Protected Groves of Garhwal Himalaya, India: Biodiversity Status and Strategies for their Conservation

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Abstract: The people of Garhwal, a part of central Himalaya, follow ancestral worship and animism in the form of deity worship, with the central focus on worship in forest patches. These social boundaries help to conserve the entire organisms as a whole, which stand the concept of sacred or protected groves. The pleasing of deities is performed every year by the villagers around the sacred groves, in honour of the deities and to gain their favour. Indigenous cultural and rituals practices of the local people in sacred groves serve as a tool for conserving biodiversity. Protected or sacred groves are distributed over a wide ecosystem and help in conservation of rare and endemic species. Well-preserved protected groves are store houses of valuable medicinal and other plants having high economic value, and serve as a refuge to threatened species. Thirty sacred and protected groves were inventoried in six districts of Garhwal Himalaya. Detailed studies were carried out in four selected groves, to understand the importance of biodiversity status and vegetation characteristics. A total of 271 plant species representing 211 genera under 88 families were recorded through baseline floristic survey. The species diversity indices were compared among the four studied groves. The vegetation composition and community characteristics were recorded. Ethnobotanical uses of species were examined, which reveal that 90% of species were used as medicine for the treatment of various ailments. A few of the medicinal plants which have disappeared from the locality are now confined only to the groves. Socio- cultural aspects were investigated taking into account the attitudes of local people, which indicates social beliefs and taboo are eroding simultaneously degrading the degree of protection of sacred and protected groves. Therefore, conservation measures of protected groves need to be formulated considering the factor of degradation and the basic necessities of the local people. Until and unless a viable option is provided to the local people for sustaining their economic condition, no step for conservation of biodiversity will be successful.
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1. Introduction

In India as elsewhere in many parts of world a number of communities practice different form of nature worship. One significant tradition of nature worship is that of providing protection to patches of forest dedicated to deities or ancestral sprits. These patches of forests are known as sacred or protected groves. The institution of sacred groves is very ancient and once was widespread in most parts of the world with over 50,000 sacred groves so far reported from different parts of India. Sacred groves are the rich heritage of India, and play an important role in the religious and socio cultural life of the local people. Sacred groves are ecosystems by themselves and perform all the ecological function. Many threatened endangered, and rare species find safe refuge in the sacred groves. Himalaya has been a perennial source of attraction, curiosity and challenge to human intellect throughout the ages. Uttarakhand possesses luxuriant and varied vegetation within the Himalayan region. Almost every plant has economic importance from either a nutritional, aesthetic or medicinal viewpoint. In fact, large percentage of crude drugs in the Indian market comes from this Himalayan area (Badoni 1990). Nearly thirty species from the Garhwal Himalaya have been listed in various categories under threat in the Indian Red Data Book (Nayar and Sastry, 1987, 1988 and 1990) of which 24 species are from high altitude alpine region.

Garhwal Himalaya in India commonly referred to as Dev Bhumi (land of the Gods) houses many important religious shrines like Badrinath, Kedarnath, Yamanotri and Gangotri etc. besides the sacred confluence of five tributaries of holy Ganga. It is interesting to note here that many a time an entire landscape represented by a variety of species and ecosystems had been considered sacred or protected and conserved as such in pristine condition by forbidding the use of any resource from it. This strategy seems to be quite analogous to the present day's concept of species conservation through sanctuaries, national parks and biosphere reserves. The examples of forest community conservation are the well known Chipko, Raksha Sutra and Maity movements. These are among the pioneer social movements towards the conservation and regional environment initiated in the Central Himalaya. All these movements had one common objectives i.e., to

conserve the serenity of the environment by maintaining the natural forest wealth. The Chipko and Raksha Sutra were aimed to prevent the forests by deforestation while Maity movement aimed to raise new forest through plantation programs. Many traditional societies all over the world revered and worshipped nature and considered certain plants and animals as sacred. Some communities also followed the practice of setting aside certain patches of land or forest as "sacred groves" dedicated to a deity or village God, protected and worshipped. In India sacred groves are found all over the country and abundantly along the Western Ghats and the West coast and in several parts of Kerala, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Rajasthan, Orissa and Himachal Pradesh.

Sacred groves in different states are locally known by different names. In Kerala there are hundreds of small jungles dedicated to snakes called Sarpakavu (sarpa meaning snake and kavu meaning jungle). There are the Ayyappan kavus dedicated to Lord Ayyapan, the most famous of which is Sabarimala, visited by millions of devotees every year. These areas have protected many rare and endangered species, including valuable medicinal plants. In Maharashtra, the sacred groves are known as deonus and are found in the Western Ghats region. Known as samas in Bihar, such groves are seen in the Chotanagpur regions, established by the Munda tribe as abodes of their godly spirits. In the arid regions of Rajasthan there are many sacred groves, variously called as Oraans, Vanis, and Kenking. The Bishnois of Rajasthan have also been responsible for preserving the habitats of the Khejadi tree (*Prosopis cineraria*).

The role of sacred groves in the conservation of biodiversity has long been recognized (Kosambi, 1962; Gadgil and Vartak, 1976; Haridasan and Rao, 1985; Khan *et al.* 1997). All forms of vegetation in the sacred groves are supposed to be under the protection of the reigning deity of that grove, and the removal of even a small twig is taboo (Vartak and Gadgil, 1973). It is believed that sacred virgin forests date back to several thousands of years when human society was in the primitive state. Gadgil and Vartak (1973) have traced this historical link of the sacred groves to the pre-agricultural, hunting and gathering societies. Hughes and Chandran (1997) have presented an overview on the distribution of sacred groves around the earth in Asia, Africa, Australia, Europe and America.

In India, the earliest documented work on sacred groves is that of the first Inspector General of Forests, Brandis (1897). Burman (1992) has reported the existence of sacred groves all along the Himalaya from the northwest to northeast, western Himalaya of Kumaun and Garhwal, Darjeeling and Meghalaya. Ramakrishnan (1996) also identified sacred groves from different parts of India, known by different names given to them in ethnic terms. Many scholars have been working on conservation of sacred groves through socio-cultural practices in different parts of India (Gadgil and Vartak, 1975; Boojh and Ramakrishnan, 1983; Rodgers, 1994; King, 1997; Tiwari *et al.*, 1998; Sinha and Maikhuri, 1998.

However, little information is available on protected groves and conservation of the biodiversity of Garhwal Himalaya, in Uttarakhand. People of Garhwal follow ancestral worship and animism in the form of deity worship, with the central focus of worship on forest patches which signify protected or sacred groves. The area of protected groves range from a few square meters to several hectares situated in different altitudinal gradients and natural ecosystems which helps in conservation of biodiversity. But unfortunately, due to population explosion, various encroachment and activities, protected groves have also become the victim of encroachment and exploitation, though the extent of degradation in the groves is less when compared with the other forests. Degradation of groves not only signifies loss of rich and relict vegetation but also the loss of rich cultural diversity. Therefore, it has become an urgent need to make an extensive inventory of the groves, their biodiversity and ethnobotanical importance, and analyze the role of associated cultural and religious beliefs, and their conservation.

Affection towards nature was a zoolatry (worshipping of animals), totem (considering plants and animals sacred), etc., which in turn led to a sort of prudent conservation. Religious beliefs, traditions and customs of Indians bear an allegiance in restricting the exhaustive use of natural resources. In the present study, an attempt has been made to document and analyze the vegetation composition and ethnobotanical uses of plant species in protected groves of Garhwal Himalaya. People's attributes towards the sacred groves were investigated to find out the causes of degradation and to develop strategies for their conservation.

2. Identification of Protected groves

An extensive field survey was undertaken to identify the protected groves of Garhwal Himalaya (Figure1). Records of local government and literature was screened to locate the grove and to ascertain their historical background. Traditional institutes such as village headman, priests and priestesses or the local folk, denizens and caretakers of the protected groves etc. were approached for identifying groves in the area under investigation. Data on protected groves were collected through various sources including informal and formal interviews and by visiting the groves and using a transect or quadrat.

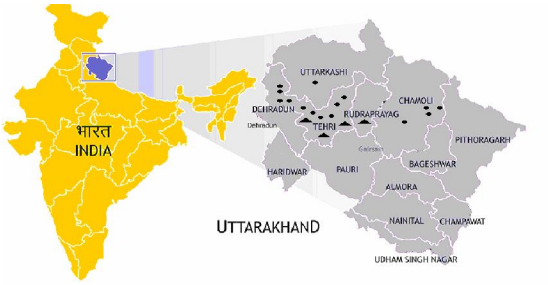

Figure 1. Map of Uttarakhand showing distribution of Protected Groves in Garhwal Himalaya. (5) Indicates the location of selected groves for the present study. From left to right are Kukuru Shah PG (PG 1), Dubakoti PG (PG 2), Hariyali Devi Sacred grove (PG 3) and Karuna Devi PG (PG4)

Table 1. General characteristics of the selected protected groves

Name of grove	Locality	Area Sq.km.	Aspect and position	Elevation range (meters)
Kukuru shah van (PG1)	Lawa (Tehri)	1.1	Eastern Valley	950-1200
Dobakoti van (PG2)	Gaja (Tehri)	2.5	Western hill slope	1700-1900
Hariyali Devi sacred Van (PG3)	Kodima (Rudraprayag)	5.5.	Northwest hill	2800-3200
Karuna sacred van (PG4)	Maruraghad (Tehri)	1	Eastern Valley	850-1200

The identified groves were listed accordingly. Most of the protected groves were open and did not have well- demarcated boundaries, and therefore, the area measured for a given grove was mainly based on the information collected from the concerned village headman and through measurement based on an imaginary lines or boundary around the groves. The information about the protected groves has been obtained from multiple sources like interviewing large number of people around the groves, specially the people concerned with running and maintaining such places of worship. Inventories of thirty protected groves from the six districts of Garhwal Himalaya were collected and four protected groves from two districts were selected for the purpose of detailed studies on floristic composition and ethnobotanical importance. The selection of these four groves was made taking into consideration their size, vegetation and location. The selected protected groves were Kukuru Shah (PG 1) Dobakoti (PG2) Hariyali Devi (PG3) and Karuna van (PG4). Among these one is temperate and rests are sub-tropical forests as their dominant vegetation. General information about these four groves is summarized in Table 1.

Table 2. Physicochemical features of the sorts of four groves

Parameters	PG 1	PG 2	PG 3	PG 4
Organic carbon (%)	1.07	1.04	1.12	0.98
Total Nitrogen (%)	0.047	0.10	0.15	0.14
Soluble Phosphorus (kg/ha)	12.31	14.44	12.99	12.82
Exchangeable Potassium	212	197.66	200	176.66
pH	6.09	6.07	6.04	6.11
Plant diversity (Total no. of species)	110	129	84	114

3. Methodology

The Lesser Himalaya and Shivalik region of Gahwal Himalaya was surveyed for two successive years (December 2005- July 2007). Phytosociological studies in the groves were carried out by quadrat method. Ten quadrats of 10 x 10m were laid randomly in each grove for tree species. Ten quadrats of 5 x 5m for shrubs and 20 quadrats of 1 x 1m size for herbs were laid within the same 10 x 10m quadrats that were laid for the study of tree species. Density (tree ha-1) and basal area values were calculated for each species. Importance Value Index (IVI) of each species was calculated as per Misra (1968). The similarity index (Sorensen 1948), species diversity index (Shannon and Weiner 1963), concentration of dominance of the community (Simpson 1949), species richness index (Menthinick 1964) and evenness index (Pielou 1969) were calculated following the formula as given by them.

4. Results and discussion

An ethnobotanical survey was carried out to collect information on the uses of plants in medicinal and other purposes by local people who reside near the groves. Detail information on herbal drug plants was gathered from the local 'Vaidys' to whom the traditionation knowledge was passed on from their ancestors. Other ethnobotanical data were prepared, including the collection of information through folk, oral tradition, etc. The floristic composition of the four groves is summarized in Table 3. Angiospermic flora, of the study site comprises total 271 species respectively 87 families, 250 species were dicotyledons (75 families) and 21 species of monocotyledons (12 families) collected during the study period. Out of 87 angiospermic families, Lamiaceae contributed maximum share 8.9% (24 species), followed by Asteraceae 8.5% (23 species) Euphorbiaceae 7.0% (19 species) and Rosaceae 5.5% (15 species), Apiaceae and Ranunculaceae both 3.3% (9 species each), Acanthaceae 3.0% (8 species). Out of 87 families, single genera and species, 46 families with single genera but two to more species represented 6 families (Table 3).

Table 3. Floristic composition of four protected groves.

Family	Genera No.	Percentage	Species No.	Percentage
Acanthaceae	6	2.8	8	3.0
Amarantaceae	2	0.9	3	1.1
Anacardiaceae	6	1.9	6	1.8
Apiaceae	7	3.3	9	3.3
Apocynaceae	1	0.5	1	0.4
Aquifoliaceae	1	0.5	1	0.4
Araceae	1	0.5	1	0.4
Araliaceae	1	0.5	1	0.4
Asclepiadaceae	1	0.5	1	0.4
Asteraceae	20	9.5	23	8.5
Balsaminaceae	1	0.5	2	0.7
Berberidaceae	1	0.5	1	0.4
Betulaceae	2	0.9	2	0.7
Bombacaeae	1	0.5	1	0.4
Boraginaceae	1	0.5	2	0.7
Brassicaceae	1	0.5	1	0.4
Buddlejaceae	1	0.5	1	0.4
Burseraceae	1	0.5	1	0.4
Buxaceae	1	0.5	1	0.4
Caesalpinaceae	2	0.9	6	2.2
Cannabinaceae	1	0.5	1	0.4
Caprifoliaceae	3	1.4	3	1.1
Caryophyllaceae	3	1.4	3	1.1
Celastraceae	1	0.5	1	0.4
Chenopodiaceae	1	0.5	1	0.4
Combretaceae	1	0.5	1	0.4
Convolvulaceae	1	0.5	4	1.5
Cornaceae	1	0.5	1	0.4
Crassulaceae	1	0.5	1	0.4
Cucurbitaceae	1	0.5	1	0.4
Cupressaceae	1	0.5	1	0.4
Cuscutaceae	1	0.5	1	0.4
Cyperaceae	1	0.5	1	0.4
Dipsacaceae	1	0.5	1	0.4
Elaeagnaceae	1	0.5	1	0.4
Ericaceae	2	0.9	3	1.1
Euphorbiaceae	12	5.7	19	7.0
Fabaceae	3	1.4	4	1.5
Fagaceae	1	0.5	3	1.1
Gentianaceae	3	1.4	5	1.8
Geraniaceae	1	0.5	1	0.4
Hippocastanaceae	1	0.5	1	0.4
Hydrangeaceae	1	0.5	1	0.4
Hypericaceae	1	0.5	2	0.7
Juglandaceae	1	0.5	1	0.4
Lamiaceae	18	8.5	24	8.9
Lauraceae	3	1.4	3	1.1
Linaceae	1	0.5	1	0.4
Lythraceae	1	0.5	1	0.4
Malvaceae	3	1.4	4	1.5
Meliaceae	2	0.9	2	0.7
Menispermaceae	1	0.5	1	0.4
Mimosaceae	2	0.9	3	1.1
Moraceae	2	0.9	6	2.2
Myricaceae	2	0.9	2	0.7
Myrsinacaeae	1	0.5	1	0.4
Nyctaginaceae	1	0.5	1	0.4
Oleaceae	1	0.5	1	0.4
Onagraceae	2	0.9	2	0.7
Oxalidaceae	1	0.5	2	0.7
Papaveraceae	1	0.5	1	0.4
Pinaceae	3	1.4	4	1.5
Piperaceae	1	0.5	1	0.4
Poaceae	7	3.3	7	2.6
Polygonaceae	2	0.9	4	1.5
Ranunculaceae	5	2.4	9	3.3
Rhamnaceae	1	0.5	2	0.7
Rosaceae	12	5.7	15	5.5
Rubiaceae	4	1.9	4	1.5
Rutaceae	5	2.4	6	2.2
Salicaceae	1	0.5	1	0.4
Santalaceae	1	0.5	1	0.4
Sapotaceae	1	0.5	1	0.4
Saxifragaceae	2	0.9	2	0.7
Scrophulariaceae	4	1.9	4	1.5
Smilacaceae	1	0.5	1	0.4
Solanaceae	3	1.4	4	1.5
Sterculiaceae	1	0.5	1	0.4
Symplocaceae	1	0.5	1	0.4
Urticaceae	5	2.4	5	1.8
Verbenaceae	2	0.9	2	0.7
Violaceae	1	0.5	3	1.1
Zingiberaceae	1	0.5	1	0.4

Table 4. Similarity (based on Sorensen similarity index (%) among the tree, shrub and herb species occurring in the selected Protected groves (T – trees, S – shrubs and H – herbs).

GROVES	(PG2)			(PG2)			(PG4)		
	T	S	H	T	S	H	T	S	H
(PG1)									
T	11.76			7.27			76.05		
S		7.01			7.69			78.68	
H			11.42			14.95			85.33
(PG2)									
T				28.57			10.34		
S					23.72			14.7	
H						20.97			11.53
(PG3)									
T	33.35						6.19		
S		23.72						7.17	
H			23.77						12.85

4.2. Comparison of diversity of the four protected groves

The similarity index among the four protected groves varied considerably (Table 4). The highest similarity index was observed between groves 1 and 3 exhibiting 80.02% and lowest between groves 1 and 2 (1.06%). While considering the similarity index value among the tree, shrub and herb species separately, the maximum similarity value (%) was evinced between groves 1 and 4 contributing 76.05% for tree, 78.68% for shrub and 85.33% for herb species (Table 4). Groves 3 and 4 were least similar in terms of tree species having 7.17% similarity index, while groves 1 and 2 showed least similarity (11.42%) for herb species.

The maximum similarity index value for shrubs was displayed between groves 1 and 4 exhibiting 78.68% and groves 2 and 3 recording 28.57%. The density and IVI values of each species are given in Table 5 Some groves with least common species among the four groves may be due to diverse natural ecosystems, altitudinal variation, edaphic, physiographic and micro environment factors. The transition of vegetation type and habitat complexity in each grove may restrict the occurrence of similar species in different groves. The vegetation of the two groves located in the similar areas (1 and 4) was found to be similar. The reason may be attributed to close altitudinal range, physiographic, soil and climatic conditions, etc.

Table 5 Density (plant ha-1) and Importance value index (IVI) of different plant species occurring in the selected protected groves of Garhwal Himalaya.

SPECIES	PG1		PG2		PG3		PG4	
	Density /ha	IVI	Density /ha	IVI	Density /ha	IVI	Density /ha	IVI
TREE								
Acacia catechu	2.9	11.6					4.4	12.77
Benthamedia capitata			6.3	14.43	5.8	9.01		
Betula alnoides					106.6	15.70		
Bomax ceiba	1.3	10.91					1.7	11.27
Emblica officinalis			4.2	13.56				
Ficus auriculata	2.3	12.19					4.3	13.75
Ficus palmate	2.6	10.23	6.9	16.53			3.2	10.2
Garuga pinnata			6.3	19.94				
Buchanania lanzan	7.6	22.46						
Lannea coromandelica	3.1	12.67					4.1	13.09
Lyonia ovalifolia					133.5	19.16		
Madhuca longifolia			5.5	15.51				
Mallotus philippensis	3.9	13.06					5.4	13.76
Myrica esculenta			10.3	22.18	22.60	14.61		
Picea smithiana					2	13.94		
Pinus roxburghii	1.4	12.3					2.6	13.18
Pinus wallichiana					8.3	20.86		
Pyrus pashia	2.3	11.14	6.1	16.23	7.5	7.44	3.5	12.19
Quercus floribunda			9.4	22.91	19.5	21.55		
Quercus leucotrichophora			7.9	22.39	183.2	25.73		
Quercus semecarpifolia			8.5	24.33	256	31.68		
Rhododendron arboreum			10.6	29.63	403.4	42.96		
Rhododendron barbatum					16.3	16.65		
Syzygium cumini	0.8	11.04					1.2	11.64
Tectona grandis	0.9	10.18					1.7	11.3
Toona ciliate	0.8	12.21					1.6	13.42
SHRUB								
Artemisia roxburghiana			4.8	11.68				
Berberis asiatica					9	12.33		
Boenninghausenia albiflora			3.6	9.6	6.1	11.62		
Bambusa arundinacea	1.4	14.57					2.4	15.1
Buddleja asiatica			3.8	10.28				
Cassia tora	3.1	11.36					5.1	12.3
Cotoneaster microphyllus			3.9	11.13				
Daphne papyracea			2.2	6.9	7.8	11.37		
Debregeasia longifolia					8.7	13.34		
Desmodium elegans					7.3	13.6		
Deutzia compacta					11.7	15.5		
Euphorbia royleana	2.8	33.78					4.6	34.63
Indigofera heterantha			2.7	11.3	4	8.41		
Inula cappa			2.7	13				
Murraya paniculata	4.8	13.16					5.8	12.57
Prinsepia utilis			4.5	12.41	5.4	9.59		
Reinwardtia indica	5.1	11.84					6.9	11.94
Rhus ellipticus	1.4	12.82					3.4	14.32
Rhus parviflora	3.7	11.73	4.7	11.97			3.7	10.53
Rosa brunoni	3.4	8.28	6.3	14.64	6	10.91	3.8	7.56
Roylea cinerea	6.1	13.82					6.4	12.12

Rubus ellipticus			5.5	13.29				
Sarcocca saligna					7.1	12.8		
Spiraea bella			4	10.16	4.9	13.92		
Viburnum cotinifolium					7.4	11.47		
Woodfordia fruiticosa	3.9	14.52	5	11.31			5.4	14.72
Zanthoxylum armatum	3.5	21.97			4.7	9.48	2.9	20.25
HERB								
Ageratum conyzoides	16.7	4.61	21.9	3.01	10.6	3.48	16.7	62
Agrimonia pilosa					16.3	4.91		
Apluda mutica	27.3	5.02					27.3	5.02
Argemone mexicana	24.3	5.11					24.3	5.12
Arisaema intermedium					13	4.36		
Arisaema jacquemontii					13.4	4.43		
Bryophyllum pinnatum			10.7	1.64	17	4.79		
Bupleurum falcatum			24.5	3.18				
Centella asiatica	21.9	5.29					21.9	5.3
Crotalaria medicaginea			19.8	2.87				
Cynodon dactylon	34.4	6.43					34.4	6.44
Desmodium heterocarpon			22.5	2.89				
Erigeron canadensis			7.6	3.73				
Gerbera gossypina			22.8	3.07				
Justicia procumbens					13.7	4.48		
Lespedeza juncea					14.4	4.35		
Leucas cephalotes	19.6	4.74					19.6	4.75
Origanum vulgare			16	1.99	14.6	4.39		
Pimpinella diversifolia			20.6	2.92	13	3.39		
Plectranthus mollis			22.2	3.03				
Poa annua	36	5.66					36	5.56
Potentilla fulgens			23	3.08	9.9	3.85		
Ranunculus laetus					15.6	4.31		
Stellarea media	28	5.59			12.8	3.6	28	5.6
Tagetes minuta			23.5	2.96				
Tridax procumbens	19	4.91					19	4.92
Urtica dioica					15.3	4.5		
Viola betonicifoila	20.3	5.08	16.1	2	4.5	2.22	20.3	5.09
Viola biflora					18.2	4.5		

Table 6. Species richness (SR), species richness index (SRI), diversity index (H'), concentration of dominance (Cd) and Evenness index (E) computed in selected groves.

GROVES	SR			SRI			H'			Cd			E		
	T	S	H	T	S	H	T	S	H	T	S	H	T	S	H
PG 1	32	25	52	1.39	0.94	0.59	3.21	3.18	3.84	0.05	0.04	0.02	0.93	0.98	0.97
PG 2	19	31	84	0.51	0.93	0.75	2.78	3.35	4.5	0.07	0.04	0.01	0.98	0.98	1
PG3	23	27	55	0.52	0.65	0.72	2.94	3.26	3.98	0.06	0.04	0.02	0.94	0.99	0.99
PG 4	29	36	68	1.15	0.81	0.6	3.27	3.21	3.84	0.04	0.04	0.02	0.94	0.98	0.97

Table 7. Species similarity (based on Sorensen similarity index (%) among the select protected groves.

SACRED GROVE	PG 2	PG 3	PG 4
PG 1	1.06	9.97	80.02
PG 2	100	24.42	12.19
PG 3	26.94	100	8.73

Species richness is one of the major criteria in recognizing the importance of an area for conservation. In general, species richness in grove 2 is greater than the other three groves. Species richness, species richness index, species diversity, concentration of dominance and evenness index recorded for the four protected groves are given in Table 7. The highest species richness for tree species was recorded for PG I (32 species) and lowest for PG II (19 species). In case of species richness index of tree species it was again set highest in PG I (1.39) and lowest in PG II (0.51).

The number of shrub species in the grove was smaller than the tree and herb species. Groves 1 and 2 showed 25 and 31 species each, grove 3 recorded 27 species and grove 4 attained the highest number having 36 species. The maximum species of herbs were recorded in PG 1 and 4 with 84 and 68 species each and the minimum in PG 1 with 52 species only.

The species richness index of shrubs ranged from 0.65 (PG 3) to 0.94 (PG 1), whereas for herbs it varied from 0.59 (PG 1) to 0.75 (PG 2).The value of Shannon and Wiener species diversity index for tree species fluctuated from 2.78 (PG 2) to 3.27 (PG 4). For shrubs, it ranged from 3.21 (PG 4) to 3.35 (PG 2), while for herb species the value was maximum in PG 2 (3.35) and minimum in PG 4 (3.21). It is apparent from Table 7 that PG1 and 4 exhibited highest similarity followed by PG 2 and PG 4. The reason for highest similarity coefficient lies in common aspect (eastern valley) and elevation range.

5. Ethnobotanical uses of species and conservation status

Ethnobotanical use of plants has been known since time immemorial in the history of human civilization and without these medicinal plants good health in the past would have been impossible. Ethnobotany explains the holistic scope of the relationship between plant and human being. Still, many communities of Garhwal depend largely on medicinal plants. The utilization of plants and animals for medicinal purposes is closely related with their culture and ritual practices which have been developed by their forefathers through trial and error methods and passed on orally from generation to generation. Traditional knowledge systems of folk, oral tradition and the published and unpublished manuscripts are the important sources of locating the potential of bioresources. Unfortunately, the lack of written data, communication and intermingling due to the varying ways of life, many of the earlier remedies that survived only by word of mouth from generation to generation are slowly disappearing.

Moreover, herbal healers had a strong tendency to keep their knowledge secret without any documentation until the end of their life. Out of 271 species altogether recorded from the four protected groves, 220 species are found to be of medicinal value. Indeed, it is evident that sacred groves are the storehouse of many useful medicinal plants. Therefore, protection and conservation of protected groves is essential for the conservation of medicinal plants. Four species, *Arisaema jacquemontii*, *Barleria cristata*, *Delphinium denudatum* and *Rubia manjith* among the 220 medicinal plants, are used especially for the treatment of snake bite. Besides their medicinal values, some of the species are employed in different uses like traditional soap and detergent, hair lotion and sericulture. The products of *Dioscorea deltoides* and *Sapindus mukorossi* are used in preparation of traditional soap and detergents for washing clothes by the people of Garhwal Himalaya. *Ageratum conyzoides*, *Artemisia nilagirica*, *Oxalis corniculata*, and *Phyllanthus emblica* are the species used as an ingredient for the preparation of indigenous hair lotion. *Litsea umbrosa* and *Quercus serrata* are the sericulture trees. A few of the sacred species found in the groves are associated in rituals or are believed to be the icon of the deity. Different faith and beliefs related to the sacred species include curing sickness, purifying household, purifying of the person before entering the shrine etc. various medicinal plants are also used as vegetables, spices etc. Interesting information comes through interviews with the local people who reside near the groves. Many people revealed that they had never consulted any doctor till date nor taken any tablets or pills. Headache, fever, cold, body pain can easily be cured with the help of medicinal plants. Some people used to consume daily a little amount of bitter, sour or sweet exudates from the plant parts which protects them from physical problems.

Many people of Garhwal Himalaya still depend on herbal medicine, though they are highly adjustable with the influences of modern practices and widespread use of allopathic medicine. Therefore, it is necessary to know the potential and values of medicinal plants for the improvement of health and hygiene in an eco-friendly manner. The data generated from the present study regarding the medicinal plants

may be helpful for the conservation strategies of protected groves by the government authority and other concerned organizations. Proper documentation of such plants and necessary action plans for their conservation are needed to taken up in time. It also required maintaining a sustainable use of such plants for their natural regeneration.

Table 8. Ethnobotanical Importance of Plants

Botanical name	**Vernacular name**	**Disease/aliment**	**Part used/mode of application**
Aconitum atrox	Meetha Bish	Rheumatism, Paralysis Dyspepsia, Phthisis & fever	Paste of rhizomes fried in Ghee for external used.
Actaea acuminate	Mamira	Bronchial	Decoction of root
Allium consanguineum	Pharan	Indigestion	Leaves
Anemone polyanthes	Ratanjot	Food poisoning	Seed decoction
Angelica glauca	Choru	Flatulence, colic	Root-stocks
Arisaema wallichianum	Meen erysipelas	Erysipelas and Scabies	Root-past (externally)
Arnebia benthamii	Laljari balchari	Cuts and wounds	Juice of fresh root
Asparagus filicinus	Jhirni	Urinogenital disorders	Power of dried tuberous root
Bergenia stracheyi	Shilphari	Kidney stones, sores, jaundice	Decoction of roots
Caltha palustris	Kushnya	Abscesses	Leave juice
Dactylorrhiza hatagirea	Salampanja	Cuts and wounds	Power of the root
Delphinium denudatum	Nirbishi	Contusions	Root paste
Dioscorea bulbifera	Genthi	Bronchial coughs	Tubers
Dioscorea deltoides	Tairu	spermatonorrhoea	Rhizomes
Euphorbia hirta	Dudhibari	Piles	Entire plant with curd
Fumaria indica	Pitapapra	Fever	Juice of entire plant
Gentiana stipitata	Bumlya	Urinary infection	Root decoction
Geranium wallichiana	Neenai	Dysentery and diarrhoea	Root decoction
Hippophae rhamnoides	Dhooplakkar	Cardiac trouble	Fruit juice
Megacarpea polyandra	Barmoola	Fever, stomachache	Root
Morina longifolia	Bishkandara	Snake-bite	Root-decoction
Origanum vulgare	Bantulsi	Whooping cough	Extract of leave
Paris polyphylla	Satwa	Diarrheoa	Root power
Picrorrhiza scrophulariflora	Kutki	Server coughing, fever	Root power
Rheum australe	Dolu	Bone-ache, muscular pains.	Root paste mixed with turmeric.
Solanum nigrum	Makoi	Spleen	Infusion of leaves and stem
Swertia chirayita	Chirayata	Fever	Decoction of entire plant
Taraxacum officinale	Dudhli	Gall stones	Power of root
Thalictrum foliolosum	Pilijari	Eye-inflammation	Root-decoction
Thymus linearis	Van Ajwain	Asthmatic cough	Extract of leaves and floral heads
Typhonium diversifolium	Nakdoon	Anorexia and as an energetic	Root power mixed with honey
Urgenia indica	Vanpyaz	Intestinal colic	Juice of tubers
Urtica ardens	Kandali	Dysmenorrheal	Decoction of entire plant
Vitex negundo	Shinwali	Arthritis, Gout	Leave-decoction
Woodfordia fruticosa	Dhaula	Vaginitis	Powder of dried flowers
Zanthoxylum armatum	Timru	Tooth-ache, Tooth decay	Seed power, Stem bark

Table 9. Beliefs associated with plants

Botanical name	Vernacular names	Families	Belief /use
Acacia catechu	Khair	Mimosaceae	Sacred tree
Aegle marmelos	Bel	Rutaceae	Sacred tree
Artemisia nilagarica	Kunja	Asteraceae	Use in rituals
Azadirachtia indica	Neem	Meliaceae	Sacred tree
Betula utilis	Bhoj	Betulaceae	Use in rituals
Bombax ceiba	Semal flower	Bombaceae	Use in rituals
Cedrus deodara	Deodar	Pinaceae	Sacred tree
Colebrookia oppositifolia	Binda	Lamiaceae	Use in rituals
Cynodon dactylon	Dubla	Poaceae	Use in rituals
Daphne papyracea	Satpura	Thymelaeaceae	Use in rituals
Ficus benghalensis	Bar	Moraceae	Use in rituals
Ficus religiosa	Pipal	Moraceae	Sacred tree
Mallotus philippensis	Ruina	Euphorbiaceae	Use in rituals
Mangifera indica	Aam	Anacardiaceae	Sacred tree
Musa paradisiaca	Kela	Musaceae	Use in rituals
Nardostachys grandiflora	Jatamanshi	Valerianaceae	Use in rituals
Phyllanthus emblica	Amla	Euphorbiaceae	Sacred tree
Pinus roxburghii	Kulain, chir	Pinaceae	Use in rituals
Prunus cerasoides	Paiyan	Rosaceae	Use in rituals
Quercus leucotrichophora	Oak	Fagaceae	Sacred tree
Reinwardtia indica	Phulei	Linaceae	Use in rituals
Rhododendron arboreum	Burans	Ericaeae	Use in rituals
Rhus parviflora	Tungla	Anacardiaceae	Use in rituals
Sassurea obvallata	Brahm- kamal	Asteraceae	Use in rituals
Sesamum orientale	Til	Pedalaceae	Use in rituals
Taxus baccata	Thuner	Taxaceae	Sacred tree
Urtica dioica	kandali	Urticaceae	Use in rituals
Vitex negundo	Shiwali	Verbenaceae	Use in rituals
Zanthoxylum armatum	Timuroo	Rutaceae	Sacred tree

6.5 Conservation status of protected groves:

Earlier sacred groves were indicator of the phenomenon of ethno-environmental management. Our ancestors were fully aware that the natural resources that sustained them must be conserved for the sustenance of future generations. But, at present, fast growth of infra-structural facilities and on-farm activities is the prime cause of deteriorating quality status of the groves. As in the forest, many of the tree species are valuable timber species, they have been largely extracted for timber during the past few decades and thus, subsequently replacing the climax forests (oak) to early successional pine forests. This has done considerable ecological damage in the region, making the soil more acidic and adversely affecting nutrient cycling and soil fertility. Growth of tourism industry is also deteriorating the faith towards deity and groves. Protected groves are the victims of this grim tragedy. The groves located near the settlements are disappearing at a faster rate. Only few protected groves are in their pristine condition. These are Hariyali, Dubakoti, Kukuru Shah and Tardkeshwar in Garhwal Himalaya. Other groves are disappearing, as the forests are being cleared and utilized for construction and repairing of deity houses. Most of the temple groves are seen disappearing due to inevitable factors like animal grazing and human interference.

Protected groves are a social institution, which permits management of biotic resources through people's participation. A scientific understanding of the protected groves would be significantly important for designing strategies for rehabilitation of degraded landscapes, involving local people's participation, and training for promotion of traditional and social norms. There is a need of preservation, restoration and proper management of existing groves.

Various traditional approaches to conservation of nature require a belief system, which includes a number of prescriptions and proscriptions for restrained resource use. These forestlands need proper conservation and protection by formulating consistent conservation strategies in order to save them from the verge of further degradation. Proper legislative support and specific policies should be provided. Mushrooming infrastructure facilities in the area are deteriorating the

proper functioning of social institutions, which reflect that protected or sacred groves are no longer getting the privilege they had in the past. Human interference should be regulated by encoding various indigenous practices along with scientific implications rather than only old religious prescriptions and proscriptions.

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