Land Use Policy 89 (2019) 104213

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Stakeholder motivation for the conservation of sacred groves in south India: An analysis of environmental perceptions of rural and urban neighbourhood communities

U. Prashanth Ballullaya[a], K.S. Reshmi[a], T.P. Rajesh[a], K. Manoj[a], Margaret Lowman[b], Palatty Allesh Sinu[a,b,*]

[a] Department of Animal Science, Central University of Kerala, Periya 671316, Kerala, India
[b] California Academy of Sciences, Golden Gate Park, San Francisco, CA, USA

ARTICLE INFO

Keywords:
Sacred forests
Biocultural conservation
Cultural forest
Cultural diversity
Deity
Environmental perception
Environmental policy
Conservation
Community-conserved area
Religion

ABSTRACT

Sacred groves (SGs) of south India are the local communities' self-enforced spiritual institutions, which contain natural forests and swamps. Thus, the communities' faith in traditional rituals and local deities are important for their existence. SGs preserve cultural practices of ethnic communities and conserve biodiversity. Although most of these groves can be found in rural areas, rapid urban annexation is changing their landscapes. We hypothesise that the landscape type (rural versus urban) and the deity type of the SGs among other factors might affect the communities' spiritual and environmental perceptions of SGs. This study was conducted in rural highlands of the Western Ghats in Kodagu and adjoining urban lowlands in Kasaragod. We found that the urban communities valued SGs, not only for their spiritual importance but also for their environmental merits. Both urban and rural communities were cautious enough not to access or abuse the SGs. This behaviour also depended on the deity that was housed in the SG. SGs that housed highly revered deities (eg. *naga*) were seldom abused. The religious adherence was prominent especially in rural communities, so much so that the habitat quality of the SGs could be predicted based on the deity that was worshipped there. Apart from these spiritual influences, SGs are influenced by economic (coffee industry in Kodagu) and societal pressures. Sanskritization of deities or change in faith, construction of temples, land encroachments, and changes in the neighbouring societies also negatively affect the SGs. Since the SGs receive reverence on the power of the local deities, governmental bodies must discourage the Sanskritization of local deities and construction of temples. Considering the historical, biological, and cultural importance of SGs, the policies governing them is necessary to ensure that SGs stay intact.

1. Introduction

Sacred groves (SGs) of India (Gadgil et al., 1993; Ormsby and Bhagwat, 2010), Southeast Asia, (Bhagwat and Rutte, 2006), Africa (Sheridan and Nyamweru, 2007), and church forests of Ethiopia (Wassie et al., 2005; Reynolds et al., 2017) are the examples of community-conserved forests (Verschuuren et al., 2010). Although the motivation to protect these sacred sites is different between regions, spiritual values have contributed enormously to the conservation of local, regional, and global biodiversity (Ormsby and Bhagwat, 2010; Rutte, 2011; Notermans et al., 2016; Reynolds et al., 2017). As the communal reasons for conserving SGs were different from nature conservation *per se*, many countries do not have rigid policies to ensure their continued protection (Berkes, 2009; Rutte, 2011; Ormsby, 2014; Lowman and Sinu, 2017).

Religious and cultural beliefs are the major drivers for the conservation of SGs in India (Freeman, 1999; Ramachandran, 1999; Bhagwat and Rutte, 2006; Ormsby and Bhagwat, 2010; Notermans et al., 2016; Lowman and Sinu, 2017). The religious communities worshipped nature as such, the natural processes, animals, and attributed Godly qualities to such entities, essentially spiritualising the whole area (Nutgeren, 2005; Negi, 2010; Notermans et al., 2016). For instance, King Cobra (*Ophiophagus hannah*), a vulnerable species red-listed by IUCN, is a major deity of traditional SGs in Kerala (Anonymous, 1889; Ramachandran, 1999; Murugan et al., 2008; Notermans et al., 2016; Das and Balasubramanian, 2017). Although it is one of the deadliest snakes, the Hindu community of Kerala and parts of Malnad region of Karnataka rarely harm it. Harming a King Cobra is

* Corresponding author at: Department of Animal Science, Central University of Kerala, Periya 671316, Kasaragod, Kerala, India.
E-mail address: sinu@cukerala.ac.in (P. Allesh Sinu).

https://doi.org/10.1016/j.landusepol.2019.104213
Received 20 February 2018; Received in revised form 2 September 2019; Accepted 8 September 2019
0264-8377/ © 2019 Elsevier Ltd. All rights reserved.

considered a curse, which can attract the wrath of god and natural calamities (Ramachandran, 1999; Notermans et al., 2016). SGs of Kerala contain sculptures of *naga* and *nagathara* (Ramachandran, 1999; Bhagwat and Rutte, 2006). The pre-Hindu animism among the tribes associated with these SGs has changed after the inception of Hinduism and Sanskritization of traditional deities. This led to shifts from ascribing spirits to natural processes to propitiating Hindu gods instead (Bhagwat and Rutte, 2006; Notermans et al., 2016). For instance, in developed central and southern parts of Kerala, relocation of *naga* monoliths has become a ceremonial custom to claim the forest land for other purposes (Notermans et al., 2016). Therefore, periodically examining the religious and environmental perceptions of the local community on the SGs is important for their conservation.

The land-use experts argue that the stewardship of forest resources would be improved in tropical ecosystems when responsibility is delegated to the locals who use them for their livelihood (Poffenberger and McGean, 1996; Gillinham and Lee, 1999; Schwartzman et al., 2000; Bray et al., 2003; Sinu et al., 2012). In rural Indian communities, the forest is a source of livelihood, firewood, medicines, and fodder (Sinu et al., 2012). Therefore, locals value the forests in their neighbourhoods as a usufruct system and use them sustainably and serve as local custodians (Nagendra and Gokhale, 2008; Sinu et al., 2012). Forests that forbid the local community to have access for livelihood are often treated destructively because they are perceived as 'public' forests (Sinu et al., 2012).

There is no denying that SGs are threatened (Osuri et al., 2014). Over 100,000 SGs were documented in nineteen states of India (Malhotra et al., 2001; Khan et al., 2008); a lion's share of it was found in peninsular south and northeastern India (Tiwari et al., 1998; Malhotra et al., 2001; Upadhaya et al., 2003; Khumbongmayum et al., 2004). Kerala state is known for lore and religious beliefs associated with SGs, giving the state the title "gods-own country" (Freeman, 1999). It had over 10,000 SGs when the State was formed in 1956, which has now reduced to just 1500 (Suchitra, 2015). The SGs of old Travancore region, particularly in the coastal region, are lost (Suchitra, 2015). However, the SGs of Malabar region are relatively undisturbed (pers. observ.), and the local community still maintains faith in local deities and performs traditional rituals associated to those local deities, such as *theyyam* (Freeman, 1999).

Several factors have threatened SGs of Kerala. The primary reason for the fragmentation of SGs was land encroachment. The land encroachment was fuelled by enforcement of Land Reformation Bill in 1957, Joint Family System Abolishment Act in 1975, increased land value (Notermans et al., 2016), loss of faith in traditional religious beliefs and rituals among the contemporary generation, sanskritization of local deities, and temple construction (Notermans et al., 2016). Single or joint Hindu families or Hindu religious institutions are the present-day custodians of SGs in Kerala (Chandrashekara and Sankar, 1998; Ramahandran, 1999; Bhagwat and Rutte, 2006).

The adjoining Kodagu district in Karnataka also had a large number of SGs (Chandrakanth et al., 2004; Osuri et al., 2014). According to Osuri et al. (2014), many SGs in Kodagu's map are either not physically seen or badly disintegrated. Kodagu is a major coffee and wildlife belt of India. Both the coffee and tourism industry influence land-use practices in Kodagu (Gokhale, 2004; Ormsby, 2011). The amended Indian Forest Act, 1878 prohibited coffee cultivation inside SGs. In 1905, the SGs of Kodagu were classified as protected forests. The management was transferred from the Forest Department to the Revenue Department. This interim change in the management resulted in widespread encroachment of SGs in Kodagu (Kalam, 1996; Chandrakanth et al., 2004; Gokhale, 2004; Ormsby, 2011, 2013; Rao et al., 2016). In 1985, the management of the groves was given back to the Forest Department and declared the SGs as Reserve Forests (Kalam, 1996). Currently, the SGs of Kodagu are classified as Reserve Forest and co-managed by a village temple committee and the Forest Department (Ormsby, 2011). In Kodagu, they are managed by village temple committees (Bhagwat and Rutte, 2006; Ormsby, 2013).

SGs were established for one common reason – worship of local deities and natural processes. Differences in the ecological outcomes in the SGs (e.g., forest cover loss) might be due to differences in local communities' perspectives on the SGs (Notermans et al., 2016).

Although SGs of South India are the private properties of Hindu families or Hindu religious institutions at present, we hypothesize that the entire local community is likely to be affected or benefited by the grove (Ormsby, 2011, 2013; Osuri et al., 2014; Cox et al., 2017). Hence, their perceptions of the groves seem to be important for the management and conservation of SGs. We also hypothesize that the landscape type (rural versus urban) and the deity type might affect the communities' spiritual and environmental perceptions on SGs, and that might suggest the quality of the SGs. This study is focused on the local communities in the neighbourhood of SGs in Kodagu (highlands of the Western Ghats; rural) and adjoining Kasaragod (plains of Malabar: urban). We also assessed the habitat quality of SGs through visual surveys of habitat disturbance and studied whether the cultural aspects of the SGs predicted the habitat quality of SGs.

2. Material and methods

2.1. Study area

In peninsular India, the northern Malabar region of Kerala State (Kasaragod and Kannur districts) and the adjoining Kodagu district of Karnataka State are some of the SG hotspots (Induchoodan, 1996; Bhagwat and Rutte, 2006). A traditional SG of Kerala and Karnataka (*kaavu*) is a relatively undisturbed piece of evergreen forest that contains idols of local deities or monoliths (Chandrashekara and Sankar, 1998; Bhagwat and Rutte, 2006; Notermans et al., 2016). In Kerala, they also contain sacred pond or well and idols of *naga* (Ramachandran, 1999; Notermans et al., 2016) (Fig. 1).

Although Kasaragod and Kodagu are close to each other, landscape



Fig. 1. A) A typical sacred grove of Kerala. *Cheemeni Dharmasastha Kavu* of Kasaragod in the state of Kerala, India shows the sacred grove, a temple (outside the grove); B) an urban sacred grove in Kasaragod, Kerala (Mannampurathukavu, Nileswar); C) a rural sacred grove in Kodagu (Heggala, Virajpet taluk).

Table 1
Physical and demographic characteristics of Kasaragod and Kodagu districts of Kerala and Karnataka states of India, respectively.

Parameter	Kasaragod (Urban)	Kodagu (Rural)
Population*	1307375	554519
Annual population growth*	8.58	1.09
Area of the district (sq. km.)*	1989	4102
Human density/ sq. km.*	657	135
Literacy level (%)*	90.09	82.61
Forest area (Ha)*	5435	333900
Percent forest area	2.51	81.38
Reduction of private forest (1940-70) (%)$	70	–
Number of households surveyed in the present study	160	207

* courtesy: India Census Report 2011; $Amruth (2004).

type, socio-cultural and socio-economic background of the people, lifestyle, economy type and source of economy, and the population density distinguish them into rural (Kodagu) and urban (northern Malabar region) landscapes (Table 1). Kodagu has a forest-dominated landscape, on the plateau of the Western Ghats at an altitude between 700 m a.s.l. and 1200 m a.s.l. Western Ghats is a global biodiversity hotspot and a UNESCO World Heritage site (Ormsby et al., 2016). In Kodagu, population density is relatively very low and coffee plantation is a major land-use type. Consequently, SGs exist adjacent to state-protected forests and coffee plantations. Kasaragod district is a low-lying area (sea-level to 150 m a.s.l) in the western slope of the Western Ghats. It has a higher population density and lesser forest cover (Table 1). SGs in urbanised Kasaragod are easily visible within the neighbourhood of densely-populated towns and coastal villages. Thus, the two regions are biologically, culturally, and topographically diverse (Manoj et al., 2017; Rajesh et al., 2017). Nonetheless, the villages of both sites are dominated by Hindu communities comprised of several of its caste and sub-caste types.

2.2. Sampling

We conducted personal interviews with the residents adjacent to twenty SGs in Virajpet and Madikeri taluks of Kodagu district and ten SGs of Kasaragod district (Fig. 2; Table S1). The questionnaire addressed both open and closed questions (Table S2). The households selected for sampling were within 500 m radius from the SG's boundaries. It was expected that they were most directly affected by the neighbouring forests. We used Google Earth images to find the density of households around the SGs. In Kodagu, we covered almost every household in the neighbourhood of the SGs as households near the groves were fewer. In Kasaragod, where the population density is high, we selected every 5th household for interview. Together, we recorded the responses of 207 households (10.35 ± 2.5 SD; range = 7–19 households/SG) in Kodagu and 160 households in Kasaragod (16 ± 5.16 SD; range = 10–20 households/SG). Only 4.63% of the total households in both the sites belonged to non-Hindu (Christian or Muslim) communities. The non-Hindu participant households in Kodagu were mostly the migrants from Kerala. In Kasaragod, they were migrants from Travancore part of Kerala State (Sebastian, 2002). To ensure the diversity of households, we included the responses of all non-Hindu households in our survey. Their perceptions were strikingly different from that of the Hindu community. As the number of non-Hindus was small when compared to the entire population, we decided not to use the religiosity of the members as a factor in the statistical models.

We recorded the participants' responses on use, benefits, local vigilance, crop-raiding by wildlife and other types of wildlife-human conflict, solid waste disposal, pest problem, mosquito-related health issues, management, and the measures taken by the participants to conserve the groves (Table S2). We also recorded the deities of the SGs and the rituals and customs associated with each SG (Table S3). The first four authors of this paper conducted interviews in local languages specific to each site (*Kannada* in Kodagu and *Malayalam* in Kasaragod). To document the overall perception of conservation of SGs, we invited all members to share their viewpoints towards specific questions on traditional beliefs and conservation methods. Respondents were aged between 30 and 70 years and included both men and women. About 88% and 70% of the respondents of Kodagu and Kasaragod were women. There were two major ways the households depended on the groves. First, women collected firewood, leaf litter, fodder, and local medicinal plants. Therefore, questions related to these aspects were asked specifically to women participants or labourers of the households.

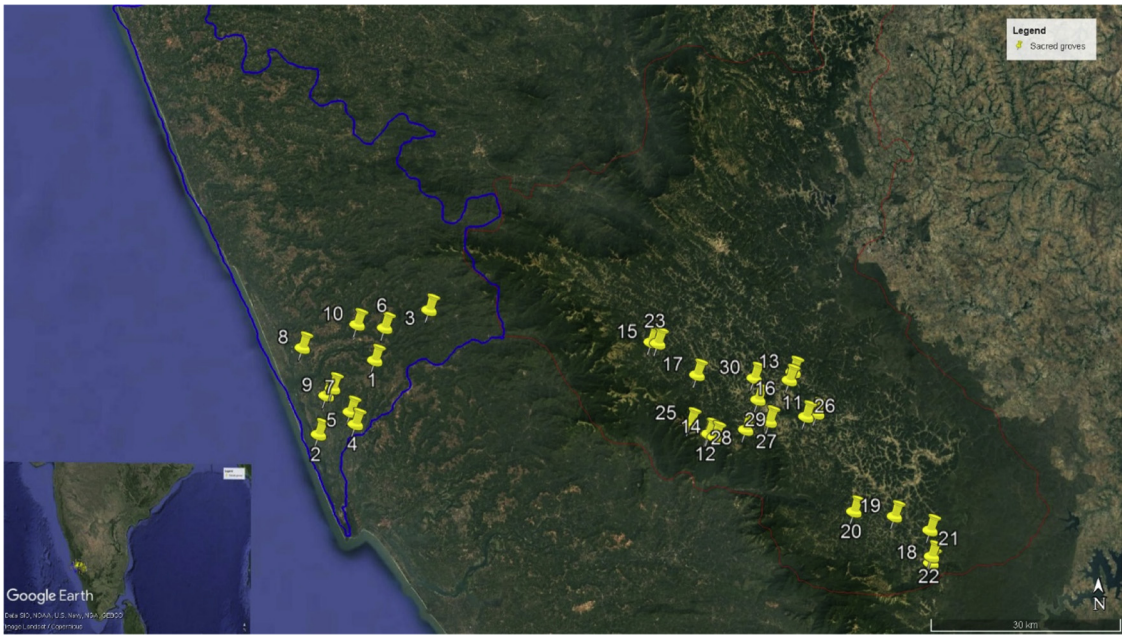


Fig. 2. Google Earth map illustrates the study sites. 1–10 are the sites in Kasaragod district of Kerala and 11–30 are the SGs in Kodagu district of Karnataka. Inset: the south peninsular India.

Second, the men collected honey, poles, and very rarely tree foliage to prepare compost. Therefore, questions related to these aspects were addressed to male participants. Our questions related to conservation and management were particularly asked the middle-aged members of the household either through personal interview or telephonic conversation, because they are the future stakeholders of the SGs. The responses relevant to each question were collected from the expected target member/s of the households and entered in relevant parts of the datasheet. Together, we had 207 and 160 responses from rural and urban SGs respectively. Most of the rural areas of southern Karnataka including Kodagu district have free-ranging cattle. Fourteen SGs out of twenty that we visited had either cattle trenches or wire- or bio-fences around the forest. Free-ranging cattle are not commonly seen in Kerala. Nevertheless, all the SGs in Kerala had either wire or bio-fences. The state government provides a grant to individual groves through Malabar Devoswam Board to fence the groves. As part of our dung beetle diversity studies, we counted the number of naturally available dung pads in two 100 sq m quadrats inside the SGs of Kerala and Karnataka (Asha and Sinu, Unpublished). It showed that the SGs we surveyed in Kodagu had cow dung and that in Kasaragod had no dung inside the forest. The land of some SGs was claimed by some households, particularly in Kasaragod. Households that claimed the ownership of forest land have been recorded as owners of SGs.

2.3. Statistical analyses

Frequency distributions of the responses and the descriptive answers for each question were extracted from the datasets of rural and urban landscapes into contingency tables. To test the hypotheses that the landscape type affects the perception of the community about use, management, and conservation, we produced paired contingency tables for each variable in rural and urban SGs, and performed Pearson's $\chi 2$-test or binomial test of independence on the contingency tables.

We used generalized linear mixed models (GLMMs) to find significant explanatory variables that affect the local community's use and perceptions on the management and conservation of SGs (Table 2). We used landscape type, size of the grove, type of deity, ownership status, and management type as the fixed parameters (explanatory variables) in the models (Table 2). Wherever relevant, we have specified binomial, poisson with log link function, quasipoisson, or negative binomial (count) distribution as an error type in the models. The significance of the model predictors was assessed through Wald's $\chi 2$ test available in the R package "car".

By assessing the quality of each SG, we ranked them on a scale of 1 to 5. The visually-estimated canopy cover (closed, partially closed, open, degraded, and < 10% canopy cover), canopy structure (presence and number of large emergent trees (> 25 m height) and multiple forest layers), leaf litter bed structure (intact or disturbed litter bed), fencing type, tree and branch cutting, and overall aesthetic quality, which we assessed both from our survey and Google Earth images, were used to assign a score. We did not take into account components, such as vegetation, composition, and indicator species of habitat quality that may be useful to determine habitat quality (Nogué et al., 2017). Wherever threatened plant species were noticed, they were recorded. To study whether the landscape type, cultural attributes (primarily the deity/spirit type), management type, and human use of forests predicted the quality of SGs, we used these variables as explanatory variables in another generalized linear mixed model. We also assessed the effect of the existing management regime on the area of the SGs using a generalised linear mixed model. In this model, the landscape was used as a random factor. All the analyses were performed in R version 3.2.3 (R Core Team, 2014).

3. Results

3.1. Attitude of the local community on use, management, and conservation of neighbourhood sacred groves

The environmental perspectives of rural versus urban communities on SGs were quite different (Table 3). The rural communities valued their SGs as a usufruct forest – a forest that permits access and use of resources freely but gives only temporary or provisional ownership to the users (Nagendra and Gokhale, 2008; Sinu et al., 2012). They used SGs for collecting firewood, fodder, foliage, and medicinal plants in a non-destructive fashion. Spirituality was the major driver of conservation for at least 12% of rural respondents. They felt that SGs was not particularly beneficial to them because of the limited access to the forest and the forest resources. However, the urban communities perceived SGs not just as a spiritual hub, but as a functional ecosystem providing gas exchange, biodiversity, and water security. Urban respondents reported that their SGs supported wildlife, albeit threats to property, livestock, and crops. The perceptions of wildlife and human-wildlife conflict were quite different between rural and urban communities. For urban communities, problematic wildlife included insect pests, snakes, wild boar, porcupine, monkey, civet, bat, fox, jungle cat, and occasionally leopard cat. For rural communities, monkeys, wild boar, leopard cat, tiger, wild gaur, and elephants were the sources of human-wildlife conflict. The rural community believed that the SGs of Kodagu since distributed in a forest landscape, functioned as an effective wildlife corridor. The residents in the neighbourhood of *Badaga Kaapangadi Ayyappa Devarakadu* and *Kutta Thaila Devarakadu* said that elephants and monkeys halt in the SGs particularly in the summer months and threaten their provisions and crops. They also said that the SGs in Virajpet taluk give a connection between Brahmagiri Wildlife Sanctuary and Wayanad Wildlife Sanctuary. According to them, the menace from elephants was more during summer when most of the orchard crops, such as jackfruit (*Artocarpus heterophyllus* and *A. hirsutus*) and mangoes (*Mangifera indica*) were ripening and water was scarce inside the forest. 58% of the rural community and 36% of the urban community reported some degree of crop loss due to wildlife. The loss incurred was not considered serious by 21% and 56% of the respective rural and urban communities.

The landscape type predicted the response that the SGs are the reason for the mosquito-borne health issues in the neighbourhood

Table 2
Description of the explanatory variables.

Used for	Predictive variables	Description of the variables	scale of measurement
Dependent variables in Tables 4 and 5	*Ownership.type*	Whether the interviewee an owner of the sacred grove (Yes = 1; No = 0)	dummy scale
	size.sg	Area of the forest of sacred grove (acres)	interval scale
	deity.type	The deity inside the sacred grove (most fearful deity (rank = 1; *Naga* (King cobra); *Shiva; Vishnu; Shasthav; Subramanya; Ayyappa*) and less fearful deity (rank = 2) (*Devi; Anjaneya* (Langur); *Bhagavati; Karakkayil Bhagawati; Kavilamma*))	dummy scale
	management.type	The present protection method (forest department = 1; joint families-2; temple trust = 3; village committee = 4)	dummy scale
	forest.dependence	Whether forests are used for timber and NTFP harvest (Yes = 1; No = 0)	dummy scale
	Landscape.type	The SGs of Kodagu (rural) and Kasaragod (urban); Kodagu (rural)	dummy scale

Table 3
Perception of local community on use, management, and conservation of neighbourhood sacred groves in rural and urban landscapes of south India.

Variable	Rural (% Y) (N = 207)	Urban (% Y) (N = 160)	$\chi 2$ value	P-value
Forest dependence (Y/N)	30.9	3.1	43.9	< 0.00001
Perception on SG				
No benefit/wildlife menace	12.1	4.4	5.8	0.01
A spiritual hub	14	0	22.4	< 0.00001
Environmental merit/nature conservation	73.9	95.6	29.1	< 0.00001
Wildlife encountered in SG* (Y/N)	79.7	100	34.7	< 0.00001
Wildlife conflict due to SG (Y/N)	16.9	35.6	15.8	0.00006
Crop/livestock loss due to wildlife conflict (Y/N)	58.4	35.6	17.9	0.00002
No loss	21.7	56.2	44.7	< 0.00001
Negligible loss	26.6	15	6.5	0.01
Moderate loss	7.2	17.5	8.2	0.004
High loss	17.4	3.12	17.1	0.00003
Very high loss	7.2	–		
Not assessed	19.8	8.1		
Mosquito-related health issues due to SG (Y/N)	37.2	25.6	5.0	0.025
Illegal waste disposal in the SG (Y/N)	16.9	20.0	0.39	0.58
Public trespass/ abuse of SG (Y/N)	10.1	15.0	1.5	0.213
Local vigilance given to SG (Y/N)	87.4	96.9	9.2	0.002
Is SG good in your neighbourhood (Y/N)	99.5	100	0	1
Who should protect the forest				
Local community	58.9	99.375	80.0	< 0.00001
Forest department	7.2	0.62	8	0.005
Participatory	29.5	–		
Not concerned	4.3	–		

* types of wildlife harbours in rural and urban sacred groves are different; in urban sites, the respondents reported small vertebrates including primates, rats, mouse, and reptiles as wildlife; in rural sites, the respondents reported both small and large vertebrates as wildlife.

communities. Rural households believed that the SGs in their vicinity 'conserve' the life-threatening mosquitoes (37% (rural) vs 26% (urban); $p = 0.025$). Urban dwellers blamed substandard drainage systems and accumulated solid wastes in different parts of the town were the major mosquito breeding sites in their neighbourhoods. Although the difference was insignificant, more urban households (20%) admitted that public dumping of solid wastes is common in SGs. The urban community was more vigilant (97%) than the rural community (87%) regarding the neighbouring SGs. But almost 100% of both the rural and urban communities appreciated and valued their SGs for the environmental merits. All the urban respondents believed that protection of SGs will be materialised only when the neighbouring communities are entrusted and empowered to protect the forest. In contrast, only 59% of the rural community felt that SG protection should be a local responsibility. The second major claim was that effective conservation of SGs might be possible only through a participatory framework (29%). A minority of the interviewees (7%), however, believed that conservation of SGs is the responsibility of governmental institutions, such as the Forest Department.

3.2. Predictors of local community's use, environmental perceptions, and conservation of SGs

The predictive models suggested that the landscape type and the deity type of SGs have a significant impact on local communities' perception of management and conservation of SGs (Table 4). For instance, forest dependence for natural resources was predicted by the landscape type, size of the grove, ownership of the grove and interaction of size of the grove, deity type, and ownership status (Table 4). Urban residents did not extract natural resource from the groves ($z = -5.06$, $p < 0.00005$). The extraction increased with the size of the grove ($z = 1.841$, $p = 0.06$) and decreased when the groves abode fierce local deities ($z = -1.67$, $p = 0.09$). *Naga* (King cobra), *Shiva, Vishnu, Shasthav, Subramanya, and Ayyappa* are generally perceived as more fearful deities of SGs. The less fearful deities are *Devi, Anjaneya* (monkey god) *Bhagavati, Karakkayil Bhagawati, and Kavilamma* (Table 2) The communities' environmental perception of the groves was predicted by the landscape, deity, the management type, and the interactions of the size of the grove with the deity and management types. Urban communities found strong environmental benefits of the SGs ($z = 2.41$, $p = 0.01$). The human-wildlife conflict due to SGs was predicted both by the landscape and the deity type. The urban communities found that the groves could be a reason for increased human-wildlife conflict ($z = 5.58$, $p < 0.00005$), but, not a reason for the crop, property, and livestock loss in their vicinity ($z = 1.59$, $p = 0.11$). The human-wildlife conflict ($z = -5.07$, $p < 0.00005$) and crop, livestock, and property loss ($z = -2.77$, $p = 0.005$) were reported lower by the communities where the abiding deities of the neighbourhood SGs were feared less. It indirectly suggests that the SGs in which deities are feared less contain lower levels of biodiversity and have less problematic wildlife. Human trespass or abuse of the SGs and waste disposal in the SGs were predicted by the size of the grove. Human trespass/abuse increased ($z = 3.33$, $p = 0.008$) and the waste-disposal decreased ($z = -2.64$, $p = 0.007$) when the groves were larger.

3.3. The drivers of habitat quality of SGs

Based on our visual surveys for forest disturbance, we found that SGs managed by village temple committees contained better quality forest than those classified as Reserve Forest (GLMM: one-way ANOVA $F_{1,56.17} = 11.094$, $p = 0.001$) (Fig. 3). The SGs' habitat quality was predicted by the landscape, deity, management, size of the forest, forest dependence by the communities, and interactions of some of these factors (Table 5). Urban SGs have a poor quality forest ($z = -4.802$, $p < 0.00005$). The size of the SG did not ensure good quality forest ($z = -2.21$, $p = 0.02$). A less-fearful deity was an indicator of lower quality SGs ($z = -2.444$, $p = 0.01$).

4. Discussion

Local perceptions have a significant impact on the conservation and habitat management of SGs (Chandrashekara and Sankar, 1998; Chandrakanth et al., 2004; Bhagwat and Rutte, 2006; Ormsby, 2013; Osuri et al., 2014). The cultural beliefs and religious taboos play major roles in the conservation of SGs (Bhagwat and Rutte, 2006; Ormsby, 2013). It has been suggested that there are three factors primarily

Table 4
Predictors of local community's dependence and perceptions of environmental merits/demerits, management, and conservation of sacred groves (response variables in bold); method: generalized linear mixed model. Factors having significant loadings ($p < 0.15$) are only shown.

Response variable	Wald's $\chi 2$	df	p-value
Model predictors			
Forest dependence			
Landscape.type	10.55	1	0.001
Size of forest	2.65	1	0.10
Ownership	2.38	1	0.12
Size × deity × ownership	3.16	1	0.07
Environmental merits			
Landscape.type	5.80	1	0.01
Deity type	32.5	1	< 0.00005
Management type	10.51	3	0.01
Size × deity	17.3	1	< 0.00005
Size × Management type	9.14	1	0.002
Human-wildlife conflict			
Landscape.type	23.51	1	< 0.00005
Size of forest	2.64	1	0.10
Deity type	27.6	1	< 0.00005
Management type	5.99	3	0.11
Size × deity	47.2	1	< 0.00005
Size × management	9.14	1	0.002
Crop raid/livestock & property loss			
Deity type	7.88	1	0.0004
Ownership	9.56	1	0.002
Size × deity	14.36	1	0.004
Pest problem in crops			
Landscape.type	9.18	1	0.002
Size of forest	2.18	1	0.14
Deity type	31.19	1	< 0.00005
Management type	8.29	3	0.04
Size × deity	8.9	1	0.002
Size × management	20.05	1	< 0.00005
Deity × management	7.64	1	0.005
Mosquito-related health issues			
Landscape.type	15.0	1	0.0001
Ownership	2.54	1	0.11
Size × deity	9.82	1	0.001
Size × ownership	2.26	1	0.13
Size × management	10.43	1	0.001
Deity × management	4.21	1	0.04
Ownership × management	4.93	2	0.08
Illegal waste disposal			
Size of forest	14.68	1	0.0001
Deity type	5.9	1	0.01
Size × deity	14.3	1	0.0001
Size × management	2.27	1	0.13
Ownership × management	4.51	2	0.10
Size × deity × ownership	3.55	1	0.05
Trespass/abuse of sacred grove			
Size of forest	6.9	1	0.008
Size × deity	6.7	1	0.009
Size × management	15.6	1	< 0.00005
Local vigilance given			
Landscape.type	3.35	1	0.06
Management.type	15.7	3	0.001
Ownership	4.28	1	0.04
Deity × management	6.39	1	0.01
Size × deity	6.56	1	0.01

affecting the local conservation of SGs. First, the growing disbelief in traditional rituals and cultural practices associated with the SGs among the young generation of local communities (Ormsby, 2013). Second, the advent of Hinduism and Vedic practices that have changed the local deities to Hindu Gods and Goddesses (Sanskritization) and sculptures and monoliths of deities by constructed temples inside the groves (Bhagwat and Rutte, 2006; Blicharska et al., 2013). Third, industrialisation and socio-cultural changes in the neighbouring communities of the SGs (Bhagwat and Rutte, 2006; Ormsby, 2013). In the present study, we have recorded the local communities' cultural and environmental perceptions and studied how this might affect the

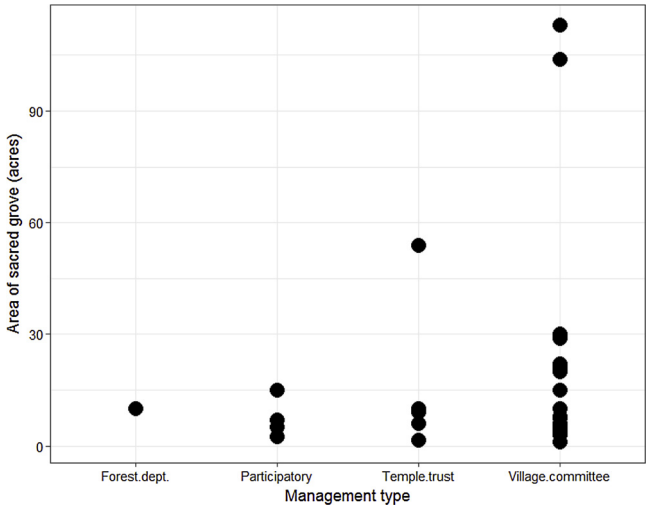


Fig. 3. Scatterplot shows distribution of sacred groves of different sizes managed by different stakeholders.

Table 5
Predictors of habitat quality of sacred groves; method: generalized linear mixed model; interaction terms of the predictive variables given in Table 2 have been used in the model; only significant single and interaction terms are shown.

Factors	Wald's $\chi 2$	p-value
Size of sacred grove	353.68	< 0.00005
Landscape.type	101.37	< 0.00005
Deity type	20.77	0.00005
Forest.dependence	11.37	0.0007
Management.type	4.93	0.02
Forest.dependence × deity.type	19.65	< 0.00005
Forest.dependence × size	8.44	0.004
Landscape.type × size	12.33	0.0005
Deity × size	17.04	< 0.00005
Landscape.type × management	16.06	< 0.00005
Size × management	57.02	< 0.00005
Size × landscape.type × management	9.95	0.001
Size × deity type × forest dependence	15.63	< 0.00005

continued conservation and management of SGs in rural and urban landscapes. The sites – Kasaragod district of Kerala and the Kodagu district of Karnataka – are the major homes of SGs in south India (Induchoodan, 2004; Bhagwat and Rutte, 2006). In spite of their visible propinquity, the cultural aspects associated with their respective SGs are entirely different. Kodagu is relatively heavily forested than the Kasaragod district of Kerala state (Table 1). However, Kodagu is also a major coffee plantation belt of south India. Coffee has a major influence on land-use change in tropical forests of South and Southeast Asia, Central and South America, and tropical parts of Africa (Ambinakudige and Choi, 2009). In Kodagu also, the coffee industry has a tremendous influence on land-use change and regional economic growth and development (Kalam, 1996; Garcia et al., 2010; Ormsby, 2011, 2013). Kasaragod is a rapidly urbanizing district of Kerala with only about 3% of its geographical area under forest. The increased land value is a major economic pressure on SGs of Kasaragod (pers.observ.). Some changes in the faith of *naga* worship have also accelerated the fragmentation and thinning of SGs in Kerala (Notermans et al., 2016). For instance, relocation of *naga* deity from *naga kavu* to another place, despite a costly exercise, is common in central and southern parts of Kerala (Notermans et al., 2016).

Our results showed that cultural and religious beliefs are stronger among rural communities than in urban communities. This functioned as a major driver for the conservation of SGs. Our models suggest that the landscape type and deity type predict the level of access and use/

abuse of forest resources of SGs.

Religious beliefs and taboos play crucial roles in shaping attitudes toward wildlife (Anonymous, 1889; Knight, 1999; Ormsby, 2013). Among the Hindu communities of South India, particularly in Kerala and parts of Karnataka, it is still a belief that harming a King Cobra is a curse, and it can attract the wrath of god (Notermans et al., 2016). Our study clearly showed that the reverence or the fear for the local deities predicted people's perception of use, management, and conservation of SGs. The groves that house relatively highly feared deities, such as *naga* are highly regarded and protected. The fear that they implant in the local communities helps minimise exploitation, sometimes so much so that they hindered us installing traps inside SGs to collect insects as part of the erstwhile studies (Manoj et al., 2017; Rajesh et al., 2017). The reason they cited was that the insects that might be trapped in our pitfall traps could be the natural diet of *naga* – the snake god! But, this kind of faith in *naga* worship is diminishing in more developed central and southern parts of Kerala (Notermans et al., 2016). Relocation, reduction, and destruction of *naga* monoliths have become a ceremonial custom to claim the forest land for other purposes in central and south Kerala (Notermans et al., 2016). But, it is a costly ceremony, and it can cost about USD 4000 (Notermans et al., 2016). In north Kerala, including Kasaragod, this is a very rare practice. Most of the groves are managed by the *Thiyya* and *Viswakarma* communities, whose faith in traditional rituals and local deities are stronger than the communities that the ancient Indian society considered upper castes (pers. observ.). Many SGs in Kasaragod do not have a constructed temple inside the grove, and those that have a temple inside the grove encroached only a little part of the grove.

From our interaction with local communities, it was clear that the relationship between people and wildlife that live in and around SGs was predominantly peaceful. However, the change in land usage from conventional rice paddy agroecosystem to growing commercial crops like coffee, betelnut, and plantains have created conflicts in some regions — particularly in Kodagu. The respondents in the study said that primates are increasingly a major source of human-wildlife conflict around both rural and urban SGs. Bonnet macaques stay for a longer period in the groves of Kodagu during the fruiting periods in summer months. In Kasaragod, they reside in some SGs. Provisioning wild primates is a socio-religious tradition in many Asian countries including India, and humans and primates have co-existed in different cultures (Radhakrishna, 2018). For Hindus, Bonnet macaque is an icon of Lord *Hanuman*, a masculine character from the epic *Ramayana* (Saraswat et al., 2015). It is believed that provisioning macaques result in attainment of masculine growth, early sexual maturity, and longer lifespan (Medhi et al., 2007). In the SGs of Kerala, they are surviving in small islets of forests with the food the villagers and the devotees offer and at the cost of orchard crops (banana, jackfruit, mango, cashew, coconut, and so on) and the vegetables (pumpkin, gourds, melons, and so on) that the farmers grow around the SGs during non-festival season (pers. observ.). Although it is a major pest for crops, farmers rarely physically harmed them until recently both in Kasaragod and Kodagu. However, in *Edayilakkadu kavu* and *Cheemeni kavu* – the two sites that we studied in Kasaragod – monkeys were poisoned and killed by anonymous people in 2017 (Parakkatt, 2018). This suggests that the monkey-human relationship has been changing for the worse around SGs (Radhakrishna, 2018).

The socio-cultural and economic factors of local communities explain their relationship with the neighbourhood forests and the wildlife in different parts of the world (Tuan, 1968; Dickman, 2010; Allendorf et al., 2014; Ghosal et al., 2015; Anand et al., 2018). Although bonnet macaques in and around SGs are normally unharmed, the community in the eastern part of Kasaragod – a migrant Christian belt – think that bonnet macaques are a vermin species and must be killed (Anand et al., 2018). Our study had only 4% of the respondents belonging to non-Hindu communities. Despite a minority, they had a negative perception towards conservation of SGs in their neighbourhood.

Although the sanctity of SGs conserves the biodiversity, some rituals like *bappidal* – celebrated by killing small wild animals in the SGs of Kasaragod – adversely affect the biodiversity of SGs (Freeman, 1999). Although it is an important part of the annual festival it was stopped as per the direction of Honorable High Court of Kerala (Anonymous a, 2015). As *Bappidal* is an important part of the culture, respondents consider celebrating festivals of *Vayanattu kulavan theyyam* and *Kandanar Kelan theyyam* without this ritual as incomplete and futile. The bushmeat hunted from the SGs is offered to the deity and cooked to feed the devotees. Here, the spiritual and conservation outcomes of the SGs contradict.

The respondents in Kodagu reported a recurring crop loss due to wildlife. Although it is a forest belt, some respondents said that SGs are particularly used by large vertebrates, such as elephants and gaur during summer months creating havoc to their orchards and food provisions. Although we did not collect data on the change in the usage of lands around SGs, our field surveys and detailed responses of local communities suggest that paddy land is rapidly being converted into horticultural orchards (banana, coffee, cardamom, betelnut, etc.) and ginger fields in Kodagu, a trend seen in the mid and highlands of Kerala and Karnataka (Mundoli et al., 2016; Sinu et al., 2012). This might have aggravated human-wildlife conflict among small agricultural holders in Kodagu.

Whatever the value the local community of rural and urban landscapes assign to SGs, they, largely concur that their SGs must be protected. SGs of south India are under severe pressures from land-use change and cultural assimilation of animistic society into mainstream Hinduism (Sanskritisation) (Chandran and Hughes, 1997; Notermans et al., 2016). Therefore, the institutions managing SGs must be stable and capable to ensure the conservation of SGs (Berkes, 2009; Rutte, 2011; Rao et al., 2016). The SGs of Kerala are scattered in an urbanised and populated landscape. Majority of the SGs studied in Kasaragod belonged to the Revenue Department, while others are owned by single or joint families and temple trusts. Therefore, SGs in the urban environment might have the luxury of vigilance and the circumspection of local peoples or village-level democratic institutions rather than the understaffed distantly located Forest Department. Of the twenty SGs that we observed, we conclude that SGs protected by the Forest Department in Kodagu are degraded, with less forest cover and lower-quality forest due to increased public usage. This is also in agreement with other studies (Osuri et al., 2014).

Like the forest-dominated rural landscape (Ormsby and Ismail, 2015), urban SGs are also the natural sanctuaries for wildlife and forest genetic resources (Induchoodan, 1996; Chandrashekara and Sankar, 1998; Manoj et al., 2017; Rajesh et al., 2017). Though are unlikely to protect large animals, SGs, conserve primary and secondary terrestrial and swampy forests, endemic, endangered, and medicinal plants, wild birds, bats, small vertebrates, including primates, snakes, lizards, frogs, toads and caecilians, and invertebrates. This, in turn, helps sustain the functions they provide to the terrestrial ecosystems (Induchoodan, 1996; Bhagwat et al., 2005; Bhagwat and Rutte, 2006; Manoj et al., 2017; Rajesh et al., 2017). In the present study, we have not investigated any indicator species to assess the habitat quality of SGs. But, studies suggest that SGs also support plant species that thrive in undisturbed forests (Nogué et al., 2017) and conserve a diverse and rare group of parasitoid insects (Manoj et al., 2017; Rajmohana et al., 2017). Therefore, SGs function both as an ecological and evolutionary sink, providing information and fresh insights on the degradation of protested forests in the region.

Perceptions and reasons for conservation of SGs differ between rural and urban communities. However, understanding this contradiction might help the future conservation of SGs in these two landscapes. A strong environmental understanding is a major factor for the conservation of SGs among urban residents. Many urban respondents in this study are aware of the crucial roles that forests play in carbon sequestration, water and biodiversity conservation, and combating

climate change. SGs are often the spots the urban schools and colleges in Kerala bring their students for environmental education and even to show the nature of a forest (pers. observ.). Unlike this, SGs, for many respondents of Kodagu, are a source of fodder, medicines, honey, food, poles, and construction materials. They value SGs as a usufruct system and use them sustainably and serve as local custodians (Nagendra and Gokhale, 2008; Sinu et al., 2012). Therefore, we argue that the religious or cultural factor alone, which is elastic and dynamic (Chandran and Hughes, 1997; Notermans et al., 2016), may not ensure successful conservation of SGs. We recommend using both spiritual values (deity type and traditional rituals, particularly) as well as environmental and usufruct values to bring peoples of different socio-cultural backgrounds together for pragmatic conservation of SGs (Lowman and Sinu, 2017).

Urban communities of Kerala belong to different ethnicities and religious backgrounds, and dynamic. Since the traditional non-Hindu worship of nature and local deities and rituals have given their ways to Sanskritization of local deities to Hindu Gods and Goddesses, the religious sentiments may not get sufficient support from all religious walks of life for the conservation of SGs. SGs in India are found mostly in natural landscapes dominated by evergreen forests and swamps. Biodiversity conservation is used as a major currency to demand their conservation (Chandrashekara and Sankar, 1998; Tiwari et al., 1998; Upadhaya et al., 2003; Boraiah et al., 2003; Khumbongmayum et al., 2004; Bhagwat and Rutte, 2006; Ormsby and Bhagwat, 2010; Ormsby and Ismail, 2015; Osuri et al., 2014; Rajesh et al., 2017; Manoj et al., 2017). This might get national and international attention to SGs. But, it is inadequate to influence local neighbourhood communities' perception on conservation of the SGs, because urban residents might consider urban wildlife a menace (Gunnarsson et al., 2017; Parakkatt, 2018; Soga et al., 2016). Today, urban forests around the world are greatly valued for their aesthetic quality, health benefits, and recreational values (Cox et al., 2017; Gunnarsson et al., 2017; Soga et al., 2016). We suggest that the aesthetic and health, especially mental health, benefits of the SGs must be informed to the public to get a much bigger positive outlook on the SGs from all walks of life. On June 5, 2019 – the International Environment Day- the state of Kerala has initiated a flagship program, *viz*. *pachathuruth* (the green islets). It envisages creating small green islets in government-owned degraded lands across the state with a mission to enhance the regional biodiversity (Anonymous b, 2019). We suggest that the state must consider including the remaining 1500 SGs of Kerala (Suchitra, 2015) in this scheme as the premier natural green islets and give maximum attention to protect them.

5. Concluding remarks

Today, sacred forests around the world are considered as important community-conserved areas that conserve biodiversity, cultural diversity, and ecosystem services (Bhagwat et al., 2005; Verschuuren et al., 2010; Reynolds et al., 2017; Lowman and Sinu, 2017). The Western Ghats biodiversity hotspot has recently been inscribed into the UNESCO World Natural Heritage Sites (Ormsby et al., 2016). But, there are no specific guidelines on the conservation of SGs of the Western Ghats despite they are abundant and important cultural forests that preserve cultural diversity of the people and biodiversity of the Western Ghats. These are pivotal to maintain the heritage and legacy of the Western Ghats.

Very few studies in India have demanded for the recognition of anthropological and religious values, traditional rituals, and taboos associated with the SGs (but see, Chandran and Hughes, 1997; Negi, 2010; Nutgeren, 2005; Ormsby, 2013; Notermans et al., 2016). Our study agrees with Ormsby (2013) that the deity is a major driver of conservation of SGs. Faith in traditional deities of SGs, however, is declining among the devotees and the title holders of SGs (Chandran and Hughes, 1997; Ormsby, 2013; Notermans et al., 2016). We recommend that examining the religious and cultural aspects of the dynamic communities living around the SGs is pivotal for the conservation of SGs.

Declaration of Competing Interest

Authors report no conflict of interest.

Acknowledgements

Authors would like to thank all the households for their cooperation in the research. PAS thanks Kerala and Karnataka Forest Departments for research permits. We thank the committee members of temple trusts and village committees for giving permission to access the sacred groves for sampling insects. UPB would like to thank Kerala State Council for Science Environment and Technology for a doctoral fellowship. The study was supported by a Conservation Research Exploration grant of National Geographic Society (9295-13) and Young Scientist Grant of Science Engineering Research Board of Government of India (SB/FT/LS-325/2012) awarded to PAS. PAS also thanks UGC-New Delhi and California Academy of Sciences, USA for fellowship and facilities for his post-doctoral research in USA. We thank the three anonymous reviewers for their constructive and critical comments in the previous versions of the manuscript. We thank Anjana P. Unni and Badrinarayanan S. for proof-reading the manuscript.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2019.104213.

References

Allendorf, T.D., Brandt, J.S., Yang, J.M., 2014. Local perceptions of Tibetan village sacred forests in northwest Yunnan. Biol. Conserv. 169, 303–310.
Ambinakudige, S., Choi, J., 2009. Global coffee market influence on land-use and land-cover change in the Western Ghats of India. Land Degrad. Dev. 20, 327–335.
Amruth, M., 2004. Forest-Agriculture Linkage and Its Implications on Forest Management: A Study of Delampady Panchayat, Kasaragod District, Kerala. Discussion Paper No. 69. Centre for Developmental Studies, Thiruvananthapuram pp. 88.
Anand, S., Binoy, V.V., Radhakrishna, S., 2018. The monkey is not always a god: attitudinal differences toward crop-raiding macaques and why it matters for conflict mitigation. Ambio 47, 711–720.
Anonymous, 1889. Ophiolatreia: an Account of the Rites and Mysteries Connected With the Origin, Rise, and Development of Serpent Worship in Various Parts of the World. Unspeakable Press pp. 103.
Anonymous a, 2015. The Hon. High Court of Kerala Judgement. https://indiankanoon.org/doc/12074573/.
Anonymous b, 2019. 15 Green Islets to Be Set up in Kottayam. The Hindu. https://www.thehindu.com/news/national/kerala/15-green-islets-to-be-set-up-in-kottayam/article28067199.ece.
Berkes, F., 2009. Community conserved areas: policy issues in historic and contemporary context. Conserv. Lett. 2, 20–25.
Bhagwat, S.A., Rutte, C., 2006. Sacred groves: potential for biodiversity management. Front. Ecol. Environ. 4, 519–524.
Bhagwat, S.A., Kushalappa, C.G., Williams, P.H., Brown, N.D., 2005. The role of informal protected areas in maintaining biodiversity in the Western Ghats of India. Ecol. Soc. 10, 8. www.ecologyandsociety.org/vol10/iss1/art8/.
Blicharska, M., Mikusiński, G., Godbole, A., Sarnaik, J., 2013. Safeguarding biodiversity and ecosystem services of sacred groves – experiences from northern Western Ghats. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 9, 339–346.
Boraiah, K.T., Vasudeva, R., Bhagwat, S., Kushalappa, C.G., 2003. Do Informally managed sacred groves have higher richness and regeneration of medicinal plants than state-managed reserve forests? Curr. Sci. 84, 804–808.
Bray, D.B., Merino-Pérez, Negreros-Castillo, P., Segura-Warnholts, G., Torres-Rojo, J.M., Vester, H.F.M., 2003. Mexico's community managed forests as a global model for sustainable landscapes. Conserv. Biol. 17, 672–677.
Chandrakanth, M.G., Bhat, M.G., Accavva, M.S., 2004. Socioeconomic changes and sacred groves in south India: protecting a community-based resource management institution. Natural Resource Forum 28, 102–111.
Chandran, M.D.S., Hughes, J.D., 1997. The sacred groves of South India: ecology, traditional communities and religious change. Soc. Compass 44, 413–428.
Chandrashekara, U.M., Sankar, S., 1998. Ecology and management of sacred groves in Kerala, India. Forest Ecol. Manag. 112, 165–177.

Cox, D.T.C., Shanaha, D.F., Hudson, H.L., Plummer, K.E., Siriwardena, G.M., Fuller, R.A., Anderson, K., Hancock, S., Gaston, K.J., 2017. Doses of neighborhood nature: the benefits for mental health of living with nature. BioScience 67, 147–155.

Das, D., Balasubramanian, A., 2017. The practice of traditional rituals in Naga Aradhana (Snake worship): a case study on Aadimoolam Vetticode Sree Nagarajaswami temple in Kerala, India. SHS Web of Conferences 33, 00025. https://doi.org/10.1051/shsconf/20173300025.

Dickman, A.J., 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. Anim. Conserv. 13, 459–466.

Freeman, J.R., 1999. Gods, groves and the culture of nature in Kerala. Mod. Asian Stud. 33, 257–302.

Gadgil, M., Berkes, F., Folke, C., 1993. Indigenous knowledge for biodiversity conservation. Ambio 22, 151–156.

Garcia, C., Bhagwat, S., Ghazoul, J., Nath, C., Nanaya, K., Kushalappa, C., Raghuramulu, Y., Nasi, R., Vaast, P., 2010. Biodiversity conservation in agricultural landscapes: challenges and opportunities of coffee agroforests in the western ghats. India. Conservation Biology 24, 479–488.

Ghosal, S., Skogen, K., Krishnan, S., 2015. Locating human-wildlife interactions: landscape constructions and responses to large carnivore conservation in India and Norway. Conserv. Soc. 13, 265–274.

Gillinham, S., Lee, P.C., 1999. The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania. Environmental Conservation 26, 218–228.

Gokhale, Y., 2004. Reviving traditional forest management in Western Ghats-Study in Karnataka. Econ. Polit. 39, 3556–3559.

Gunnarsson, B., Knez, I., Hedblom, M., Sang, O., 2017. Effects of biodiversity and environment-related attitude on perception of urban green space. Urban Ecosyst. 20, 37–49.

Induchoodan, N.C., 1996. Ecological Studies of the Sacred Groves of Kerala. Ph.D. Thesis. Central University of Pondicherry, India 135 pp.

Knight, J., 1999. Monkeys on the move: the natural symbolism of people-macaque conflict in Japan. J. Asian Stud. 58, 622–647.

Kalam, M.A., 1996. Sacred Groves in Kodagu District of Karnataka (South India): a Sociohistorical Study. Institute Francais de Pondicherry, Pondicherry, India.

Khan, M.L., Khumbongmayum, A.D., Tripathi, R.S., 2008. The sacred groves and their significance in conserving biodiversity, an overview. Int. J. Ecol. Environ. Sci. 34, 277–291.

Khumbongmayum, A.D., Khan, M.L., Tripathi, R.S., 2004. Sacred groves of Manipur – idean centre for biodiversity conservation. Curr. Sci. 87, 430–433.

Lowman, M., Sinu, P.A., 2017. Can the spiritual values of the forests inspire effective conservation of tropical forests? BioScience 67, 688–690.

Malhotra, K.C., Gokhale, Y., Chatterjee, S., 2001. Cultural and Ecological Dimensions of Sacred Groves in India. Indian National Science Academy and the Indira Gandhi Rastriya Manav Sangrahalaya, New Delhi and Bhopal, India.

Manoj, K., Rajesh, T.P., Prashanth Ballullaya, U., Meharabi, K.M., Shibil, V.K., Rajmohana, K., Sinu, P.A., 2017. Diversity of Platygastridae in leaf litter and understory layers of tropical rainforests of the Western Ghats biodiversity hotspot, India. Environ. Entomol. 46, 685–692.

Medhi, R., Chetry, D., Choudhury, B., Bhattacharjee, P.C., 2007. Status and diversity of temple primates in northeast India. Primate Conserv. 22, 135–138.

Mundoli, S., Joseph, G., Setty, S., 2016. Shifting agriculture": the changing dynamics of Adivasi farming in the forestfringes of a tiger reserve in South India. Agroecol. Sustain. Food Syst. 40, 759–782.

Murugan, K., Ramachandran, V.S., Swarupanandan, K., Remesh, M., 2008. Socio-cultural perspectives to the sacred groves and serpentine worship in Palakkad district, Kerala. Indian J. Tradit. Know. 7, 455–462.

Nagendra, H., Gokhale, Y., 2008. Management regimes, property rights, and forest biodiversity in Nepal and India. Environ. Manage. 41, 719–733.

Negi, C.S., 2010. The institution of taboo and the local resource management and conservation surrounding sacred natural sites in Uttarakhand, Central Himalaya. Int. J. Biodivers. Conserv. 2, 186–195.

Nogué, S., Tovar, C., Bhagwat, S.A., Finsinger, W., Willis, K.J., 2017. Exploring the ecological history of a tropical agroforestry landscape using fossil pollen and charcoal analysis from four sites in Western Ghats, India. Ecosystems 21, 45–55.

Notermans, C., Nugteren, A., Sunny, S., 2016. The changing landscape of sacred groves in Kerala (India): a critical view on the role of religion in nature conservation. Religions 7, 38. https://doi.org/10.3390/rel7040038.

Nutgeren, A., 2005. Belief, Bounty, and Beauty: Rituals Around Sacred Trees in India. Brill., Amsterdam.

Ormsby, A., 2013. Analysis of local attitudes toward the sacred groves of Meghalaya and Karnataka, India. Conservation and Society 11, 187–197.

Ormsby, A., 2011. The impacts of global and national policy on the management and conservation of sacred groves of India. Hum. Ecol. 39, 783–793.

Ormsby, A., Bhagwat, S.A., 2010. Sacred forests of India: a strong tradition of community-based natural resource management. Environ. Conserv. 37, 320–360.

Ormsby, A., Ismail, S.A., 2015. Cultural and ecological insights into Sacred grove management: managing timber resources for improved conservation of Sacred Groves. For. Trees Livelihoods 24, 244–258.

Ormsby, A., Jackson, W., Bhagwat, S., 2016. Can World Heritage Status Help Protect Sacred Sites in Asia? In Asian Sacred Natural Sites, Philosophy and Practice in Protected Areas and Conservation. Routledge, NY.

Osuri, A.M., Madhusudan, M.D., Kumar, V.S., Chengappa, S.K., Kushalappa, C.G., Sankaran, M., 2014. Spatio-temporal variation in forest cover and biomass across sacred groves in a human-modified landscape of India's Western Ghats. Biol. Conserv. 176, 193–199.

Parakkatt, J., 2018. Conservation Is No Monkey Business for This Woman Labourer. https://english.manoramaonline.com/women/on-a-roll/2018/05/29/conservation-is-no-monkey-business-for-this-daily-labourer.html.

Poffenberger, M., McGean, B., 1996. Village Voices, Forest Choices: Joint Forest Management in India. Oxford University Press, Calcutta.

R Core Team, 2014. R: a Language and Environment for Statistical Computing. R Foundation for statistical computing, Vienna, Austria. http://www.R-project.org).

Radhakrishna, S., 2018. Primate tales: using literature to understand changes in human–primate relations. Int. J. Primatol. 39, 878–894.

Rajesh, T.P., Prashanth Ballullaya, U., Surendran, P., Sinu, P.A., 2017. Ants indicate urbanization pressure in Southwest India: a pilot study. Curr. Sci. 113, 314–317.

Rajmohana, K., Veenakumari, K., Bijoy, C., Mohanraj, P., Sinu, P.A., Ranjith, A.P., 2017. Anokha gen. N. (Hymenoptera: platygastroidea: scelionidae) and two new species from India. Halteres 8, 77–84.

Ramachandran, B., 1999. Significance of 'Kavu' – a note on the sacred groves of Kerala in eco-cultural context. J. Hum. Ecol. 10, 285–288.

Rao, M., Nagendra, H., Shahabuddin, G., Carrasco, L.R., 2016. Integrating community-managed areas into protected area systems: the promise of synergies and the reality of trade-offs. In: Joppa, L.N., Baillie, J.E.M., Robinson, J.G. (Eds.), Protected Areas: Are They Safeguarding Biodiversity? Wiley Blackwell, pp. 169–189.

Reynolds, T.W., Collins, C.D., Wassie, A., Liang, J., Briggs, W., Lowman, M.D., Sisay, T.S., Adamu, E., 2017. Sacred natural sites as mensurative fragmentation experiments in long-inhabited multifunctional landscapes. Ecography 40, 144–157.

Rutte, C., 2011. The sacred commons: conflicts and solutions of resource management in sacred natural sites. Biol. Conserv. 144, 2387–2394.

Saraswat, R., Sinha, A., Radhakrishna, S., 2015. A god becomes a pest? Human–rhesus macaque interactions in Himachal Pradesh, northern India. Eur. J. Wildl. Res. 61, 435–443.

Schwartzman, S., Moreira, A., Nepstad, D., 2000. Rethinking tropical forest conservation: perils in parks. Conserv. Biol. 14, 1351–1357.

Sebastian, P.T., 2002. Christian migration to malabar. PhD Thesis, Department of History. University of Calicut, pp. 1930–1980.

Sheridan, M.A., Nyamweru, C., 2007. African Sacred Groves: Ecological Dynamics and Social Change. Oxford University press 230 pp.

Sinu, P.A., Kent, S.M., Chandrashekara, K., 2012. Forest resource use and perception of farmers on conservation of a usufruct forest (Soppinabetta) of Western Ghats. India. Land Use Policy 29, 702–709.

Soga, M., Gaston, K.J., Koyanagi, T.F., Kurisu, K., Hanaki, K., 2016. Urban residents' perceptions of neighbourhood nature: Does the extinction of experience matter? Biol. Conserv. 203, 143–150.

Suchitra, M., 2015. Sacred Groves of Kerala: From 10000 to 1200. Down to Earth. http://www.downtoearth.org.in/news/sacred-groves-of-kerala-down-from-10000-to-1200-49070.

Tiwari, B.K., Barik, S.K., Tripathi, R.S., 1998. Biodiversity value, status, and strategies for conservation of sacred groves of Meghalaya, India. Ecosystem Health 4, 20–22.

Tuan, Y., 1968. Discrepancies between environmental attitude and behavior: examples from Europe and China. The Canadian Geographer 12, 176–191.

Upadhaya, K., Pandey, H.N., Law, P.S., Tripathi, R.S., 2003. Tree diversity in sacred groves of the Jaintia hills in Meghalaya, Northeast India. Biodivers. Conserv. 12, 583–597.

Verschuuren, B., Wild, R., McNeely, J., Oviedo, G., 2010. Sacred Natural Sites: Conserving Nature and Culture. Routledge 300pp.

Wassie, A., Teketay, D., Powell, N., 2005. Church forests in north Gondor Administrative Zone. For. Trees Livelihoods 15, 349–374.