Environmentalist (2010) 30:101–110
DOI 10.1007/s10669-009-9249-x

Role of traditional conservation practice: highlighting the importance of Shivbari sacred grove in biodiversity conservation

Vikrant Jaryan · Sanjay Kr. Uniyal · Gopichand · R. D. Singh · Brij Lal · Amit Kumar · Varun Sharma

Published online: 26 November 2009

Abstract Recognizing the importance of sacred groves in biodiversity conservation and management, and the recent threats to them, the present study was conducted in Shivbari sacred grove of Himachal Pradesh. The study aimed at documenting the floral wealth of Shivbari and promoting plantation of indigenous species in participation with local people. For this, systematic field surveys in different seasons were conducted in Shivbari from April 2005 to November 2009, and liaison was maintained with the local community and temple management authority for gaining insight into the history and problems of Shivbari and initiating plantation activities. A total of 69 flowering plant species were identified inside the grove, which include 14 trees, 9 shrubs, 3 lianas and 43 herbs. This represents almost 2% of the total flowering plant species occurring in the state of Himachal Pradesh. *Mallotus philippensis* followed by *Putranjiva roxburghii* was the most dominant tree species. *Adhatoda zeylanica* was the most common shrub species, while *Achyranthes aspera* was the most common herb species. The grove harbours 23 plants species that are in high demand in the market, and at the same time also influences the microclimate of the area. The temperature inside the grove was significantly lower than the temperature outside the grove. The recent changes in socio-economic status of the local people and a shift towards market-oriented economy have threatened the survival of Shivbari. However, the deeply held beliefs of the pilgrims, local people and priest offer a ray of hope. During the course of the study, 3,000 plants were planted inside the grove out of which 60% have survived.

Keywords Biodiversity · Conservation · Himachal Pradesh · Sacred grove · Shivbari

V. Jaryan · S. Kr. Uniyal (✉) · Gopichand · R. D. Singh · B. Lal · A. Kumar · V. Sharma
Biodiversity Division, Institute of Himalayan Bioresource Technology, CSIR, Post Box # 6, Palampur, Himachal Pradesh 176 061, India
e-mail: suniyal@ihbt.res.in

V. Jaryan
e-mail: vikrantjaryan@gmail.com

Gopichand
e-mail: gc57@rediffmail.com

R. D. Singh
e-mail: rdsingh@ihbt.res.in

B. Lal
e-mail: brijihbt@yahoo.co.in

A. Kumar
e-mail: amitpnk@yahoo.co.in

V. Sharma
e-mail: varunsharma26@rediffmail.com

1 Introduction

Traditional customs and beliefs of human society have played a major role in biodiversity conservation worldwide (Ramakrishnan 1998). Sacred groves, which are defined as patches of forests conserved through man's spiritual belief and faith (Dash 2005), represent an excellent example of traditional conservation practice that still continues to provide respite to the dwindling bioresources. Their importance is now well realized and even in IUCN's six protected categories, cultural and spiritual values are better reflected (IUCN 2007). Not restricted to any particular place or community, sacred groves are well distributed across the globe and vary in size from few hectares to kilometres. In east Africa, groves of the *Mugumu* trees are considered sacred (Hughes and Chandran 1998). In China,

monastery groves are known to preserve species such as Ginkgo (Wei et al. 2008). The Balinese, in Indonesia have "monkey forests" (http://www.monkeyforestubud.com). The Celts, Slavs and Germans regard oaks as the most divine tree and preserve these forests (Farrell et al. 2000). Sacred groves of Sierra Leone are repositories of medicinal plants (Lebbie and Guries 1995). In Egypt, it was a practice in ancient times to have sacred groves in the precincts of every sizable temple (Hughes and Chandran 1998). Sacred groves have been reported from every continent except Antarctica (Bhagwat and Rutte 2006). Bhagwat and Rutte (2006) have provided an account of these sacred sites and their global distribution. In India alone, the number of sacred groves is estimated between 100,000 and 150,000 which are distributed in 19 states (Malhotra et al. 2001). They are found right from the tropical forests of southern India to the snow-covered peaks of Himalaya in northern India (Malhotra et al. 1999). In different areas, these groves are referred differently but are revered to the same extent at each place (Table 1). Religion plays an important role in defining norms and codes for the management of these groves in India. In Himalaya, trees of *Cedrus deodara* are highly revered and locally called "*devdaru*" meaning tree of Gods (Tewari 1994). Generally, these groves can broadly be classified into three categories (Pandey and Rao 2002), the "**traditional sacred grove**"- a grove where a village deity resides, "**temple grove**"- a grove created around a temple and "**burial or cremation grove**"- a grove created around a burial or cremation ground.

Not only in biodiversity conservation, the groves also play an important role in water and soil conservation (Dabral and Subba Rao 1969). In some places, sacred groves have become the last resort for meeting the water requirements of many animals especially in the dry season (Pushpangadan et al. 1998). Unfortunately, these sacred groves, which were once highly revered and maintained, are now fast degrading under the influence of rapid socio-economic transformations and materialistic attitude. One of such scared groves in India is Shivbari, where plant resources are extracted only for cremation purposes. It is believed that anyone extracting plant resources for other purpose than rites suffers the wrath of the God. Shivbari is also core of socio-cultural activities, and an annual fair is held in the grove on Shivratri, generally held in the month of March, when people from far-off places come to worship Lord Shiva (Murari 2007). However, owing to shifting social and cultural perspectives, coming up of many industries on fringes of Shivbari, laxity on the part of nurturing the bioresource to offset constant extraction of wood for rites, Shivbari is gradually developing vacant patches. Thus, the present study was initiated to explore the plant resources of Shivbari and initiate awareness programme amongst local people. In addition, the study also aimed at promoting plantation of few indigenous species

Table 1 Local name of sacred groves in different states of India

States	Local name of sacred groves
Arunachal Pradesh	Gumpa forest areas
Assam	*Than, Madaico*
Bihar	*Sarnas*
Chhattisgarh	*Sarna*, *Devgudi, Gaondevi, Matagudi and Jahera*
Haryana	Groves
Himachal Pradesh	*Deobans*
Jharkhand	*Sarana*, *Jaherthan, Jayar* or *Jilujayar*
Karnataka	*Devara kadus, Devrabana, Hulidevarakadu, Nagabana, Bhutappanbana, Jatakappanbana, Chowdibana, Kans*
Kerala	*Kavu*
Madhya Pradesh	*Devnu van, Sarna*
Maharashtra	*Devrais, Devrahati, Devgudi*, *Deorai, 'Dev-rai'*
Manipur	*Lai Umang*
Meghalaya	*Ki Law Lyngdoh, Ki Law Kyntang, Ki Law Niam, Ki Law Adong, Ki Law Shnon, Khloo Blai in Jaintia, Asheng khosi*
Mizoram	*Mawmund*
Orissa	*Jaherthan, Jahera, Thakuramma*
Rajasthan	*Orans*, *Vanis, Kenkris, Shamlat, Dehs, Devbanis*
Tamil Nadu	*Kovilkadugal*
Uttarakhand	*Bugyal, Devvan*
West Bengal	*Deotasara, Garamthan, Shitalathan, Harithan, Jahera*

with people's participation for sustaining the grove and conserving its rich heritage. Cursory observations on fauna were also recorded.

2 Study area

Out of the estimated 100,000–150,000 number of sacred groves in India (Malhotra et al. 2001), Himachal Pradesh harbours around 5,000 groves (Down To Earth 2003). These groves, locally called "**deobans**", are dispersed across the length and breadth of the state and hence the state is called "land of deities and sacred groves" (Sharma 2000). One of the most important amongst them is the "**Shivbari**", located between 31°40′47″–31°41′28″ N latitude and 76°03′38″–76°04′09″ E longitude. It lies in the foothills of the Shivalik range at an altitude of 461 amsl (Fig. 1). Tropical climatic conditions prevail in the area with temperatures ranging from 3°C in winter to 46°C in summer. The grove covers an area of ca 25 ha along the bank of river Swan. The Swan river affects the ecology of the region and is an important tributary of the river Sutlej. With more than 70% canopy cover, the grove appears to be a "Forest Island" on the otherwise totally denuded human-dominated landscape. Shivbari is primarily a temple grove with a temple dedicated to lord Shiva. It is believed that the temple was constructed by Guru Dronacharya and is more than 5,000-years old (Murari 2007). This grove is unique, since in addition to temple it has *Samadhis* (graves) of three holy men, who local people narrate, got incarnation here. The *Panchayat* (executive committee) of the village Ambota and temple authority headed by the chief priest manage Shivbari.

3 Methods

Systematic field surveys in different seasons were conducted in Shivbari from April 2005 to November 2009. During these surveys, entire grove was covered for preparing an inventory of angiosperms and gymnosperms growing in the grove. Pteridophytes were also collected from the grove. Surveying the grove at least once in spring, rainy and winter seasons ensured representation of seasonal flora in the checklist. For generating quantitative information, random sampling was done. A total of 10 quadrats of 10 × 10 m were laid for sampling tree species, for shrubs 10 quadrats of 5 × 5m were laid and for herbs 30 quadrats of 1 × 1m were laid. For comparison, observations were also recorded from vicinity around the grove.

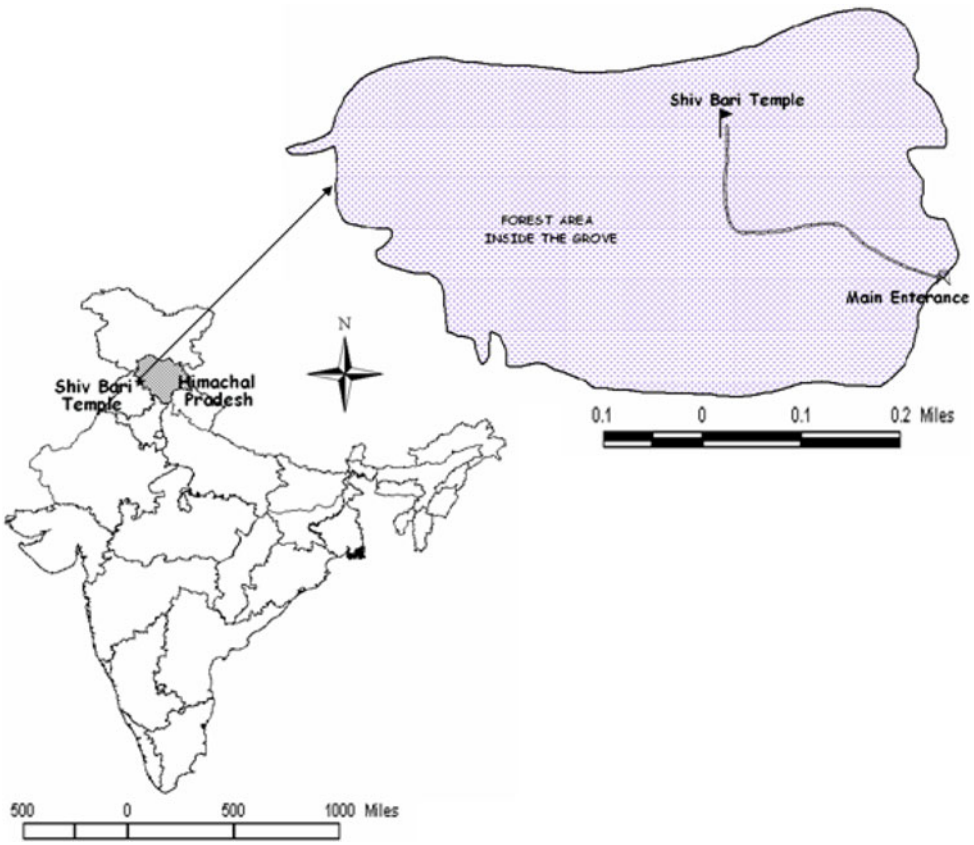

Fig. 1 The study area of Shivbari sacred grove located in Una District, Himachal Pradesh

Plant species were identified using relevant floras and keys (Singh and Sharma 2006; Chowdhery and Wadhwa 1984; Kaur and Sharma 2004). With permission from the temple management committee, plant samples were collected for herbarium preparation and future reference. The specimens are preserved at the herbarium (PLP) of Institute of Himalayan Bioresource Technology (IHBT). During the course of plant surveys, cursory observations, if any, on wildlife were recorded. Site characteristics of the grove like crown density, slope and soil were also recorded. Crown density was recorded using a densiometer while the slope was measured using a clinometer. Temperature measurements were taken using a Multi Thermometer. For physico-chemical analyses of soil, randomly collected composite soil samples were brought to the institute and analysed as per the standard procedures (Subbiah and Asija 1956; Mehlich 1984; Gupta 1999; Hach 1988). The data on ambient temperature and soil temperature were statistically compared using Mann–Whitney U test (SPSS 1996).

Location information of the grove in terms of latitude and longitude was collected using an etrex Garmin Global Positioning System (GPS) and an estimate of the area of the vacant pockets inside the grove was also generated using GPS. In order to fill these vacant pockets, IHBT provided saplings of suitable tree species. The authors along with the temple authority participated in digging of pits of 30 × 30 × 30 cubic cm dimension and also in the plantation drive. Liaison was maintained with the local community and temple management authority for gaining insight into the history and problems of Shivbari.

4 Results

Shivbari, that has gentle slope (not more than 15°) and soil varying from loam to sandy loam with pH ranging from 6.29 to 6.53, is rich in floral values. Total of 93 plant species, including Pteridophytes were collected from the grove. No Gymnosperm was found growing inside the grove. Sixty-nine angiosperm plant species were identified inside the grove, which includes 14 trees, 9 shrubs, 3 lianas and 43 herbs. These plant species belong to 65 genera placed in 34 families. Asteraceae family has the highest species richness having 14 species followed by Fabaceae, Acanthaceae, Moraceae and Euphorbiaceae each of which has 4 species. Families such as Boraginaceae, Rutaceae, Solanaceae and Scrophulariaceae have two species each, while Amaranthaceae, Meliaceae, Myrtaceae and Rutaceae were represented by only one species each (Appendix 1).

Total tree density of the grove was 410 individuals/ha while the shrub density was 3720 individuals/ha. Herbs reported a density of 12.59/m^2. The dominant trees of the grove are *Mallotus philippensis* that recorded a density of 170 individuals/ha followed by *Putranjiva roxburghii* which had a density of 140 individuals/ha, *Syzygium cumini* and *Phoenix sylvestris* had 10 individuals/ha, each. Amongst the shrubs *Adhatoda zeylanica* with 2320 individuals/ha was the most dominant followed by *Hiptage benghalensis* (440 individuals/ha). The most common herb in the grove was *Achyranthes aspera* (6.92/m^2). Analysis of information reveals that as many as 23 plants inside the grove are of high medicinal importance as they are in heavy demand in the market (Sarin 2008). The details of part(s) used, chemical constituents, biological activity and diseases cured by these plants are provided in Table 2. Additionally, during these surveys the area of vacant pockets inside the grove was measured to be about 9 acres.

Owing to interactions with the local people, it was revealed that lack of replanting options was a major drawback in the conservation of this grove. Consequently, IHBT provided more than 3000 saplings comprising of *Acacia catechu, Bauhinia variegata, B. vahlii, Cinnamomum camphora, Elaeocarpus ganitrus, Emblica officinalis, Grewia optiva, Murraya paniculata, Putranjiva roxburghii, Sapindus mukorossi, Saraca indica, Terminalia arjuna, T. belerica* and *T. chebula* that were planted in the vacant areas of Shivbari from September 2006 to October 2007 (Fig. 2). These species were chosen because of their high medicinal importance and current conservation status. Some species such as *Elaeocarpus ganitrus* were selected due to the request of the temple management committee for beautification of the temple campus. The success rate of plantation was observed to be about 60%, as Blue bull (*Boselaphus tragocamelus*) commonly referred to as "neelgaye" and other cattle in the forest grazed many saplings. As already mentioned, many plant species such as *Adhatoda zeylanica*, *Boerhaavia diffusa*, *Callicarpa macrophylla*, *Cissampelos pareira*, *Mallotus philippinensis*, *Melia azedarach*, *Plumbago zeylanica*, *Putranjiva roxburghii*, *Syzygium cumini* and *Vitex negundo* of the grove are medicinally important (Table 2). Though not from the grove, industrial units exploit these plants from the foothills of Shivaliks. Therefore, during interactions the temple management committee and local people were made aware about the importance of these plants and a need to further conserve them. In subsequent surveys, it was heartening to note that people care for these plants and have in-fact put tree guards on their own at some places.

The grove which is a forest island is surrounded by human dwellings and industrial units. The area outside the grove is dominated by *Saccharum spontaneum, Cynodon dactylon* and *Imperata cylindrica*. The diversity of trees is very poor and mainly consists of planted *Eucalyptus* sp. and *Populus* sp. along the highway. The shrub layer has preponderance of *Lantana camara Parthenium hysterophorous* and *Cassia tora*. Other common species outside the

Table 2 Important medicinal plants found in Shivbari, their chemical constituents, biological activity, diseases cured and market price

S. no.	Plant name	Part(s) used	Chemical constituents	Biological activity	Disease	Price (Rs/kg)[4]
1	*Adhatoda zeylanica* Medik.	Terminal leafy branches with flowering	Vasicine, oxyvasicine and ketone vascicinone[1]	Expectorant, ureotonic and bronchodilatory[1]	Cough, bronchial and respiratory disease[1]	50–55
2	*Albizia lebbeck* (L.) Benth.	Bark	Echinocytic acid, β-sitosterol, tannins, lebbekanins D, F, G, H and saponin[1]	Anti-asthmatic, antianaphyla[1]	Oedema, constipation, night blindness, respiratory disorders and diarrhoea caused by worm infection[2]	NA
3	*Boerhaavia diffusa* Linn.	Root	β-ecdysone, triacentariol and β-sitosterol, 5,7-dihydroxy-3,4—dimethoxy-6,7 dimethyl flavone[1]	Diuretic laxative, stomachic, diaphoretic and anthelmintic[2]	Jaundice, dropsy and gonorrhoea[2]	NA
4	*Bauhinia vahlii* Wight & Arn.	Root	Quercitroside, isoquercitroside and rutoside, kaempferol glycosides[2]	Aphrodisiac, astringent and demulcent[3]	Fever, Malaria, Dysentery[3]	NA
5	*Callicarpa macrophylla* Vahl.	Roots and leaves	Calliterpenone, luteolin, apigenin, luteolin-7-O-glucuronide, apigenin-7-O-glucuronide and flavon CMF-1[1]	Cooling, astringent, febrifuge and blood purifier[2]	Dysentery, fever, and emesis[2]	NA
6	*Cassia fistula* Linn.	Fruit, root bark and leaves	Proanthocynidin, (−) epiatzelechin, (+) catechin, kaempferol, dihydrokaempferol and 1,8-dihydroxy-3-methylanthraquinone[1]	Emetic, febrifuge, laxative, purgative[2]	Boils, pustules, flatulence, dyspepsia, constipation, indigestion, thoracic obstructions fever and heart disease[2]	8–10
7	*Chenopodium album* Linn.	Leaves	β-ecdysone, polysone and polypodine B (Rastogi and Mehrotra 1993), β-carotene, catechins, galloatechin, caffeic acid, p-coumeric acid, ferulic acid, β-sitosterol, campesterol, xanthotoxin, stigmasterol, scopoletin and chenopodium ambrosioides[3]	Rich in vitamin C, anthelmintic and laxative[2]	Stomach pain[2]	NA
8	*C. ambrosioides* Linn.	Leaves and seeds	Kaempferol-7, shamnoside, ambroide, limonene, p-cymene, trans carveol, ascaridole, thymol, carvone trans- iso carveol, p-mentha-8-en-1,2-diol, p- menthe-2,8-diene-1,4diol and 1,4 epoxy-p-mentha-2,3-diol[1]	Anthelmintic (Ravindra Sharma 2003), antifungal and nematicidal[3]	Effective against intestinal parasite and amoebic dysentery[2]	NA

Table 2 continued

S. no.	Plant name	Part(s) used	Chemical constituents	Biological activity	Disease	Price (Rs/kg)[4]
9	*Cissampelos pareira* Linn.	Root	Isoquinoline, pelosins, berberine and saponin, respine, cissampeline, hyatin, hyatinin, quercitel and sterol[2]	Anthelmintic, antidote to poison, antilithic, astringent, cardiac, carminative, diuretic expectorant, febrifuge sedative, suppurative and tonic[2]	Asthma, cold, cough, colic diarrhoea and dysentery, fever, indigestion, inflammation of kidney, bladder piles and ulcer[2]	15–20
10	*Euphorbia hirta* Linn.	Herb and seeds	Rutin, quercetin rhamnoside, n-octacosanol, β-sitosterol,, euphorbol hexacosanoate, β- amyrin acetate, 1-hexacosanol, cycloartenol[1]	Vermifuge[2]	Colic troubles, dysentery, cough, asthma, worms and vomiting[2]	NA
11	*Mallotus philippensis* (Lam.) Muell.—Arg.	Fruit	Resin (80%), tannic acid, gum and volatile oil, rottlerin, isoallotrotterin, betulin-3-acetate, lupeol, lupeol acetate, sitosterol, bergenin, acetylal euritolic acid and α- amyrin[1]	Anthelmintic, antioxidant, aphrodisiac, blood purifier and purgative[2]	Scabies, pimples, ringworm, weeping, eczema, boils and also used in bile troubles[2]	NA
12	*Melia azedarach* Linn.	Leaves, fruits and seeds	Nimbinene, 6-deacetylnimbinene, nimbandiol, 6-O-acetylnimbandiol and β-sitosterol[4]	Bark-Astringent, tonic antiperiodic and vermifuge. Fruit-purgative, emollient and anthelmentic. Leaves-antiseptic and insecticide[4]	Leprosy, intestinal worms, piles and urinary disease[2]	NA
13	*Nelumbo nucifera* Gaertner	Flowers seeds and roots	Querestrin-3-glucoside, nuciferine, benzyltetrahydroisoquinoline, fatty acids, phytol, linalool, nonadecane, liensinine, isoliensinine and neferine[1]	Cooling, astringent and diuretic[2]	Diarrhoea, cholera, fever, disease of liver and cardio-tonic. Seeds- check vomiting, diuretic, leprosy, cooling medicine for skin and root powder used for piles dysentery and skin infection[2]	NA
14	*Oxalis corniculata* Linn.	Whole plant	Oxalic acid, vitamin C and potassium oxalate[2]	Refrigerant, antiscorbutic and diuretic[3]	Leaf juice- removing warts and cataract of eye. Paste of top shoot—boils abscesses, wound and weeping eczema. Leaves and root—dysentery and diarrhoea[2]	NA

Table 2 continued

S. no.	Plant name	Part(s) used	Chemical constituents	Biological activity	Disease	Price (Rs/kg)[4]
15	*Dicliptera bupleuroides* Nees	Leaf and top shoot	Not available	Not available	Paste of leaf and top shoot applied on the wound and snake bite. Juice of leaves given to children suffering from fever and stomach trouble[4]	NA
16	*Plumbago zeylanica* Linn.	Root and leaves	Zeylanone, isozeylanone, plumbagic acid, plumbagin, β- sitosterol, vanillic acid, catechol, tannin and steroidal glucoside[1]	Obortifacient, vesicant, diuretic caustic and expellant of phlegmantic tumours[2]	An irritant of the skin, treatment of dyspepsia, piles, anasarca and skin disease[2]	30
17	*Putranjiva roxburghii* Wallich.	Leaves and stones	Glucoputranjivi, glucocochlearin, glucojiaputin, gluco-cleomin, minnitol, saponin glucosides and fatty acid[2]	Not available	Decoction used for cold and cough, rheumatism. To effect conception in sterile women and attributed with the birth of a male child[2]	12
18	*Solanum nigrum* Linn.	Leaves and seeds	Leaves—riboflavin, nicotinic acid and vitamin C. Green fruits—solamargine, solasonine and α- solanigrine, tigogenin, ittronin A, utterosides A and B, desgalaxtotigonin, solmargine and solasonine[2]	Antiseptic, emollient, diuretic, laxative, tonic, carthartic and antidysentric[2]	Wounds sores, psoriasis, eczema, piles and syphilis[2]	200
19	*Ricinus communis* Linn.	Seeds	Ricinius, taxalbumin ricin, rutin, hyderoside, apigenin and chlorogonic acid[1]	Lactagogue and emmenagogue[2]	Purgative for pregnant women and during menses[2]	10
20	*Stellaria media* (L.) Villars	Whole plant	Not available	Not available	Used for eye infection and haemorrhoids. Poultice made from the plant is used to treat ulcers and skin sores[2]	NA
21	*Syzygium cuminii* (L.) Skeels	Bark and seeds	Methylxanthoxyline, 2,6-dihydroxy-4-methoxyacetophenone, bornylacetate, α and β-pinene[1]	Not available	Bark juice and milk is given for diarrhoea. Seed powder for diabetes and bark in throat sores, bronchitis, asthma, ulcer and dysentery[2]	80

Table 2 continued

S. no.	Plant name	Part(s) used	Chemical constituents	Biological activity	Disease	Price (Rs/kg)[4]
22	*Verbascum thapsus* Linn.	Herb and seed	Thapsuines A and B and their respective C-16 glucosides isolated from capsules[1]	Febrifuge, aphrodisiac and narcotic[2]	Treatment of asthma and pulmonary complaints. Roots decoction is administered in cramps and migraines[2]	NA
23	*Vitex negundo* Linn.	Leaves	6-C-glucosyl-5-O- rhamnopyranosyl trimethoxy isogonin (I) and acerosin-5-O glucoside monoacetate (II), α- pinene, limonene, camphene, β-phellandrene, methylheptenone, p-cymene, linalool, camphor, 4-terpinol, citral oxide, terpinyl acetate, benzaldehyde, cinnamaldehyde, negundoside, nishindaside[1]	Alternative, anodyne, antiarthritic, antiparasitic, appetizer, aromatic, astringent, febrifuge and nervine tonic properties[2]	Asthma, lung disease, splenic enlargement, urinary troubles, tonsillitis and scratica rheumatism[2]	10

[1] Rastogi and Mehrotra 1993; [2]Ravindra Sharma 2003; [3]Kaushik and Dhiman 1999; [4]Chauhan 1999

NA not available

Fig. 2 Planting material provided by IHBT for filling up the pockets

grove include *Euphorbia hirta, Ipomoea fistulosa* and *Xanthium indicum.* These species are common in the human disturbed landscapes and rarely occur in dense undisturbed forests. Our simultaneous real-time temperature measurements showed that compared to the area outside Shivbari, the ambient temperature inside Shivbari was always 2–3°C less. The difference was even more pronounced in case of soil temperature. Soil temperature inside Shivbari was 5–8° C less than the outside soil temperature. Though the difference in ambient temperature was not statistically significant, difference in soil temperature was found to be statistically significant (Mann–Whitney U test $p < 0.05$). Further, the soil inside the grove was nutrient rich and fertile when compared to soil outside the grove (Table 3).

5 Discussion and conclusion

It can be seen that though Shivbari occupies minuscule geographical area of Himachal Pradesh, it supports 2% of the total flowering plant species occurring in the state. It has been reported that ca 3,500 plant species are found in Himachal Pradesh (Chowdhery and Wadhwa 1984). Further, the dominant plant families of the grove are also the dominant families reported for the state of Himachal Pradesh (Chowdhery 1999)**.** Thus, the grove provides a spectrum of diversity and is a repository of floral wealth of Himachal Pradesh. History of "social fence" (Bhagwat and Rutte 2006) and escape from anthropogenic pressures coupled with diversity of available habitats has resulted in floral richness in Shivbari. It has been reported that majority of the sacred groves across the globe are less than 1 ha in size (Bhagwat and Rutte 2006), the large area of Shivbari (ca 25 ha), therefore comes up as an added advantage for supporting higher species richness. Many of

Table 3 Comparison between the properties of the soil of Shivbari sacred grove and the surrounding area

Soil sampled from	pH	Organic matter (%)	C:N ratio	E.C. (mmhos/cm)	Available *N* (kg/ha)	Available *P* (ppm)	Available *K* (ppm)	Texture
Shivbari	6.33	6.42	15.76	0.24	486.08	134.84	472.72	Sandy loam
Surrounding area	7.64	0.46	3.47	0.17	112.90	9.94	59.65	Sandy loam

the important medicinal plants which otherwise are heavily traded for medicine find respite in Shivbari. Inside the Shivbari, good population of *Putranjiva roxburghii*, *Syzygium cuminii* and *Grewia optiva* can be seen which are rare in nature. The importance of sacred groves as an abode of rare and threatened plants has been demonstrated by many workers (Das and Chandana 1997; Bhagwat et al. 2005a, b) which holds true for Shivbari also. On the other hand, preponderance of exotic and invasive species inside the grove is comparatively low. The area adjacent to the grove is fully dominated by *Parthenium hysterophorous*, *Cassia tora* and *Lantana camara* that are ecologically detrimental (Annapurna and Singh 2003).

Large trees with girth more than 8 m which are seldom encountered outside the grove are not uncommon inside Shivbari (especially Ficus trees). The continuous chirping and noise from these trees attracts even the most unattentive. Hundreds of bats can be seen roosting on these trees that are ideal roosting sites. Thus, Shivbari not only adds greenery to the otherwise drab surroundings but also provides habitat to wild fauna. Bats, which roost here in hundreds, are a potent example of this. Bats have an important role in pollination and seed dispersal, and thus the entire ecosystem functioning (Purohit et al. 2006). Though, no special efforts were made for recording fauna, herds of neelgaye can be seen foraging on the natural resources. In addition, many of the cattle, which are either old or diseased and hence have been left by their owners, find shelter in this grove.

Shivbari offers many indirect ecological benefits, which further augment its importance. Being located at the bank of river Swan, Shivbari sacred grove helps in checking erosion. Eroded slopes can be seen around the banks of river Swan away from the grove. It has been reported that almost 20 t/ha soil is lost as a result of erosion from the slopes (Sharda 2002). Shivbari attracts lots of tourists and students. Every year, hundreds of students visit this grove to study and see nature at its best. Even the employees of State Forest Department make regular appraisal visit to this grove. Similar trends have been reported for Maphlang sacred grove in Meghalaya that attracts tourists and researchers from various places because of its rich orchid and rhododendron diversity (Anonymous 2004). Thus, Shivbari is a living laboratory acting as an ecotourism and educational centre for all interested.

As already mentioned, Shivbari is a green island that is surrounded by various industries. Toxic emissions from these industries pollute the environment. With the growing concern about global warming and its implications, the importance of such green patches becomes even more. Shivbari certainly acts as a sink for the enhanced CO_2 in the environment, which also influences the microclimate of the region as is evident from the real-time temperature measurements.

The traditional conservation practices like planting of trees, worshiping certain tree species viz., *Ficus religiosa, F. benghalensis, Aegle marmelos* and *Emblica officinalis*, felling of only dried trees, etc., which once helped in biodiversity conservation, are now slowly breaking up mainly because of commercialization and short-term economic benefits (McNeely 1990). Grazing, lopping and other human pressures have also affected the status of sacred groves all over the India (Bhandary and Chandrashekar 2003), and Shivbari is no exception to it. Setting up of industries around this grove is causing deleterious effect on it. According to the priest, people have even encroached the sacred grove land. Further, an unmetalled road has been constructed, which is fragmenting the landscape (Fig. 3). Earlier, no resources were collected from this grove except for cremation purposes and that too only dead and fallen

Fig. 3 Recently constructed unmetalled road has threatened the survival of Shivbari (also note the industrial chimney in background)

wood. Of late, people do not hesitate even to cut and lop trees. Attempts to revive Shivbari by IHBT have received good response and the deeply held beliefs of the pilgrims, local people and priest offer a ray of hope.

Globally also, the importance of sacred groves is now attracting many international organizations such as United Nations Educational, Scientific and Cultural Organization (UNESCO), The World Conservation Union (IUCN) and World Wide Fund for Nature (WWF). These organizations have developed draft guidelines for management of sacred natural sites in protected areas.

Acknowledgments Authors are grateful to the Director, Institute of Himalayan Bioresource Technology, Palampur, for facilities and encouragement. Special thanks are due to Mr. Om Parkash for his help in the field. Help and support of the staff of IHBT herbarium is duly acknowledged. The authors also thank Ministry of Environment and Forests for financial support through the IER Programme at GBPIHED, Almora.

References

Annapurna C, Singh JS (2003) Phenotypic plasticity and plant invasiveness: case study of congress grass. Curr Sci 85(2):197–201

Anonymous (2004) Mawphlang grove: where indigenous faith and old wisdom mingle. The sentinel, Guwahati

Bhagwat SA, Rutte C (2006) Sacred grove; potential for biodiversity management. Front Ecol Environ 4(10):519–524

Bhagwat SA, Kushalappa CG, Williams PH, Brown ND (2005a) The role of informal protected areas in maintaining biodiversity in the Western Ghats of India. Ecol Soc 10:8

Bhagwat SA, Kushalappa CG, Williams PH, Brown ND (2005b) A landscape approach to biodiversity conservation of sacred groves in the Western Ghats of India. Conserv Biol 19:1853–1862

Bhandary MJ, Chandrashekar KR (2003) Sacred groves of Dakshina Kannada and Udipi districts of Karnataka. Curr Sci 85(120): 1655–1656

Chauhan NS (1999) Medicinal & aromatic plants of H. P. Indus Publishing Company, New Delhi

Chowdhery HJ (1999) Himachal Pradesh. In: Mudgal V, Hajra PK (eds) Floristic diversity and conservation strategies in India, vol II. Dehradun, pp 845–887

Chowdhery HJ, Wadhwa BM (1984) Flora of Himachal Pradesh, vol 1–3. B.S.I., Calcutta

Dabral BG, Subba Rao BK (1969) Interception studies in Sal ((*Shorea robusta*) and Khair (*Acacia catechu*) plantations, new forest. Ind For 95:313–323

Das I, Chandana SK (1997) *Philautus sanctisilvaticus* (Anura: Rhacophoridae), a new frog from the sacred groves of Amarkantak, central India. Hamdryad 22:21–27

Dash SS (2005) Kabi sacred grove of north Sikkim. Curr Sci 89(30):427–428

Down To Earth (2003) Extra- a down to earth supplement on sacred Grove

Farrell EP, Fuhrer E, Ryan D, Andersson F, Huttl R, Piussi P (2000) European forest ecosystems: building the future on the legacy of the past. For Ecol Manage 132:5–20

Gupta PK (1999) Soil, plant, water and fertilizer analysis. Agrobios (India) pp 14–18

Hach (1988) DR/2000 Spectrophotometer handbook procedure manual. Hac Company, pp 353–356

http://www.monkeyforestubud.com, information downloaded on 03/11/2009

Hughes JD, Chandran MDS (1998) Sacred groves around the earth: an overview. In: Ramakrishnan PS et al (eds) Conserving the sacred for biodiversity management. Oxford and IBH publishing Co, New Delhi

IUCN (2007) World commission on protected areas task force on protected area categories, One of a series of papers for the IUCN Categories Summit, Andalusia, Spain

Kaur H, Sharma M (2004) Flora of Sirmour (Himachal Pradesh). Bishen Singh, Mahendra Pal Singh, Dehra Dun

Kaushik P, Dhiman KA (1999) Medicinal plants and raw drugs of India. Bhishen Singh, Mahendra Pal Singh, Dehra Dun

Lebbie AR, Guries RP (1995) Ethnobotanical value and conservation of sacred grove of the kpaa Mande in Sierra Leone. Econ Bot 49:297–308

Malhotra KC, Gokhale Y, Chatterjee S, Shrivastava S (1999) Sacred grove in India: an overview. National Museum of Mankind, Bhopal

Malhotra KC, Gokhale Y, Chatterjee S (2001) Cultural and ecological dimensions of sacred groves in India. India National Science Academy and the Indira Gandhi Rashtriya Manav Sangrahalaya, New Delhi and Bhopal, India

McNeely JA (1990) How conservation strategies contribute to sustainable development. Environ Conserv 17:9–13

Mehlich A (1984) Mehlich no 3 soil test extractant: a modification of Mehlich no 2. Commun Soil Sci Plant Anal 15:1409–1416

Murari K (2007) Dron Shiv mandir. Shivbari, Ambota

Pandey A, Rao VP (2002) Impact of globalization on culture of sacred: a revival of common, but decay of the traditional institution. Ninth Biennial conference of IASCP, Zimbabwe

Purohit A, Vyas KB, Senacha KR (2006) Population dynamics of bats in and around Jodhpur of Great Indian desert. Tigerpaper 33:15–22

Pushpangadan P, Rajendraprasad M, Krishnan RN (1998) Sacred groves of Kerala: a synthesis on the state of art of knowledge. In: Ramakrishnan PS et al (eds) Conserving the sacred for biodiversity management. Oxford and IBH publishing Co, New Delhi

Ramakrishnan PS (1998) Conserving the sacred for biodiversity: the conceptual framework. In: Ramakrishnan PS, Saxena KG, Chandrashekara UM (eds) Conserving the sacred for biodiversity management. Oxford and IBH Publishing Co, New Delhi

Rastogi RP, Mehrotra BN (1993) Compendium of Indian medicinal plants, Vol. II & III CDRI, Lucknow. Publications & Informations Directorate, New Delhi

Sarin YS (2008) Principal crude herbal drugs of India: an illustrated guide to important, largely used and traded medicinal raw materials. Bhishen Singh, Mahendra Pal Singh, Dehradun

Sharda VN (2002) Natural resource management through integrated watershed management. In: Mishra AS, Sharda VN (eds) Short course on agroforestry in relation to NTFT. CSWCRTI, Dehradun, pp 1–22

Sharma BR (2000) Sacred groves and their role in social life in Himachal Himalayas, Abstract, National workshops on community strategies on the management of natural resources, Bhopal

Sharma R (2003) Medicinal plants of India an encyclopedia. Daya Publication House, Delhi

Singh H, Sharma M (2006) Flora of Chamba district (Himachal Pradesh). Bishen Singh Mahendra Pal Singh, Dehra Dun

SPSS (1996) SPSS for windows ver 7.5.1

Subbiah BV, Asija GL (1956) A rapid procedure for assessment of available nitrogen in soils. Curr Sci 25:256–259

Tewari DN (1994) A monograph on deodar (*Cedrus deodara* (Roxb.) G.Don), International Book Distributors, Dehradun

Wei G, Qui YX, Chen C, Ye Q, Fu CX (2008) Glacial refugia of Ginkgo biloba L. and human impact on its genetic diversity: evidence from chloroplast DNA. J Integr Plant Biol 50(3):368–374