms (Bhandari, *et al.,* 2000). Presence of sufficient number of seedlings, saplings, and young trees in a given population indicate a successful regeneration (Saxena and Singh, 1984). The present study provides quantitative information on the community structure and regeneration status of recorded species of the site.

## 2. Materials and methods

### *2.1 The Study area*

The study area was located at $29^0 48'$-$29^0 48'$ and Lat. and $78^0 36'$-$78^0 37'$E Long., covering an altitude of 700m asl to 1000 m asl (Figure 1).

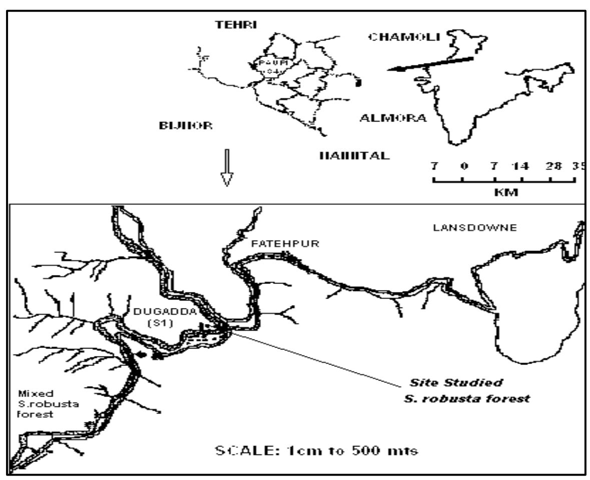


**Figure 1. Study site**

### *2.2 Vegetational sampling*

The phytosociological analysis of each site of forest was conducted by using ten randomly placed 10 x 10 m, quadrat for trees and 5 x 5m size for seedlings and saplings. All the woody species ≥31.5 cm CBH (circumference at breast height) were considered as trees and all the individuals of 10.5 to 31.4 cm CBH were tallied as saplings and all the individuals with CBH less than 10.5 cm are tallied as seedlings following Ralhan *et al.,* (1982). The vegetational data were quantitatively analyzed for abundance, density, and frequency following Curtis and McIntosh (1950). Quadrat data was pooled by plots to estimate density, frequency, total basal area, and relative values of density, frequency, total basal area (Misra, 1968; Muller-Dombois and Ellenberg, 1974). Importance value index (IVI) was calculated by summing up the relative values of density (RD), frequency (RF), and total basal area (TBA) (Curtis, 1959). Species richness was determined as the number of species per unit area (Whittaker, 1975). The ratio of abundance to frequency was determined to evoke the distribution patterns. This ratio indicates regular (<0.025), random (0.05 to 0.05) and contagious (>0.05) distributions (Curtis and Cottam, 1956). Regeneration status of species was totally based on population size of seedlings and saplings (Khan *et al*., 1987). Good regeneration if seedlings >saplings >adults; fair regeneration, if seedlings> or ≤ saplings ≤ adults; poor regeneration, if the species survives only in sapling stage, but no seedlings (saplings may be <, > or = adults). If a species is present, only in an adult form it is considered as not regenerating. Species is considered as new if the species has no adults but only seedling or saplings.

## 3. Results

### *3.1 Dominance of Trees, Saplings, and Seedlings*

22 tree species, 15 sapling species and 16 seedling species was observed from the site. Among the trees, *Shorea robusta* was the dominant (IVI- 180.72) and *Mallotus philippensis* (IVI-45.22) was co-dominant species. Highest tree density was also observed for *Shorea robusta* (3.80 tree 100m$^{-2}$). The least dominant was *Gardenia turgida* (IVI-0.59). In saplings *Shorea robusta* had the highest tree density (15.70 tree 100m$^{-2}$) and was the dominant species (IVI-66) and the co-dominant species was *Mallotus philippensis* with tree density (12.18 tree 100m$^{-2}$) and IVI-49.17. In seedling layer again *Shorea robusta* had the highest tree density (26.81 tree 100m$^{-2}$) and was the dominant species IVI (56.41). Co-dominant species was *Mallotus philippensis* with tree density (20.98 tree 100 m$^{-2}$) and IVI-44.79. In order of dominance, other associated species reported from the site were *Terminalia tomentosa, Holoptelea integrifolia* and *Syzygium cumini.* The distribution pattern of most of the species was contagious and few were distributed randomly (Table 1A, B, C and 2).

### *3.2 Regeneration Potential*

As far as the regeneration status is concerned, out of the total 22 tree species 18 tree species showed good regeneration, 02 species showed poor regeneration and 02 tree species showed no regeneration at all. Total species with sapling in this forest is 81.81% and species with seedling is 68.18% (Table 3).

Table 1 A, B and C. Phytosociological analysis of trees, saplings, and seedlings in the studied forest site

**A. Tree Species**

| Species | Density (tree100m$^{-2}$) | A/F | Total Basal Cover (cm$^2$ 100m$^{-2}$) | IVI |
|---|---|---|---|---|
| *Shorea robusta* Roxb.ex Gaertner f. | 3.80 | 0.038 | 2058.36 | 180.72 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 1.08 | 0.029 | 153.37 | 45.22 |
| *Terminalia tomentosa* (Roxb.) Wight & Arn. | 0.52 | 0.035 | 113.20 | 24.13 |
| *Holoptelea integrifolia* (Roxb.) Planchon | 0.18 | 0.05 | 130.90 | 15.95 |
| *Syzygium cumini* (L.) Skeels | 0.11 | 0.111 | 18.90 | 6.12 |
| *Lagerstroemia parviflora* Roxb. | 0.05 | 0.325 | 23.50 | 3.32 |
| *Garuga pinnata* Roxb. | 0.05 | 0.25 | 19.04 | 3.15 |
| *Cassia fistula* L. | 0.04 | 0.375 | 11.63 | 2.70 |
| *Adina cordifolia* (Roxb.) Hook .f .ex Brandis | 0.04 | 0.4 | 11.08 | 2.67 |
| *Anogeissus latifolius* (Roxb. ex DC.) | 0.04 | 0.7 | 14.70 | 2.41 |
| *Buchanania lanzan* Sprengel | 0.04 | 0.333 | 12.46 | 2.33 |
| *Emblica officinalis* Gaertner | 0.03 | 0.333 | 7.64 | 1.98 |
| *Lannea coromandelica* (Houttuyn)Merrill | 0.02 | 0.8 | 8.80 | 1.51 |
| *Ougeinia oojeinensis* (Roxb.) Hochreutiner | 0.02 | 0.65 | 4.97 | 1.32 |
| *Terminalia tomentosa,* (Roxb.) Wight & Arn | 0.02 | 0.75 | 3.14 | 1.25 |
| *Wendlandia exserta* (Roxb.) DC. | 0.02 | 0.75 | 3.08 | 1.25 |

| | | | | |
|---|---|---|---|---|
| *Bauhinia vahlii* Wright & Arn. | 0.01 | 0.6 | 4.12 | 0.72 |
| *Tectona grandis* L.f. | 0.01 | 0.6 | 3.57 | 0.70 |
| *Acacia catechu (*L.f.) Willd. | 0.01 | 0.7 | 3.06 | 0.68 |
| *Lagerstroemia indica* L. | 0.01 | 0.5 | 2.99 | 0.67 |
| *Helicteres isora* L. | 0.01 | 0.6 | 1.19 | 0.61 |
| *Gardenia turgida* Roxb. | 0.01 | 0.7 | 0.84 | 0.59 |

**B. Sapling Species**

| **Species** | **Density (tree100m$^{-2}$)** | **A/F** | **Total Basal Cover (cm$^2$ 100m$^{-2}$)** | **IVI** |
|---|---|---|---|---|
| *Shorea robusta* Roxb.ex Gaertner f. | 15.76 | 0.09 | 1153.63 | 66 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 12.18 | 0.11 | 834.30 | 49.17 |
| *Terminalia tomentosa* (Roxb.) Wight & Arn. | 11.56 | 0.14 | 354.80 | 33.56 |
| *Holoptelea integrifolia* (Roxb.) Planchon | 10.09 | 0.25 | 345.60 | 26.39 |
| *Syzygium cumini* (L.) Skeels | 8.76 | 0.21 | 87.86 | 18.84 |
| *Garuga pinnata* Roxb. | 8.76 | 0.15 | 611.7 | 26.7 |
| *Adina cardifolia* (Roxb.) Hook .f .ex Brandis | 7.91 | 0.18 | 455.7 | 21.78 |
| *Anogeissus latifolius* (Roxb. ex DC.) | 6.85 | 0.08 | 162.0 | 14.1 |
| *Buchanania lanzan* Sprengel | 4.36 | 0.46 | 50.9 | 9.22 |
| *Lannea coromandelica* (Houttuyn ) | 4.36 | 0.48 | 57.1 | 8.45 |
| *Ougenia oojeinensis* (Roxb.) Hochreutiner | 2.8 | 0.12 | 164.9 | 8.84 |
| *Tectona grandis* L.f. | 1.6 | 0.13 | 112.9 | 6.2 |
| *Acacia catechu* (L.f.) Willd. | 1.6 | 0.28 | 37.8 | 3.31 |
| *Lagerstroemia indica* L. | 0.98 | 0.28 | 38.91 | 2.7. |
| *Gardenia turgida* Roxb. | 0.98 | 0.28 | 41.1 | 2.76 |

**C. Seedling Layer**

| **Species** | **Density (tree100m$^{-2}$)** | **A/F** | **Total Basal Cover (cm$^2$ 100m$^{-2}$)** | **IVI** |
|---|---|---|---|---|
| *Shorea robusta* Roxb.ex Gaertner f. | 26.81 | 0.10 | 197.5 | 56.41 |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 20.98 | 0.14 | 146.4 | 44.79 |
| *Terminalia tomentosa* (Roxb.) Wight & Arn. | 20.98 | 0.12 | 138.6 | 42.39 |
| *Holoptelea integrifolia* (Roxb.) Planchon | 16.15 | 0.26 | 94.1 | 29.01 |
| *Garuga pinnata Roxb.*Roxb. | 14.13 | 0.07 | 76.72 | 26.23 |
| *Cassia fistula* L. | 12.65 | 0.07 | 68.68 | 20.20 |
| *Adina cardifolia* (Roxb.) Hook .f .ex Brandis | 11.69 | 0.09 | 57.98 | 17.71 |
| *Anogeissus latifolia* | 11.69 | 0.13 | 53.30 | 16.19 |
| *Buchanania lanzan* Sprengel | 9.20 | 0.16 | 37.07 | 12.72 |
| *Emblica officinalis* Gaertner | 8.68 | 0.24 | 33.90 | 10.74 |
| *Lannea coromandelica* (Houttuyn ) | 7.12 | 0.42 | 26.20 | 8.74 |
| *Ougenia oojeinensis* (Roxb.) Hochreutiner | 7.12 | 0.43 | 22.20 | 7.91 |
| *Terminalia tomentosa* (Roxb.) Wight & Arn | 7.12 | 1.2 | 14.24 | 6.36 |
| *Wendlandia exserta* (Roxb.) DC. | 4.67 | 0.87 | 11.67 | 4.31 |
| *Bauhinia vahlii* Wright & Arn. | 3.98 | 1.1 | 11.46 | 3.44 |
| *Tectona grandis* L.f. | 3.98 | 1.3 | 7.00 | 2.76 |
| *Acacia catechu (*L.f.) Willd. | 2.85 | 1.3 | 5.70 | 2.04 |
| *Gardenia turgida* Roxb. | 2.85 | 1.3 | 5.70 | 2.04 |

Table 2. Distribution pattern (percentage) of *Shorea robusta* forest

| **Stratum** | **Regular** | **Random** | **Contagious** |
|---|---|---|---|
| Tree layer | 9.09 | 4.45 | 86.36 |
| Sapling layer | 11.11 | 11.11 | 77.77 |
| Seedling layer | - | 13.34 | 86.66 |

Table 3. Regeneration Status of forest stand

| Species | Trees/ ha | Sapling/ ha | Seedling/ ha | Status* |
|---|---|---|---|---|
| *Shorea robusta* Roxb.ex Gaertner f. | 380 | 1576 | 2681 | G |
| *Mallotus philippensis* (Lam.) Muell.-Arg. | 108 | 1218 | 2098 | G |
| *Terminalia tomentosa* (Roxb.) Wight & Arn. | 52 | 1156 | 2098 | G |
| *Holoptelea integrifolia* (Roxb.) Planchon | 18 | 1009 | 1615 | G |
| *Syzygium cumini* (L.) Skeels | 11 | 876 | - | P |
| *Lagerstroemia parviflora* Roxb. | 5 | - | - | N |
| *Garuga pinnata* Roxb. | 5 | 876 | 1413 | G |
| *Cassia fistula* L. | 4 | - | 1265 | G |
| *Adina cordifolia* (Roxb.) Hook .f .ex Brandis | 4 | 791 | 1169 | G |
| *Anogeissus latifolius* (Roxb. ex DC.) | 4 | 685 | 1169 | G |
| *Buchanania lanzan* Sprengel | 4 | 436 | 920 | G |
| *Emblica officinalis* Gaertner | 3 | - | 868 | G |
| *Lannea coromandelica* (Houttuyn)Merrill | 2 | 436 | 712 | G |
| *Ougeinia oojeinensis* (Roxb.) Hochreutiner | 2 | 280 | 712 | G |
| *Terminalia tomentosa,* (Roxb.) Wight & Arn | 2 | - | 712 | G |
| *Wendlandia exserta* (Roxb.) DC. | 2 | - | 467 | G |
| *Bauhinia vahlii* Wright & Arn. | 1 | - | 398 | G |
| *Tectona grandis* L.f. | 1 | 160 | 398 | G |
| *Acacia catechu* (L.f.) Willd. | 1 | 160 | 285 | G |
| *Lagerstroemia indica* L. | 1 | 98 | - | P |
| *Helicteres isora* L. | 1 | - | - | N |
| *Gardenia turgida* Roxb. | 1 | 98 | 285 | G |

**G-Good regeneration, P-Poor regeneration and N-No regeneration*

## 4. Discussion

The total density value of present study for trees was 610 tree ha$^{-1}$ and TBC 26.1 m$^2$ha$^{-1}$. These values are within the ranged values 420 to 1640 trees/ha reported by Saxena and Singh (1982) and Tiwari (1982) for temperate forests of Kumaon Himalaya. Bargali *et al.* (1987) described the values of density ranging from 490 to 1640 trees/ha. Pangtey *et al.*.(1989) reported the values of density ranged from 140 to 750 trees/ha in Pindari catchments forest. Kumar *et al.* (2001) reported density values ranged between 652 to 1028 trees/ha. Most of the vegetation layers were distributed contagious. This type of distribution has been reported by several workers Greig-Smith (1957); Kershaw (1973); Singh and Yadav (1974). Odum (1971) have emphasized that contagious distribution is the commonest pattern in nature. Kumar and Bhatt (2006) also reported contagious distribution pattern in foothills forest of Garhwal Himalaya. The density values of seedling and saplings are considered as regeneration potential of the species (Dhaulakhandi *et al.* 2008). The presence of good regeneration potential shows suitability of species to the environment. Good and Good (1972) have considered three major components which cause the successful regeneration of tree species. These components are 'the ability to initiate new seedlings, ability of seedlings and saplings to survive, and ability of seedlings and saplings to grow'. Higher percentage of regeneration in the present study might be due to different physiographic, better habitat conditions, and awareness of villagers for the conservation of forests of the area.

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