

Structure and Diversity of Sal Forests in Government and Community Management Systems in Kumaun Region of Central Himalaya

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ABSTRACT

The present study deals with structure, diversity and regeneration of Sal (*Shorea robusta* Gaertn.) forests in Kumaun region of Central Himalaya. Two forest types were investigated i.e. Sal dominant forest and Sal teak (*Tectona grandis* Linn.) mixed forest in Kumaun Himalaya. Tree, sapling and seedling density was 650- 911, 36-1303 and 400-6656 ind.ha⁻¹, respectively. Sal showed reverse J-shaped curve representing good regeneration and *T. grandis* showed reverse bell shaped indicating fair regeneration in community management system while Sal showed poor regeneration in the government management forest. Sal showed comparatively good regeneration in Sal mixed in community managed forest while poor regeneration in Sal dominant government management system. Over exploitation of Sal species for basic needs of people consequently impart the negative impact on regeneration of forest. Thus it is suggested that in mixed forests with higher number of species reduces the pressure on individual species as brought by local people so that forest should be managed and conserved sustainably.

Key words: *Shorea robusta*; *Tectona grandis*; density; species diversity; regeneration; Van panchayat.

INTRODUCTION

Forests of Himalaya play significant role for sustainable development of the region as they not only provide timber and resin to industries but also fulfills the basic needs of villagers such as fuel, small timber, fodder, and other minor products residing nearby areas. Forest area and forest cover accounted for about 65 and 46 percent in the Uttarakhand. In Kumaun region, forest cover is 40.3 percent of the state's forest cover. The maximum forests are being managed by foresters while a small area (20%) is under the management control of village community commonly known as Van Panchayat forests. The dependence of hill people for their basic needs lies only in community managed (Van Panchayat) forests because of strict rules implemented by the government forest

department. Therefore in community managed forests the resource extraction pressure are growing regularly, consequently impacting the existence of such forests as the forest sites contain very small number of usable plant species. In our study sites, Sal is one of the dominant forest communities in Shivalik of Kumaun region in Uttarakhand. This region is also mostly populated and having different development activities therefore the forests in the area are suffering from human and animal's pressure. Since last five decades, such growing anthropogenic pressure on forests and expansion of infrastructure has led to over exploitation of flora and fauna. Conservation of biological resources under community based conservation system is a key tool to lessen the depletion of biodiversity. In many part of Central Himalayan region and elsewhere due to deforestation and forest degradation showed that the

diversity, species composition and regeneration of forest tree species are being changed consequently influencing the productivity and sustainability of the forest ecosystems¹. The deforestation and over exploitation activities in forests not only concentrated in the lower belt but it also expanded in the upper part of Himalayan forests dominated with broad-leaved and conifer forest species. Population structure of tree species in a forest conveys its regeneration behavior, which is characterized by the presence of sufficient population of seedlings, saplings and young trees for successful regeneration².

Forests are one of the major sources of biodiversity and it is essential for human survival and economic well being and for the ecosystem function

and stability³. Economically and environmentally, the natural resources are the main source for people in Kumaun region⁴. The forest of tropical dry deciduous, generally dominated by Sal (*Shorea robusta*) natural forests⁵ planted forest species included teak (*Tectona grandis*) followed by *Acacia catechu* and *Syzygium cumini*⁶. Composition of the forest is diverse and varies from place to place because of varying topography such as plains; foothills and upper mountains⁷. On a global basis, 52% of the total forests are tropical forests having rich species diversity^{8,9,10,11}. In the Himalayan forest, various changes are appearing in their structure, density, composition and regeneration due to biotic pressure on them such as illegal lopping and cutting of trees for fuel wood, fodder and grazing¹². There are several

Table 1: Geographical locations in studied different forest types

Forest site	Forest type	Latitude	Longitude	Elevation (m)	Management regime
Musabangar (site-I)	Sal dominant forest	29°32'	79°24'	500-580	Government managed
Syat(site-II)	Sal mixed teak forest	29° 39'	79°34'	700-863	Community managed

Table 2: Density (ind.ha⁻¹) of trees, saplings and seedlings in each studied forest site

Species	Family	Government managed forest			Community managed forest		
		Tree	Sapling	Seedling	Tree	Sapling	Seedling
<i>Shorea robusta</i>	<i>Dipterocarpaceae</i>	613	3	-	570	1060	3290
<i>Tectona grandis</i>	<i>Verbenaceae</i>	-	-	-	217	100	483
<i>Mallotus philippensis</i>	<i>Euphorbiaceae</i>	37	30	350	17	20	863
<i>Cassia fistula</i>	<i>Caesalpinaceae</i>	-	-	20	27	10	180
<i>Syzygium cumini</i>	<i>Myrtaceae</i>	-	-	-	37	20	360
<i>Holarrhena pubescens</i>	<i>Apocynaceae</i>	-	-	-	10	37	673
<i>Dalbergia lanceolaria</i>	<i>Fabaceae</i>	-	-	-	7	7	33
<i>Aegle marmelos</i>	<i>Rutaceae</i>	-	-	-	7	3	3
<i>Randia dumetorum</i>	<i>Rubiaceae</i>	-	-	7	13	37	673
<i>Mangifera indica</i>	<i>Anacardiaceae</i>	-	-	-	3	-	7
<i>Ficus hispida</i>	<i>Moraceae</i>	-	-	-	3	3	10
<i>Holoptelea integrifolia</i>	<i>Ulmaceae</i>	-	3	23	-	3	37
<i>Grewia asiatica</i>	<i>Tiliaceae</i>	-	-	-	-	-	10
<i>Haldina cordifolia</i>	<i>Rubiaceae</i>	-	-	-	-	3	17
<i>Schleichera oleosa</i>	<i>Sapindaceae</i>	-	-	-	-	-	17
Total		650	36	400	911	1303	6656

methods to study the regeneration status such as a dominance diversity curve¹³ a density diameter curve¹⁴ and the population structure². The objectives

of present study were to assess the tree structure and regeneration of Sal forests in two different management systems in foot hills of Kumaun region of Central Himalaya.

Table 3: Species diversity (H') and concentration of dominance (Cd) of tree species in each forest site

Tree layer	Government managed forest		Community managed forest	
	H'	Cd	H'	Cd
Tree	0.313	0.894	1.681	0.452
Sapling	0.871	0.674	1.182	0.670
Seedling	0.722	0.772	2.363	0.291

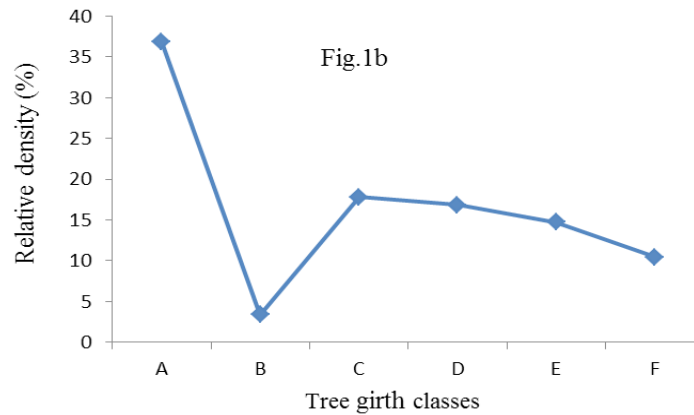
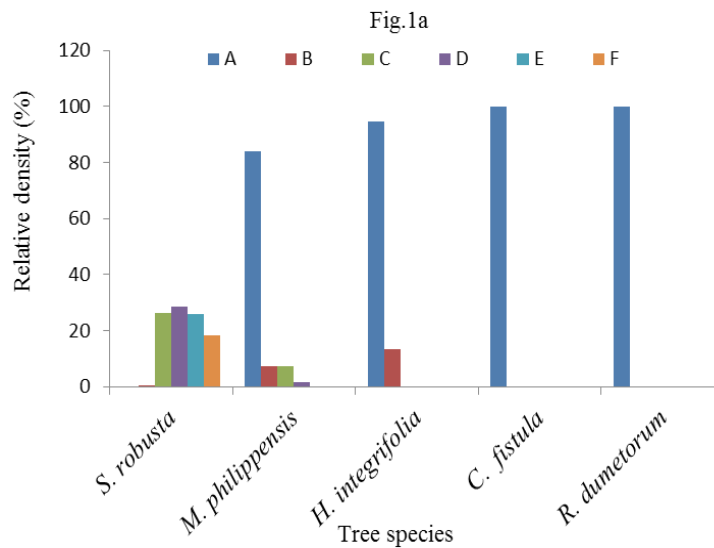


Fig. 1: Population structure Fig. 1a and regeneration status of tree species (fig.1b) in government managed forest site. Different size girth classes i.e. A= seedling 0-10.0cm, B= sapling 10.1-30.0cm, C=30.1-60cm, D=60.1- 90.0cm, E= 90.1-120cm and F=> 120.0cm

MATERIALS AND METHODS

Description of study sites

The present study has been carried out in Kotabagh Block forest of Nainital District in central Himalaya region of Uttarakhand, India. At the study site, two forest types i.e. Sal dominant and Sal mixed teak forest (Table 1).

Sampling and data analysis

Vegetation analysis was done by using quadrat method^{15,14}. The size of quadrat used for tree layer analysis was 10x10m. The sample size was one hectare forest, which was divided into four sub- sample plots of size 50x50 (2500m²). In each sub-sample plot, tree species were measured and categorized into different girth classes i.e. <10cm for

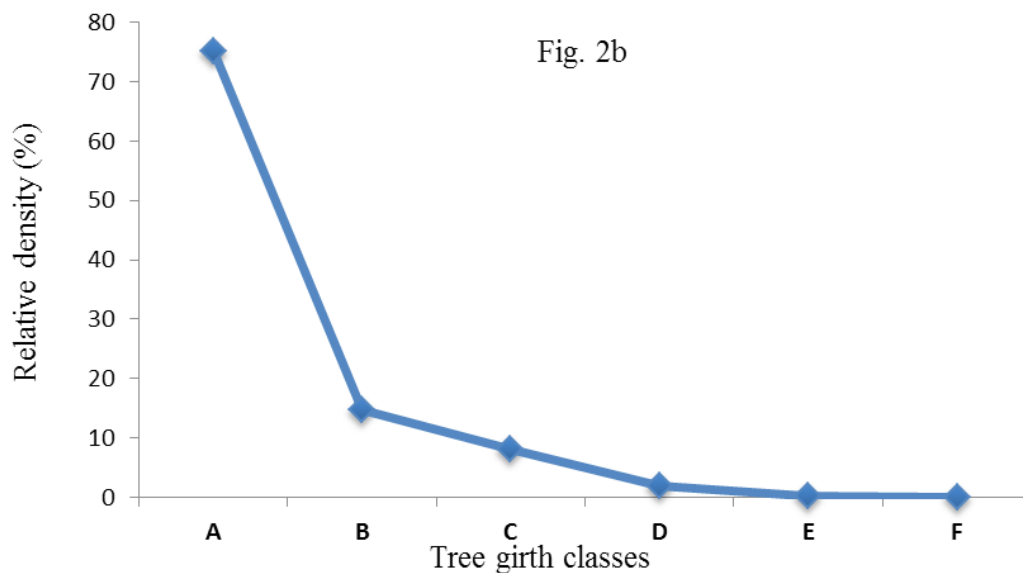
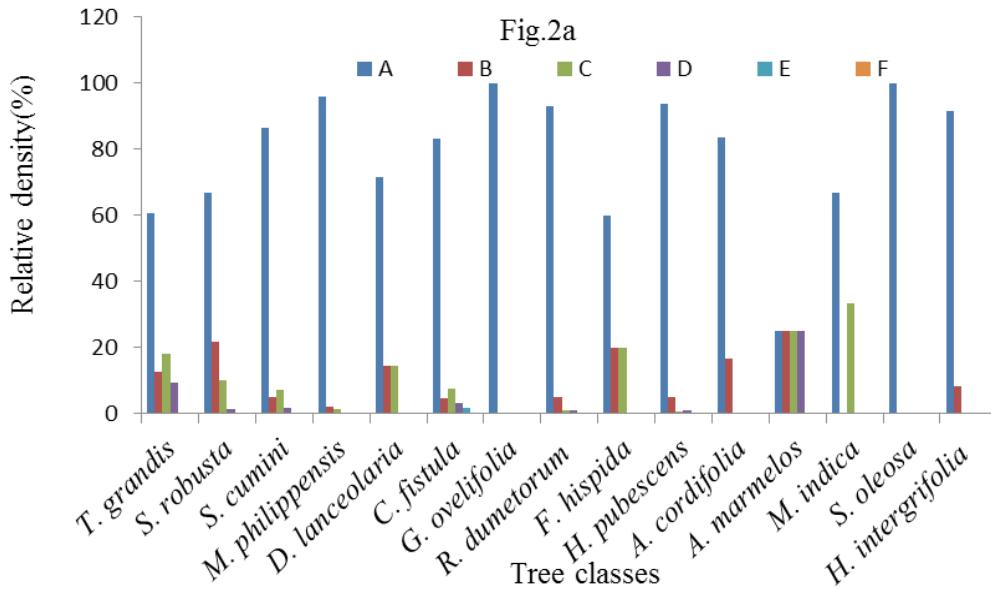


Fig. 2: Population structure fig.2a and regeneration of tree species fig.2b in community managed forest. Different size tree girth classes i.e. A= seedling 0-10.0cm, B= sapling 10.1-30.0cm, C=30.1-60.0cm, D=60.1-90.0cm, E= 90.1-120.0cm and F=120.1cm<

trees. The girth of seedling and sapling was taken at 15 and 50cm from ground level respectively. The tree girth was measured at breast height i.e. 1.37m from ground level. The regeneration of tree species in each forest was assessed as discussed and followed Shanker¹⁶. Tree species diversity of forest was determined by using Shannon-Weiner information index¹⁷.

RESULTS

Tree vegetation analysis

Total 15 tree species were reported in studied forest sites. These numbers of species in each tree category consisted of viz., *Shorea robusta* Gaertn., *Tectona grandis* Linn., *Cassia fistula* Linn., *Mallotus philippensis* (Lam.)Muell-Arg., *Syzygium cumini* (L.) Skeels., *Ficus hispida* Linn., *Holarrhena pubescens* (Buch.- Ham.) wall, *Schleichera oleosa* Lour., *Randia dumetorum* Retz., *Holoptelea intergrifolia* Roxb., *Haldina cordifolia* (Roxb.) Ridsdale, *Aegle marmelos* L., *Dalbergia lanceolaria* L., *Grewia asiatica* L., and *Mangifera indica* L. reported in both forest sites.

Total density of tree, sapling and seedling were 650, 36 and 400 ind.ha⁻¹ in government managed forest and 911, 1303 and 6656 ind.ha⁻¹ for community managed (van panchayat) forest, respectively (Table 2). The species diversity for trees, saplings and seedlings was 0.313, 0.871 and 0.722 while concentration of dominance was 0.894, 0.674 and 0.772 respectively, in government managed forest. The species diversity was 1.681, 1.182 and 2.363 and concentration of dominance was 0.452, 0.670 and 0.291 in community managed forest, respectively (Table 3).

Regeneration of tree species

The relative proportion of seedlings, saplings, and trees of different size classes to the total density of tree species at each forest site were calculated to develop the population structure. In government managed forest tree species showed fair regeneration which was in order: Seedling >Sapling <Tree. But the Sal tree showed poor regeneration while *M. philippensis* showed fair regeneration. The other tree species such as *H. integrifolia*, *C. fistula* and *R. dumetorum* were also reported in the studied forest (Fig.1). Sal was dominant and teak was co-

Table 4: Comparative studies of density and species diversity of different Sal forest in India

Forest type	Density ind.ha ⁻¹			Species Diversity			Reference
	Tree	Sapling	Seedling	Tree	Sapling	Seedling	
Shiwalik range Kumaun Himalaya	550-820	390-530	970-1800	1.96-4.33	2.58	2.08	Bohra et al. 2010 ²²
Sub-tropical forest in Shikim Himalaya	562	1776	5474	-	-	-	Sunderyal et al.1994 ²³
Sal mixed forest Kumaun Himalaya	610	270	2450	2.04-2.59	1.28-1.95	0.87-1.29	Pathak, 2008 ²⁴
Similipal biosphere reserve	680-970	-	-	1.79-2.29	-	-	Mohanty et al. 2005 ²⁵
Mid-elevational forests of central Himalaya	-	160-1200	80-170	-	-	-	Khera et al., 2001 ²⁶
Terai-Bhabhar forest in Katarniaghat Wildlife Sanctuary	484-515	197-501	13-722	4.27-4.85	-	-	Chauhan et al.,2008 ⁶
Sal forest in Eastern Himalaya	484	-	6625	3.59	-	-	Shankar, 2001 ¹⁶
Sal dominant reserve forest of Central Himalaya	650	36	400	0.31	0.87	0.72	Present study
Sal mixed teak community forest of Central Himalaya	911	1303	6656	1.68	1.18	2.36	Present study

dominant tree species in community managed forest. Where Sal showed reverse J-shape curve indicating good regeneration (seedling>sapling>tree) and teak showed fair regeneration while the other tree species also have showed fair regeneration (Fig.2).

DISCUSSION

In the Himalayan region, forest tree species composition and structure vary from lower to higher elevations due to varying soil and climatic conditions. Apart from these, the management and usufructs extraction methods used by foresters and village community people. In this study, the species diversity and regeneration results of government managed forests were not found satisfactory compared to community management forests because of large area of forests as well as higher density of tree species. However, diversity of species in each forest management system was on the lower side than forests studied in other parts of the region and elsewhere (Table 4). It showed that forests in both management systems declined their species diversity that may be due to poor inputs of management and unsustainable use of usufructs from the forests. It is stated that forest dominated by individual one as in case of government management system, the tree density was on lower side than community management system having more number of species and density. So it is concluded that the forest that were managed by community having more density and diversity compared to the forest managed by government.

The regeneration and density of teak was similar to those have been reported for the same species by Carnevale and Monlagnii (2002) and Kaewkrom *et al.*, (2005)^{18,19}. They also reported that the regeneration of teak tree species with regard to density was higher in mixed forest plantation than pure forest plantation. The seedlings, saplings and trees of a plant species exhibit the population dynamic which is used to decide their regeneration status²⁰. The recruitment of seedlings was higher in Sal forests but its seedlings were unable to reach adult stage because of disturbances brought by frequent fire incidence, erosion of soil and water, uncontrolled grazing by nearby animals, cuttings of under canopy plant species by villagers for their domestic cattle. In case of teak, seedlings were higher but they are unable to reach sapling stage because of uprooting of seedlings for nursery use by the foresters and villagers. Besides this, the use of saplings for fuel and agriculture purposes by local people. According to Good and Good (1972)²¹ the soil nutrient, water and sunlight conditions may be the major factors for successful regeneration of tree species. Thus it is concluded that in mixed forests with more number of tree species possibly reduces the pressure on individual species which brought by local people for their use, therefore such forest comparatively received better time for their growth and development.

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