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Community Structure and Plant Diversity of Community Based Religious Conserved Forests of Garhwal Himalaya, India

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Abstract

The present study was carried out in four community based religious conserved forests areas i.e., Ansuiya Devi, Ulkagari, Maroor and Jameshwar in Garhwal Himalaya. The aim of the study was to access the ecological and diversity status. The selected sites have status either of reserve forest, communal forest/Van Panchyat or a combination of these apart from having several temples of religious significance. Study was conducted following the stratified random sampling technique by placing random quadrats of 10 m × 10 m size at forest floor. A total of 240 species of plants were recorded from the four study sites, which varied from 93 in Jameshwar to 119 in Ansuiya Devi. The density of these forests ranged from lowest of 782 trees/ha in Jameshwar to 1352 trees/ha in Maroor. The total basal cover (TBC) for trees showed a range of 31.67 m^2/ha in Ulkagari to 84.34 m^2/ha in Ansuiya Devi. Distribution pattern of whole herb and shrub layers were found contagious whereas only three tree species were found randomly distributed. Shannon diversity index (H') for tree species was recorded highest in Ansuiya Devi (2.93) whereas; lowest value (2.10) was recorded in Maroor. Species richness (Margalef index) for trees ranged from 3.29 to 4.35. The study is a pioneer in the aspect and can be helpful in making protocols and policy implications to protect these sites by involving local communities in biodiversity conservation outside the protected area network.

Keywords: Ecosystem; Conservation; Sacred; Protected; Himalaya; Random sampling

Introduction

The urge for the protection of sacred natural sites have been recognized by the Convention on Biological Diversity (CBD) and the UN Permanent Forum on Indigenous Issues. The CBD in 2004 developed the Akwe Kon voluntary guidelines for the conduct of cultural, environmental and social impact assessments regarding proposed developments that may affect sacred sites and on lands and waters traditionally occupied or used by indigenous and local communities (Secretariat of the Convention on Biological Diversity, 2004). Sacred natural sites are part of a broader set of cultural values that different social groups, traditions, beliefs or value systems attach to places and which 'fulfil humankind's need to understand, and connect in meaningful ways, to the environment of its origin and to nature' [1]. There is still disagreement, however, as to what are the "best practices" for forest conservation [2,3] with some advocating strict protection and others arguing for alternative schemes such as community-based, locally-implemented conservation. There are at least three research findings that argue for the need to develop alternatives to strict forest protection. First, empirical accounts indicate significant social and economic costs for local populations derived from the establishment of strictly protected forests [4,5]. Second, recent research suggests that after controlling for (statistically) confounding variables, the effectiveness of strict forest protection in reducing deforestation rates may not be as high as previously estimated (i.e., a 10% reduction vs. earlier estimates of up to 65% reduction) [6] Third, there is evidence that within the same region, forests managed by local or indigenous communities for the production of goods and services can be equally (if not more) effective in maintaining forest cover than those managed under solely protection objectives [7-9]. In Uttarakhand Himalaya biodiversity conservation outside the protected area system is rich because of close relationship between religious, socio-cultural beliefs and conservation [10,11]. These informal protected areas are important from the conservation point of view. These areas include sacred groves, which exhibit rich floral and faunal diversity with some rare and threatened plant species present in them and indicate an ecosystem with various life forms [12].

Over the past few decades, the view that biodiversity rich areas partially or largely managed by local residents, sometimes referred to as community-conserved areas (CCAs), can be effective in saving species from extinction, has gained considerable ground [13,14]. Several ecological studies have been carried out in sacred forest patches. Floristic composition of sacred groves in different parts of India viz., Karnatka [15], Kerala [16], Pondicherry [17], West Bengal [18], Meghalaya [19] and Manipur [20] have been studied by number of researchers. Several ecological investigations have been made in sacred groves of Meghalaya [21-23]. In Uttarakhand [11,24,25] has carried out some studies in and described ecological studies in community conserved and sacred forests. Khumbangmayum et al. made detailed ecological study of four sacred groves of Manipur and found that biological spectrum of the groves is similar to normal

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spectrum of phanerogamic flora of the world. Despite the vast and varied flora in the Garhwal Himalayan region of Uttarakhand, the biodiversity of community, sacred and protected landscapes is yet to be explored sufficiently. Therefore, the present work was carried in some forests of Garhwal Himalaya region in Uttarakhand state of India having several temples with religious significance by local communities to assess their plant diversity and ecological indices.

Materials and Methods

Study area

The present study was carried out in four community conserved forests (Ansuiya Devi, Maroor, Ulkagari and Jamaeshwar) of Garhwal Himalaya located in three districts of Uttarakhand as shown in Figure 1. The selected sites were having status either of reserve forest/ communal forest/Van Panchyat or a combination of these and are having one to several temples with religious significance. The Garhwal Himalayan region of Uttarakhand falls between the geo-coordinates 29° 30′ to 31° 30′ N and 77° 30′ to 80° 15′ E. The rainfall pattern is governed by the summer monsoon. The year has warm dry period, warm wet period and cool dry period. The climatic conditions tend to become cold and harsh with increasing elevation. The annual rainfall varies between 1300 mm to 2500 mm and average annual temperature range is confined between 23°C at 300 m and 13°C at 2000 m. Snowfall occurs above 1800 m. The area receives adequate rainfall generally commencing from mid-June and extending till mid-September but occasional rainfall is also recorded in winter months. Most of the people are dependent on agriculture and forests for their daily needs. Of the total geographical area of the state, about 19% is under permanent snow cover, glaciers and steep slopes where tree growth is not possible due to climatic and physical limitations [26]. The recorded forest area of the State is 34,691 km^2, which constitutes 64.79% of its geographical area.

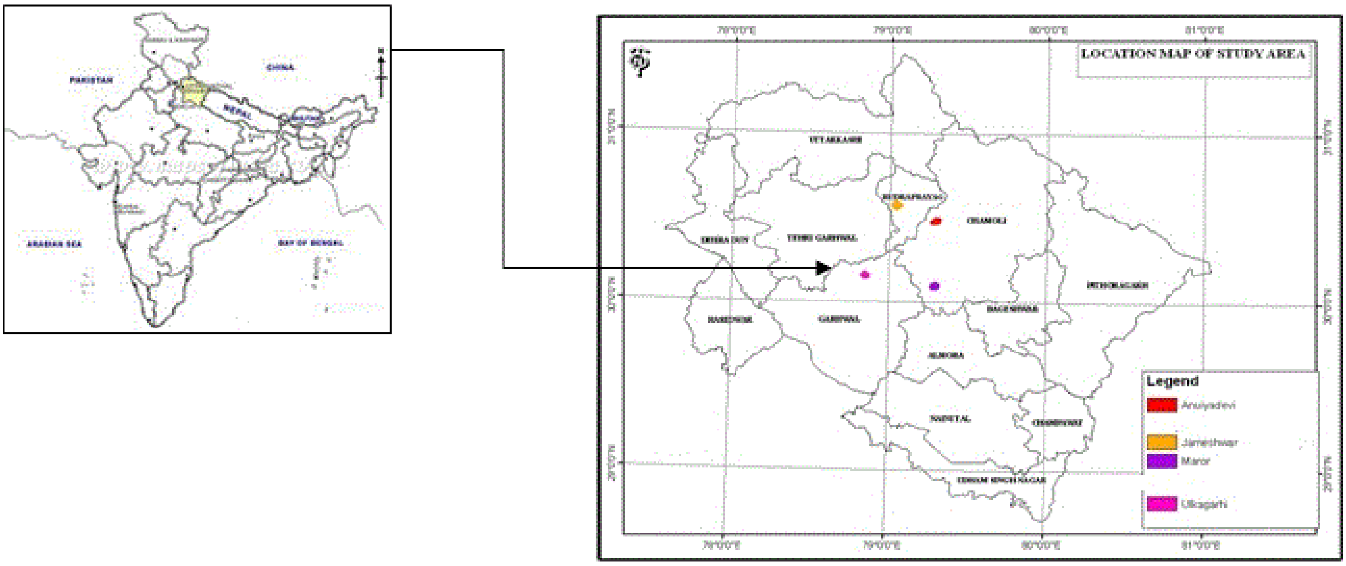

Figure 1: Location of study sites in Garhwal Himalaya.

Methodology

Stratified random sampling technique was applied and quadrats were laid down in forest and were spatially distributed so as to minimize the autocorrelation in the vegetation. Species area curve was used to determine minimal sample area which is based on quantitative variation of the vegetation in terms of species number. Quadrats of 10 m × 10 m were used for tree layer, 5 m × 5 m for shrubs and 1 m × 1 m for herbs species. The GBH (girth at breast height, 1.37 m) measured with tape was used to calculate the basal area. Plant species present in the forest were listed and vegetation was quantitatively analysed for density, frequency, abundance and basal area using appropriate methods [27]. Species richness [28], Shannon diversity index [29], important value index (IVI) [30], Simpson dominance index [31], Berger-Parker diversity index [32] and evenness [33] were also computed.

Results and Discussion

Jameshwar

Among 23 tree species, *Quercus floribunda* with IVI of (54.8) was dominant followed by *Lyonia ovalifolia* (16.1) and *Alnus nepalensis* (15.1). The maximum value of frequency (42%) and density (1.74 trees 100 m^{-2}) were also recorded for *Quercus floribunda* followed by *Aesculus indica* with frequency (30%) and density (0.84 trees 100 m^{-2}). Among shrubs, *Berberis aristata* with IVI (24.52) was dominant species followed by *Eupatorium adenophorum* (19.87) and *Daphni papyracea* (12.53). *Pogostemon benghalense* with IVI (2.08) was found least dominant species followed by *Indigofera heterantha* (2.45). The highest value of frequency (35%) and density (2.03 shrubs 25 m^{-2}) were again recorded for *Berberis aristata* followed by *Eupatorium adenophorum* with frequency (27%) and density (1.70 shrubs 25 m^{-2}). *Andropogon munroi* with IVI (25.29) was found dominant species among herbs followed by *Cynodon dactylon* (17.75). *Arisaema* *tortuosum* with IVI (1.05) was found least dominant herbaceous species (Table 1).

Name of species	Site							
	Jameshwar		Maroor		Ulkagari		Ansuiya Devi	
	Density	IVI	Density	IVI	Density	IVI	Density	IVI
Trees (ind. 100 m^{-2})								
Abies spectibilis (D.Don) Mirl.	-	-	-	-	-	-	0.32	10.95
Acer caesium Wallich ex Brandis	0.28	8.69	0.12	2.79	-	-	0.12	3.53
Acer oblongum Wallich. Ex DC.	-	-	-	-	-	-	0.08	2.03
Aesculus indica (Wall. Ex Camb.) hook.f	0.84	57.96	-	-	0.08	1.05	0.32	8.53
Albizia julibrissin Durazzini,	0.2	6.22	-	-	-	-	-	-
Alnus nepalensis D.Don	0.4	15.13	0.26	7.12	-	-	0.54	17.36
Baxus wallichiana Baill,	0.36	11.64	-	-	-	-	0.12	2.98
Benthamidia capitata (Wallich ex Roxb.) Hara			0.28	7.4	0.2	2	-	-
Betula alnoides Buch-Ham, ex. D. Don	0.12	4.24	0.08	3.24	-	-	-	-
Carpinus faginea Lindl.	-	-	-	-	-	-	0.1	3.27
Carpinus viminea Lidle.	0.1	3.47	-	-	-	-	0.64	16.41
Celtis australis L.	-	-	-	-	0.06	0.29	-	-
Cinnamomum tamala	-	-	-	-	0.08	0.33	-	-
Cotoneaster confuses Klotz	0.06	1.77	0.26	6.19	0.14	1.64		
Cupressus torulosa D. Don in Lambert	0.06	2.37	0.12	2.34	0.22	5.19	0.16	5.6
Daphniphyllum himalayense Wall. Ex Steud.	0.22	8.84	-	-	-	-	1.3	37.94
Eurya acuminata DC	-	-	-	-	-	-	0.16	4.27
Ficus auriculata Lour.	-	-	-	-	-	-	0.08	2.19
Ficus neriifolia Smith	-	-	0.04	1.49	-	-	-	-
Fraxinus micrantha Lingelsheim	0.3	11.82	0.1	2.22	0.08	0.8	0.12	3.41
Ilex dipyrena Wallich	-	-	-	-	-	-	0.26	6.77
Juglans regia L.	0.24	8.5	0.06	2.12	0.14	1.32	0.26	12.88
Lindera pulcherrima (Nees) Benth.ex Hook.f.	-	-	0.06	1.89	-	-	-	-
Lyonia ovalifolia (Wallich) Drude,	0.54	16.08	2.68	55.2	1.1	9.88	0.32	10.61
Myrica esculanta Buch-Ham. Ex D.Don,			0.78	19.32	0.64	13.01	0.08	2.04
Neolitsea cuipala (Buch-Ham, ex. D. Don) Kostermans	0.12	4.48	-	-	-	-	-	-
Persea duthiei (King ex Kook.f.)	0.46	17.86	0.2	3.98	0.12	1.08	0.32	7.01
Pinus roxburghii Sargent	-	-	0.38	9.89	0.46	3.08	0.7	15.82
Populus ciliata Wallich ex Royle	-	-	-	-	0.18	2.49	-	-
Prunus cerosoides D.Don.	0.08	2.35	0.08	1.93	0.08	0.58	-	-
Pyrus communis L.	-	-	0.1	2.1	0.08	0.5	-	-

Pyrus pashia Buch-Ham, ex. D. Don	0.24	10.03	0.2	6.17	-	-	0.24	6.97
Quercus floribunda Lindley ex Rehder	1.74	54.76	0.26	8.64	-	-	0.82	22.02
Quercus glauca Thunb.	-	-	-	-	-	-	0.44	16.42
Quercus leucotrichophora A. Camus	0.42	14.69	4.78	94.77	2.44	28.7	1.04	37.03
Quercus semecarpifolia J.E.Smith.	0.06	2.93	-	-	-	-	-	-
Rhododendron arboreum Smith, Exot.Bot.	0.34	10	2.3	50.96	1.62	19.22	0.98	33.45
Taxus baccata L.SSP	-	-	-	-	-	-	0.16	5.1
Toona serrata (Royle) Roem	-	-	-	-	0.04	0.73	-	-
Toona serrata (Royle) Roem	-	-	-	-	-	-	0.08	2.87
Swida macrophylla (Wallich) Sojak	0.22	10.37	0.16	5.36	0.14	2.89	0.08	2.53
Symplocos rasmosissima Wallich ex G.Don	0.42	15.78	0.12	3.17	0.56	4.31	-	-
Shurbs (ind. 25 m^{-2})								
Arachne cordifolia (Decne.) Hurusawa	-	-	-	-	-	-	0.13	1.79
Artemisia japonica Thunb.,	0.33	4.66	-	-	0.24	4.9	-	-
Artemisia roxburghiana Wallich ex Berser	-	-	0.42	4.37	0.47	4.68	0.33	4.5
Asparagus adscendens Buch-Ham. Ex Roxb.,	-	-	-	-	0.2	2.61	-	-
Asparagus curilius Buch-Ham. Ex Roxb.	-	-	-	-	-	-	0.35	3.81
Asparegus racemosus Willd.,	-	-	-	-	0.84	11.47	-	-
Berberis aristata DC.,	2.03	24.52	2.67	26.05	0.79	12.89	1.17	12.37
Berberis asiatica Roxb. Ex DC	0.54	7.01	0.2	3.43	0.21	3.94	0.47	6.34
Berberis lycium Royle.	-	-	-	-	-	-	1.33	13.8
Berchemia edgeworthii Lawson	-	-	0.24	1.99	-	-	-	-
Boehmeria macrophylla (Hook.) Reichb. Ex Meisn	-	-	-	-	-	-	0.07	1.45
Boehmeria platyphylla D.Don	-	-	-	-	-	-	0.07	1.19
Buddleja paniculata Wall.	-	-	-	-	-	-	0.63	7.5
Caryopteris foetida (D.Don) Thellung,	-	-	-	-	1.09	17.44	-	-
Caryopteris odorata (D.Don) B.L.Robinson,	-	-	-	-	0.17	3.16	-	-
Colebrookia oppositifolia J.E.Smith	0.56	6.86	0.42	5.31	0.27	3.59	-	-
Cotoneaster bacillaris Wallich	0.36	5.45	0.25	2.28	0.32	5.18	-	-
Cyathula tomentosa (Roth) Moq.	0.21	2.94	0.46	4.11	-	-	0.15	1.63
Daphne papyracea Wallch ex Steudei	0.91	12.53	0.68	7.64	0.29	4.73	1.67	21.27
Debregeasia salicifolia (D.Don) Rendle	0.17	3.81	0.06	1.03	-	-	0.29	2.95
Desmodium concinnum DC	-	-	-	-	0.09	1.62	0.29	3.21
Desmodium elegans DC.	-	-	0.18	1.67	-	-	0.24	3.2
Elsholtzia flava (Benth.) Benth	-	-	-	-	0.31	5.12	-	-
Elshotzia fruticosa (D.Don) Rehder	0.72	4.45	-	-	-	-	0.92	10.18

Eupatorium adenophorum Sprengel	1.7	19.87	0.27	5.22	3.78	41.64	-	-
Flacourtia indica (Burm. F.) Merrill	-	-	-	-	0.03	0.45	-	-
Girardinia diversifolia (Link) Friis	-	-	-	-	-	-	0.12	1.2
Goldfussia dalhousiana Nees	0.33	4.66	-	-	-	-	-	-
Hypericum elodeoides Choisy,	0.25	5.25	0.19	1.96	0.32	4.93	0.83	7.6
Indigofera cassioides	-	-	0.09	0.95	-	-	-	-
Indigofera dosua Buch-Ham.ex D.Don	-	-	-	-	-	-	0.59	7.01
Indigofera heterantha Wallich ex Brandis	0.1	2.45	0.26	3.04	-	-	-	-
Inula cappa (Buch-Ham. Ex D.Don) DC.,	0.3	4.73	-	-	0.12	1.82	-	-
Inula cuspidate (DC.) C.B.Clarke	0.4	6.6	-	-	-	-	-	-
Lantana camara L.	-	-	0.29	4.38	0.2	2.61	-	-
Leptodermis lanceolata Wallich	0.17	2.94	0.35	3.52	0.23	3.06	0.13	1.79
Rhamnus persica Boissier	0.37	6.1	-	-	-	-	-	-
Rhamnus purpureus Edgew	0.25	4.38	-	-	-	-	-	-
Rhamnus virgatus Roxb.	-	-	-	-	-	-	0.25	2.72
Rhus parviflora Roxb.	0.11	2.52	0.44	4.71	0.11	2	-	-
Rosa brunonii Lindley	0.21	3.81	0.3	4.44	-	-	0.15	1.9
Rosa macrophylla Lindley	-	-	0.15	2.69	0.27	5.1	-	-
Rubia manjith Roxb. Ex Fleming			0.35	4.7				
Rubus ellipticus Smith	0.8	9.72	0.65	6.3	0.25	3.2	0.12	1.47
Rubus niveus Wallich ex G.Don	-	-	-	-	0.23	3.06	0.21	2.23
Rubus paniculatus Smith,	-	-	-	-	0.17	2.41	-	-
Sarcococca saligna (Don) Munell.	-	-	-	-	-	-	2.44	26.89
Saxifraga diversifolia Wallich ex Seringe	-	-	0.61	5.14	-	-	-	-
Segereetia filiformis (Roth) G.Don. Syst.	-	-	0.37	3.86	-	-	-	-
Sinarundinaria falcata (Nees) Chao and Renvoize	0.13	2.66	0.18	1.67	-	-	0.31	3.06
Skimmia anquetilia Taylor & Airy Shaw	-	-	0.35	4.7	-	-	-	-
Smilax aspera L.	0.26	3.87	0.32	4.07	-	-	0.17	2.81
Smilax glaucophylla Klotz.	-	-	0.12	1.63	-	-	0.67	5.87
Solanum nigrum L.	-	-	-	-	-	-	0.8	5.8
Spermadictyon sauveoleus Roxb.,	-	-	-	-	0.14	2.71	-	-
Spiraea canescens D.Don	0.23	3.66	0.1	1.01	0.15	2.27	-	-
Taxillus articulatum Var. liquidambaricolum	-	-	-	-	-	-	0.18	2.6
Thamnocalamus falconeri Hook. F. ex Munro	-	-	-	-	-	-	0.64	5.96
Thamnocalamus spathiflora (Trinius) Murno	-	-	-	-	-	-	0.5	4.92
Urtica ardens Link.	-	-	-	-	-	-	0.31	2.53

Urtica dioica L.	0.96	11.15	0.33	3.18	0.44	5.24	0.3	2.74
Viburnum cotinifolium	-	-	0.28	3.86	-	-	-	-
Woodfordia fructicosa (L.) Kurz	-	-	0.19	1.72	-	-	0.15	2.16
Zanthoxylum armatum	-	-	0.34	2.99	-	-	-	-
Herbs (ind. m^{-2})								
Angelica glauca Edgew.	-	-	4.94	38.61	-	-	-	-
Anthraxon prionodes (Steuel) Dandy	-	-	-	-	0.11	1.25	-	-
Apluda aristata L.			0.35	3.4	-	-	-	-
Apluda mutica L.	1.29	6.51	0.24	3.24	0.67	5.35	0.83	6.47
Argostemma verticillatum Wallich	-	-	-	-	-	-	0.11	1.11
Arisaema tortuosum (Wallich) Schott	0.05	1.05	0.17	1.86	-	-	-	-
Arundinella bengalensis (Spreng.) Druce	-	-	-	-	-	-	0.16	1.62
Arundinella birmanica Hook. F	0.55	4.31	-	-	0.1	0.87		
Arundinella nepalensis Trin	-	-	-	-	-	-	0.19	2.11
Arundinella nervosa (Roxb.) Neex ex Hook. &Arn	0.58	3.92	-	-	0.09	1.35	-	-
Bergenia ciliata (Haworth) Sterbn	0.28	3.52	0.17	2.48	0.57	5.84	0.95	11.31
Bidens bipinnata L.	-	-	0.26	2.93	-	-	-	-
Bidens pilosa L.	-	-	0.34	3.35	0.43	3.59	-	-
Boenninghausenia albiflora (Hook.) Reichb. Ex Meisn	0.34	3.74	0.13	1.68	0.28	3.11	1.96	12.67
Boerhavia diffusa L.	-	-	0.51	5.83	-	-	-	-
Bupleurum falcatum L.	-	-	0.21	2.49	-	-	-	-
Bupleurum hamiltonii Balakrishnan	0.57	3.75	-	-	-	-	-	-
Cannabis sativa L.	0.6	4.01	-	-	-	-	-	-
Carex caricina (D.Don) Ghildyal and Battacharyya	-	-	-	-	0.81	7.68	-	-
Centella asiatica (L.) Urban	-	-	-	-	-	-	0.3	3.27
Chenopodium album L.	-	-	-	-	-	-	0.15	2.2
Circea alpina L.	-	-	-	-	-	-	0.16	2.25
Coelogyne cristata Lindley	-	-	-	-	-	-	0.21	1.6
Commelina paludosa Blume,	-	-	-	-	-	-	0.22	2.78
Convolvulus arvensis L.	0.12	1.43	-	-	0.9	7.16	-	-
Conyza stricta Willd.	-	-	-	-	-	-	0.15	2.08
Cucurbita maxima Duchesne	-	-	0.25	3.32	-	-	-	-
Curcuma aromatica Salisbury	-	-	0.1	1.51	-	-	-	-
Cuscuta santapaui	-	-	-	-	-	-	0.21	2.73
Cymbopogon martini (Roxb.) W. Watson	1.33	6.66	1.84	20.93	0.21	1.28	-	-

Cynodon dactylon (L.) Pearsoon	3.73	17.75	0.48	3.84	3.95	21.51	-	-
Cynoglossum zeylanicum (Valh ex Hornem.) Thunb. Ex	-	-	-	-	-	-	0.23	2.32
Danthonia schneidri Pilger.	-	-	-	-	-	-	0.24	1.86
Datura fastuosa	-	-	0.18	2.11	-	-		
Datura stramonium L.	-	-	-	-	-	-	0.22	2.63
Desmodium trifloum (L.) DC.	0.26	2.7	-	-	0.24	2.26	-	-
Dichrocephala integrifolia (L.f.) Kuntze	-	-	-	-	-	-	0.14	1.15
Dryopteris cochleata (Buch-Ham. Ex D.Don)C. chr	1.32	14.51	-	-	1.07	9.84	0.9	10.7
Dryopteris juxtaposita Christ,	0.42	4.19	-	-	0.24	2.71	0.63	7.82
Drypteris redactopinnata Basu Et Panigr	-	-	1.16	10.12	-	-	-	-
Drypteris wallichiana (Sprengin.L)Hayland	-	-	0.42	3.72	-	-	-	-
Drypteris xyloides (Ktze) C. Chr	-	-	1.2	11.33	-	-	-	-
Dyropteris nigropaleacea (Jankins) Jankins	-	-	-	-	-	-	0.1	1.7
Epilobium royleanum Haussknecht	-	-	-	-	-	-	0.41	4.41
Eragrostis nigra Nees ex Stud.) Meld.	-	-	-	-	-	-	0.14	1.63
Euphorbia pilosa L.	0.29	2.94			0.27	1.96	-	-
Fragaria nubicola Lindley ex Lacaita	0.19	2.57	0.23	2.59	0.93	5.55	-	-
Galium aparine L.	-	-	-	-	-	-	0.32	3.49
Galium elegans Wallich,	0.26	3.09	-	-	0.25	2.4	0.17	2.3
Gebera gossypina (Royle) G. Beauv.	-	-	-	-			0.06	0.65
Gentiana capitata Buch-Ham. Ex D.Don	0.2	3.35	-	-	0.1	1.47	0.19	2.37
Gentiana pedicellata (D.Don) Wallich	0.3	3.22	-	-	0.1	0.96		
Geranium wallichianum D.Don ex Sweet	-	-	-	-			0.59	5.74
Gerbera gossypina (Royle) G. Beaue.,	0.29	3.55	-	-	0.08	0.64		
Herteropogon contortus (L.) P. Beauv. Ex Roemer & Schultes,	1.17	5.56	-	-	1.36	8.54	-	-
Imperata cylindrica (L.) P. Beauv	0.28	3.64	-	-	0.69	4.72		
Isachne albens Trinius.	0.2	3.23	-	-	0.19	1.83	0.12	1.41
Linderbergia indica (L.) Vatke	0.45	4.04	-	-	0.17	2.08		
Mentha arvensis L.	-	-	0.13	1.66	-	-	-	-
Micromaria biflora (Buch-Ham. Ex D.Don) Benth	0.42	4.81	-	-	0.29	2.29	-	-
Neanotis calycina (Wallich ex Hook. F.) W.H.Lewis	-	-	-	-	-	-	0.09	1.42
Origanum vulgare L.	-	-	0.12	2.05	-	-	0.37	4.6
Oxalis corniculata L.	-	-	0.19	2.4	0.22	1.43	0.43	3.72
Parthenium hysterophorus	-	-	0.38	4.97	-	-	-	-

Paspalum scrobiculatum L.	-	-	-	-	-	-	0.14	1.63
Perilla frutescens (L.) Britton	0.25	2.19	0.09	1.19	0.18	1.45	0.13	1.58
Pimpinella diversifolia DC	-	-	-	-	-	-	0.1	0.69
Polystichum squarrosum (D.Don) Fée	-	-	0.44	5.06	0.1	1.24	-	-
Polystichum stimulana	-	-	0.22	1.9	-	-	0.19	2.01
Potentilla fulgens Wallich ex Hook	0.57	5.5	0.15	2.17	0.46	4.91	0.5	4.57
Potentilla gerardiana Lindley ex Lehmann	-	-	0.1	1.33	-	-	0.3	3.15
Primula denticulata Smith	-	-	0.11	1.56	-	-	-	-
Reinwardtia indica Dumortier	0.37	3.88	-	-	0.4	2.6	-	-
Rumex hastatus D.Don	-	-	0.2	2.63	-	-	0.17	2.55
Salvia lanata Roxb.	0.52	5.56	0.33	3.9	0.24	2.71	-	-
Salvia nubicola Wallich ex Sweet	0.14	1.75	-	-	0.14	1.99	-	-
Scutellaria grossa Wallich ex Benth	-	-	-	-	0.35	3.29	-	-
Sedum multicaule Wall. Ex Lindl	-	-	-	-	-	-	0.43	3.47
Senecio nudicaulis Buch-Ham ex D.Don	0.38	5.03	0.05	1.08	0.28	2.68	-	-
Senecio rufinervis DC.			0.3	4.37	-	-	0.03	0.39
Siegesbeckia orientalis L.	-	-	-	-	0.66	4.45	0.15	1.42
Sonchus oleraceus L.	-	-	-	-	0.22	2.72	-	-
Swertia chirayita (Roxb. Ex Fleming) Karsten	0.37	3.61	-	-	-	-	0.15	1.68
Taraxacum officinale Weber,	-	-	-	-	0.17	2.34	-	-
Thalictrum foliolosum DC.	-	-	-	-	0.48	3.76	-	-
Themeda anathera (Nees ex Steud.) Hack	-	-	-	-	-	-	0.46	4.13
Themeda arundinacea (Roxb.) Ridley			1.39	12.06	-	-	-	-
Triplostegia glandulifera Wall ex. DC	-	-	-	-	-	-	0.35	3.1
Veronica biloba L.	0.27	3.23			0.51	3.29		
Vicatia coniifolia DC	-		-	-	-	-	0.23	2.8
Viola betonicifolia J. Snith	0.12	2.17	-	-	0.59	4.34		
Viola biflora L.			0.27	2.98	-	-	-	-
Viola canescens Wallich	0.18	3.03	-	-	0.52	4.87	-	-

Table 1: Density and importance value index (IVI) of different life forms in different study areas.

Maroor

Among tree species *Quercus leucotrichophora* with IVI (94.76) was dominant followed by *Lyonia ovalifolia* (55.20) and *Rhododendron arboreum* (50.95). *Ficus neriifolia* with IVI (1.49) was found least dominant tree species. Among shrubs, *Berberis aristata* with IVI (26.05) was dominant species followed by *Pyracantha crenulata* (22.36). *Indigofera cassoides* with IVI value of (0.95) was found least dominant species followed by *Viburnum cordifolium* (1.01). The overall value of density for shrubs was recorded as 18.76 shrubs 25 m^{-2}. Among herbs *Angelica glauca* was dominant with IVI value of (38.60) followed by *Cymbopogon martinii* (20.95). *Senecio nudicaulis* with IVI value of 1.07 was recorded least dominant herbaceous species. *Senecio nudicaulis* with 0.05 herbs m^{-2} was having lowest density followed by *Curcuma aromatic* and *Smilax aspera* with density value of 0.09 herbs m^{-2} each (Table 1).

Ansuiya Devi

A total of 119 species were recorded from *Ansuiya* Devi forest. Among 27 tree species, *Daphniphyllum himalayense* with IVI (37.94) was dominant followed by *Quercus leucotrichophora* (37.03) and *Rhododendron arboreum* (33.45). Distribution pattern of only three tree species was found random whereas rest of the species was distributed contagiously. Among shrubs *Sarcococca saligna* with IVI (26.89) was dominant followed by *Daphne papyraceae* (21.27). *Boehmeria platyphylla* with IVI (1.19) was found least dominant species followed by *Girardinia diversifolia* (1.20). The highest values of frequency (50%) and density (2.44 shrubs 25 m^{-2}) were also observed for *Sarcococca saligna* followed by *Daphne papyraceae* with frequency (45%) and density (1.67 shrubs 25 m^{-2}). *Andropogon munroi* among herbs was dominant with IVI (27.14) followed by *Boenninghausenia albiflora* (12.67). The highest density (4.73 herbs m^{-2}) was recorded for *Andropogon munroi* followed by *Boenninghausenia albiflora* (1.96 herbs m^{-2}) (Table 1).

Ulkagari

Among 21 tree species, *Quercus leucotrichophora* with IVI (82.14) was dominant followed by *Rhododendron arboreum* IVI (50.89). The maximum value for frequency (86%) and density (2.44 trees 100 m^{-2}) was recorded for *Quercus leucotrichophora* followed by *Rhododendron arboreum* with frequency (44%) and density (1.62 trees 100 m^{-2}). Distribution pattern of only one tree species was found random while it was found contagious for rest of tree species. Among shrubs, *Eupatorium adenoporum* with IVI value of 41.64 was dominant species followed by *Caryopteris foetida* (17.44). *Flacourtia indica* was least dominant species with IVI value (0.45). The overall density of shrubs was (14.81shrubs 25 m^{-2}). Among herbs *Andropogon munroi* with IVI value of (25.68) was dominant species followed by *Cynodon dactylon* (21.51) and *Dryopteris cochleata* (9.84). *Gerbera gossypina* and *Arundinella nervosa* were having lowest density of (0.08 plants m^{-2}). The overall density of herbs was (26.7 herbs m^{-2}) (Table 1).

Within the context of science and the environmental movement, Berkes [34] argues that community-based conservation must not be viewed as a "panacea," but rather needs to be integrated as one part of a broader "interdisciplinary science of conservation." Integration and exchange among forms of knowledge has been cited as a key aspect of successful community based conservation projects [35,36]. Such fusions need to involve actual discussions among multiple groups, rather than simply being gestures toward multiple epistemological frameworks [37]. The structure and function of forest ecosystem is determined by the plant component more than any other living component of the system [38]. A total of 240 species of plants were recorded from the four sites which varied from 93 in Jameshwar to 119 in Ansuiya Devi. The density values of these forests ranged from lowest of 782 trees ha^{-1} in Jameshwar to 1352 trees ha^{-1} in Maroor. The values of the present study are supported by the results of Sinha and Maikhuri [39] who reported density values of 1399 trees ha^{-1} and 1144 trees ha^{-1} in core zone and interactive zone of Hariyali sacred forest in Garhwal Himalaya. Chandrashekara and Sankar [16] reported stem density of 3341 ha^{-1} for Iringole sacred grove in Kerala. The reason for the lower density values in the present study may be that sacred groves in Maharashtra and elsewhere are more pristine and more conserved than sacred groves or Community Conserved Areas of Garhwal Himalaya, where majority of communities depend on forests for their livelihood activities. Shrub density in the present study varied from 14.12/25 m^{-2} in Jameshwar to 18.76/25 m^{-2} in Maroor, whereas density of herbaceous flora ranged between 20.14 plants m^{-2} in Maroor to 26.7 plants m^{-2} in Ansuiya Devi. Pala et al. [21] has reported trees, shrubs and herbs density of 6.88 trees 100 m^{-2}, 12.8 shrubs 25 m^{-2} and 16.34 herbs m^{-2} respectively in Chanderbadni sacred forest of Garhwal Himalaya.

The total basal cover (TBC) for trees showed a range of 31.67 m^2 ha^{-1} in Ulkagari to 84.34 m^2 ha^{-1} in Ansuiya Devi (Table 2). The variation in the TBC in different study sites may be due to variation in number and size of tree species in different sites. Vidyasagaran et al. [40] reported the average TBC value of 25.79 m^2 ha^{-1} in sacred groves of Thrissur district of Kerala. Sinha and Maikhuri [39] also reported TBC values of 47.59 to 26.87 m^2 ha^{-1} in the core and interactive zone of Hariyali sacred forest from Garhwal Himalaya which are also comparable to present study. The TBC values of present study are on upper side to the reported values of 37.37 m^2 ha^{-1} to 53.15 m^2 ha^{-1} by Chandrashekara and Sankar from some sacred groves of Kerala. Taboos are associated with green felling in the forest which may be another reason to curb the biomass extraction. Sacred forests mostly show reduced forest loss than unprotected areas and higher plant species richness, canopy heights and stem diameters [41]. Rawat [42] also reported TBC values between 3.74-80.36 m^2 ha^{-1} for temperate forests in Garhwal Himalaya and are in accordance with the present study. Pande et al. [43] also reported TBC values of 56.42-126 m^2 ha^{-1} in Garhwal Himalayan forests and is also in support of our study. For tree species, contagious distribution pattern was found at most of the sites in the present study except few tree species which were found randomly distributed. Several workers [44,45] have reported contagious distribution in natural vegetation. However, shrubs and herbs were found distributed contagiously in all study sites. Regular distribution pattern was entirely absent. Mishra and Laloo [46] and Upadhaya et al. [47] also reported contagious pattern of distribution for sub-tropical forests of north-east India. Other studies conducted within Garhwal Himalaya [48,49] also show contagious pattern of Vegetational distribution in different forest types.

Parameters	Jameshwar	Ulkagari	Ansuiya Devi	Maroor
Tree density (m^{-2} ha^{-1})	782	858	984	1352
Shrub density (25 m^{-2})	14.12	14.81	17.9	18.78
Herb density (m^{-2})	26.29	26.7	21.76	20.14
TBC (m^2ha^{-1})	60.12	31.67	84.34	58.78
No. of species/ species richness	93	102	119	102
Diversity Index: (Tree)				
Shannon Index (H')	2.67	2.35	2.93	2.1

Simpson Index (CD)	0.08	0.14	0.06	0.19
Margalef Index (Spp. richness)	3.69	3.29	4.35	3.53
Berger-Parker Index	0.22	0.28	0.13	0.35
Evenness	0.85	0.76	0.87	0.78
Diversity Index: (Shrub)				
Shannon Index (H')	3.07	2.49	3.42	2.97
Simpson Index (CD)	0.06	0.09	0.06	0.05
Margalef Index (Spp. richness)	4	4.52	5.07	5.44
Berger-Parker Index	0.14	0.25	0.14	0.14
Evenness	0.92	0.83	0.93	0.8
Diversity Index: (Herb)				
Shannon Index (H')	3.11	3.28	3.51	3.05
Simpson Index (CD)	0.07	0.06	0.08	0.09
Margalef Index (Spp. richness)	4.66	5.47	6.02	5.06
Berger-Parker Index	0.2	0.16	0.22	0.25
Evenness	0.84	0.84	0.88	0.81

Table 2: Different ecological and diversity parameters across study sites.

Diversity Indices

In the present study Shannon diversity index (H′) for tree species was recorded highest in Ansuiya Devi (2.93) whereas lowest value (2.10) was recorded in Maroor. For shrubs Shannon diversity index (H') was found highest for Ansuiya Devi (3.42) and lowest (2.49) for Ulkagari. For herb layer lowest value of Shannon diversity Index was observed for Maroor (3.05) whereas highest was observed for Ansuiya Devi (3.51) (Table 2). Pala et al. [21] reported Shannon and Simpsons diversity indices for tree layer (2.42) and (0.13) and for shrub layer (3.24) and (0.05) respectively for Sem Mukhem sacred forest of Garhwal Himalaya, which are comparable to the values reported in the present study. Khumbongmayum et al. [50] reported Shannon diversity index (H′) ranging from 1.79 to 3.17, 1.89 to 2.25 and 2.77 to 3.13, whereas values for Simpsons Index (Cd) varied between 0.07 to 0.59, 0.11 to 0.16 and 0.06 to 0.50 for trees, shrubs and herbs respectively in four sacred groves of Manipur which are in support of present study. The reasons for higher values of Shannon Indices in trees may be due to favourable climatic conditions and more protection. Local communities have also established communal forests, from where fuel wood, fodder and other small timber for daily uses is extracted. Simpson's index was recorded as reverse of Shannon diversity which is a general trend. Highest value of Simpson's index 0.19 was recorded for Maroor, whereas lowest 0.06 was observed for Ansuiya Devi. Simpson's value for shrubs did not vary much and was within the range of 0.05 to 0.09. Simpson's index observed for herb layer was within the range of 0.06 to 0.09. Shannon Index diversity (H′) and concentration of dominance (CD) were found inversely proportional to each other which have also been suggested by Misra et al. [51]. The values of present study for (CD) fall within the reported values of Whittaker and Niering [52] and Risser and Rice [53] for temperate vegetation (0.01-0.99) [54].

Species richness (Margalef index) for trees ranged from 3.29 to 4.35 in the present study. Similar trend (1.28-4.30) was found by Sagar et al. [55] for dry deciduous sub-tropical forests of Northern India. Shrubs and herbs were the highest contributors to plant richness. The richness (Margalef) index for shrubs and herbs ranged from 4 to 5.44 and 4.66 to 6.02 respectively. Berger-Parker index value for trees in the present study ranged from 0.13 to 0.35, for shrubs 0.14 to 0.25 and while for herbs it was recorded within the range of 0.16 to 0.25. For tree species, the value of evenness did not vary much and was within the range of 0.76 to 0.87 in the present study. In case of shrub and herb layer it was recorded 0.83 to 0.93 and 0.81 to 0.88 respectively [56,57]. The values are more or less similar to reported values of (0.55 to 0.83), (0.93 to 0.99) and (0.92 to 0.96) for trees, shrubs and herbs in four sacred groves of Manipur. The values of present study are little more than reported value (0.4) for a sacred grove in Meghalaya north-east India [51].

Conclusion

State of Uttarakhand has a long history about community conservation efforts like Chipko movements and Van Panchyat forests. Garhwal Himalaya, a religious land adds another dimension of social conservation to these forests. The tree diversity and TBC may be comparable with other state owned forests but sustainable utilization of resources in these forests better as there is more belief. Various provisions in the Biological Diversity Act, 2002, such as the preparation of the people's biodiversity register (PBR) and documentation of community-conserved areas such as the SNS, provide an opportunity for involving local communities in biodiversity conservation outside the Protected Area Network. Such efforts in biodiversity conservation have immense ecological value since these areas would serve as refuge, buffers, and corridors for a large number of species to thrive. The present study can highlight the importance of these forests in conservation of flora as these can be strong candidates to be declared as community or conservation reserve to expand protected area network.

References

1. Putney A (2005) Building cultural support for protected areas through sacred natural sites' in McNeely J Friends for Life IUCN Gland Switzerland and Cambridge.
2. Shahabuddin G, Roa M (2010) Do community-conserved areas effectively conserve biological diversity? Global insights and the Indian context. Biological Conservation 143: 2926-2936.
3. Wilshusen PR, Brechin SR, Fortwangler CL, West PC (2002) Reinventing a square wheel: critique of a resurgent "protection paradigm" in international biodiversity conservation. Society and Natural Resources 15: 17-40.
4. Ferraro PJ (2002) The local costs of establishing protected areas in low-income nations: Ranomafana National Park Madagascar. Ecological Economics 43: 261-275.
5. Andam K, Ferraro PJ, Sims K, Healy A, Holland M (2010) Protected areas reduced poverty in Costa Rica and Thailand. PNAS 107: 9996-10001.
6. Andam K, Ferraro PJ, Pfaff A, Sanchez-Azofeifa GA, Robalino JA (2008) Measuring the effectiveness of protected area networks in reducing deforestation. PNAS 105: 16089-16094.
7. Bray DB, Duran E, Romas VH, Mas JF, Velazquez A, et al. (2008) Tropical deforestation, community forests, and protected areas in the Maya Forest. Ecology and Society 13: 56.
8. Ellis EA, Porter-Bolland L (2008) Is community-based forest management more effective than protected areas? A comparison of land use/land cover change in two neighboring study areas of the Central Yucatan Peninsula, Mexico. For Ecol and Management 256: 1971-1983.
9. Nepstad D, Schwartzman S, Bamberger B, Santilli M, Ray D, et al. (2006) Inhibition of Amazon Deforestation and Fire by Parks and Indigenous Lands. Conservation Biology 20: 65-73.
10. Pala NA, Negi AK, Todaria NP (2014) The religious, social and cultural significance of forest landscapes in Uttarakhand Himalaya, India. International Journal of Conservation Science 5: 215-222.
11. Pala NA, Negi AK, Todaria NP (2015) Ecological status and socio-cultural significance of Sem mukhem temple landscape in Garhwal Himalaya, India. Indian Forester 141: 496-504.
12. Dash S (2005) Kabi Sacred grove of North Sikkim. Current Science 89: 427-428.
13. Bray DB, Merino-Perez L, Negreros-Casillo P, Segura-Warnholtz G, Torres-Rojo, et al. (2003) Mexico's community forests as a global model for sustainable landscapes. Cons Biology 17: 672-677.
14. Kothri A (2006) Community conserved areas: towards ecological and livelihood security. Parks 16: 703-733.
15. Vasanth VKR, Shivprasad PV, Chandrashekar KR (2001) Dipterocarps in a sacred grove at Nadikoor, Udupi Districts of Karnataka India. In: Ganeshaiah KN, Uma Shanker R, Bawa KS (eds.). Tropical Ecosystems Structure Diversity and Human Welfare. Oxford and IBH Publishing New Delhi.
16. Chandrashekara UM, Sankar S (1998) Ecology and management of sacred groves in Kerala. For Ecol and Manag 112: 165-177.
17. Kadamba D, Ramanujam MP, Praveen CK, Krishnan V (2000) Changing strategy for biodiversity conservation: rediscovering the roots in cultural traditions. Abstract, National Symposium on Environmental Crisis and Security in the New Millennium.
18. Basu R (2000) Studies on sacred groves and taboos in Purulia district of West Bengal. Indian Forester 126: 1309-1318.
19. Tiwari BK, Barik SK, Tripathi RS (1999) Sacred Forests of Meghalaya: Biological and Cultural Diversity. Regional Centre, National Afforestation and Eco-Development Board, North- Eastern Hill University, Shillong.
20. Khumbongmayum AD, Khan ML, Tripathi RS (2004) Sacred groves of Manipur - ideal centres for biodiversity conservation. Cur Sci 87: 430-433.
21. Khiewtam RS (1986) Ecosystem Function of Protected Forests of Cherrapunji and Adjoining Area. Thesis North-Eastern Hill University Shillong India.
22. Khan ML, Raj JPN, Tripathi RS (1987) Population structure of some tree species in disturbed and protected sub-tropical forests of North East India. Acta Oecologia Oecologiaapplicata 8: 247-255.
23. Pandey HN, Tripathi OP, Tripathi RS (2003) Ecological analysis of forest vegetation of Meghalaya. In: Bhatt BP, Bujarbaruah KM, Sharma YP, Patiram (eds.) Approaches for increasing agriculture productivity in hill and mountain ecosystem. ICAR Research Complex for NEH Region Umain Meghalaya. pp: 37-49.
24. Pala NA, Negi AK, Gokhale Y, Todaria NP (2011) Species composition and phytosociological status of Chanderbadni Sacred forest in Garhwal Himalaya Uttarakhand India. NeBIO 2: 52-59.
25. Pala NA, Negi AK, Gokhale Y, Todaria NP (2013) Tree Regeneration status of sacred and protected landscapes in Garhwal Himalaya, India. Journal of Sustainable forestry 32: 230-246.
26. FSI (2009) State of Forest Report. Forest Survey of India, Ministry of Environment and Forests Govt. of India Dehradun India pp: 159-162.
27. Mishra R (1968) Ecology Work Book. Oxford and IBM publishing Co Calcutta.
28. Margalef R (1958) Information theory in ecology. General Systems 3: 36-71.
29. Shannon CE, Wiener W (1963) The mathematical theory of communication. University of Illinois Press Urbana.
30. Phillips EA (1959) Methods of Vegetation Study. Henry Hill & Co Inc., USA.
31. Simpson EH (1949) Measurement of diversity. Nature (London) 163: 688.
32. Berger WH, Parker FL (1970) Diversity of planktonic foraminifera in deep-sea sediments. Science. 168: 1345-1347.
33. Pielou EC (1966) The measurement of diversity in different types of biological collections. J of Theoretical Biology 13: 131-144.
34. Berkes F (2004) Rethinking community-based conservation. Conservation Biology 18: 621-630.
35. Drew JA (2005) Use of traditional ecological knowledge in marine conservation. Cons Biology 19: 1286-1293.
36. Fraser DJ, Coon TP, Michael R, Dion R, Bernatchez L (2006) Integrating traditional and evolutionary knowledge in biodiversity conservation: A population level case study. Ecology and Society 11: 621-630.
37. Mwangi G, Luc L (2007) Application of fragmentation research to conservation planning for multiple stakeholders: An example from the taita hills, southeast kenya. Biological Conservation 134: 271-278.
38. Richards PW (1996) The tropical rain forest: An ecological study. Cambridge University Press New York.
39. Sinha B, Maikhuri RK (1998) Conservation through socio-cultural-religious practice in Garhwal Himalaya: A case study of Hariyali sacred site. In:Ramakrishnan PS, Saxena KG, Chandrashekara UM (eds.). Conserving the sacred for biodiversity management. UNESCO and Oxford-IBH Publishing,New Delhi.
40. Vidyasagaran K, Abhilash D, Babu LC (2005) Plant diversity and conservation of Kalasamala sacred grove of Thrissur District Kerala. In: Kunihikannan C, Singh BG (eds.). Starategy for conservation of sacred groves Institute of Forest Genetics and Tree Breeding, Coimbatore.
41. Campbell MO (2004) Traditional forest protection and woodlots in the coastal savannah of Ghana. Environmental Conservation 31: 225-232.
42. Rawat RS (2005) Studies on interrelationship of woody vegetation density and soil characteristics along altitudinal gradient in a montane forest of Garhwal Himalays. Indian Forester 131: 990-994.

43. Pande PK, Negi JDS, Sharma SC (2001) Plant species diversity and vegetation analysis in moist temperate Himalayan forest. Indian Journal of Forestry 24: 456-470.
44. Greig-Smith P (1957) Quantitative Plant Ecology. Butterworth London.
45. Singh JS, Yadav PS (1974) Seasonal variation in composition plant biomass and net primary productivity of tropical grassland at Kurukshetra, India. Ecology Monograph 44: 351-376.
46. Mishra BP, Laloo RC (2005) Effect of fragmentation on plant diversity and community characters of the sacred grove of Meghalaya. In: National Conference on Current Trends of Research in Science and Technology 50th Annual Technical Session of Assam. Science Society Deka PC, Jha DK Assam Science Society Guwahati.
47. Upadhaya K, Pandey HN, Law PS, Tripathi RS (2004) Diversity and population characteristics of woody species in sub-tropical humid forests exposed to culture disturbances in Meghalaya NE India. Tropical Ecology 45: 303-314.
48. Bhandari BS, Mehta JP, Tiwari SC (1998) Woody vegetation structure along an altitudinal gradient in a part of Garhwal Himalaya. Journal of Hill Research 11: 26-31.
49. Pande PK, Negi JDS, Sharma SC (2002) Plant species diversity, composition, gradient analysis and regeneration behaviour of some tree species in a moist temperate western Himalayan forest ecosystem. Indian Forester 128: 869-889.
50. Khumbongmayum AD, Khan ML, Tripathi RS (2005) Survival and growth of seedlings of a few tree species in the four sacred groves of Manipur Northeast India. Cur Sci 88: 1781-1788.
51. Mishra BP, Tripathi OP, Tripathi RS, Pandey HN (2004) Effects of anthropogenic disturbance on plant diversity and community structure of a sacred grove in Meghalaya, northeast India. Biodiversity and Conservation 13: 421-436.
52. Whittaker RH, Niering WA (1965) Vegetation of the santa catalina mountains, Arizona: A gradient analysis of the south slope. Ecology 46: 429-452.
53. Risser PG, Rise EL (1971) Diversity in tree species in Oklhoma upland forest, Ecology. 52: 876-880.
54. Bartz AE (1988) Basic Statistical Concepts. Macmillan Publishing Company New York.
55. Sagar R, Raghubanshi AS, Singh JS (2003) Tree species composition, dispersion and diversity along a disturbance gradient in a dry tropical forest region of India. For Ecol And Management 186: 61-71.
56. Uniyal P, Pokhriyal P, Dasgupta S, Bhatt D, Todaria NP (2010) Plant diversity in two forest types along the disturbance gradient in Dewalgarh Watershed Garhwal Himalaya Cur Sci 98: 938-943.
57. Secretariat of the Convention on Biological Diversity (2004) 'Akwé: Kon voluntary guidelines for the conduct of cultural, environmental and social impact assessment regarding developments proposed to take place on, or which are likely to impact on, sacred sites and on lands and waters traditionally occupied or used by indigenous and local communities', CBD Guidelines Series, Montreal.