Sacred Groves in Western Himalaya, India: Community-Managed Nature Refuges for Conservation of Biodiversity and Culture

Sushma Singh, Jahangeer A. Bhat, Zubair A. Malik, Mudasir Youssouf, Rainer W. Bussmann and Ripu M. Kunwar

Databases and Inventories

Abstract

Background: Dedication of forests to a god or goddess is a potent example of an indigenous conservation practice, devised by native inhabitants to put an end to the unrestricted utilization of community forests. The present paper describes a case study of three little known Sacred Groves (SGs) from the Western Himalayas. SGs are communally protected forest fragments with significant religious connotations.

Methods: A preliminary survey was conducted in and around these SGs to evaluate the status of biodiversity, different myths and beliefs associated with them and their role in the biodiversity conservation. After establishing oral prior informed consent, data was gathered from the local participants especially from elderly people through semi-structured questionnaires. Approximately 30% of the total households in each SG were interviewed. Two different sampling methods (random sampling and snowball sampling) were used for selection of informants from two different communities. The information collected included the general information regarding the SGs and the associated deity, nearby human occupancy, floral and faunal diversity and the ethnomedicinal property of different plants.

Results: A total of 78 plant species (including 37 trees, 27 shrubs and 14 herbs) belonging to 58 genera and 41 families were reported from the three sacred groves. About 91% of these plant species had ethno-medicinal importance. A few rare and threatened animal species were also reported that included *Naemorhedus gora* (Himalayan goral, near threatened, NT) reported from SG2 and SG3; *Panthera pardus* (leopard, vulnerable, Vu) and *Ursus thibetanus* (black bear, critically endangered, CR) both reported from all the three SGs.

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Conclusion: SGs are not only the important repositories of ethno-medicinal plant species, but also act as corridors for animal migration in anthropogenic landscapes. However, in recent times, the SGs are threatened by uncontrolled and unplanned developmental activities, as well as invasive species, land use change, population growth and sociocultural change. Therefore, the specific guidelines to protect these sacred areas and promote traditional knowledge about conservation are pressing.

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Keywords: Sacred Grove, Ethnobotany, Traditional Beliefs, Biodiversity Conservation, Deity, Western Himalaya.

सार

पृष्ठभूमि: एक देव या देवी के लिए जंगलों का समर्पण एक स्वदेशी संरक्षण अभ्यास का एक शक्तिशाली उदाहरण है, जो समुदाय के वनों के अप्रतिबंधित उपयोग को समाप्त करने के लिए मूल निवासियों द्वारा तैयार किया गया है। प्रस्तुत पत्र में पश्चिमी हिमालय के तीन छोटे ज्ञात पवित्र कुंजो ं के एक अध्ययन का वर्णन किया गया है। पवित्र कुंज महत्वपूर्ण धार्मिक धारणाओं के साथ सांप्रदायिक रूप से संरक्षित वन टुकड़े हैं।

कार्यप्रणाली: जैव विविधता की स्थिति, उनके साथ जुड़े विभिन्न मिथकों और विश्वासों और जैव विविधता संरक्षण में उनकी भूमिका का मूल्यांकन करने के लिए इन पवित्र कुंजो ं में और उसके आसपास एक प्रारंभिक सर्वेक्षण किया गया था। मौखिक पूर्व सूचित सहमति की स्थापना के बाद, स्थानीय प्रतिभागियों से विशेष रूप से बुजुर्ग लोगों से अर्ध-संरचित प्रश्नावली के माध्यम से आँकड़े एकत्र किए गए थे। प्रत्येक पवित्र कुंज में कुल घरों के लगभग 30 प्रतिशत का साक्षात्कार लिया गया था। दो अलग-अलग समुदायों से सूचकों के चयन के लिए दो अलग-अलग नमूनों के तरीकों (यादृच्छिक और स्नोबॉल) का उपयोग किया गया। एकत्र की गई जानकारी में पवित्र कुंज और संबंधित देवता, आस-पास की मानव अधिभोग, पुष्प और जीव विविधता और विभिन्न पौधों की नृवंशीय संपत्ति के बारे में सामान्य जानकारी सम्मिलित थी।

परिणाम: तीन पवित्र कुंजो ं से कुल ‰ पौधों की प्रजातियाँ (३‰ पेड़, २‰ झाड़ियाँ और १४ जड़ी-बूटियाँ शामिल हैं) में ५ं वंश और ४१ परिवार शामिल हैं। इन पौधों की प्रजातियों में से लगभग ९१ प्रतिशत का नैतिक-औषधीय महत्व था। कुछ दुर्लभ और खतरे वाली जानवरों की प्रजातियां भी बताई गई थीं जिनमें शामिल हैं नएमोर्हेदूसगोरा (हिमालयन गोरल, खतरे के पास, ऍन टी) पवित्र कुंज „ और पवित्र कुंज … से रिपोर्ट की गई; पैंथरपार्डस (तेंदुआ, भेद्य, वु) और उर्सुस्टिबेटेनस (काला भालू, गंभीर रूप से लुप्तप्राय, सीआर तीनों पवित्र कुंजो ं से रिपोर्ट किए गए।

निष्कर्ष: पवित्र कुंज न केवल एथनो-औषधीय पौधों की प्रजातियों के महत्वपूर्ण भंडार हैं, बल्कि मानवजनित परिदृश्य में पशु प्रवास के लिए गलियारे के रूप में भी कार्य करते हैं। हालांकि, हाल के दिनों में, पवित्र कुंजो ं को अनियंत्रित और अनियोजित विकास गतिविधियों के साथ-साथ आक्रामक प्रजातियों, भूमि उपयोग परिवर्तन, जनसंख्या वृद्धि और समाजशास्त्रीय परिवर्तन से खतरा है। इसलिए, इन पवित्र क्षेत्रों की सुरक्षा और संरक्षण के बारे में पारंपरिक ज्ञान को बढ़ावा देने के लिए विशिष्ट दिशा-निर्देश दबाव डाल रहे हैं।

कुंजी शब्द: पवित्र कुंज, नृवंशीय वनस्पतिशास्त्र, पारम्परिक मत, जैव-विविधता संरक्षण, ईश्वर, पश्चिमी हिमालय

Background

Sacred Groves (SGs) are communally protected forest fragments with notable religious connotations. They are regarded as “Sacred Natural Sites” by IUCN (Oviedo *et al.* 2005) and have been prioritized for biodiversity conservation and ecological services at local landscapes. These community lands are considered a storehouse of local biodiversity. They are hailed for richness of endemic species, ecological services and subsistence economy (Jamir & Pandey 2003, Kandari *et al*. 2014, Negi 2010, Singh *et al*. 2017). Because of limited human activity due to socio-cultural taboos and prohibitions, the SG frequently accounts old-growth forests, many ecologically and socio-culturally valuable plant species (Malik *et al.* 2016, Ray *et al*. 2010). Thus, the SGs are now being frequently accessed and assessed for integrating ecological research, conservation policy, traditional management and local livelihood (Singh *et al*. 2017).

SGs have gained much significance in recent times, particularly after the ratification of the “Convention on Biological Diversity (CBD)”. SGs are considered to be an excellent example of community-based nature conservation and can prove helpful in acquiring the goals of CBD, community-based conservation being one of the main agendas of CBD. The significance of SGs in socio-religious life as well as livelihood

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security has benefitted the local communities long-term and are substantiated by numerous local customs, folklore, social and religious taboos (Anthwal *et al.* 2010, Kandari *et al*. 2014, Negi 2010). SGs are reported from many countries all over the world, but their present occurrence is mostly restricted in Africa and Asia (Hughes & Chandran 1998). In India, they are known by different names, e.g. as *'Kovil kadu'* in Tamil Nadu (Amirthalingam, 1998), *'Sarnas'* in Bihar and Bengal, *'Devarakadu'* in Karnataka, *'Lai Umang'* in Manipur *'Kavu'* in Kerala, *"Oran"* in Rajasthan, '*Devari'* in Maharastra, *Bani'* in Jammu, *'Asthan'* in Kashmir, '*Dev Van'* in Himachal Pradesh, Madhya Pradesh and Uttarakhand (Ormsby & Bhagwat 2010) and '*Mandu'* in Nepal (Kunwar 2018). India has more than 4,000 sacred groves that cover about 39,000 ha of forests (Malhotra *et al*. 2007). Although sacred groves are seen in many parts of India, Uttarakhand state in Western Himalaya is a unique landscape known for sustaining this tradition. Termed as *Dev-bhumi* or "land of gods", Uttarakhand is rich in biodiversity and a number of SGs have been established for its conservation. There are about 1,000 SGs, and almost every village or group of villages has its own deity with a shrine often surrounded by a forest patch considered as sacred (Bisht & Ghildiyal 2007). Some well-known sacred groves in the state include *Haryalidevi, Tungnath, Chiplakedar, Binsar, Tarkeswar, Tapovan, Paabo, Dewal and Chapdon.* Sacred groves are viewed as a representation of ethnicity and an age-old policy for the sustainable utilization of natural resources (Bhakat & Sen 2012).

SGs are generally a part of reserve/protected forest systems or under strong community management and are mostly in conservation and management agenda for their expanse, rich biodiversity, tradition, heritage and cultural values. As an ecosystem, SGs help in soil and water conservation besides preserving biological wealth. However, changing social and traditional perspectives have altered the grove management systems (Ray & Ramachandra 2010). SGs are slowly vanishing under the impact of modernization (Singh *et al*. 2017). Assessment of biodiversity proves extremely practical for determining the diminishing biodiversity. Only after assessment, preservation measures can be taken. The present paper reports a case study of three little known SGs of Uttarakhand and with the aim: i) to assess and document the floral and faunal diversity of these SGs, ii) to document the ethnomedicinal plants along with their uses and iii) to document the different socio-cultural taboos, myths, and beliefs regarding biodiversity conservation.

Material and Methods

Study area

The present study was carried out in three little known sacred groves (Nagdev, Chanderbadni, and Surkanda) from the Western Himalaya located in two districts of Uttarakhand (Figure 1, Table 1).

Nagdev SG (SG1) is located in Pauri district and managed by Pauri Forest Division of Uttarakhand Forest Department (Table 1 and Figure 1). Nagdev Temple is a Hindu shrine dedicated to *Nag Dev* (the serpent god) and is located amidst the dense vegetation of *Pinus wallichiana* A. B. Jacks and *Rhododendron arboreum* Smith. The total forest area of Nagdev Range is 6,641 ha of which 337 ha belongs to Nagdev Block (Rawat *et al.* 2014) and 42.9 ha to Nagdev temple forest (SG1). Nagdev SG is surrounded by two villages, *Kewras* and *Chopra* which are located at about 2 kms north from the Nagdev (SG1). The other two SGs, Chanderbadni (SG2) and Surkanda (SG3) are located in Tehri district of Uttarakhand (Figure 1 and Table 1). Chanderbadni SG is dedicated to the goddess *Durga*. SG2 is one of the 52 *Siddhapeeths* in India. According to Hindu mythology, *Siddhapeeth* is a holy place where all your wishes are fulfilled. This temple is surrounded on all sides by dense oak forests (*Quercus leucotrichophora* A. Camus and *Q. floribunda* Lindl. ex A. Camus). The nearest village, *Pujar* is about 3 kms away from this SG.

Surkanda SG (SG3) is dedicated to *Sati*, wife of Lord *Shiv* and is located in District Tehri (Table 1 and Figure 1). A temple called "Surkanda Temple" found in this SG is located on the summit of a hill accessible by about 2 km adequately steep track from the adjacent motorable road. Located amid dense forests, Surkanda has beautiful scenery. *Kaddukhal* is the nearest habitation, located at a distance of about 2 kms from SG3.The climate of the study areas is flexible and is divided into four different seasons *viz.,* summer (April-July), rainy (August-October), winter (November-January) and spring (February-April). The rainfall in the area is mainly governed by the monsoon rains (about 70%-80% of the total annual rainfall occurs during raining season. Nevertheless, precipitation occurs almost daily at higher altitudes.

Ethnobotanical data collection

An introductory survey was carried out (following Singh *et al.* 2017) in the above mentioned SGs to study their biodiversity, and different myths and beliefs associated and their role in conservation. The inhabitants of the study area are *Hindus*. There are usually four social classes in Hinduism*: Brahmins* (priests, scholars and teachers)*, Kshatriyas* (rulers,

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warriors and administers), *Vashyas* (agriculturists and merchants) and *Shudras* (laborers and service providers). Among these four classes, *Brahmins* and *Kshatriyas* are considered upper class Hindus, *Vashyas* are middle class while the *Shudras* belong to the lower class. With the help of semi-structured questionnaires and informal interviews, information regarding the socio-religious role of the sacred forests was collected by the survey which was chiefly carried out among the elderly and knowledgeable persons of the adjoining villages, after getting their oral prior informed consent (Negi 2015). The persons interviewed (usually the heads of the families) were chosen to include almost equal representation from different classes. The informants were selected using two different sampling methods and random sampling (for upper class Hindus) and snowball sampling (in case of lower class Hindus). Since the area is dominated by upper class Hindus, the number of lower class families that could be interviewed was limited. It was hard for the authors to locate potential lower class informants by random sampling and hence we had to adopt the snowball sampling method, starting with suggestions from the local village councils.

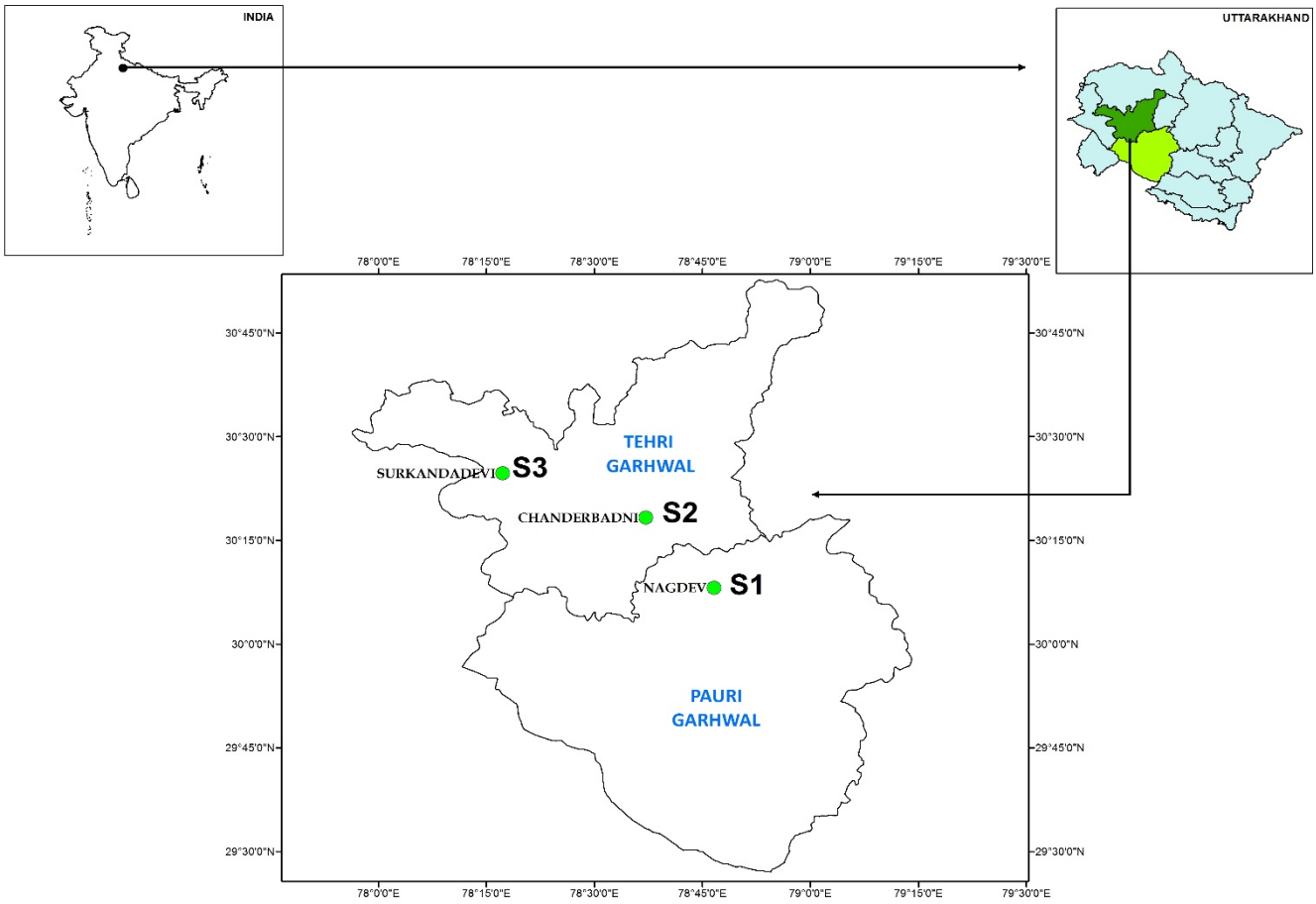

Figure 1. Map of the study area showing the location of SGs (Sacred Groves).

Semi-structured questionnaires were used to interview approximately 30% of the total households in each adjoining village (a total of 123 households in 4 villages). The villages surveyed include *Chopra* and *Kewras* (adjoining villages of SG1), *Pujar* (adjoining village of SG2) and *Kaddukhal*, adjoining village of SG3 (Table 1). Governmental and non-Governmental agencies, as well as literature sources, were also consulted. The information collected included general details regarding the SGs and the associated deity; their floral and faunal diversity; adjoining human habitation and access to them. Information about the ethnomedicinal properties of different plant species was collected from the local people living around the SGs (Singh *et al.* 2017). The local people normally do not share the ethno-medicinal information with an outsider as they believe that the effect of that particular plant will

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vanish if they reveal it to anybody. Building confidence took quite a long time. Herbarium specimens were collected for the proper identification and authentication of plants. Each of the collected plants was given a collector number in the field itself starting from 5001. Medicinal plants were also identified by matching the live plants with a pictorial field guide (Murthy 2011) and specimens of all plants were collected and rechecked for proper identification using standard literature including the local floras (Gaur 1999, Naithani 1984-1985), and doubtful specimens were further verified at the herbarium of HNB Garhwal University (GUH Srinagar, Uttarakhand). Fauna was identified by using standard literature (Chakraborty *et al.* 2005; Sharma *et al.* 2014).

Table 1. Details/Characteristics of the studied Sacred Groves (SGs)

Features	**Nagdev (SG1)**	**Chanderbadni (SG2)**	**Surkanda (SG3)**
Place	Pauri Garhwal	Tehri Garhwal	Tehri Garhwal
Geo-coordinates, elevation	30º 15'30 N"; 78º 48' 15" E	30º 18'15" N; 78º 35' 10" E	30 º 26' 12"N; 78 º 19' 40" E
Altitude (m asl)	1900	2300	2700
Devotion for which god/goddess	*Nag Dev,* the serpent god	goddess *Durga*	*Sati,* wife of Lord Shiva
Plant species richness (S)	75	61	23
Number of medicinal plant species	45	40	12
Key plants	*Pinus roxburghii* and *Rhododendron arboreum*	*Quercus leucotrichophora* and *Q. floribunda*	*Euonymus tingens* and *Lyonia ovalifolia*
Animal species richness (S)	5	10	8
Adjoining villages	*Kewras* and *Chopra*	*Pujar*	*Kaddukhal*
Number of households (HH) in adjoining villages	223 (*Kewras*); 42 (*Chopra*)	83	60
Number of HH surveyed	67 (*Kewras*); 13 (*Chopra*)	25	18
Plant diversity (H)	2.75	2.38	1.95
Key animals	Leopard	Leopard	Black bear
Nearest home distance (km)	2	2	1
Distance from motorable road/nearest market (km)	5	3	3
How many people annually visit this site (number)	About 8,000-10,000	About 80,000	> 100,000

Results

Biodiversity

Nagdev SG is bestowed with a rich floral and faunal diversity. A total of 75 plant species were reported from this SG (Table 2). The number of species varied in different life forms and taxonomic categories (Figure 2). Rosaceae, with the maximum number of species (14) was observed to be the dominant family. Almost all the plant species had one or another ethnomedicinal importance (Table 2). The predominant vegetation is represented by species of *Abies* (**Raga**), *Acer* (**Kanchula**), *Aesculus* (**Panagar**), *Buxus* (**Papdi**), *Cedrus* (**Devdar**), *Pinus* (**Chir**), *Quercus* (**Banj/Moru**) and *Rhododendron* (**Burans**).

Chanderbadni is a *Siddhapeeth* i.e. the sacred site where all the desires are fulfilled (according to a religious belief). A total of 61 ethnomedicinally important plant species were reported in all the three life forms from this SG (Table 2). The number of species varied in different life forms and taxonomic categories (Figure 2). Rosaceae, with the maximum number of species (11) was the dominant family in this SG also (Table 2).

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A total of 23 plant species that have ethno-medicinal importance were reported from Surkanda, SG3 (Table 2). The number of species reported was much less as compared to SG1 and SG2 (Figure 2).

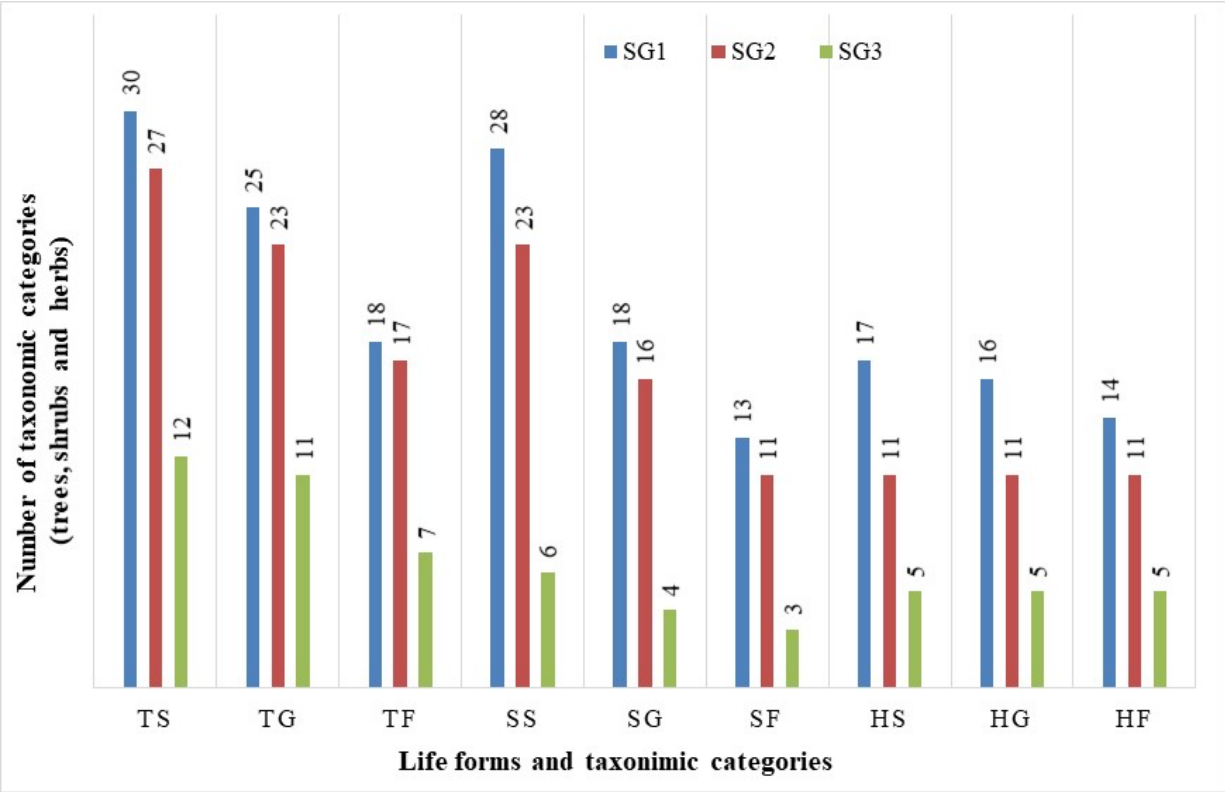

Figure 2. Diagrammatic representation of different life forms (Herb, Shrub and Trees) and taxonomic categories (Species, Genera and Families) in the studied SGs.
Abbreviations: TS= tree species; TG= tree genera; TF= tree families; SS=shrub species; SG=shrub genera; SF=shrub families; HS=herb species; HG=herb genera HF=herb families.

Table 2. List of plant species (with ethnomedicinal importance) reported from SG1 (Nagdev), SG2 (Chanderbadni) and SG3 (Surkanda) Sacred Groves.

Family / Scientific Name	Vernacular Name	Life form	Voucher number	Reported from	Ethnomedicinal importance
Acanthaceae					
Strobilanthes wallichii Nees	**Pathora \ Jaunya**	Shrub	5027	SG1	Leaves and flower occasionally cooked as vegetables.
Pteracanthus angustifrons Bremek.	**Pathora**	Shrub	5042	SG1	
Aceraceae					
Acer oblongum Wall. ex DC.	**Kanchula**	Tree	5060	SG1	Used in rituals/ The leaves are packed around apples, root crops etc. to help preserve them.

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Acer acuminatum Wall. ex D. Don	**Rath- kanchula**	Tree	5026	SG2 / SG3	The leaves are packed around apples, root crops to preserve them
Acer caesium Wall. ex Brandis.	**Kanjula**	Tree	5073	SG2 / SG3	The juice of the bark is used externally to treat muscular swellings, boils and pimples.
Adoxaceae					
Viburnum cotinifolium D. Don	**Bhatnoi**	Shrub	5061	SG1 / SG2 / SG3	The decoction of bark used in hepatic and digestive troubles.
Viburnum cylindricum Buch.-Ham. ex D. Don	**Rashina**	Shrub	5025	SG1 / SG2	-
Viburnum erubescens Wall.	**Ganai**	Shrub	5028	SG1 / SG2 / SG3	Leaves used as insecticide.
Anacardiaceae					
Rhus chinensis Mill.	**Dumfela**	Tree	5001	SG1 / SG2	Possess antiviral, antibacterial, anticancer properties
Betulaceae					
Alnus nepalensis D. Don	**Utees**	Tree	5043	SG1, SG2	Used for Reducing swelling of legs, bark used in local medicine.
Betula alnoides Buch.-Ham. ex D. Don	**Kath- bhuj**	Tree	5072	SG1 / SG2 / SG3	Sacred plant/ Used as antidote in the treatment of snake bite.
Carpinus viminea Lindl.	**Chamkharik**	Tree	5024	SG1 / SG2	Used in rituals/ Wood is used for furniture, articles of sports and weaving shuttles.
Corylus jacquemontii Decne.	**Bhotiyabadam**	Tree	5059	SG2 / SG3	
Buxaceae					
Buxus wallichiana Baill.	**Papdi**	Tree	5071	SG1 / SG2	In the treatment of rheumatism, and syphilis.
Caprifoliaceae					
Valeriana moonii Arn. ex C. B. Cl.	**Shammia**	Herb	5002	SG1	Treatment of rheumatism and

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					low blood pressure. Roots used as aphrodisiac, and in mental disorders.
Celastraceae					
Euonymus tingens Wall.	**Kumkum/Barmeli**	Tree	5023	SG1 / SG2 / SG3	Used in the treatment of eye diseases and also in cases of chronic constipation. Considered sacred by the locales and used in various religious ceremonies.
Cornaceae					
Benthamidia capitata (Wall.) H. Hara	**Bhamora**	Tree	5003	SG1	Wood used in agriculture implements.
Cupressaceae					
Cupressus torulosa D. Don ex Lamb.	**Surai**	Tree	5044	SG1 / SG2	Sacred tree/ Wood is used for general construction. Dried leaves used as incense '*dhup'* for Rituals.
Daphniphyllaceae					
Daphniphyllum himalayense (Benth.) Mull.- Arg.	**Ratendu**	Tree	5058	SG1	Timber is used in construction and furniture making.
Ericaceae					
Lyonia ovalifolia (Wall.) Drude	**Ainyaar**	Tree	5022	SG1 / SG2 / SG3	Used externally as an infusion to treat skin diseases and external parasites. Seed paste applied on wounds and boils.
Rhododendron arboreum Sm.	**Burans**	Tree	5074	SG1 / SG2	Nectar is brewed to make wine and is effective in diarrhea and dysentery.
Rhododendron campanulatum D. Don.	**Burans**	Tree	5062	SG3	

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Fabaceae					
Indigofera dosua D. Don	**Kathi**	Shrub	5021	SG1	Used to produce dye-indigo.
Indigofera cassioides DC	**Sakena**	Shrub	5029	SG1 / SG2	Leaf powder taken in malaria
Albizia julibrissin Durazz.	**Sirsa**	Tree	5004	SG1 / SG2	Best used for insomnia.
Fagaceae					
Quercus floribunda Lindl. ex A. Camus.	**Moru**	Tree	5045	SG1 / SG2	Used in treatment of hemorrhages, chronic diarrhea, dysentery
Quercus leucotrichophora A. Camus	**Banj**	Tree	5057	SG1 / SG2 / SG3	Used in treatment of gonorrhea, indigestion, asthma, and diarrhoea.
Gentianaceae					
Swertia chirayita H. Karst.	**Chiraita**	Herb	5063	SG1 / SG2 / SG3	Used to stimulate the appetite and also used in cough and malaria. The plant is also well known for Ayurvedic medicine '*Chiretta'*, which is used in blood disease and as febrifuge.
Hypericaceae					
Hypericum perforatum L.	**Kalamath weed**	Herb	5065	SG1 / SG2 / SG3	Effective antidepressant. Infusion of leaves given in malarial fever.
Juglandaceae					
Juglans regia L.	**Akhrot**	Tree	5046	SG1 / SG2 / SG3	An important tree of social forestry. The seeds are diuretic and stimulant.
Lamiaceae					
Micromeria biflora (Buch.-Ham. ex D.Don) Benth.	**Ban ajwain**	Herb	5020	SG1 / SG2	Treatment of toothache and sinusitis.
Vitex negundo L.	**Shivli**	Herb	5075	SG1 / SG2	Used to treat arthritis.
Linaceae					
Reinwardtia indica Dumort.	**Phiunli**	Shrub	5064	SG1 / SG2	Petals chewed as tongue wash;

Published: 01 May 2019

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					consideration sacred, as indicator of spring season.
Moraceae					
Ficus nerifolia Sm.	**Dudhla**	Tree	5030	SG1	The latex is applied to boils especially those on tongue.
Myricaceae					
Myrica esculenta Buch.-Ham.ex. D.Don	**Kaphal**	Tree	5055	SG1 / SG2	Used against disease like fever, cardiac debility typhoid, diarrhea, dysentery.
Phyllanthaceae					
Glochidion heyneanum Wight & Arn.) Wight	**Chamri**	Tree	5005	SG2	Wood is used for fuels.
Primulaceae					
Myrsine africana L.	**Chupra**	Shrub	5019	SG1 / SG2	Used in treatment of tapeworm.
Myrsine semiserrata Wall.	**Gaunta**	Shrub	5047	SG1 / SG2	Decoction of the leaves is used as a blood purifier.
Oleaceae					
Fraxinus micrantha Ling.	**Angu**	Tree	5066	SG1 / SG2	Leaves and bark used in fever and blood dysentery.
Pentaphylacaceae					
Eurya acuminata DC.	**Bakryal**	Shrub	5070	SG1 / SG2	Used mainly as a fuel and fodder.
Pinaceae					
Abies pindrow (Royle ex D. Don) Royle	**Raga/Fir**	Tree	5031	SG1 / SG2 / SG3	Used in rituals, curing respiratory ailments such as asthma, fever and cough.
Cedrus deodara (Roxb. ex D. Don) G. Don	**Devdar**	Tree	5056	SG1, /SG2	Used in neurological disorders, asthma, fever, infested wounds. Bark used in bowel complaints and externally applied on piles.

Published: 01 May 2019

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Pinus roxburghii Sarg.	**Chir**	Tree	5078	SG1 / SG2 / SG3	The resin is antiseptic, diuretic and vermifuge.
Pinus wallichiana A. B. Jacks.	**Kail**	Tree	5032	SG1 / SG2	Commercial source of turpentine and tar.
Picea smithiana (Wall.) Boiss.	**Raga**	Tree	5048	SG3	Resin applied on cuts, sores and body pain.
Polygonaceae					
Rumex hastatus D. Don	**Kilmori**	Herb	5067	SG1 / SG2	Leaf extract applied on cuts and wounds to check bleeding and also believed to relive from suffering of nettle sting
Ranunculaceae					
Ranunculus diffusus DC.	**Angasia- jhar**	Herb	5018	SG1 / SG2	
Rhamnaceae					
Rhamnus purpurea Edgew.	**Luish**	Shrub	5076	SG2	Bark extract with given in digestive disorders.
Rhamnus virgatus Roxb.	**Chentuli**	Shrub	5017	SG1 / SG2	Bark paste applied on eczema and ringworm
Rhamnus procumbens Edgew		Shrub	5033	SG1	Wood yellowish, used for walking sticks
Rhamnus triquetra (Wall.) Brandis	**Gaunta**	Shrub	5049	SG1	
Rosaceae					
Prunus cerasoides Buch.-Ham. ex D. Don	**Paiya**	Tree	5006	SG1 and SG2	Sacred plant, used in rituals. Also used for treating back ache.
Prunus cornuta (Wall. ex Royle) Steud.	**Jamnoi**	Tree	5016	SG1, SG2 and SG3	The resin is sometime used medicinally.
Prunus persica (L.) Batsch	**Aaru**	Tree	5034	SG1	Gives relief from cancer, obesity, cholesterol.
Prunus venosa Koehne.	**Gadh-aru**	Tree	5077	SG1	Seed paste applied on sores and skin eruptions.
Pyrus pashia Buch.-Ham. ex D. Don	**Mehal**	Tree	5015	SG1 / SG2	Juice of the ripe fruit is used in

Published: 01 May 2019

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					treating conjunctivitis.
Cotoneaster microphyllus Wall. ex Lindl.	**Wanni**	Shrub	5068	SG1 / SG2 / SG3	The branches are used for making baskets. Leaf extract and fruits taken in diarrhoea, root paste applied on cuts and wounds.
Prinsepia utilis Royl	**Bhainkal**	Shrub	5035	SG1 / SG2	Used in the treatment of rheumatism and in muscular pain. Root bark used in diarrhea
Pyracantha crenulata (D. Don) Roem.	**Ghingaru**	Shrub	5014	SG1 and SG2	Treatment of bloody dysentery.
Rosa microphylla Desf.	**Ban –Gulab**	Shrub	5007	SG1 / SG2	Reduces the incidence of cancer and halts of cancer. Flower paste applied on skin ailments.
Rubus biflorus Buch. Ham. ex Sm.	**Hinsar**	Shrub	5036	SG1 / SG2	Decoction of roots given in diarrhoea
Rubus ellipticus Sm.	**Hinsar**	Shrub	5050	SG1 / SG2	As an adstringent. Root extract used in local beverages as intoxicating ingredient.
Rubus niveus Thunb.	**Anchu**	Shrub	5069	SG1 / SG2	Root juice used as an antidote of snake bite.
Potentilla gerardiana Lind. ex Lehm.	**Bajardanti**	Herb	5013	SG1	Used in the treatment of mouth and throat swelling. Roots paste applied on wounds
Potentilla fulgens Wall. ex Hook.	**Bajardanti**	Herb	5037	SG1 / SG2 / SG3	Possess anti-diabetic and anti-parasitic properties. Plant juice applied on mouth in stomatitis and aphthae.
Rubiaceae					
Leptodermis lanceolata Wall.	**Padera**	Shrub	5051	SG1	A tea from the leaves is used

Published: 01 May 2019

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					for the treatment of cough.
Randia tetrasperma Benth. & Hook. f.	**Bhotiyaghingaru**	Shrub	5054	SG1 / SG2	Used in the famous Ayurveda pancha karma procedure called as *Vamana* (Vomiting therapy).
Rutaceae					
Zanthoxylum armatum DC.	**Timroo**	Shrub	5008	SG1 / SG2	Used for toothache. Sometimes kept in the house doors, believed to get rid of all evils.
Sabiaceae					
Meliosma simplicifolia (Roxb.) Walp.	**Kharas**	Tree	5012	SG1	Wood as fuel and minor implements.
Salicaceae					
Salix acutifolia Willd.	**Barroi**	Shrub	5038	SG1 / SG2	Stems are flexible and are used in basket making
Salix babylonica L.	**Majnu**	Tree	5041	SG2	Decoction of the leaves is used in the treatment of fever, rheumatism, skin diseases, ulcers etc.
Sapindaceae					
Aesculus indica (Wall. ex Cambess.) Hook.	**Pangar**	Tree	5053	SG1 / SG2	Used in rituals/ Best used for leukemia. Seed paste and oil applied in rheumatic pain.
Scrophulariaceae					
Verbascum thapsus L.	**Geedartambaku**	Herb	5009	SG1 / SG2	Remedy for skin, throat and breathing ailments.
Solanaceae					
Solanum nigrum L.	**Kirmoi**	Herb	5011	SG1 / SG2	Possess anti-oxidant,diuretic and anti-pyretic properties.

Published: 01 May 2019

http://dx.doi.org/10.32859/era.18.15.1-21

Thymelaeaceae					
Daphne papyracea Wall. ex G. Don.	**Satpura**	Shrub	5039	SG1	Especially used for religious purposes; leaf paste applied on eczema.
Urticaceae					
Urtica dioica L.	**Kandali**	Herb	5052	SG1 / SG2	Treatment of rheumatism and influenza.
Violaceae					
Viola canescens Wall.	**Vanafsa**	Herb	5040	SG1	Decoction of plant useful in malarial fever, bronchitis and asthma, leaf juice applied on cuts and wounds.
Zingiberaceae					
Hedychium spicatum Sm.	**Kapurkachri**	Herb	5010	SG1 / SG2 / SG3	Used in the treatment of liver disorders and tuberculosis.

According to Hindu mythology, the gods and goddesses travel at very high speed on different animals and birds called deity mounts or *vahanas* (animal vehicles). *For* example, Lord *Ganesha* (the elephant headed god) rides on a mouse/musk shrew, Lord Indra (god of rain and thunderstorm) on an elephant and *Kartikeya* (god of war) on a peacock. This concept is introduced to promote and maintain harmony in nature. Conservation of biodiversity along with human beings is essential to sustain ecological stability (Malik 2014). Hence, many wild and domestic animals were deliberately attached to gods to weave mythology for protection of animals and plants (Kandari *et al.* 2014).

The animals that are often seen in and around the studied sacred groves include *Felis chaus* (**Jangli Billi**), *Macaca mulatta* (**Bandar**), *Panthera pardus* (**Guldar**), *Selenarctos thibetanus* (**Bhalu**), *Sus scrofa cristatus* (**Janglisaur**, wild boar), *Vulpes vulpes* (**Lombdi**, fox) etc. Some of these animals are threatened and endangered (Table 3), while some are associated with religious beliefs and hence are considered to be sacred (Table 3). *e.g. Macaca mulatta* (monkey) is a sacred animal in the Hindu religion and is to be revered and protected.

Socio-cultural taboos and rituals

The studied sacred landscapes contain rich biodiversity. These are regarded as 'sacred' due to association with one or another deity and are conserved in a pristine condition. According to the local population, cutting of green trees has been prohibited and partial extraction of biomass in the form of dead, fallen and dry trees is permitted from the forest floor around the temples. Forest Department Officials, in association with the denizens, have set up rules and regulations for the better administration of these undisturbed woods. This strategy is comparable with the today's concept of biodiversity conservation by means of protected areas (sanctuaries, national parks, and biosphere reserves).

Taboos are the unwritten, verbally conveyed traditional and social rules while *rituals* are the religious customs. Both play an important role in the conservation of biodiversity. These are the motivating factors for sustainable use of the resource. In the present study, some taboos were noted that are to be followed by all the villagers. The study area is dominated by upper class Hindus (*Brahamins* and Kshatriyas) that govern the *Taboo* system while the middle and lower classes were relegated to carrying out functionary tasks. The *Taboos* include:

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a) *Shudras* (lower class members) and women are strictly prohibited from entering the sacred forest due to the belief that they are impure. Women, irrespective of the class, are not allowed to enter into a sacred grove especially during their menstruation.

b) Collection of bio-mass in the form of fodder and fuel-wood is strictly prohibited in these SGs which protects the economically important plant species from the ruthless exploitation.

c) The temples located in these SGs should be visited barefooted so that the wishes become true.

d) Killing of animals and uprooting of plants is not allowed in the SGs. Use of iron made tools (like a knife, sickle) on the plants and animals could hurt the feelings and emotions of gods and goddess and makes them sad. The forest fairies, in turn, are angered and their rage can make the offender mad or deformed.

e) Anything made of animal skin/hide is banned in these SGs.

Table 3. List of wild animals commonly found in the sacred groves (SG1, SG2 and SG3).

Scientific name	**Common name**	**English name**	**IUCN Status***	**Associated belief**	**Reported from**
Felis chaus Schreber, 1777	**Jungli billi**	Wild cat	LC	-	SG2 / SG3
Lepus nigricollis F. Cuvier, 1823	**Khargosh**	Indian Hare	LC	-	SG2
Macaca mulatta Zimmermann, 1780	**Bandar**	Monkey	LC	Associated with Hindu god "Hanuman"	SG1 / SG2 / SG3
*Muntiacus muntjak (*Zimmermann*, 1780*	**Kakad**	Barking deer	LC	Associated with lord *Shiva* and pedestal *Revanta,* the god of hunting	SG1 / SG2 / SG3
Naemorhedus goral Hardwicke, 1825	**Ghural**	Himalayan goral	NT	-	SG2, /SG3
Panthera pardus Linnaeus, 1758	**Guldar**	Leopard	Vu	Associated with goddess *Durga*	SG1 / SG2 / SG3
Ursus thibetanus G. Baron Cuvier*, 1823*	**Bhalu**	Black bear	CR	In the epic Ramayana, Jambavantha (black bear) helped Rama find his wife SIta and fight her abductor, Ravana.	SG1 / SG2 / SG3
Suncus murinus Linnaeus 1766	**Chuchundar**	Musk shrew	LC	Lord *Ganesha* is accompanied by musk shrew wherever he travels.	SG2
Sus scrofa cristatus aff. *Gray,* 1847	**Jungle suar**	Wild boar	LC	Associated with lord *Vishnu.*	SG1 / SG2 / SG3
Vulpes vulpes Linnaeus, 1758	**Lomdi**	Fox	LC	-	SG2 / SG3

Notes: *LC= Least Concern, DD= Data Deficient, NT= Near Threatened, Vu= Vulnerable, CR= Critically Endangered;
Source: http://www.iucnredlist.org/

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Myths associated with the Nagdev, Chanderbadni and Surkanda Scared Groves

Nagdev SG is named after the 'Nagdev temple' located in this area. Nagdev temple is worshiped by the people of '*Dobhal'* caste. *Dobhal* is a surname of some families of the upper class, the *Brahamins.* A mythology prevails behind the establishment of this temple. It is believed that a person named *Gangu Ramola* lived with his wife in *Sem Mukhem* village. They had no children. He used to drink alcohol and used to tease the girls of the village. His wife was a great devotee of *Lord Krishna*. After many years, they were blessed with a baby boy whose upper portion resembled a snake and the lower portion was similar to a human being. The villagers were afraid of him as they thought that the boy could do harm to them and therefore, they wanted to kill him. To save their child from the villagers, *Gangu* and his wife took their child to a forest nearby Pauri and left him there. And from then, people worship that place to seek shield from snakebite. Later on, the place became famous by the name of "*Nagdev"* (snake god).

Chandrabadni peak *(Siddha Peeth)* located on the frontier of tehsil *Devaprayag* and *Pratapnagar* is familiar for the temple of *Chandrabadni Devi*. The goddess (*devi*) linked with the temple is *Durga Mata Sati* who was the wife of *Lord Shiva* and daughter of *Daksha Prajapati*), and is considered as one of the famous deities in Garhwal Himalaya (Pala *et al.* 2014). The belief held for the foundation of this temple and the surrounding SG is that when *Sati* had some argument with her father and she ended her life in the *yagya* (the fire around which the prayer is performed in Hinduism) initiated by her father, *Prajapati Daksha* who was not willing to embrace *Shiva* as her daughter's husband. It is commonly held that Lord *Shiva* carried *Sati's* corpse, on his *Trishul* to this place from Haridwar.

One of the most persistent myths behind the origin of worship at the Surkanda site is associated with the life of *Sati*, who was the wife of the god *Shiva* and daughter of the Puranic god, king *Daksha*. *Daksha* was not satisfied with his daughter's choice of husband, and when he performed a grand Vedic sacrifice for all the deities, he did not invite *Shiva* or *Sati*. *Sati,* in fury, jumped into the fire to make the sacrifice impure and unholy. It is said that being the all-powerful mother goddess, *Sati* left her body in that moment to be reborn as the goddess *Parvati*. In the meantime, *Shiva* was stricken with sadness and anger at the loss of his wife. He took *Sati's* body on his shoulder and started his *tandava* (dance of cosmic destruction) throughout the heavens and vowed not to stop till the body was completely decayed. The other's gods, scared of their annihilation, entreated *Vishnu* to appease *Shiva*. Thus, wherever *Shiva* roamed while dancing, *Vishnu* followed. He sent his *chakram* (*Sudarshana*, a discus) to destroy the corpse of *Sati.* Pieces of her body fell until *Shiva* was left with nothing to carry. *Shiva* then did *Mahatapasya* (great penance) to punish himself for his wrongdoings. It is held that there are about 51 pieces of *Sati's* body scattered throughout the Indian subcontinent. These locations are called *Shakti Peeths* (the holy places which are sources of energy for the visitors) and are devoted to different mighty goddesses. The head of *Sati* fell in the locality where the modern temple of *Surkanda Devi* stands. Due to this reason, it became *Sirkhanda* (*sir* in Hindi means *head* and *khanda* means *part*) which later on became *Surkanda*.

Ethno-medicinal plants and uses reported by participants

A total of 78 plant species (including 37 trees, 27 shrubs and 14 herbs) belonging to 58 genera and 41 families were reported from the three sacred groves. The majority of the plant species belong to least concern, LC, except *Acer acuminatum* and *Corylus jacquemontii,* which are data deficient (DD). About 91% of these plant species had ethno-medicinal importance. These plant species were used by local inhabitants for treating various ailments like asthma, cough, cold, cholera, constipation, cuts/wounds, digestive disorders, fever, eye/ear diseases, rheumatism and toothache (Table 2). It was observed that a particular disease was cured by many different plant species and, further, many plant species were reported to cure more than one ailment. The most privileged family used for the curing of disease was the Rosaceae. Although all plant parts were used in various remedies (Figure 3), the leaves were used more frequently (31%) as compared to roots (27 %), bark (22%), seeds (9%), fruit (6%) and flowers (5%, Figure 3).

Current threats to grove system and future prospective/conservation measures

SGs depict an excellent example of community based nature conservation. The method of protecting the natural biodiversity with the help of establishment of SGs is a unique feature of Western Himalaya. The present resurgence of interest in the grove system is mainly due to its valuable contribution towards much talked 'biodiversity conservation' and a number of free but important ecosystem services. SGs are more or less pockets of climax vegetation preserved on religious grounds (Sujana & Sivaperuman 2008). These harbour rare and endemic species protected on isolated land with social and religious beliefs (Kulkarni & Shindikar 2005). Nevertheless, during the recent times SGs are threatened due to

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unplanned developmental activities besides various biological (invasive species, soil erosion, land-use change, etc.) and social threats like lost belief, violation of social taboos, change in religious and cultural life and population increment (Ray & Ramachandra 2010, Singh *et al.* 2017).

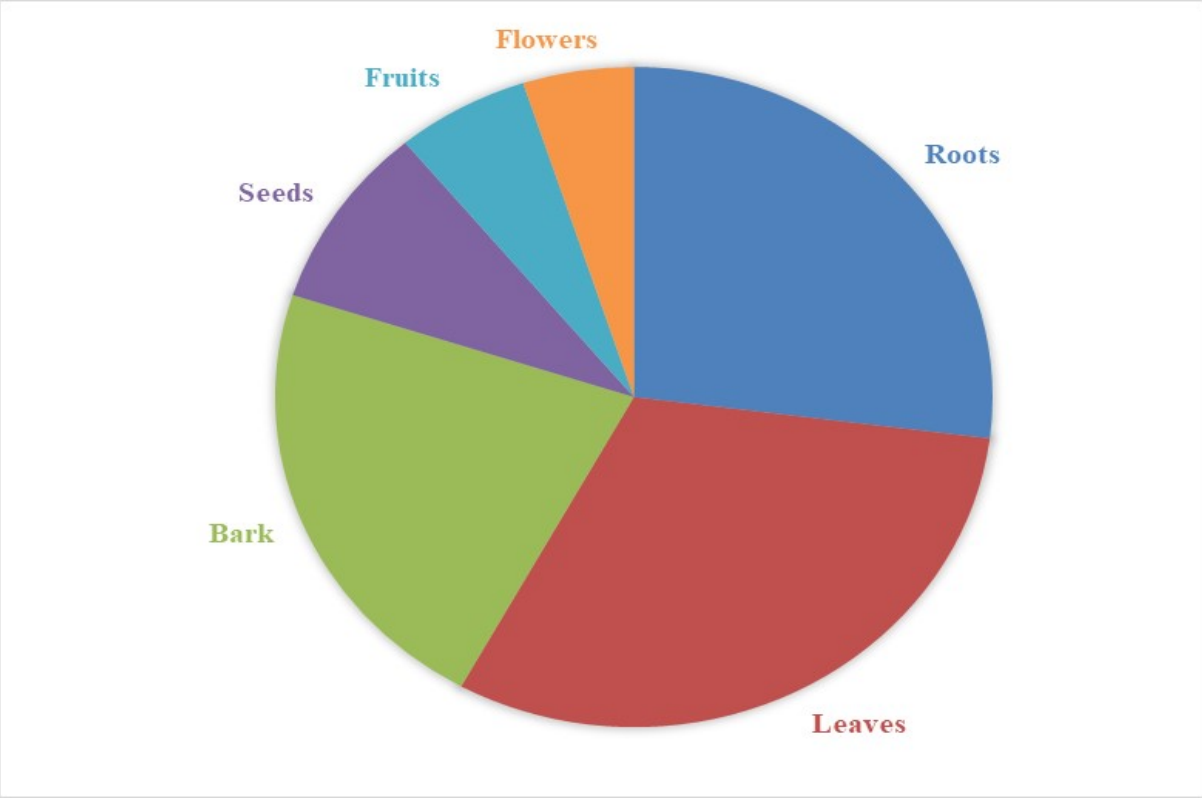

Figure 3. Plant parts used in preparing medicines.

Present day groves are experiencing different types of pressures majority of which are human induced. Anthropogenic pressures include fragmentation, area shrinkage, and degradation, alien species invasion, grazing and resource extraction (Malik *et al.* 2016, Ray *et al.* 2010,). Fragmentation is a continuous procedure during which the natural habitat is progressively reduced into smaller patches that become more isolated and increasingly affected by edge effects (McGarigal 2002). Forest fragmentation is the chief reason for the degradation of groves (Ray *et al.* 2010; Singh *et al.* 2017). Due to the fragmentation, the species composition as well as the microclimatic conditions of the habitat are altered. It is because, as soon as a forest is fragmented, its interior is exposed to somewhat harsh environmental conditions due to which sun-loving plant species start invading and in due course of time dominate the region (Malik 2014). Thus, there is an urgency to maintain village traditions related to the conservation of SGs. At National level, different state forest departments, village level committees, academicians and researchers are working with various aspects as well as are actively involved in grove conservation works (Ray *et al.* 2010). Conservation goals can be achieved by strengthening the existing conservation activities of the villagers and restoration of the degraded sacred groves. For providing necessary protection to the SGs and maintain their natural identity and sanctity, it is imperative that the surrounding population is taken into confidence. The local denizens need to be educated and guided for sustaining the sanctity of existing grove and strengthening them (Kandari *et al.* 2014). Singh *et al.* (2017) also realized and advocated the same. Conservation of SGs is out of question until the local communities show their active participation. The local communities will participate and assist in achieving these conservation goals only if they are given some compensation. Because conservation unaccompanied by compensation is only conversation (gossip) and nothing else (Malik 2014, Malik *et al.* 2014, Sing *et al.* 2017). By upgrading their living standards and providing with the benefits of conservation to them, long-term conservation goals in these SGs can be achieved. It

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is also possible that some important SGs are brought under the protected area network 'PAN' to ensure their proper conservation.

Discussion

The results of the present study underline that the local SGs are not only important repositories of ethno-medicinal plant species, but also act as corridors for animal migration in anthropogenic landscapes. A total of 78 plant species and 10 commonly found animal species were reported from the three sacred groves. None of the reported plant species is endangered or threatened but among the animal species, a few are rare and threatened like *Naemorhedus goral* (Himalayan goral, near threatened); *Panthera pardus* (leopard, vulnerable) and *Ursus thibetanus* (black bear, critically endangered). During interviews we came to know that these are commonly seen wild animals in these SGs, although these have been kept in threatened categories by IUCN. In rural areas of Devbhumi, a number of plants, animals and even lakes and rivers are considered sacred and hence no felling or exploitation is being carried out (Singh *et al*. 2017). As a result of this consecration many economically and ecologically important species of plants and animals which may be threatened and endangered in other areas are preserved in Sacred Groves and can form a genetic reservoir to serve as a guide against extinction of these species. For example, *Naemorhedus goral* (Himalaya Goral) is a threatened taxon because of poaching and habitat destruction (Duckworth & MacKinnon 2008). In India, within protected areas, the status of goral populations is probably satisfactory; they are however often hunted for meat even within many of the protected areas (IUCN 2008). In Tibet, poaching is thought to be limited due to prevailing religious beliefs (http://www.wilddocu.de/himalayan-goral-nemorhaedus-goral/). These areas in Tibet can serve as a genetic reservoir in case there is a fear of extinction of Himalayan Goral in its other habitats. Similar is the case of leopard. The leopard's (*Panthera pardus*) broad geographic range, remarkable adaptability, and secretive nature have contributed to a misconception that this species might not be severely threatened across its range. Other studies (Jacobson *et al.*, 2016) found that not only are several subspecies and regional populations critically endangered but also the overall range loss is greater than the average for terrestrial large carnivores. In the present study, we learnt during interviews that *Panthera pardus* (guldar) is considered as sacred due to its association with goddess *Durga* and hence is protected. In this way the present SGs can serve as a genetic reservoir for this awesome animal that is threatened otherwise.

Out of the reported 78 plant species, about 91% had ethno-medicinal importance. These plant species were used by local inhabitants for treating various ailments. The leaves were used more frequently (31%) as compared to roots (27 %), bark (22%), seeds (9%), fruit (6%) and flowers (5%). Similar results were reported by Keter & Mutiso 2012 from Kenya; Bhat *et al*., (2013), Malik *et al*. 2015, and Rathore *et al.* 2015 from Western Himalaya, and Akhtar *et al*. 2013 from Pakistan.

The religiously conserved regions provide a comprehensive and rich ecological niche as repositories of genetic diversity (Anthwal *et al.* 2010). But nowadays the condition of sacred groves is not good because of deteriorating belief and faith. While interacting with the senior participants, we learnt that especially youngsters have lost the faith and belief in religious matters. They hardly care about these things. The other reasons for the increased threats to SGs can be many *viz.,* dearth of an integral conservation effort, increased demands for biomass extraction in the form of NTFPs (non-timber forest products), fuelwood and fodder; decrease in religious beliefs along with the declined dedication of present generation towards such natural sacred places (Singh *et al.* 2017). Thus, these SGs need to be protected and managed wisely. Only then these can be saved from disappearance; the concerned organizations at National and International levels can play an important role in this regard.

Conclusions

The studied SGs play a vital role in the conservation of biodiversity. It can be imagined by the fact that collection of bio-mass in the form of fodder and fuel-wood and killing of animals is strictly prohibited in these SGs which further leads to the protection of economically and ecologically important biodiversity from the ruthless exploitation. SGs can also offer protection to those fragile habitats and rare/endemic species that are excluded from conventional protected areas (PAs), and this approach to conservation has greater importance. However, like in many other areas, the studied SGs face a number of challenges that need to be addressed. The studied SGs are not free from anthropogenic interferences. The main reason for the deteriorated condition is mistrust of traditional beliefs, social customs, and taboos, which not only indicates the loss of the biodiversity but also its tapestry of culture associated with the grove. Hence, in order to protect and conserve these unique and biodiversity rich

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SGs which represent the repositories of many endemic and threatened biota, it is very important to maintain those beneficial social customs and beliefs that really help in conserving the studied SGs as a whole. Having the local community as the custodians of the SGs can provide an effective tool for ensuring their conservation through community participation. The need of the hour is external intervention taking the local people into confidence. It is high time for the conservationists, ethno-biologists and communities along with government and non-governmental organizations to take up strategies for conserving these fragile landscapes for the betterment of humankind. These responsible persons of the society should highlight the ecological services rendered free by SGs and common people should be made to realize that the conservation of groves is crucial for their sustenance.

Declarations

Ethics approval and consent to participate: All participants provided prior informed consent before the interviews.

Availability of data and materials: Data are available from the first author.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: SS carried out the field study. SS and MY analyzed the data. ZAM identified the plant species and wrote the initial draft of the manuscript. RWB, RMK and JAB thoroughly revised the manuscript and reshaped it to the present form. All authors read and approved the manuscript.

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