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Regeneration Status of Two Forest Types in Dhundsir Gad Watershed of Garhwal Himalaya, Uttarakhand (India).

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Research Article

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ABSTRACT

The present study was carried out in two forest types in Dhundsir Gad Watershed of Garhwal Himalaya, Uttarakhand (India) to assess regeneration status of tree species. The overall regeneration status was fairly good in both forest types, although regeneration was better at the *Anogeissus latifolius* Forest with its high seedling (1,190 per ha) and saplings density (860 per ha), than the *Pinus roxburghii* Forest where the number of seedlings was 1,080 per ha and the number of saplings 600 per ha. Diameter class distribution of tree species in both forest types showed the highest number of individuals concentrated in the lower diameter classes than the higher diameter classes, suggesting that they have good regeneration potential. The most of the tree species was found with good regeneration in the both forests. Species such as *Acacia catechu*, *Aegle marmelos*, *Anogeissus latifolius*, *Bauhinia variegata*, *Lannea coromandelica*, *Ougeinia oojeinensis*, *Phyllanthus emblica* and *Syzygium cumini* showed good regeneration, while the species *Engelhardia spicata*, *Erythrina variegata*, *Pinus roxburghii* and *Terminalia alata* exhibited fair regeneration in the study area.

INTRODUCTION

The existence of a species in a forest community mainly depends on its ability to regenerate under diverse environmental settings [1]. The future composition of forests depends on the potential regenerative status of tree species within a forest stand in space and time [2]. The regeneration potential of a species can be predicted by the age structure and population dynamics of seedlings and saplings in a forest community [3–7]. Regeneration of a particular species is poor if the numbers of seedlings and saplings are much less than the adult trees.

The mechanism of regeneration may vary for different species as determined by their growth features and nature of disturbance [8]. Poor regeneration is a major problem of mountain forests [9]. Habitat loss is a main problem in the Himalayan region. It includes various forms of land degradation, adverse human impacts on plant resources, deforestation and lowering of the productive capacity of rangelands. Furthermore, other anthropogenic activities like constructions of hill roads, forest fires, over-grazing, lopping of trees for fodder and fuel-wood, removal of leaf and wood litter from the forest floor, are also affecting plant diversity in the Garhwal Himalayan region [10, 11].

Successful management and conservation of natural forests require reliable data on regeneration trends [12]. Therefore, the study of regeneration of forest trees has important implications for the management of natural forests [13]. Keeping in view the aforesaid facts, an attempt has been made to study the regeneration status of two forest types in Dhundsir Gad Watershed of Garhwal Himalaya, Uttarakhand (India).

MATERIALS AND METHODS

Study Area

The watershed is located between 30o13' to 23o23' N latitudes and 78o44' to 78o49' E longitudes (Figure 1) with the elevation ranging from 530 m to 2350 m asl in Garhwal Himalaya, Uttarakhand (India). Dhundsir Gad is the main stream of study area. It rises from Gaddikhal at the height of 2350 m in the north. After flowing 17 Km towards southern direction it joints the Alaknanda river at Dhund Prayag. Besides providing perennial water source it provides habitat to many plant and animal communities.

Methodology

We used quadrat method to assess the species composition at both Forest types during the years 2011–2012. Trees were measured in ten randomly selected quadrats of 10 m × 10 m size, while saplings and seedlings were counted in 40 quadrats of 5 m × 5 m in size at each forest type. The diameter at breast height (DBH at 1.37 m from the ground) for each individual tree was recorded. Based on their DBH, individuals of each species were considered trees if their DBH ≥ 31.5 cm, as saplings when their DBH was between 10.5–31.4 cm and as seedlings when their DBH < 10.5 cm. The density value of seedlings, saplings and trees was calculated following Curtis & McIntosh [15] . These densities were further divided into successive diameter classes, i.e., >10, 10–30, 30–60, 60–90, 90–120 and <120m to find out the regeneration potential and population structure of tree species at each study site. The density-diameter (d-d) distribution of the number of stems for each species was calculated to understand the regeneration pattern.

The regeneration status of tree species was also determined by recording the size of the population of seedlings and saplings. We used following definitions for assessing regeneration: good regeneration if, for any particular species, this condition prevails: number of seedlings > number of saplings > number of trees; fair regeneration again if for any species, the number of seedlings > number of saplings ≤ number of trees and poor regeneration if a species survives only in the sapling stage, i.e., no seedlings present. If a species is present only in the form of adult trees it is considered not regenerating. A species is considered not abundant if the species is not represented by trees, but only by saplings and/or seedlings [16].

RESULTS AND DISCUSSION

The three life stages (seedlings, saplings and trees) for different species suggested their possible future status in the forest [10, 17]. Those species which have nearly equal number of representatives at each of the three life stages are expected to remain dominant in the near future [18]. The tree density in both the forest types varied greatly and it was higher in *Anogeissus latifolius* Forest (650 per ha) than *Pinus roxburghii* Forest (650 per ha). The average sapling density of *Anogeissus latifolius* Forest was also higher (1190 per ha) than *Pinus roxburghii* Forest (1080 per ha). Seedling density was also reported high in *Anogeissus latifolius* Forest (860 per ha) than *Pinus roxburghii* Forest (600 per ha).

The highest tree density in *Pinus roxburghii* Forest was recorded for *Pinus roxburghii* (380 per ha) followed by *Acacia catechu* (50 per ha). Whereas for *Anogeissus latifolius* Forest, the highest tree density was recorded for *Anogeissus latifolius* (400 per ha) followed by *Lannea coromandelica* (80 per ha).

In general, both the forest types were regenerating, although regeneration was better at the *Anogeissus latifolius* Forest (Figure 2) with its high seedling density (1,190 per ha) and saplings (860 per ha) than the *Pinus roxburghii* Forest where the number of seedlings was 1,080 per ha and the number of saplings 600 per ha. The presence of sufficient number of seedlings, saplings and adults trees in a given population indicates successful regeneration [3, 19] and may help in predicting the possible future trend of forests [20].

At *Pinus roxburghii* Forest, out of seven tree species, four species, viz., *Acacia catechu*, *Bauhinia variegata*, *Lannea coromandelica* and *Phyllanthus emblica* showed good regeneration, since all these species possessed a good number of seedlings and saplings (Table 1). The remaining three species, *Engelhardia spicata*, *Erythrina variegata* and *Pinus roxburghii* showed fair regeneration. In this forest type, the highest density of seedling was recorded for *Pinus roxburghii* (450 per ha) followed by *Acacia catechu* (200 per ha), whereas the lowest seedling density (40 per ha) was recorded for *Erythrina variegata*. The highest sapling density (310 per ha) was again recorded for *Pinus roxburghii* followed by *Acacia catechu* and *Lannea coromandelica* (90 per ha). The lowest sapling density was represented by *Erythrina variegata* (10 per ha).

At *Anogeissus latifolius* Forest, seven out of nine tree species, viz., *Acacia catechu*, *Aegle marmelos*, *Anogeissus latifolius*, *Lannea coromandelica*, *Ougeinia oojeinensis*, *Phyllanthus emblica* and *Syzygium cumini*

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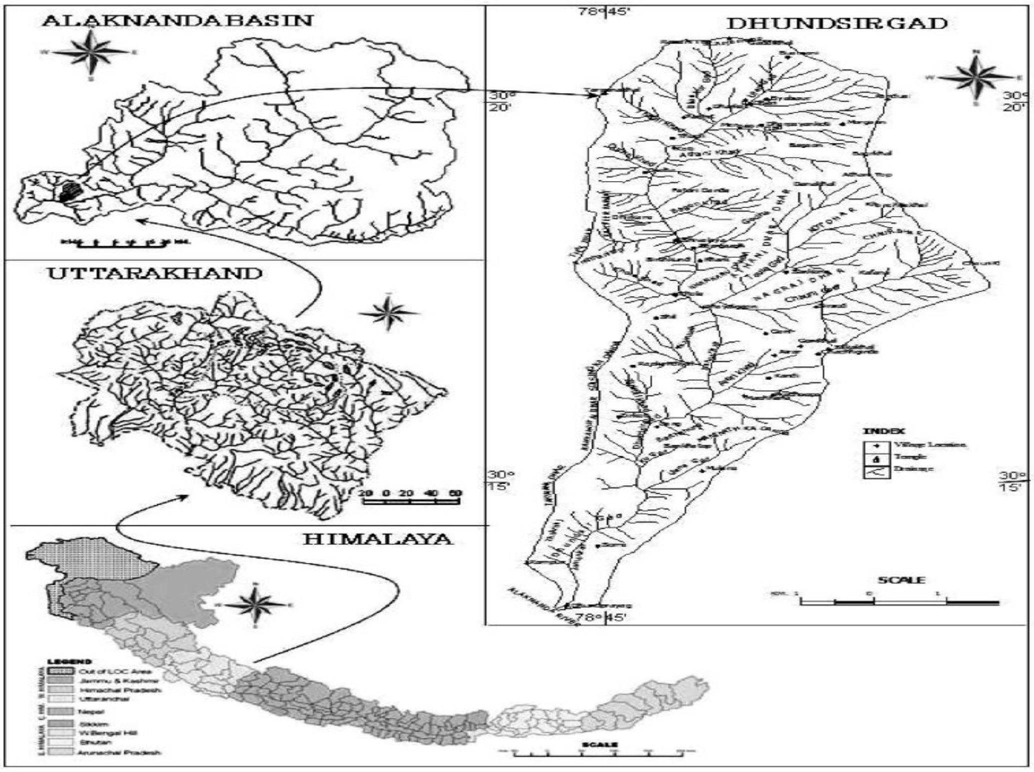
showed good regeneration, while two species, *Engelhardia spicata* and *Terminalia alata* exhibited fair regeneration. In this forest type, the maximum seedling density (490 per ha) was recorded for *Anogeissus latifolius* followed by *Acacia catechu* (180 per ha) and minimum (40 per ha) for *Engelhardia spicata.* Whereas the highest sapling density (430 per ha) was again recorded for *Anogeissus latifolius* followed by *Acacia catechu* (130 per ha) and the lowest sapling density was represented by *Engelhardia spicata* (20 per ha).

Table 1. Seedling, sapling and tree density (ha−1) in different study sites.

Species	*Pinus roxburghii* Forest				*Anogeissus latifolius* Forest			
	Seeding	Sapling	Tree	Regeneration status	Seeding	Sapling	Tree	Regeneration status
Acacia catechu	200	90	50	Good	180	130	30	Good
Aegle marmelos	–	–	–	–	50	30	20	Good
Anogeissus latifolius	–	–	–	–	490	430	400	Good
Bauhinia variegata	120	50	20	Good	–	–	–	–
Engelhardia spicata	50	–	10	Fair	40	20	30	Fair
Erythrina variegata	40	10	10	Fair	–	–	–	–
Lannea coromandelica	120	90	30	Good	170	100	80	Good
Ougeinia oojeinensis	–	–	–	–	70	40	30	Good
Phyllanthus emblica	100	50	40	Good	50	50	20	Good
Pinus roxburghii	450	310	380	Fair	–	–	–	–
Syzygium cumini	–	–	–	–	60	30	10	Good
Terminalia alata	–	–	–	–	80	30	30	Fair
Total	1080	600	540		1190	860	650	

Figure 1. Map showing the study area (Source Ballabh et al. 2011).



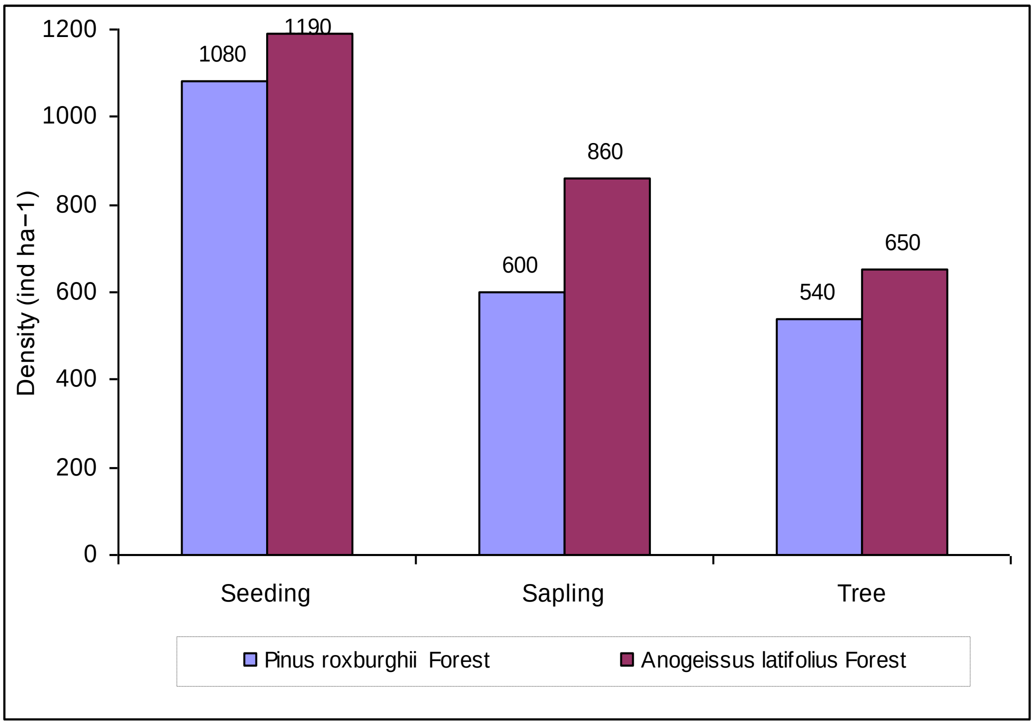


Figure 2. Density (ha−1) of seedlings, saplings and trees at both study sites.

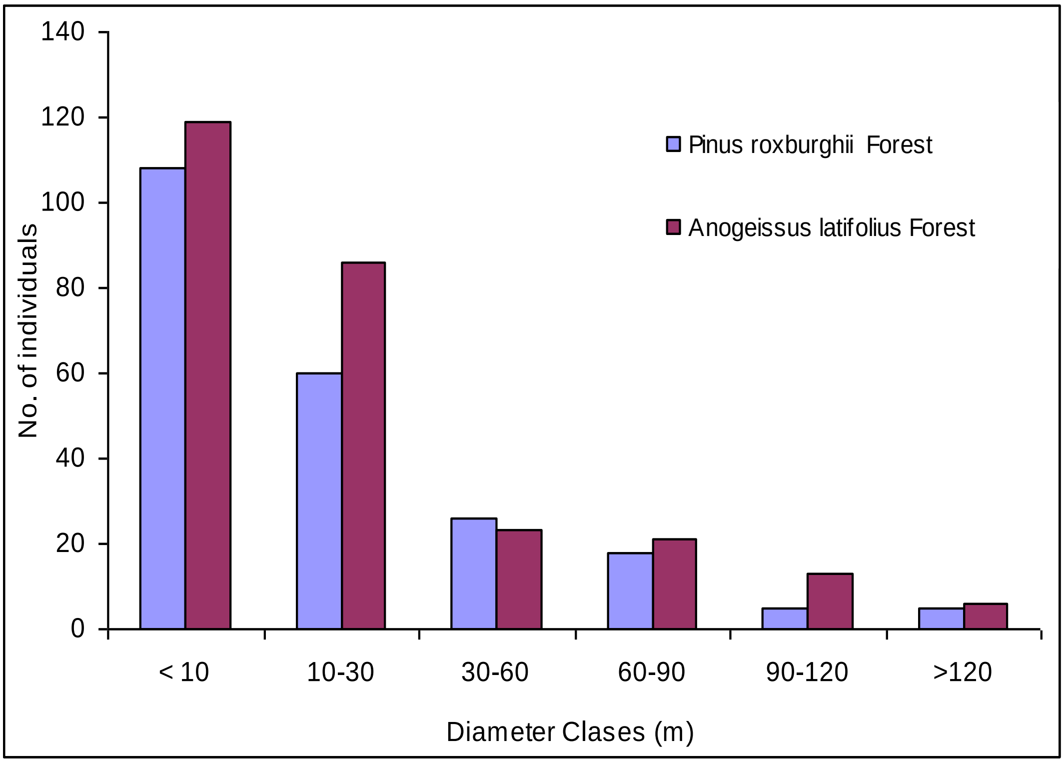


Figure 3. Population structures of tree species at both study sites.

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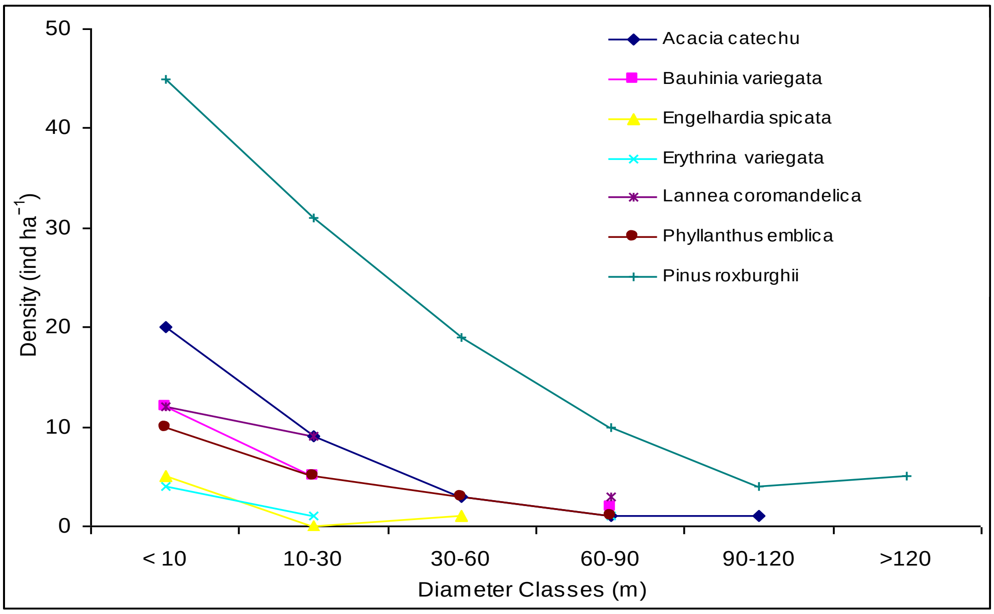

Figure 4. Density of tree species in different diameter classes at *Pinus roxburghii* Forest.

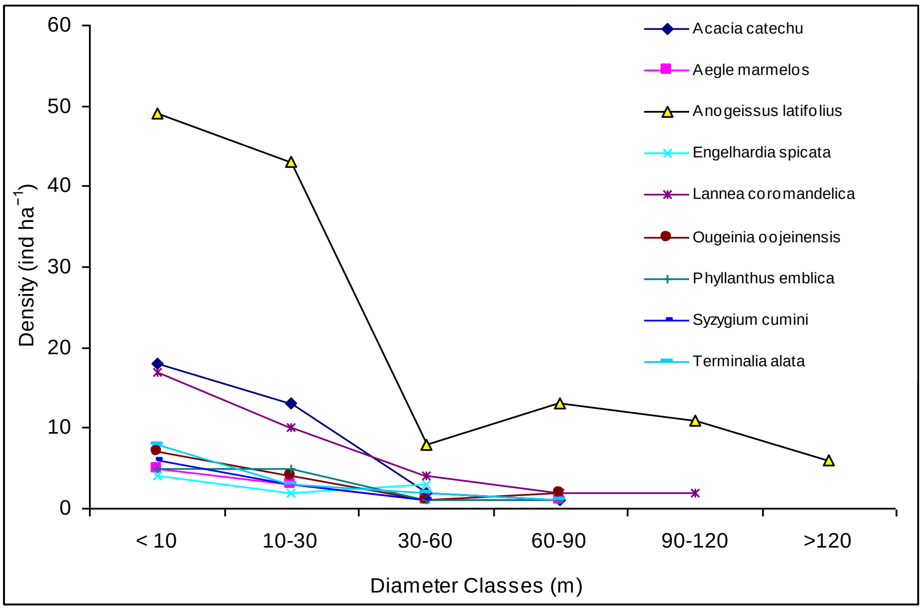

Figure 5. Density of tree species in different diameter classes at *Anogeissus latifolius* Forest.

Regeneration of a species is dependent on internal forest processes and exogenic disturbances [27]. In general both the forests were regenerating, although regeneration was better at the *Anogeissus latifolius* Forest than the *Pinus roxburghii* Forest, which could be due to more human interference at *Pinus roxburghii* Forest. At this forest type, the anthropogenic activities such as over-grazing, lopping of tree branches for fodder and fuel-wood, forest fires, etc., are affecting the diversity and regeneration of tree species. Harvesting of fuel-wood and timber has profound effects on the biodiversity of forest ecosystems [28], often leading to a change in forest structure, composition and its regeneration ability.

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REFERENCES

1. Bargali K, Bisht P, Khan A, Rawat YS. Diversity and regeneration status of tree species at Nainital Catchment, Uttarakhand, India. Int J Biodivers Conserv. 2013;5(5):270–280.
2. Ayyappan N, Parthsarathy N. Biodiversity inventory of trees in a large scale permanent plot of tropical evergreen forest at Varagalaiar, Anamalais, Western Ghats, India. Biodivers Conserv. 1999;8:1533–1554.
3. Saxena AK, Singh SP, Singh JS. Population structure of forests of Kumaun Himalaya: Implication for management. J Environ Manage. 1984;19:307–324.
4. Khan ML, Tripathi RS. Tree regeneration in disturbed subtropical wet-hill forest of North East India. Effects of stump diameter and height on sprouting of four tree species. Forest Ecol Manag. 1987;17:199–209.
5. Ashton PS, Hall P. Comparisons of structure among mixed dipterocarp forests of north-western Borneo. J Ecol. 1992;80:459–481.
6. Gunatilleke CVS, Weerasekara N, Gunatilleke IAUN, Kathriarachchi HS. The role of dipterocarps, their population structures and spatial distributions in the forest dynamics plot in Sinharaja, Sri Lanka. In: Tropical Ecosystem: Structure, Diversity and Human Welfare. Proceedings of the International Conference on Tropical Ecosystems, New Delhi. 2001; pp 591–594.
7. Boraiah KT, Vasudeva R, Shonil A, Bhagwat, Kushalappa CG. Do informally managed sacred groves have higher richness and regeneration of medicinal plants than state managed reserved forests? Curr Sci. 2003;84(6):804–808.
8. Pandey SK, Shukla RP. Plant diversity in managed sal (Shorea robusta Gaertn.) forests of Gorakhpur, India: Species composition, regeneration and conservation. Biodivers Conserv. 2003;12:2295–2319.
9. Krauchii N, Brang P, Schonenberger W. Forests of mountainous regions: Gaps in knowledge and research needs. Forest Ecol Manag. 2000;132:73–82.
10. Ballabha R, Tiwari JK, Tiwari P. Regeneration of Tree Species in the Sub-Tropical Forest of Alaknanda Valley, Garhwal Himalaya (India). For Sci Pract. 2013;15(2):89–97.
11. Radha Ballabha. Floristic Diversity and Quantitative Features of Vegetation around Alaknanda River: A Case Study of the Srinagar Hydroelectric Power Project in Garhwal Himalaya. Ph.D. Thesis, HNB Garhwal University Srinagar Garhwal- 246174, Uttarakhand, India, 2011.
12. Eilu G, Obua J. Tree condition and natural regeneration in disturbed sites of Bwindi Impenetrable Forest National Park, southwestern Uganda. Trop Ecol. 2005;46(1):99–101.
13. Coates KD. Tree recruitment in gaps of various sizes, clear cuts and undisturbed mixed forest of interior British Columbia, Canada. Forest Ecol Manag. 2002;155:387–398.
14. Ballabh H, Chauniyal DD, Lodhi MS. Geomorphic Evidence of Active Tectonics in the Dhundsir Gad Watershed of Alaknada Basin, Uttarakhand, India. Nature and Science. 2011;9(6):1–6.
15. Curtis JT, McIntosh RP. The Interrelations of Certain Analytic and Synthetic Phytosociological Characters. Ecol. 1950;31(3):434–455.
16. Shankar U. A case of high tree diversity in a sal (Shorea robusta)-dominated lowland forest of Eastern Himalaya: Floristic composition, regeneration and conservation. Curr Sci. 2001;81:776–786.
17. Pokhriyal P, Uniyal P, Chauhan DS, Todaria NP. Regeneration status of tree species in forest of Phakot and Pathri Rao watersheds in Garhwal Himalaya. Curr Sci. 2010;98(2):171–175.
18. Bhuyan P, Khan ML, Tripathi RS. Tree diversity and population structure in undisturbed and human-impacted stands of tropical wet evergreen forests in Arunachal Pradesh, Eastern Himalayas, India. Biodivers Conserv. 2003;12(8):1753–1773
19. Khan ML, Raj JPN, Tripathi RS. Regeneration and survival of tree seedlings and sprouts in tropical deciduous and subtropical forests of Meghalaya, India. Forest Ecol Manage. 1987;14:293–304.
20. Sundriyal RC, Sharma E. Anthropogenic pressure on tree structure and biomass in the temperate forest of Mamlay watershed in Sikkim. Forest Ecol Manag. 1996;81:113–134.
21. Leak WB. An expression of diameter distribution for unbalanced, uneven-aged stands and forests. Forest Sci. 1964;10:39–50.
22. Schmelz DV, Lindsey AA. Size-class structure of old-growth forests in Indiana. Forest Sci. 1965;11:258–264.
23. Harcombe PA, Marks PL. Tree diameter distributions and replacement processes in southeast Texas forests. Forest Sci. 1978;24:153–166.
24. West DC, Shugart HH, Ranney JW. Population structure of forests over a large area. Forest Sci. 1981;27:701–710.
25. Kennedy DN, Swaine MD. Germination and Growth of Colonizing Species in Disturbance and Recovery, Royal Society, London. 1991;pp 357–367.
26. Campbell DG, Stone JL, Rosa A. A comparison of the phytosociology and dynamics of three floodplain varzea. Forest of known ages, Rio jurua, western Brazilian Amazon. Bot J Linn Soc. 1992;108:213–237.
27. Barker PCJ, Kirk Patrick JB. Phyllocladus asplenifolius: variability in the population structure of the regeneration niche and dispersion pattern in Tasmanian forests. Aust J Bot. 1994;42:163–190.
28. Sayer JA, Whitmore TC. Tropical moist forests: destruction and species extinction. Biol Conserv. 1991;55:199–214.