Assessment of diversity, population structure and regeneration status of tree species in Tirthan Wildlife Sanctuary, District Kullu, Himachal Himalaya

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Abstract: The Tirthan Wildlife Sanctuary located in the Kullu district of North western Himalaya and covering an area of 61 km² has not been explored for documenting the structure and composition of vegetation. In this study we examine the site/habitat characteristics, assess the diversity of tree species, delineate forest tree communities, assess the regeneration pattern of tree species, and suggest conservation measures. Sixty-four sites were sampled between 2100-3500 m asl and for each site, habitat characteristics, altitude and dominant species were noted. Sixteen forest tree communities were recorded. Abies pindrow community was the most widely distributed followed by Quercus leucotrichophora and Abies pindrow-Taxus baccata subsp. wallichiana mixed communities. Abies pindrow community had maximum density of trees (617.5 Ind ha⁻¹), seedlings (492.5 Ind ha⁻¹) and saplings (256.25 Ind ha⁻¹), while Quercus semecarpifolia community recorded the total tree density 528.75 Ind ha⁻¹, seedling density (406.25 Ind ha⁻¹) and sapling (242.50 Ind ha⁻¹) respectively. Of the total forest communities, 07 communities showed highest regeneration of dominant species. 02 forest communities showed highest regeneration of co-dominant species indicating the possibility of at least partial replacement of the dominant species by the co-dominant species in the future; and seven communities showed poor or no regeneration of the dominant species indicating a total replacement of the dominants in the coming years. Long term monitoring of these tree communities for their conservation management is suggested.

Key words: Conservation, Tirthan Wildlife Sanctuary, Diversity, regeneration, species richness, species diversity and structural pattern.

Introduction

The structure and function of forest ecosystem is determined by the plant component more than any other living component of the system (Richards, 1996). The plant diversity at any site is influenced by species distribution and abundance patterns (Palit and Chanda, 2012) and the richness of plant species is controlled by a variety of biotic and abiotic parameters (Rannie, 1986; Huston, 1994). Topography, soil, climate and geographical location of a region influence the vegetation diversity of the forest ecosystem (Ram et al., 2004). It was found that, plant diversity inventories in tropical forests have mostly been concentrated on tree species than other life-forms (Mani and Parthasarathy, 2006). The nature of forest communities largely depends on the ecological characteristics in sites, species diversity and regeneration status of species (Khumbongmayum et al., 2006). Species diversity is one of the most important indices used for evaluating the stability and sustainability of forest communities. Information on the species composition of a forest is essential for its wise management in terms of economic value, regeneration potential (Wyatt-Smith, 1987) and ultimately may be leading to conservation of biological diversity (Verma et al., 1999).

Population structure is expressed in terms of number of individuals present in each of the definite girth class distribution of tree species. Saxena and Singh (1984) reported regeneration behaviour of tree species in a forest can be revealed from the population structure. A successful regeneration is indicated by presence of sufficient number of seedlings, saplings and young trees in a given population (Pokhriyal et al., 2010) and the number of seedling of any species can be considered as the regeneration potential of that species (Negi and Nautiyal, 2005). Natural regeneration is a central component for tropical forest ecosystem dynamics (Getachew et al., 2010) and is essential for preservation and maintenance of biodiversity (Rahman et al., 2011). It is important to understand the growth status of a species in the ecosystem and is one of the key parameter to determine ecosystem stability (Kadavul and Parthasarathy, 2001; Deb and Sundriyal, 2011). Several types of disturbances like logging, landslides, gap formation, litterfall, herbivory, etc. can affect the potential regenerative status of species composing the forest stand spatially and temporally (Guariguata, 1990; Welden et al., 1991). Present study was undertaken to analyze the tree species diversity, population dynamics and to assess the regeneration pattern of tree species. The findings of the study will definitely add records on quantitative data on tree species diversity of forest of Tirthan Wildlife Sanctuary in particular and District Kullu in general.

Material and Methods

Study Area: The State of Himachal Pradesh (geographical area, 55,673 km²) comprises the part of Trans and Northwest Himalaya that supports a unique biodiversity. Of the total geographical area, 66.45% is under forests. Protected forests comprise 59.3% and
Reserve Forests 3.41%. The state supports 32 Wildlife Sanctuaries; two National Parks; one Biosphere Reserve. The Kullu district is one of the richest districts in terms of biodiversity, and supports one National Park (i.e., Great Himalayan National Park) and six Wildlife Sanctuaries (i.e., Manali, Kanawar, Khokhan, Kais, Sainj and Tirthan) (Singh et al. 1990). Amongst the wildlife sanctuaries, Tirthan Wildlife Sanctuary is perhaps the richest wildlife sanctuary in terms of biodiversity. Present study was conducted in the Tirthan Wildlife Sanctuary of Kullu district of northwest Himalaya during 2008-2010. It covers an area of about 61 km². The altitude ranges between 2100-4800 m asl and the area supports diverse habitats, species and communities of the sub-tropical, temperate, sub-alpine and alpine zones. For the whole Himachal Pradesh only a few studies are available on forest diversity including regeneration pattern. Therefore, an attempt has been made to: (i) study the site/habitat characteristics; (ii) assess the diversity of tree species; (iii) delineate forest tree communities; and (iv) assess the regeneration pattern of tree species.

Sites were selected on accessible aspects along altitudinal gradient between 2100-3500 m asl. The habitats were identified based on physical characteristics and dominance of species. Sites having closed forest canopy with high soil humus and moisture contents were considered as moist habitats. The sites experiencing high anthropogenic pressures were considered as degraded habitats. The field surveys and vegetation sampling were conducted during 2008 to 2010 within the selected sites. For tree layer, in each site, a plot of 50 x 50 m was laid. Trees, saplings and seedlings were sampled by ten randomly placed 10 x 10 m quadrats. The size and number of quadrats were determined following Misra (1968) and Kershaw (1973). For the collection of data from these quadrats standard ecological methods (Curtis and McIntosh, 1950; Kershaw, 1973; Muller-Dombois and Ellenberge, 1974) were followed. From each site, samples of each species were collected and identified with the help of various florists and research papers (Aswal and Mehrotra, 1994; Collett, 1902; Choudhery and Wadhwa, 1984; Dhaliwal and Sharma, 1999; Singh and Rawat, 2000). For trees, basal area (BA) and Importance Value Index (IVI) were computed. IVI was calculated as the sum of relative frequency, relative density and relative basal area. Communities were named based on the IVI of species. The abundance data of different sites within the identified communities were pooled to get averages for density, BA and IVI. If a species contributed ≥50% of the total IVI in a particular site/habitat that site was considered a single species dominated community and if <50% of the total IVI, a mixed community. Shanon Wiener Information Statistic (H) (Shannon and Weaver, 1963) was used to represent species diversity.

Results and Discussion

Site and habitat characteristics: In the forest zone, total 64 sites were sampled for the analysis of vegetation between altitudinal range, 2100m to 3500m, above msl and 31°34’95” to 31°36’41” N latitudes and 77°29’20” to 77°31’97” E longitudes. The shady moist habitat represented maximum sites (30 sites) followed by degraded (09 sites), Bouldary, Riverine and Water courses (05 sites, each), Rocky (04 sites), Dry and Shrubberies (03 sites). Maximum sites (13 sites, each) were represented in North and North-west aspect, followed by South-west (11 sites), South (09 sites), West (08 sites) aspects, North-east (05 sites), South-east (03 sites) and East (02 sites). Slope ranged from 15° to 70°.

Community diversity and distribution pattern: Total 27 tree species were recorded. Based on the IVI, sixtientree communities were identified between 2100m to 3500m. The community types, altitudinal distribution, sites and habitat representation and major tree associates are presented in Table-1. Amongst the forest tree communities, Abies spinow, Quercussemecarpifolia communities represented maximum sites (08 sites, each), followed by Abies spinow-Taxus baccata subsp. wallichiana mixed (06 sites) and Prunus cornuta (05 sites) and the remaining communities represented <4 sites.

Structural Pattern: The altitudinal range, habitat (s), slope, density of trees, saplings and seedlings, TBA (total basal area) and IVI of dominant tree species of communities are presented in table 1. The total tree density ranged from 135.0-670.0 Ind ha⁻¹ and TBA, 5.60-319.08 m² ha⁻¹. Total sapling density ranged from 65-340 Ind ha⁻¹ and total seedling density 35-535 Ind ha⁻¹.

Species Diversity (H): Community wise diversity for trees, saplings, seedlings, shrubs and herbs has been presented in table 2. In general, species diversity (H) in the forest zone ranged from 0-2.05 for trees, whereas, its values for the seedlings and saplings were (0-1.83) and (0-2.01) respectively. Highest diversity in case of trees was 2.05 in Piceasmitiana community, followed by Abies spinow-Prunus cornutamixed community (1.79), Prunus cornuta community (1.62) and Juglans regia-Piceasmitiana mixed community (1.57). Betula utilis community showed no tree diversity. Amongst the seedlings, highest diversity was recorded in Piceasmitiana community (1.83), subsequently followed by the communities of by Prunus cornuta (1.60) and Aesculus indica-Acer acuminatumixed (1.48) table-2. It was recorded lowest in case of Quercussemecarpifolia (1.10) community. No seedling was found in Betula utilis community. Amongst the saplings, highest diversity was reported in Piceasmitiana community (2.01), followed by Prunus cornuta community (1.67) and Aesculus indica (1.62) community. It was lowest in Quercussemecarpifolia (1.13) community. Betula utilis community showed no sapling diversity table-2.

Regeneration status: The regeneration status of tree species in the indentified communities has been presented inFigs. 1 to 16. Based on the regeneration status i.e., proportion of saplings and seedlings in the population, the identified communities have been categorized as follows:

i) Communities with highest regeneration of dominant species: Of the total forest communities, 07 communities i.e., Abies spinow(Fig.1), Acer acuminatum(Fig.5), Aesculus indica (Fig.7), Betula utilis (Fig.10), Piceasmitiana (Fig.13), Prunus cornuta (Fig.14) and Quercussemecarpifolia (Fig.15) showed highest regeneration of dominant species. This indicates that these communities will continue their dominance in near future too.

ii) Communities with highest regeneration of co-dominant species: 02 forest communities i.e., Juglans regia (Fig.11) and
Majority of the protected areas of IHR are unexplored or under-explored (Dhar et al., 1997). For the proper management of protected areas, however, baseline information on biodiversity is required. Seventeen forest communities were identified between 2100-3500m in the Tirthan Wildlife Sanctuary. Occurrence of 17 forest communities within a small altitudinal range indicated the presence of diverse habitats supporting a diverse vegetation. Total 27 tree species were recorded. This is comparable to the richness of trees reported from temperate and sub-alpine forests of the Indian Himalayan Region (Adhikari et al., 1991). Tree species richness was within the range 9-28 reported for the sub-tropical and temperate regions (Rawat, 2001; Upreti et al., 1985). Density of trees, saplings, and seedlings, and total basal area for the Tirthan Wildlife Sanctuary communities are comparable to the values reported earlier from low and high altitude forests (Samant et al., 2002). The values for Shannon-Wiener diversity of the present communities are comparable to the previous records from various regions of west Himalaya (Joshi and Samant, 2004 and Pant et al., 1991).

### Table-1: Community types, their distribution and characteristics in the Tirthan Wildlife Sanctuary

<table>
<thead>
<tr>
<th>Community type</th>
<th>Altitudinal range (m)</th>
<th>Habitat(s)</th>
<th>Slope (o)</th>
<th>Density (Ind ha^-1)</th>
<th>TBA (m² ha^-1)</th>
<th>IVI of Dominant spp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiespindrow</td>
<td>2674-3272</td>
<td>SM, D, R, WC, Bo</td>
<td>25-65</td>
<td>617.5 492.25 256.25</td>
<td>319.08 162.34</td>
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</tr>
<tr>
<td>Abiespindrow-Prunuscomutamixed</td>
<td>2553-2756</td>
<td>SM, R</td>
<td>15-55</td>
<td>480 303.33 186.67</td>
<td>129.73 99.46</td>
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<tr>
<td>Abiespindrow-Quercussemecarpifolia</td>
<td>3207-3388</td>
<td>SM, Bo</td>
<td>20-30</td>
<td>655 535 270</td>
<td>209.79 97.65</td>
<td></td>
</tr>
<tr>
<td>Abiespindrow-Taxusbaccata subsp. wallichiana</td>
<td>2705-3529</td>
<td>SM, Ro, R, D</td>
<td>20-60</td>
<td>538.3 478.33 276.7</td>
<td>202.1 121.7</td>
<td></td>
</tr>
<tr>
<td>Aesculusindica-Acer acuminatum</td>
<td>2518-2891</td>
<td>R, SM</td>
<td>25-50</td>
<td>533.34 360 190</td>
<td>175.7 158.87</td>
<td></td>
</tr>
<tr>
<td>Aesculusindica-Prunuscornutamixed</td>
<td>2561</td>
<td>S M</td>
<td>35</td>
<td>600 520 340</td>
<td>180.12 132.9</td>
<td></td>
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<tr>
<td>Aesculusindica</td>
<td>2192-2640</td>
<td>SM, Bo</td>
<td>20-30</td>
<td>633.33 503.33 293.33</td>
<td>209.6 155.3</td>
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</tr>
<tr>
<td>Aesculusindica-Acer acuminatum mixed</td>
<td>2357-2575</td>
<td>SM, WC</td>
<td>25-35</td>
<td>660 505 300</td>
<td>176.7 108</td>
<td></td>
</tr>
<tr>
<td>Aesculusindica-Prunuscomutamixed</td>
<td>2470</td>
<td>S M</td>
<td>45</td>
<td>670 290 270</td>
<td>183.78 136.23</td>
<td></td>
</tr>
<tr>
<td>Betula utilis</td>
<td>3411-3496</td>
<td>S M</td>
<td>35-45</td>
<td>135 35 65</td>
<td>5.6</td>
<td></td>
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<tr>
<td>Juglansregia</td>
<td>2319-2581</td>
<td>SM, Dg</td>
<td>40-50</td>
<td>595 410 190</td>
<td>245.23 156.01</td>
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<tr>
<td>Juglansregia-Piceasmitamiananmixed</td>
<td>2607</td>
<td>Dg</td>
<td>50</td>
<td>170 230 210</td>
<td>96.41 125.47</td>
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</tr>
<tr>
<td>Piceasmitamiana</td>
<td>2325-2536</td>
<td>Dg</td>
<td>30-50</td>
<td>346.67 260 193.33</td>
<td>141.84 167.99</td>
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<tr>
<td>Prunuscomutam</td>
<td>2597-3031</td>
<td>SM, R</td>
<td>25-50</td>
<td>460 366 201.2</td>
<td>140.73 159.74</td>
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<tr>
<td>Quercussemecarpifolia</td>
<td>2793-3486</td>
<td>SM, Dg, WC</td>
<td>15-55</td>
<td>528.75 406.25 242.5</td>
<td>173.63 171.82</td>
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<tr>
<td>Quercussemecarpifolia- Taxusbaccatus subsp. wallichiana mixed</td>
<td>3130-3352</td>
<td>S M</td>
<td>30-40</td>
<td>620 510 205</td>
<td>182.44 121.16</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations used:** Ind ha^-1 = Individual per hectare; m² ha^-1 = Meter square per hectare; TBA=Total Basal Area; IVI=Importance Value Index

### Table-2: Community Wise Diversity (H') of Trees, Seedlings, Saplings, Shrubs and Herbs in Tirthan Wildlife Sanctuary

<table>
<thead>
<tr>
<th>Communities</th>
<th>Trees</th>
<th>Seedlings</th>
<th>Saplings</th>
<th>Shrubs</th>
<th>Herbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiespindrow</td>
<td>1.47</td>
<td>1.46</td>
<td>1.37</td>
<td>1.95</td>
<td>2.27</td>
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<tr>
<td>Abiespindrow-Prunuscomutamixed</td>
<td>1.79</td>
<td>1.37</td>
<td>1.43</td>
<td>1.96</td>
<td>2.54</td>
</tr>
<tr>
<td>Abiespindrow-Quercussemecarpifolia</td>
<td>1.47</td>
<td>1.27</td>
<td>1.34</td>
<td>1.80</td>
<td>2.96</td>
</tr>
<tr>
<td>Abiespindrow-Taxusbaccatus subsp. wallichiana mixed</td>
<td>1.39</td>
<td>1.47</td>
<td>1.49</td>
<td>1.55</td>
<td>2.79</td>
</tr>
<tr>
<td>Acer acuminatum</td>
<td>1.19</td>
<td>1.23</td>
<td>1.16</td>
<td>2.01</td>
<td>2.96</td>
</tr>
<tr>
<td>Acer acuminatum-Prunuscomutamixed</td>
<td>1.33</td>
<td>1.4</td>
<td>1.15</td>
<td>1.95</td>
<td>2.70</td>
</tr>
<tr>
<td>Aesculusindica</td>
<td>1.49</td>
<td>1.35</td>
<td>1.62</td>
<td>1.99</td>
<td>2.56</td>
</tr>
<tr>
<td>Aesculusindica-Acer acuminatum mixed</td>
<td>1.51</td>
<td>1.48</td>
<td>1.49</td>
<td>2.07</td>
<td>2.96</td>
</tr>
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<td>Aesculusindica-Prunuscomutamixed</td>
<td>1.42</td>
<td>1.3</td>
<td>1.52</td>
<td>1.64</td>
<td>2.73</td>
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<tr>
<td>Betula utilis</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.97</td>
<td>2.44</td>
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<tr>
<td>Juglansregia</td>
<td>1.38</td>
<td>1.36</td>
<td>1.23</td>
<td>1.89</td>
<td>2.84</td>
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<td>Juglansregia-Piceasmitamiananmixed</td>
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<td>1.3</td>
<td>1.55</td>
<td>2.07</td>
<td>2.96</td>
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<tr>
<td>Piceasmitamiana</td>
<td>2.05</td>
<td>1.63</td>
<td>2.01</td>
<td>3.16</td>
<td>4.54</td>
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<td>Prunuscomutam</td>
<td>1.62</td>
<td>1.6</td>
<td>1.67</td>
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<tr>
<td>Quercussemecarpifolia</td>
<td>0.83</td>
<td>1.1</td>
<td>1.13</td>
<td>1.75</td>
<td>2.49</td>
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<tr>
<td>Quercussemecarpifolia- Taxusbaccatus subsp. wallichiana mixed</td>
<td>1.20</td>
<td>1.26</td>
<td>1.29</td>
<td>1.90</td>
<td>2.15</td>
</tr>
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</table>
Fig 1.: Population Structure of Tree species of Abiespindrow Community (Where: TD = Total density; AP = Abiespindrow; AA = Acer acuminatum; AC = Acer caesium; BA = Betulaalnoides; CC = Cornuscapitata; CJ = Corylusjacquemontii; ID = Ilex dipyrena; JR = Juglansregia; MD = Meliosmadilleniifolia; PS = Piceasmithiana; PC = Prunuscornuta; QF = Quercus floribunda; QS = Quercussemecarpifolia; RA = Rhododendron arboreum; TB = Taxusbaccat subsb. wallichiana; and UV = Ulmusvillosa)

Fig 2.: Population Structure of Tree species of Abiespindrow – Prunuscornutamixed Community (Where: TD = Total density; AP = Abiespindrow; AV = Acer sterculiaceum; AI = Aesculusindica; BA = Betulaalnoides; CC = Cornuscapitata; ID = Ilex dipyrena; PS = Piceasmithiana; PC = Prunuscornuta; RA = Rhododendron arboreumand TB = Taxusbaccat subsb. wallichiana)

Fig 3.: Population structure of tree species of Abiespindrow-Quercusssemecarpifoliamixed Community (Where: TD = Total density; AP = Abiespindrow; AS = Abiesspectabalis; PC = Prunuscornuta; QS = Quercusssemecarpifolia; RA = Rhododendronarboreumand TB = Taxusbaccat subsb. wallichiana)

Fig 4.: Population Structure of Tree species of Abiespindrow - Taxusbaccat subsb. wallichianamixed Community (Where: TD = Total density; AP = Abiespindrow; AS = Abiesspectabalis; AA = Acer acuminatum; AC = Acer caesium; BA = Betulaalnoides; PC = Prunuscornuta; QS = Quercusssemecarpifolia; RA = Rhododendronarboreumand TB = Taxusbaccat subsb. wallichiana)

Fig 5.: Population Structure of Tree species of Acer acuminatum Community (Where: TD = Total density; AP = Abiespindrow; AA = Acer acuminatum; AV = Acer sterculiaceum; AI = Aesculusindica; ID = Ilex dipyrena; MD = Meliosmadilleniifolia; PC = Prunuscornuta; UV = Ulmusvillosa)
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Fig. 6: Population structure of tree species of *Acer acuminatum-Prunus cornutum* mixed Community (Where: TD = Total density; AP = Abies pindrow; AA = *Acer acuminatum*; AC = *Acer caesium*; PD = *Persea duthei*; PC = *Prunus cornuta*; TB = *Taxus baccata* subsp. wallichiana)

Fig. 7: Population structure of tree species of *Aesculus indica* Community (Where: TD = Total density; AP = Abies pindrow; AA = *Acer acuminatum*; AI = *Aesculus indica*; ID = *Ilex dipyrena*; JR = *Juglans regia*; NP = *Neolitsea pallens*; PD = *Persea duthei*; PS = *Picea smithiana*; PC = *Prunus cornuta*; PP = *Pyrus pashia*; RW = *Rhus wallichii*; and UV = *Ulmus villosa*)

Fig. 8: Population structure of tree species in *Aesculus indica-Acer acuminatum* mixed Community (Where: TD = Total density; AA = *Acer acuminatum*; AV = *Acer sterculiaceum*; AC = *Acer caesium*; AI = *Aesculus indica*; CJ = *Corylus Jacquemontii*; ID = *Ilex dipyrena*; PC = *Prunus cornuta* and Qf = *Quercus florbunda*)

Fig. 9: Population structure of tree species of *Aesculus indica-Prunus cornutum* mixed Community (Where: TD = Total density; AA = *Acer acuminatum*; AV = *Acer sterculiaceum*; AI = *Aesculus indica*; BW = *Buxus wallichiana*; PD = *Persea duthei*; PS = *Picea smithiana*; PC = *Prunus cornuta* and RW = *Rhus wallichii*)

Fig. 10: Population structure of tree species of *Betula utilis* Community (Where: TD = Total density; BU = *Betula utilis*)
Fig. 11.: Population Structure of Tree species of *Juglansregia* Community (Where: TD= Total density; AP= *Abiespindrow*; AA= *Acer acuminatum*; CJ= *Corylusjacquemontii*; JR= *Juglansregia* and PS= *Piceasmithiana*, QL= *Quercusleucotriphora*, UV= *Ulmusvillosa*)

Fig. 12.: Population structure of tree species of *Juglansregia-Piceasmithianamixed* Community (Where: TD= Total density; AP= *Abiespindrow*; AC= *Acercaesium*, CJ= *Corylusjacquemontii*, JR= *Juglansregia*, PS= *Piceasmithiana* and PC= *Prunuscornuta*)

Fig. 13.: Population structure of tree species of *Piceasmithiana* Community (Where: TD= Total density; AP= *Abiespindrow*, AI= *Aesculusindica*, CC= *Cornuscapitata*, CJ= *Corylusjacquemontii*, ID= *Ilex dipyrena*, LO= *Lyoniaovalifolia*, PS= *Piceasmithiana*, PC= *Prunuscornuta* and RA= *Rhododendron arboreum*)

Fig. 14.: Population Structure of Tree species of *Prunuscornuta* Community (Where: TD= Total density; AP= *Abiespindrow*, AA= *Acer acuminatum*, AV= *Acer sterculiaceum*, AI= *Aesculusindica*, CC= *Cornuscapitata*, CJ= *Corylusjacquemontii*, PC= *Prunuscornuta*, QF= *Quercus floribunda*, QS= *Quercussemecarpifolia* and TB= *Taxusbaccatus* subsp. *wallichiana*)

Fig. 15.: Population Structure of Tree species of *Quercussemecarpifolia* mixed Community (Where: TD= Total density; AP= *Abiespindrow*, AS= *Abiespectabalis*, AC= *Acer acuminatum*, PC= *Prunuscornuta*, QS= *Quercussemecarpifolia* and TB= *Taxusbaccatus* subsp. *wallichiana*)
Regeneration status of tree species of any forest is determined by recruitment of saplings and seedlings (Samant et al., 2007). Among the identified communities, Abiespinrow, Acer acuminatum, Aesculusindica, Betulalitilis, Piceasmithiana, Prunuscornuta and Quercussemecarpifolia showed highest regeneration of the dominant species, indicating that these communities will persist for posterity. However, Juglansregia and Juglansregia-Piceasmithiana communities showed sufficient regeneration of the dominant species but the highest regeneration was found for the co-dominant species, indicating the possibility of at least partial replacement of the present dominants by the co-dominant species in the future. 07 forest communities i.e., Abiespinrow-Prunuscornuta mixed, Abiespinrow-Quercussemecarpifolia mixed, Abiespinrow-Taxusbaccata subsp. wallichiana mixed, Acer acuminatum-Prunuscornuta mixed, Aesculusindica-Acer acuminatum mixed, Aesculusindica-Prunuscornuta mixed and Quercussemecarpifolia-Taxusbaccata subsp. wallichianamixed communities showed highest regeneration of one species indicating that community will shift from mixed to dominant type.

Most of the species present in these communities are used for fuel, fodder, making agricultural tools, house building and miscellaneous purposes. During the surveys, it has been observed that use-pressure on species along with heavy grazing is responsible for habitat degradation, poor regeneration and population depletion of the tree species. Based on the present results, it can be concluded that the Sanctuary supports a high diversity of forest trees and communities. The changing environmental conditions coupled with high anthropogenic pressures may, however, lead to depletion of population of the tree species and replacement by spiny species with no or very little economic value (Samant et al., 2000, 2006) in near future. Therefore, regular long-term monitoring of all the identified communities is suggested to understand the dynamics of vegetation. In addition, database developed through regular monitoring of these communities would help in developing adequate management plan for their conservation.

References


