

Sacred places and spiritual beliefs can enhance biodiversity conservation: A case study from the north-eastern Bangladesh

(Submitted: 06.09.2021 ; Accepted: 15.06.2022)

Fahmida Sultana^{1*}, Swapan Kumar Sarker¹

¹Department of Forestry and Environmental Science, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh,

*Corresponding author: fahmida-fes@sust.edu

Abstract

Conservation of biological diversity is one of the most challenging issues in the present era. The role of religious beliefs in conserving biodiversity is well appreciated and religious institutions are often integrated into the conservation action plans. However, we still lack an explicit understanding of the efficacy of these religious institutions and different beliefs in conserving biodiversity. We collected vegetation and animal data from the sacred places of north-eastern Bangladesh. Key respondents survey was also carried out to understand the nature of spiritual beliefs and their link with conservation. We found that sacred places and spiritual beliefs together are playing a vital role in protecting several plants and animals species. We recorded a total of 2575 individuals of 104 plant species in the sacred places. Of these, 20 species were conserved for spiritual purposes because of their usage in religious festivals, thus receiving more protection. Besides, the present study also recorded a total of 44 faunal species. We concluded that the findings of this study may help decision-makers in designing pragmatic conservation actions by taking into account the value of sacred places and spiritual beliefs in protecting threatened and endangered species in human-dominated landscapes around the world.

Keywords: Biodiversity conservation; spiritual values; sacred places; endangered species; indigenous knowledge.

1. Introduction

Sacred places, an ancient and widespread system of community-based and religiously approved protected places, are considered to promote protection and conservation of biodiversity (1, 2, 3, 4). Sacred places may include a wide variety of habitats such as small patches of forest, sacred groves and sites of ancestral or deity worship (5, 6). Worship of nature and the living creatures have been a tradition of many world religious groups (7, 8). Religious beliefs form an important component of cultures in many parts of the world and are often connected with nature conservation (9, 10, 11). In fact, an intimate cooperative relationship exists between both biological and cultural diversity, and sustainable existence on earth depends on the state of this relationship. Spiritual and cultural beliefs are in many extent act as a driving force of ecosystem management (12), consequently supply food, shelter and support many ecosystem functions and services (13).

Besides, evidences showed conservation strategies that incorporated local conservation knowledge led to successful forest biodiversity management in human-dominated landscapes (14, 15). Human and its nature both have conservation history from the ancient time; man conserves nature for their existence although

nowadays one of the primary causes of biodiversity loss is the habitat alteration initiated by human interference (16). Additionally, several spiritual beliefs that are associated with some of the floral and faunal species can facilitate biodiversity conservation in the sacred places (17, 18). Hence, sacred places also act as an additional network of biodiversity conservation along with the protected areas, and arise due to the local and cultural beliefs as a substitute of protected areas (19). Existing literature suggests that the role of protected areas in biodiversity conservation are studied in a growing number of studies worldwide (20, 21, 22, 19, 23, 24), but the efficacy of sacred places in conserving and managing biodiversity has not been clearly revealed yet.

Bangladesh, exceptionally rich in Biodiversity with a variety of flora and fauna (25, 26). However, the number of endangered species has been increasing alarmingly due to the country's tremendous population pressure, rural poverty and unemployment. Moreover, 12 wildlife species have already been reported as extinct and 40 mammals, 41 birds, 58 reptiles and 8 species of amphibians have been listed in the red data book of threatened animals of the country (27). Besides, 167 plant species have been listed as vulnerable in Bangladesh (28). Therefore, identifying threatened flora and fauna is necessary for their sustainable conservation

and management in the natural environment. As a result, the government of Bangladesh has been declared 37 natural sites as protected areas to reduce biodiversity loss.

Several policies and legal frameworks have been formulated for sustainable management of biodiversity in Bangladesh, like- National Biodiversity Strategy and Action Plan (2016-2021), National Conservation Strategy (2016-2031), Wildlife (Conservation and Security) Act 2012, and Bangladesh Biodiversity Act 2017. Besides, Government has been proclaimed biodiversity and ecologically rich areas as National Parks, Eco-Parks, Wildlife Sanctuaries, and Ecologically Critical Areas to give special consideration for biodiversity conservation. However, from the last few decades biodiversity conservation effort is also being paid outside the forest or protected areas worldwide (29). The Government of Bangladesh is also on the same track, and giving high importance on biodiversity conservation in and outside the forest areas. Besides, traditional indigenous knowledge has its own conservation value, and it is obvious that complementary approaches are necessary along with protected areas to enhance the opportunity of biodiversity conservation. Hence, sacred places and related spiritual beliefs are one of the important means of traditional biodiversity conservation.

People of many religions live in Bangladesh. They possess numerous spiritual beliefs related to biodiversity conservation and management. Muslim and Hindu communities of this country are sensitive to some sacred places (like Mazar of Shahjalal (R), Sacred grove of Shahporan (R), Kali Mondir, Moha shoshan etc.); these are prosperous for biodiversity conservation, exclusively at species and habitat level (17, 8). Moreover, each community possesses some distinctive spiritual beliefs that positively encourage biodiversity conservation. For instance, two animal species *Aspideretes nigricans* (Black Soft-shell Turtle) and *Crocodylus palustris* (Mugger Crocodile) are found to be conserved spiritually by the Muslim community and population of that species are only limited within the country in the sacred places of Sultan-ul-Arefin Hz. Bayzid Bostami (R.), Chittagong and Khan-i-Azam Hz. Khan Jahan Ali (R.), Khulna, respectively (17).

In sum, sacred places of religious communities consist cluster of floral and faunal diversity and they are protected through spiritual beliefs. Hence, it is crucial to recognize the significance of spiritual values that aid in maintaining ecosystem sustainability through conserving floral and faunal biodiversity. However, until now there is no field-based studies in Bangladesh to explore the role of sacred places and spiritual beliefs in biodiversity conservation (both flora and fauna) outside the forest and protected areas. Therefore, the present study was conducted considering the following objectives: (1) to explore the biodiversity status in sacred places of north-eastern Bangladesh, and (2) to

identify the distinctive spiritual beliefs associated with floral and faunal conservation.

2. Methodology

2.1 Study areas

Bangladesh consists of 64 districts; among them the Sylhet district is important from the spiritual point of view, since several sacred places and groves of many sufis and missionaries are located here; as well as the people of this area is very pious. Thus, Sylhet Sadar Upazila (sub-district) (Figure 1 and Table S1) from Sylhet district was purposively selected for the present study. The study area was part of the Indian subcontinent and has a long history of culture. It was assumed that Islam began to spread in this region during 6th-7th century AD and with the conquest of great muslim warrior Bakhtiyar Khalji, this religion became dominant along with the activities of Muslim Sufis like Hazrat Shah Jalal and Hazrat Shah Poran (R). In addition, before 1947 current sovereign Bangladesh was a part of India, large portion of the people then followed Hindu religion and established several shrines, temples and ashrams. Though, at the time of independence in 1971 several Hindu families migrated in India, but many of the Hindu families are still dwelling in Bangladesh. The total population of the study area is 3.4 million and the majority of the people follow Islam followed by Hindu. At present, 92.62% Muslim, 7.23% Hindu, 0.07% Christian and 0.08% other religions inhabit in the study area (30).

2.2 Sampling and data collection

We considered a total of 20 sacred places in this study, comprising 8 Mazars (mausoleum of a saint or notable religious leader, especially for the Muslim community), 4 sacred groves (forest fragments that are spiritually valuable and communally protected, also used as a buried ground for the Muslim community), 3 temples (a place of Hindu community, devoted to the worship of a god or goddess), 3 ashrams (a religious retreat of the monastic community, especially Hindu community) and 2 moha shoshan (a place, where Hindu community perform their funeral ceremony) that were randomly selected from Sylhet Sadar Upazila for data collection (Table S1).

We collected both quantitative and qualitative information during our field visits. From each sacred place, two sample plots of 10m×10m were selected for the assessment of structural and floral composition of tree species. In total, 40 sample plots were selected to collect stem/ha, basal area and presence/absence data of tree species. Moreover, within each 10m×10m sample plots, 2 subplots of 2m×2m size were taken, in total 80 plots were taken for shrubs, herbs and grasses. Presence/absence data of all species and their individual number were counted for shrubs, herbs and grasses. Plant species were identified with the help of key respondents (experienced persons engaged in different

activities of the sacred places for more than 15 years) and encyclopedia of flora and fauna of Bangladesh.

Qualitative information on faunal species (name, spiritual beliefs or myth, conservation purpose,

availability status) was collected through direct field visit and also from the key respondent survey. Total 60 respondents, 3 from each sacred place were selected purposively.

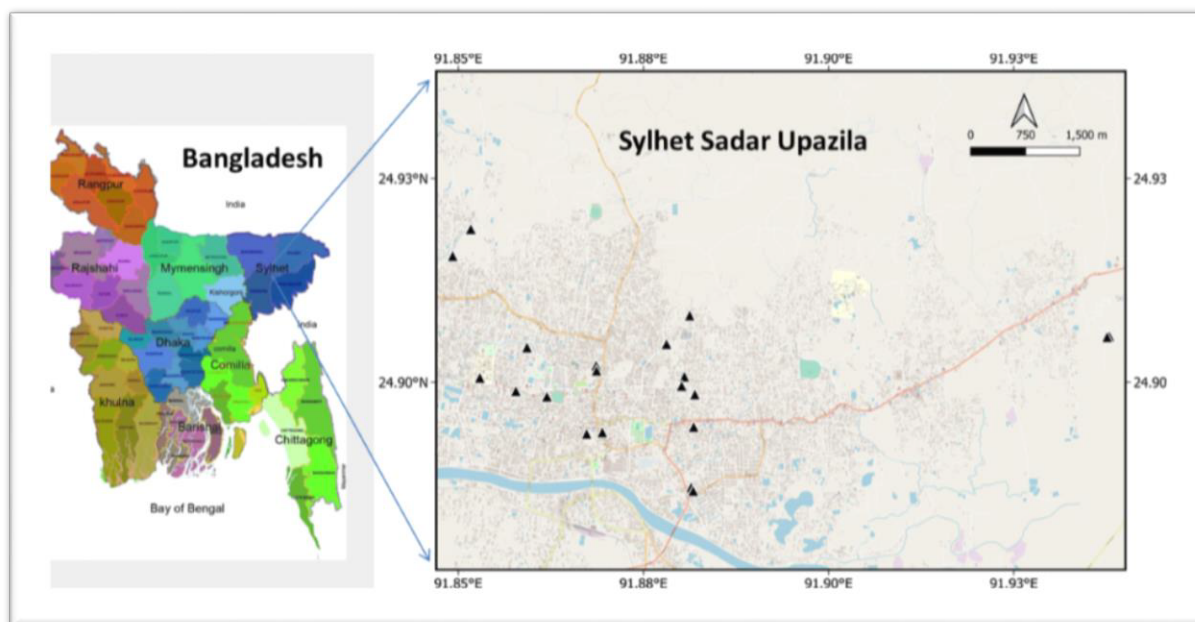


Figure 1: Map of the study area. GPS locations of the studied sacred places (triangle symbol) were shown in the map. Map was created through QGIS.

A semi-structured questionnaire was used to gather information on spiritual beliefs that were related to faunal species conservation. Moreover, the name of all floral and faunal species with spiritual importance in the studied sacred places was recorded.

2.3 Data analysis

To understand the different aspects of plant diversity in the sacred places we estimated different parameters, like species diversity, density, relative density, frequency, relative frequency, abundance, relative dominance, and importance value.

The formula used for calculating these characteristics are given below (Odum 1971):

(i) The Shanon-wiener diversity, $H = -\sum P_i \ln P_i$; Where, $P_i =$ (Number of individuals of one species/Total number of individuals in the samples).

(ii) Index of dominance, $ID = \sum (P_i)$; Where, $P_i =$ (Number of individuals of one species / Total number of individuals in the samples).

(iii) Species richness index, $R = (S-1)/\ln N$; Where, $S =$ Total number of species; $N =$ Total number of individuals of all the species.

(iv) Density of a species per unit area, $D =$ (Total number of individuals of a species)/ (Total number of sample plots enumerated).

(v) Relative density, $RD =$ (Total number of individuals of a species)/ (Total number of individuals of all species) $\times 100$.

(vi) Frequency, $F =$ (Total number of sample plots in which the species Occur)/ (Total number of sample plots enumerated) $\times 100$.

(vii) Relative frequency, $RF =$ (Frequency of the species in the stand)/ Sum of the frequencies of all species in the stand $\times 100$.

(viii) Abundance, $A =$ (Total number of individuals of the species in all the samples)/ (Total number of samples in which the species occurred).

(ix) Relative dominance, $RDo =$ (Total basal area of the species in all the Samples)/ (Total basal area of all the species in all samples) $\times 100$.

(x) Importance value Index, $IVI = RD + RDo + RF$.

Information on faunal species was collected from the respondent survey to know the present status of faunal diversity in the studied sacred places. In addition, availability of faunal species in the sacred places were ranked in three categories (low = *, medium = ** and high = ***) based on respondents opinion.

3. Results

3.1 Plant composition and diversity

Our plant species survey recorded a total of 55 tree species (530 individuals) belonging to 28 families, 30 shrub species (615 individuals) belonging to 20 families and 19 herb and grass species (1430 individuals) belonging to 11 families from the sacred places (Figure 2). Shanon-wiener index (Table 1) was the highest in trees (3.81) followed by shrubs (2.68) and herbs (1.78). The study areas were dominated by herbs, which revealed from the highest index of dominance (0.29) followed by shrubs (0.14) and trees (0.03). Tree species occupied the highest richness (8.61) followed by shrubs (4.52) and herbs (2.48).

Table 1: Different diversity index for trees, shrubs, herbs and grasses.

Diversity index	Trees	Shrubs	Herbs-Grasses
Shanon-wiener index	3.81	2.68	1.78
Index of dominance	0.03	0.14	0.29
Species richness index	8.61	4.52	2.48

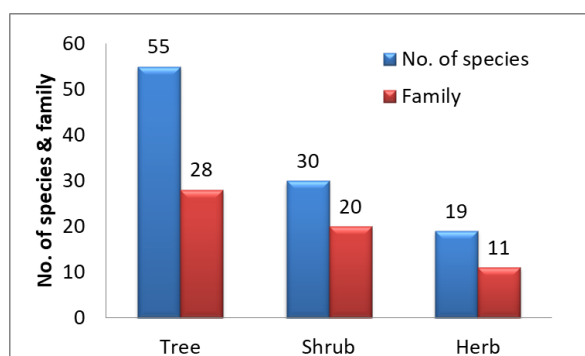


Figure 2: Illustration of the vegetative layers of the study area.

3.2 Quantitative structure of tree species

Leguminosae was found to be the dominant tree family comprising 8 species followed by Moraceae (5 species) and Euphorbiaceae, Meliaceae and Palmae (3 species each) (Table S2). Among the tree species, *Artocarpus heterophyllus* was the most prominent tree species with stem/ha (68), Ba/ha (6.27), Importance Value Index (19.97), highest relative density (5.09) and relative frequency (5.15) followed by *Cocos nucifera*, *Phoenix sylvestris*, *Azadirachta indica*, and *Delonix regia* (Figure 3 and 4). However, in terms of relative dominance, *Ficus altissima* (11.33) showed the highest value followed by *Albizia saman*, *Artocarpus heterophyllus*, *Phoenix sylvestris* (Table S3).

3.3 Quantitative structure of shrub species

Verbenaceae was the dominant shrub family containing 4 species followed by Solanaceae containing 3 species and Malvaceae, Oliaceae, Rubiaceae, Rutaceae

contained 2 species each (Table S4). Besides, *Duranta repens* was the most prominent shrub species among others (2.61 plants/4m²) followed by *Acalypha wilkesiana* (0.59 plants/4m²), *Ocimum tenuiflorum* (0.46 plants/4m²) and the lowest density was found in *Quisqualis indica* (0.01 plants/4m²). The highest frequency was found in *Acalypha wilkesiana* (26.25%) followed by *Duranta repens* L. (21.25%), *Ocimum tenuiflorum* (15.00%), *Sesamum indicum* (7.50%). The highest abundance was estimated in *Duranta repens* (12.29), followed by *Solanum indicum* (9.25), *Sesamum indicum* (6) and *Cajanus cajan* (4.33) (Table S5).

3.4 Quantitative structure of herb and grasses

The family Gramineae was dominant containing 5 species followed by Araceae, Convolvulaceae and Leguminosae containing 2 species individually and the remaining families contained 1 species each (Table S6). Among the 19 species of herbs and grasses *Cynodon dactylon* (8.85) had the highest density followed by *Mimosa pudica* (2.66), *Centella asiatica* (2.63). Besides, *Cynodon dactylon* had the highest relative density (49.51%) followed by *Mimosa pudica* (14.90%) and *Centella asiatica* (14.69%). *Cynodon dactylon* again showed the highest frequency (38.75%) followed by *Bambusa* spp. (28.75%), *Centella asiatica* (21.25%), and *Mimosa pudica* (20%). Moreover, *Cynodon dactylon* (22.84) showed the highest abundance followed by *Pisum sativum* (18.50), *Imperata cylindrica* (14) and *Mimosa pudica* (13.31) (Table S7).

3.5 Faunal species composition

The present study recorded a total of 44 faunal species in the studied sacred places, of them 40 species were naturally occurred and 4 species were being conserved due to related spiritual beliefs. The class Aves consist of the highest number of species (20 species) followed by the class Mammalia (10 species) and Actinopterygii (10 species). Besides, the class amphibians consist of 3 species and reptiles consist of 1 species only (Table S8).

3.6 Spiritual beliefs and Plants

From the interview of aged old persons involved in the management authority of sacred places, we found that Muslim and Hindu communities together conserve 20 floral species for different religious purposes, like Muslim community used to conserve most of these species to keep sacred places and graveyard holy and Hindu community mostly use fruits and flowers of these species for veneration (puja) of god. Besides, these spiritually conserved species are used in medicinal purposes for home remedies. Among these 20 species, 7 were trees, 11 were shrubs and rest of the 2 species was herbs. We found that 4 species were conserved by Muslim community and 12 were conserved by Hindu, and rest 4 were conserved by both communities (Table 2). In addition, from the respondent interview we came to know that due to the spiritual beliefs related to these

floral species they are being conserved since time immemorial.

3.7 Spiritual beliefs and Animals

We found that 3 animal species were conserved spiritually by Muslim community and 1 animal species conserved by Hindu community in the north- eastern Bangladesh (Table 3).

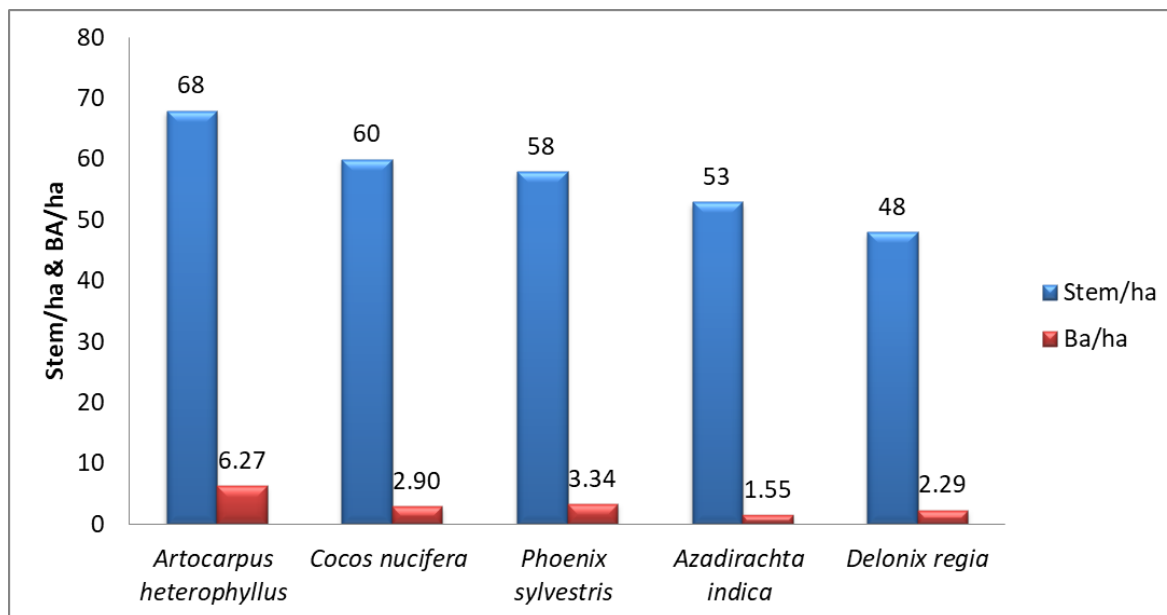


Figure 3: Stems/ha and Basal Area /ha of five major tree species.

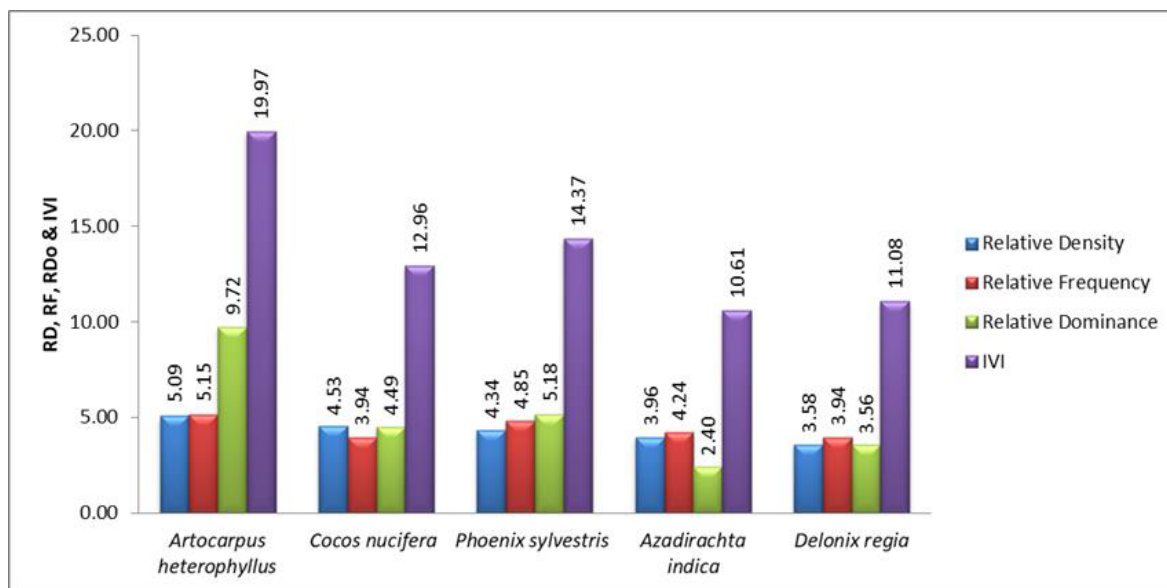


Figure 4: Five major tree species with their individual and combined positions in the sacred area.

We also explored four spiritual beliefs related to each faunal species that were helping conserving these species in the study areas. The species *Columba livia* and *Channa marulius* were conserved in the Mazar of saint Hazrat Shah Jalal (R). Since, the saint was gifted a pair of Rock pigeon from his friend hence he was very associated to Rock pigeon (*Columba livia*). Besides, it was heard that once upon a time saint Hazrat Shah Jalal (R) rehabilitated evil soul in the form of Snakehead (*Channa marulius*) in his pond as punishment for their

evilness. Moreover, *Macaca mulatta* (Rhesus macaque) is spiritually conserved in the mazar of saint Hazrat Chasni Pir (R), as the saint was very fond of this animal. Moreover, people believe that rearing and feeding these animals in mazars will make them more religious and bring good luck. Furthermore, species *Bos indicus* was spiritually conserved by Hindu community, since Lord Krishna was fond of this animal and they respect this animal like mother to satisfy the lord.

Table 2: List of floral species that have spiritual values.

S.N.	Scientific name	Local Name	Community ¹	Places ²	Life form	Cultivated or wild	Conservation status ³	Spiritual beliefs or Myths	Conservation purposes
1	<i>Aegle mormelos</i>	Bel	Hi	A, Te	tree	cultivated	LC	Krisna wanted to become a worshiper of god Shiva, hence started worshiping for seven months along using the leaves	Fruits are used in veneration (puja) of god.
2	<i>Azadirachta indica</i>	Neem	Mu, Hi	A, M, Te, Ms, Sg	tree	cultivated	LC	Bad souls never come in and around the places where it is planted	Used for providing shade to the visitors of sacred places and the departed soul.
3	<i>Bambusa spp.</i>	Bans	Mu	Ms, Sg	herb	wild	LC		Used to prepare grave and burying Muslims after death.
4	<i>Caesalpinia pulcherrima</i>	Radachura	Hi	Ms	tree	wild	LC	Flowering plants are seemed to be the sign of purity and beauty that are praiseworthy by gods	Used for providing shade in the temple and ashram.
5	<i>Cestrum Nocturnum</i>	Hasnahena	Hi	A, Te, Ms	shrub	cultivated	LC	White colour and sweet scent of this flower purify the soul and mind	Flowers are used in morning worship.
6	<i>Cocos nucifera</i>	Narikel	Mu, Hi	A, M	tree	cultivated	LC	Sign of purity and holiness	Fruits are used to prepare delicious food in the religious events such as Eid and Puja. Coconut water used to devote the God, needed for washing Shiva's foot and also used on the 7th day of Durga puja (Hi).
7	<i>Datura metel</i>	Dutura	Hi	A, Te, Ms	shrub	wild	LC	Flowers of this species keeps away bad souls from around	Flowers are used in morning worship.
8	<i>Duranta repens</i>	Katamehedi	Mu	Sg	shrub	cultivated	LC	This species planted around the graveyard as it seems to protect the buried body from the harm of outer object	Used for fencing graveyard.
9	<i>Gardenia jesminoides</i>	Gandharaj	Hi	A, Te, Ms	shrub	cultivated	LC	Fragrance of this flower purify the soul and mind	Flowers are used in morning worship of god.
10	<i>Hibiscus rosa-sinensis</i>	Joba	Mu, Hi	A, M, Te, Ms	shrub	cultivated	LC	Flowering plants are seemed to be the sign of purity and beauty that are praiseworthy by Gods	Flowers are used in morning worship of god (Hi) and also have herbal medicinal value.
11	<i>Jasminum</i>	Bely	Hi	A, Te	shrub	cultivated	LC	Fragrance of this flower purify	Flowers are used in morning

S.N.	Scientific name	Local Name	Community ¹	Places ²	Life form	Cultivated or wild	Conservation status ³	Spiritual beliefs or Myths	Conservation purposes
	<i>sambac</i>			Ms				the soul and mind	worship of god.
12	<i>Lawsonia inermis</i>	Mehedi	Mu	Sg	shrub	cultivated	LC	Colouring the hand, hair and beard with the leaves of this species (called Henna) is holy work as the prophet (S) used Henna for colouring his beard.	Used for colouring the hand in the Eid festival and also in Muslim marriage.
13	<i>Murraya paniculata</i>	Kamini	Hi	A, Te, Ms, Sg	shrub	cultivated	LC	Flowering plants are seemed to be the sign of purity and beauty that are praiseworthy by gods	Flowers are used in morning worship of god.
14	<i>Musa sapientum</i>	Banana	Hi	Ms	herb	cultivated	LC	This plant seems to be holy by the Hindu community as it used in their important life events	Fruits are offered to god in veneration (puja) to have blessings and plant is also used in the marriage ceremony of Hindu community.
15	<i>Nyctanthes arborescens</i>	Sheuli	Hi	A, Te, Ms	shrub	cultivated	LC	Flowering plants are seemed to be the sign of purity and beauty that are praiseworthy by gods	Flowers are used in morning worship of god.
16	<i>Ocimum tenuiflorum</i>	Tulsi	Hi	A, Te, Ms	shrub	cultivated	LC	Sign of god's blessing and purity.	Unavoidable in the evening worship of god.
17	<i>Phoenix sylvestris</i>	Khejur	Mu	M, Sg	tree	cultivated	LC	First mosque was built by its leaves and fruits are seemed to be holly and nutritious since it is one of the favourite fruits of prophet (S)	Leaves are used for shading purpose in the sacred places. Fruits are eaten extensively in the month of Ramadan.
18	<i>Santalum album</i>	Shwet Chandan	Hi	A, Ms, Te	tree	cultivated	NE	Once lord Brahma used chandan (medicine made from Santalum album) as an ointment all over his body to get rid of vexation pain.	Essentially needed in the worship of Brahma and the people of Hindu community apply past (made of chandan) on the forehead to protect them from evil eye and to be pious.
19	<i>Sesamum indicum</i>	Til	Hi	Ms	shrub	cultivated	LC	Bad souls never come in and around its fruits.	Fruits are used in making food to offer the god in veneration (puja).
20	<i>Ziziphus jujuba</i>	Boroi	Mu	M, Sg	tree	cultivated	LC	Bad souls do not come in and around the places, where it is planted	Muslim community use boiled leaves water to make shower of Corpses at the funeral.

Note: ¹Community, Hi= Hindu, Mu=Muslim; ²Places, A= Ashrom, M= Mazar, Ms= Moha Shoshan, Sg= Sacred groves, Te=Temple; ³Conservation status, LC = Least Concern, NE = Not evaluated.

Table 3: Conservation status of spiritually conserved faunal species

Scientific name	Common/Local name	Family	Community ¹	<u>**Conservation status</u>		Distribution	Spiritual beliefs or Myths	Conservation purposes
				Bangladesh	Global			
<i>Bos indicus</i>	Cow	Bovidae	Hi	LC	LC	Worldwide	Lord Krisna was fond of this animal and Hindu community assume this animal as equivalent to their mother	Made the lord be satisfied upon his followers and making sweets in religious festivals
<i>Channa marulius</i>	Snakehead, Gojarmach	Channidae	Mu	Endangered*	Uncommon	Worldwide	Once upon a time they were evil and saint Hazrat Shajalal (R) rehabilitated them into current condition as punishment for their evilness	There is a kind of competition among the visitors regarding feeding, as they believe that the bigger the fish they can get feed, the more likely to fulfil their desires.
<i>Columba livia</i>	Rock pigeon, Jalali kobutor	Columbidae	Mu	Declining	LC	Worldwide	Saint Hazrat Shah Jalal (R) got a pair of Rock pigeon as a gift from his friend	Made the saint become happy and to be more religious.
<i>Macaca mulatta</i>	Rhesus macaque, banor	Cercopithecidae	Mu	CE*	LC	Endemic	Saint Hazrat Chasni Pir (R) was fond of this animal	It is believed that giving them food will bring good luck.

Note: ¹Community, Hi= Hindu, Mu=Muslim; *Suggested by IUCN Bangladesh, 2000. **As per World Conservation Union. CE= Critically endangered; LC= Least concerne

4. Discussion

Study findings suggested that sacred places of two major religious communities' (Muslim and Hindu) are facilitating biodiversity conservation in north-eastern region of Bangladesh. Besides, key respondents survey also revealed the nature of spiritual beliefs related to each floral and faunal species and their association with conservation purposes in current time. Both, sacred places and spiritual beliefs together are contributing conservation effort of several plants and animals species; including endangered and critically endangered animals. Though, we recorded a total of 104 plant species in the studied sacred places, only 20 species are valuable from spiritual perspectives because these species are seemed to be the sign of purity, as well as fruits and flowers of these species are used in different religious festivals and veneration of God. Our findings also revealed that Muslim community mostly conserve tree species, used in various religious purposes and also in funeral ritual. But, Hindu community mostly conserves shrubs and herbs species because flowers of these species are used in worship of God. Moreover, we found that Muslim sacred places are conserving some endangered and critically endangered animal species like *Channa marulius* and *Macaca mulatta*, as saints of Muslim community were fond of animals. However, all the spiritually conserved plants and animal species have their individual values and purpose of conservation to religious communities.

4.1 Species compositions and diversity

We found a substantial amount of tree diversity in the sacred places, which were higher than the reported tree diversity of many forest areas in Bangladesh including Khadimnagar National Park (31) and Kaptai national Park (32). The reason behind the high number of tree species in the study areas could be that people do not harvest or fell tree species in sacred places, felling tree is considered as one of the religious offences. Besides, a myth was also found that tree species give shade to the immortal souls in sacred places. Therefore, people especially Muslim community plant and conserve tree species in the whole area of graveyard. Spiritually important tree species also play a significant role in the conservation of faunal diversity.

Moreover, sacred places of the present study had well stocked floral cluster (1325 stems/ha) compared to the other studies conducted in different forest areas of Bangladesh. Alamgir and Al-amin (33) recorded 590 stems/ha at Bamer chara and Daner chara under Banskhal upazila in Chittagong division and Nur et al (34) found 1425 stem/ha at Shitalpur Forest Beat under Chittagong North Forest Division. Total basal area of trees was found 64.525 m²/ha (dbh >5cm) indicating good stock and size of trees in the sacred places compared to other studies done by Sarker (31) and Nur et al (34); recorded basal area of trees was 60.144 m²/ha (dbh ≥5cm) at Khadimnagar National Park in Sylhet

and 0.49 m²/ha at Shitalpur Forest Beat under Chittagong North Forest Division in Bangladesh, respectively.

Sacred places were also rich in shrubs (30 species), herbs and grasses (19 species) compared to the study conducted by Sobuj and Rahman (35), documented 17 shrubs and 31 herbs species in the Khadimnagar National Park of Bangladesh. The reason behind this richness could be the conservation of floral species and protecting these species for spiritual purposes by both Muslim and Hindu communities in the sacred places.

Interestingly, the spiritually important species (Table 2) were comparatively rich in the sacred places according to density and frequency. For instance, *Cocos nucifera* and *Phoenix sylvestris* were frequently found in the studied sacred places because of their spiritual beliefs. *Cocos nucifera* is seen as a sign of purity and holiness in both Muslim and Hindu communities. Fruits of this plant are used to prepare delicious food in the religious events such as Eid and Puja. Furthermore, leaves of *Phoenix sylvestris* were used to build the first mosque of Muslim community and fruits of this species were one of the favourite of prophet (S). Though, *Artocarpus heterophyllus* does not possess any strong spiritual beliefs but it was one of the frequently found tree species in the sacred places. It might be because this species has been planted widely so that other faunal species present in the sacred places could live on the leaves and fruits of *Artocarpus heterophyllus* that eventually help to conserve the faunal diversity of the sacred places. Furthermore, the ecological reason could be the well-drained moist hilly acidic soil with medium fertility of the study area (36) which is suitable for the growth of this species. Besides, it is a multipurpose tree species hence income is generated through selling its fruits, branches and leaves as fodder and the earned money is devoted to the well beings of sacred places.

Species diversity indice Shanon-Wiener index (3.81) for trees suggested that the sacred places of the study areas were rich in tree species than other studies conducted in different forest areas of Bangladesh. Nath et al. (37) found that Shanon-wiener index for trees was 2.98 at Sitapahar natural forest in Chittagong. Similarly, Sarker (31) and Sobuj and Rahman (35) estimated Shanon-wiener index for trees was 1.07 and 2.76, respectively, at Khadimnagar National Park in north-eastern region of Bangladesh.

Furthermore, study areas were also rich in shrubs (2.68) and herbs (1.78) diversity compared to the study findings of Alamgir and Al-amin, (33), estimated that the Shanon-wiener index of shrubs was 2.34 and for herbs it was 1.21 at Banskhal upazila in Chittagong. Sobuj and Rahman (35) also found Shanon-wiener index for shrubs was 2.56 and for herbs was 3.27 at Khadimnagar National Park in north-eastern region of Bangladesh.

The species diversity index of the present study was highest in trees (0.104) followed by shrubs (0.048) and

herbs (0.013). However, a study conducted in the Western-Himalayan moist temperate forest, Sandev in Uttar Pradesh under Pithoragarh District of India and found in general the diversity index was highest for herbs and lowest for trees (38). Sarker (31) estimated the diversity index for trees was 0.06 at Khadimnagar National Park, north-eastern region of Bangladesh. On the other hand, diversity index for trees with dbh >10cm at Sitapahar natural forest of Chittagong (North) forest division was 3.395 (39), diversity index at Ramu reserve forest of Cox'sbazar forest division was 3.11 and diversity index of Banskhalī upazila, Chittagong was 2.07 (33).

4.2 Faunal species composition

Sacred places were rich in faunal diversity. The study results are in line with other studies. For instance, Hossain et al. (40) recorded a total of 30 species of birds, 3 species of amphibians and 15 species of mammals from Savar Upazila of Dhaka where as the present study recorded 20 species of birds, 3 species of amphibians and 10 species of mammals from sacred places of Sylhet sadar Upazila. Moreover, the diversity of fish species (10) were also high in the study areas. A similar result was also found by Islam et al. (41), reported 12 species of fishes from a nearby forest ecosystem namely, Ratargul Swamp Forest in Sylhet district.

4.3 Spiritual belief in biodiversity conservation

Evidence suggests that spiritual beliefs can assist biodiversity conservation in sacred places (17, 15, 2, 5). Present study indicated that sacred places like Mazar and sacred groves of Muslim community greatly conserve the tree species namely, *Phoenix sylvestris*, *Cocos nucifera*, *Duranta repens*, *Lawsonia inermis* and *Bambusa* spp. It was believed by the Muslim community that the tree species give shade to the departed soul and *Bambusa* spp are used to prepare grave of Muslims after death. The reason behind the richness of *Phoenix* spp in the sacred places of Muslim community is that the first mosque was built by its leaves and dates are one of the favorite fruits of prophet (S). Moreover, the fruits of *Phoenix* spp is also a good source of animals feed in the sacred places. However, the sacred places of the Hindu community conserve mostly the shrubs species and generally the flowering species apart from *Ocimum tenuiflorum*. This is due to the fact that Hindu community uses these flowers in their worship. Besides, Hindu community also conserve some tree species in spiritual purposes like *Caesalpinia pulcherrima*, *Santalum album* and *Aegle mormelos* because these species are used in providing shade in the temples and ashrams as well as fruits of *Aegle mormelos* are used in veneration of God. *Santalum album* has also medicinal value and a myth was associated that once lord Brahma used chandan (medicine made from *Santalum album*) as an ointment all over his body to get rid of vexation pain. In addition,

both communities conserve *Azadirachta indica*, *Cocos nucifera* and *Hibiscus rosa-sinensis* in sacred places. *Azadirachta indica* is a multipurpose tree and has medicinal properties; in addition to that spiritual people believe that bad souls never come in and around the places where it is planted. *Hibiscus rosa-sinensis* has herbal medicinal value and they planted as a sign of purity and beauty. Additionally, fruit species are planted by both communities because they are used to prepare delicious foods in the religious festivals such as Eid and Puja.

In addition to the contributions in conserving plants diversity, spiritual beliefs also protecting some animal species which have been declining alarmingly as well as bearing endangered status inside the country. Moreover, we found Muslim community spiritually conserving *Macaca mulatta* (Rhesus macaque) which is endemic in nature (42); hence negligence in conserving this species could lead to extinction in near future. Though, *Macaca mulatta* is critically endangered within the country (43, 44). Rock pigeon (*Columba livia*) population bearing declining status within the country (45), although they are least concerned around the globe. Other species like Snakehead (*Channa marulius*), reported to be endangered within the country (43) and bearing uncommon status around the globe (46). Besides, *Bos indicus* was spiritually conserved by Hindu community though they bear least concerned status. Most of the species bearing local name inside sacred places which is dissimilar from the English or Bengali name, like Rock pigeon locally called Jalali Kobutor according to the name of saint Hazrat Shah Jalal (R), who was very attached to this bird species.

We found that animal species were closely linked with the spiritual beliefs of Muslim community. Since, some saints of Muslim community were very fond of faunal species. Usually, the authority of sacred places has the responsibility to rear faunal diversity associated with spiritual beliefs, but everyday visitors also get the opportunity to feed them; as they believe that serving animals in sacred places bring good luck for them.

5. Current management and threats

It has been observed from the current study that sacred places perform diverse kinds of conservation and management strategies in association with local people based on religious beliefs. This could be a great opportunity to change societies view on biodiversity conservation, especially where government strategies regarding conservation is facing challenges. In addition, though security and food for floral and faunal diversity are adequate but there are still lacking of scientific management together with fragile ecosystem. Besides, overcrowded and frequent visitors could affect floral species regeneration by trampling and also faunal species by overfeeding that could injure the fertility (17). Moreover, due to modernization, people's behaviours regarding these spiritual values are changing; hence at present these areas are under the

threat of ecosystem loss. In particular, it is possible to use these spiritual values by the government as a substitute to conventional biodiversity conservation strategies. Subsequently, this indigenous knowledge of conservation has its own acceptability to local people; hence this opportunity could be used as a complimentary approach along with the protected areas to fulfill government strategy of increasing biodiversity outside the forests.

5. Conclusion

Conservation of biological diversity is unlike other environmental threats due to its irreversibility. At present date, sacred places have become an important tool for biodiversity conservation; especially where conventional biodiversity conservation strategies are facing political and socioeconomic challenges. Besides, sacred places are not only conserving definite flora and fauna but also these places are good habitats for different types of orchids, birds, insects and animals. Hence, considering the significance of biodiversity conservation further strategies should be taken to preserve the sanctity of the sacred places.

Our study findings reveal that people are conserving both plant and animal species in sacred places from spiritual perspective. Some spiritual values are directly related to the conservation effort. Sacred places of both Muslim and Hindu communities conserve different types of trees and shrubs species, and plant parts of these species being used for various religious purposes. Besides, spiritual values are also conserving some endangered and critically endangered faunal species inside the sacred places, though faunal species conservation mostly related to the spiritual values of Muslim community. This study finding will help to understand clearly the conservation values of many sacred places in order to take decision-makers attention to a new contrivance of biodiversity conservation regime. Further researches need to be done on the conservation ecology and underlying socioeconomic perspectives regarding these sacred sites to entirely reveal their potentiality for biodiversity conservation. In addition, the government should consider and include this especial tool of conservation in the national biodiversity conservation policy to manage these sites scientifically. Besides, these sites can be declared as a new form of protected forests called "Sacred Forest" which would be helpful for biodiversity conservation in the near future.

Acknowledgment

I acknowledge the financial support of Explorer Club, USA; that was helpful for field data collection and explore such valuable social views to the new dimension of biodiversity conservation.

References:

1. Torri, M.C., Herrmann, T.M., Spiritual beliefs and ecological traditions in indigenous communities in India: Enhancing community-based biodiversity conservation, *Nature and Culture*. 2011, 6(2); 168-191.
2. Ormsby, A., Cultural and Conservation Values of Sacred Forests in Ghana. Paper presented at the Sacred Species and Sites meeting, Cambridge Centre for Landscape and People, 23-28 September, 2007, Cambridge, UK.
3. Sponsel, L.E., Natadecha-Sponsel, P., Ruttanadukul, N. et al., Sacred and/or Secular Approaches to Biodiversity Conservation in Thailand, *World Views: Environment Culture, Religion*. 1998, 2(13); 155-67.
4. Tiwari, B.K., Barik, S., Tripathi, R.S., Biodiversity Value, Status, and Strategies for Conservation of Sacred Groves of Meghalaya, India, *Ecosystem Health*. 1998, 4(1); 20-32.
5. Bhagwat, S., Rutte, C., Sacred Groves: potential for biodiversity management, *Frontiers of Ecology and the Environment*. 2006, 4(10); 519-524.
6. Ramakrishnan P.S., Saxena K.G., Chandrashekara U.M., (Eds) *Conserving the Sacred for Biodiversity Management*. Oxford and IBH Publishing Co., New Delhi, 1998, pp 3-16.
7. Ormsby, A.A., Bhagwat, S.A., Sacred forests of India: a strong tradition of community-based natural resource management, *Environmental Conservation*. 2010, 37(3); 320-326.
8. Swamy, P.S., Kumar, M., Sundarapandian, S.M., Spirituality and sacred groves in Tamil Nadu, India, *Unasylva*. 2003, 54; 53-58.
9. Singh, S., Youssouf, M., Malik, Z.A., Bussmann, R.W., Sacred Groves: Myths, Beliefs, and Biodiversity Conservation—A Case Study from Western Himalaya, India, *International Journal of Ecology*. 2017, Article ID 3828609. <https://doi.org/10.1155/2017/3828609>.
10. Rawat, M., Vasistha, H.B., Manhas, R.K. et al., Sacred forest of Kunjapuri Siddhapeeth, Uttarakhand, India, *Tropical Ecology*. 2011, 52(2); 219-221.
11. Mgumia, F.H., Oba, G., Potential role of sacred groves in biodiversity conservation in Tanzania, *Environmental Conservation*. 2003, 30(3); 259-265.
12. Negi, C.S., Religion and biodiversity conservation: not a mere analogy, *International Journal of Biodiversity Science and Management*. 2005, 1; 85-96.

13. Parthasarathy N., Babu K.N., Sacred Groves: Potential for Biodiversity and Bioresource Management. Life on Land, Publisher: Springer, 2019, pp 1-16. DOI: 10.1007/978-3-319-71065-5_10-1
14. Joa, B., Winkel, G., Primmer, E., The unknown known – A review of local ecological knowledge in relation to forest biodiversity conservation, Land Use Policy. 2018, 79; 520–530.
15. Kala, C.P., Traditional Ecological Knowledge, Sacred Groves and Conservation of Biodiversity in the Pachmarhi Biosphere Reserve of India, Journal of Environmental Protection. 2011, 2(7); 967-973.
16. Kearns, C., Conservation of Biodiversity, Nature Education Knowledge. 2010, 1(9); 7.
17. Mukul, S.A., Rashid, A.Z.M.M., Uddin, M.B., The role of spiritual beliefs in conserving wildlife species in religious shrines of Bangladesh, Biodiversity. 2012, 13(2); 108-114.
18. Dudley, N., Higgins-Zogib, L., Mansourian, S., The Links between Protected Areas, Faiths, and Sacred Natural Sites, Conservation Biology. 2008, 23(3); 568–577.
19. Rutte, C., The sacred commons: Conflicts and solutions of resource management in sacred natural sites, Biological Conservation. 2011, 144(10); 2387-2394.
20. Anwar, H.K., 2018. 'Teknaf Wildlife Sanctuary', Department of Environment Bangladesh. 1(1); pp 1–2. Available at: <http://nishorgo.org/project/teknaf-wildlife-sanctuary/> (Accessed: 30 July 2019).
21. Monirujjaman, Khan, M.M.H., Wildlife Diversity of Madhupur National Park, Bangladesh, Jahangirnagar University Journal of Biological Sciences. 2018, 7(1); 1–13. doi: 10.3329/jujbs.v7i1.37967.
22. Rahman, M., Plant diversity in Hazarikhil Wildlife Sanctuary of Chittagong and its conservation management, Journal of Biodiversity Conservation and Bioresource Management. 2018, 3(2); 43–56. doi: 10.3329/jbcbm.v3i2.36027.
23. Rahman, M.L., Hossain, M.K., Karim, Q.M.N., Diversity and composition of tree species in Chunati Wildlife Sanctuary of Chittagong Forest Division, Bangladesh, The Chittagong Univ. J. Sci. 2000, 24(1); 89-97.
24. Varghese, A.O., Menon, A.R.R., Assessments of ecosystem and ecological levels of biodiversity: A case study of peppara wildlife sanctuary, The Malaysian Forester. 1998, 60(4); 249-262.
25. Sodhi, N.S., Koh, L.P., Brook, B.W. et al., Southeast Asian biodiversity: an impending disaster, Trends in Ecology and Evaluation. 2004, 19(12); 654–660.
26. Appanah, S., Ratnam, L., The importance of forest biodiversity to developing countries in Asia, Journal of Tropical Forest Science. 1992, 5(2); 201-215.
27. Rahman, M.R., Causes of Biodiversity Depletion in Bangladesh and Their Consequences on Ecosystem Services, American Journal of Environmental Protection. 2015, 4(5); 214-236.
28. Dey T.K., Useful Plants of Bangladesh (in Bengali), 2nd revised edition. Aligarh Library, Dhaka, Bangladesh, 2006, pp 945-949.
29. Cox, R.L., Underwood, E.C., The Importance of Conserving Biodiversity Outside of Protected Areas in Mediterranean Ecosystems, PLOS ONE. 2011, 6(1); e14508. doi:10.1371/journal.pone.0014508
30. BBS (Bangladesh Bureau of Statistics), Bangladesh Population and housing census 2011. Zila report: Sylhet. Ministry of Planning, Bangladesh. 2015, pp 486. ISBN-978-984-33-8642-7.
31. Sarker, S., 2007. Assessment of tree diversity of Khadimnagar National Park, Sylhet. A dissertation submitted for the partial fulfillment of the degree of professional B.Sc. in Forestry, Dept. of FES, SUST, Sylhet-3114.
32. Feroz, S.M., Alam, M.R., Das, P. et al., Community ecology and spatial distribution of trees in a tropical wet evergreen forest in Kaptai national park in Chittagong Hill Tracts, Bangladesh, Journal of Forestry Research. 2014, 25(2); 311–318. doi: 10.1007/s11676-013-0423-0.
33. Alamgir, M., Al-amin, M., Plant diversity and their distribution pattern at strategically selected conserved forests of Banskhal, Chittagong, Journal of Forestry and Environment. 2005, 3; 69-75.
34. Nur, A., Nandi, R., Jashimuddin, M. et al., Tree Species Composition and Regeneration Status of Shitalpur Forest Beat under Chittagong North Forest Division, Bangladesh, Advances in Ecology. 2016, 2016; 1-7. <https://doi.org/10.1155/2016/5947874>
35. Sobuj, N.A., Rahman, M., Assessment of plant diversity in Khadimnagar National Park of Bangladesh, International Journal of Environmental Sciences. 2011, 2(1); 79–91.
36. Prakash, O., Kumar, R., Mishra, A. et al., Artocarpus heterophyllus (Jackfruit): An Overview, Pharmacognosy Reviews. 2009, 3(6); 353-358.
37. Nath, T.K., Hossain, M.K., Alam, M.K., Assessment of tree species diversity of Sitapahar Forest reserve, Chittagong Hill Tracts (South) Forest Division, Bangladesh, Indian Forester. 2000, 126(1); 16-21.

38. Pande, P.K., Negi, J.D.S., Sharma, S.C., Species diversity turn-over and resources apportionment among various plant species in a Western-Himalayan forest, Indian forester. 2000, 126(7); 727-740.
39. Nath T.K., 1995. Assessment and Monitoring of Tree Species Diversity of Sitapahar Forest reserve in Chittagong Hill Tracts (South) Forest Division. Review Paper No.255. Institute of Forestry, University of Chittagong.
40. Hossain, E., Chowdhury, M.M., Iqbal, K.F., A survey on the faunal diversity of Savar Upazila, Dhaka, Bangladesh, Pakistan Journal of Biological Sciences : PJBS. 2008, 11(3); 373-379. DOI: 10.3923/pjbs.2008.373.379
41. Islam, M., Islam, M., Sweet, N. et al., Assessment of Aquatic Faunal Diversity in the Ratargul Swamp Forest at Sylhet in Bangladesh, Journal of Environmental Science and Natural Resources. 2017, 9(2); 51-64. <https://doi.org/10.3329/jesnr.v9i2.32158>
42. Hasan, M.K., Aziz, M.A., Alam, S.M.R. et al., Distribution of Rhesus Macaques (*Macaca mulatta*) in Bangladesh: Inter-population Variation in Group Size and Composition, Primate Conservation. 2013, 26(1); 125-132.
43. IUCN Bangladesh, 2000. Red Book of Threatened Mammals of Bangladesh. The World Conservation Union, 28pp.
44. Hasan, M.K., Feeroz, M.M., Distribution and status of Long-tailed Macaque (*Macaca fascicularis aurea* I. Geoffroy Saint-Hilaire, 1830) in Bangladesh, Journal of Threatened Taxa. 2010, 2(12); 1342-1344.
45. Khan M.A., Khan M.M.H., Ahmed R., Joarder N.B., Islam M.A., Ameen M., Nishat A., 2000. Red book of threatened birds of Bangladesh. Dhaka: IUCN Bangladesh.
46. Chandrasekhar, S.V.A., Fish fauna of Hyderabad and its environs, Zoos' print journal. 2004, 19(7); 1530-1533.

Supplementary information

Table S1: Name, GPS location and altitude of the studied sacred places

Sl. No.	Name of the sacred place	Latitude	Longitude	Altitude
01	Mazar of Modhushahid (R)	24°53'53.7"	091°51'43.1"	27m
02	Mazar of Chasnipur (R)	24°54'29.5"	091°52'52.5"	38m
03	Mazar of Hafiz Bulbul (R)	24°53'54.6"	091°52'55.0"	22m
04	Mazar of Lal Soiod (R)	24°54'16.9"	091°52'41.2"	35m
05	Mazar of Manikpur (R)	24°54'02.5"	091°52'49.9"	49m
06	Mazar of Shah Amin (R)	24°53'37.9"	091°52'10.0"	21m
07	Mazar of Shahjalal (R)	24°54'07.4"	091°52'07.0"	30m
08	Mazar of Shahporan (R)	24°54'20.3"	091°56'17.2"	20m
09	Sacred grove of Chowdhary Tila	24°54'02.0"	091°51'10.5"	23m
10	Sacred grove of City corporation	24°53'58.4"	091°52'48.6"	34m
11	Sacred grove of Shahjalal Mazar	24°54'05.1"	091°52'07.2"	16m
12	Sacred grove of Shahporan Mazar	24°54'20.0"	091°56'16.1"	24m
13	Kali Mondir	24°54'55.8"	091°50'57.3"	21m
14	Sri Sri Rada Mondir	24°53'56.1"	091°51'28.0"	18m
15	Sri Sri Voirob Mondir	24°53'13.5"	091°52'53.2"	20m
16	Srihotto Bihar Ashrom	24°55'07.7"	091°51'06.1"	23m
17	Nimbark Ashrom	24°53'37.2"	091°52'02.4"	17m
18	Ramkrishno Mishon and Ashrom	24°53'40.3"	091°52'54.4"	10m
19	Moha Shoshan, Chalibondor	24°53'12.0"	091°52'54.2"	21m
20	Moha Shoshan, Sogordigirpar	24°54'15.4"	091°51'33.4"	12m

Table S2: Tree composition of sacred places with families

Sl. No.	Botanical Name	Local Name	Family
1	<i>Acacia auriculiformis</i>	Akashmoni	Leguminosae
2	<i>Acacia mangium</i>	Menjium	Leguminosae
3	<i>Adina sessilifolia</i>	Puma	Rubiaceae
4	<i>Aegle mormelos</i>	Bel	Rutaceae

Sl. No.	Botanical Name	Local Name	Family
5	<i>Albizia procera</i>	Koroi	Leguminosae
6	<i>Albizia richardiana</i>	Raj koroi	Leguminosae
7	<i>Albizia saman</i>	Raintree	Liguminoceae
8	<i>Alstonia scholaris</i>	Chatim	Apocynaceae
9	<i>Anthocephalus chinensis</i>	Kadam	Rubiaceae
10	<i>Aphanamixis polystachya</i>	Pitraj	Meliaceae
11	<i>Aquilaria agallocha</i>	Agor	Thymelaeaceae
12	<i>Areca catechu</i>	Supari	Palmae
13	<i>Artocarpus chaplasha</i>	Chapalish	Moraceae
14	<i>Artocarpus heterophyllus</i>	Kanthal	Moraceae
15	<i>Averrhoa carambola</i>	Kamranga	Oxalidaceae
16	<i>Azadirachta indica</i>	Neem	Meliaceae
17	<i>Bauhinia acuminata</i>	Kanchan	Caesalpinoideae
18	<i>Bombax ceiba</i>	Shimul	Bombacaceae
19	<i>Caesalpinia pulcherrima</i>	Radachura	Caesalpinoideae
20	<i>Cassia fistula</i>	Sonalu	Leguminosae
21	<i>Cinnamomum tamala</i>	Tejpata	Lauraceae
22	<i>Citrus acida</i>	Jambura	Rutaceae
23	<i>Cocos nucifera</i>	Narikel	Palmae/Arecaceae
24	<i>Dalbergia sissoo</i>	Shishu	Papilionaceae
25	<i>Dellinia india</i>	Chalta	Dillaniaceae
26	<i>Delonix regia</i>	Krishnochura	Leguminosae
27	<i>Erythrina indica</i>	Madar	Fabaceae
28	<i>Ficus altissima</i>	Bot	Moraceae
29	<i>Ficus hispida</i>	Dumur	Moraceae
30	<i>Garcinia cowa</i>	Kau	Cuttiferae
31	<i>Litchi chinensis</i>	Litchu	Sapindaceae
32	<i>Litsea monopetala</i>	Menda	Lauraceae
33	<i>Lophopetalum fimbriatam</i>	Raktan	Celastraceae
34	<i>Macaranga denticulata</i>	Borobura	Euphorbiaceae
35	<i>Madhuca indica</i>	Mahua	Magnoliaceae
36	<i>Mangifera indica</i>	Aam	Anacardiaceae
37	<i>Michelia champaca</i>	Champa	Magnoliaceae
38	<i>Mimusops elengi</i>	Bakul	Sapotaceae
39	<i>Moras alba</i>	Tut	Moraceae
40	<i>Moringa olefera</i>	Sajina	Moringaceae
41	<i>Phoenix sylvestris</i>	Khejur	Palmae
42	<i>Phyllanthus embelica</i>	Amloki	Euphorbiaceae
43	<i>Polyalthia longifolia</i>	Debdaru	Annonaceae
44	<i>Psidium guajava</i>	Peyara	Nyrtaceae
45	<i>Spondias pinnata</i>	Amra	Anacardiaceae
46	<i>Streblus asper</i>	Sheora	Urticaceae
47	<i>Swietenia mahagoni</i>	Mahagony	Meliaceae
48	<i>Syzygium fruticosum</i>	Jam	Myrtaceae
49	<i>Tamarindus indica</i>	Tetul	Leguminosae
50	<i>Terminalia arjuna</i>	Arjun	Compretaceae
51	<i>Terminalia belerica</i>	Bohera	Compretaceae
52	<i>Trewia polycarpa</i>	Medda	Euphorbiaceae
53	<i>Ziziphus jujuba</i>	Boroi	Rhamnaceae
54	Unidentified 1	-	-
55	Unidentified 2	-	-

Table S3: Quantitative structure of tree species of sacred places

Botanical name	D	F	A	RD %	RF %	RDo %	IVI
<i>Acacia auriculiformis</i>	0.43	12.5	3.40	3.21	1.52	1.87	6.59
<i>Acacia mangium</i>	0.28	7.5	3.67	2.08	0.91	0.86	3.84
<i>Adina sessilifolia</i>	0.23	10.0	2.25	1.70	1.21	1.33	4.24
<i>Aegle mormelos</i>	0.40	22.5	1.78	3.02	2.73	2.15	7.89
<i>Albizia procera</i>	0.35	27.5	1.27	2.64	3.33	2.88	8.85
<i>Albizia richardiana</i>	0.18	15.0	1.17	1.32	1.82	1.03	4.17
<i>Albizia saman</i>	0.45	35.0	1.29	3.40	4.24	10.03	17.67
<i>Alstonia scholaris</i>	0.25	15.0	1.67	1.89	1.82	1.58	5.29
<i>Anthocephalus chinensis</i>	0.25	12.5	2.00	1.89	1.52	1.64	5.04
<i>Aphanamixis polystachya</i>	0.33	30.0	1.08	2.45	3.64	3.10	9.19
<i>Aquilaria agallocha</i>	0.18	7.5	2.33	1.32	0.91	0.14	2.37
<i>Areca catechu</i>	0.28	15.0	1.83	2.08	1.82	0.51	4.41
<i>Artocarpus chaplasha</i>	0.30	17.5	1.71	2.26	2.12	2.10	6.49
<i>Artocarpus heterophyllus</i>	0.68	42.5	1.59	5.09	5.15	9.72	19.97
<i>Averrhoa carambola</i>	0.23	17.5	1.29	1.70	2.12	0.37	4.19
<i>Azadirachta indica</i>	0.53	35.0	1.50	3.96	4.24	2.40	10.61
<i>Bauhinia acuminata</i>	0.08	5.0	1.50	0.57	0.61	0.30	1.47
<i>Bombax ceiba</i>	0.18	10.0	1.75	1.32	1.21	1.11	3.64
<i>Caesalpinia pulcherrima</i>	0.03	2.5	1.00	0.19	0.30	0.20	0.69
<i>Cassia fistula</i>	0.10	7.5	1.33	0.75	0.91	0.50	2.16
<i>Cinnamomum tamala</i>	0.03	2.5	1.00	0.19	0.30	0.05	0.54
<i>Citrus acida</i>	0.30	20.0	1.50	2.26	2.42	1.40	6.09
<i>Cocos nucifera</i>	0.60	32.5	1.85	4.53	3.94	4.49	12.96
<i>Dalbergia sissoo</i>	0.38	22.5	1.67	2.83	2.73	2.29	7.85
<i>Dellinia indica</i>	0.15	10.0	1.50	1.13	1.21	0.40	2.74
<i>Delonix regia</i>	0.48	32.5	1.46	3.58	3.94	3.56	11.08
<i>Erythrina indica</i>	0.35	15.0	2.33	2.64	1.82	2.10	6.56
<i>Ficus altissima</i>	0.43	35.0	1.21	3.21	4.24	11.33	18.78
<i>Ficus hispida</i>	0.33	25.0	1.30	2.45	3.03	1.98	7.47
<i>Garcinia cowa</i>	0.20	17.5	1.14	1.51	2.12	0.55	4.18
<i>Litchi chinensis</i>	0.28	12.5	2.20	2.08	1.52	2.09	5.68
<i>Litsea monopetala</i>	0.05	2.5	2.00	0.38	0.30	0.48	1.16
<i>Lophopetalum fimbriatam</i>	0.08	5.0	1.50	0.57	0.61	0.62	1.79
<i>Macaranga denticulata</i>	0.03	2.5	1.00	0.19	0.30	0.24	0.73
<i>Madhuca indica</i>	0.08	5.0	1.50	0.57	0.61	0.62	1.79
<i>Mangifera indica</i>	0.33	17.5	1.86	2.45	2.12	3.56	8.13
<i>Michelia champaca</i>	0.25	12.5	2.00	1.89	1.52	1.03	4.43
<i>Mimusops elengi</i>	0.23	10.0	2.25	1.70	1.21	1.33	4.24
<i>Moras alba</i>	0.20	12.5	1.60	1.51	1.52	0.50	3.53
<i>Moringa oleifera</i>	0.18	7.5	2.33	1.32	0.91	0.77	3.00
<i>Phoenix sylvestris</i>	0.58	40.0	1.44	4.34	4.85	5.18	14.37
<i>Phyllanthus embelica</i>	0.20	17.5	1.14	1.51	2.12	1.03	4.66

Botanical name	D	F	A	RD %	RF %	RDo %	IVI
<i>Polyalthia longifolia</i>	0.15	7.5	2.00	1.13	0.91	0.17	2.21
<i>Santalum album</i>	0.13	10.0	1.25	0.94	1.21	1.06	3.22
<i>Psidium guajava</i>	0.18	10.0	1.75	1.32	1.21	0.22	2.75
<i>Spondias pinnata</i>	0.08	7.5	1.00	0.57	0.91	0.40	1.88
<i>Streblus asper</i>	0.10	5.0	2.00	0.75	0.61	0.27	1.63
<i>Swietenia mahagoni</i>	0.15	10.0	1.50	1.13	1.21	1.14	3.49
<i>Syzygium fruticosum</i>	0.20	12.5	1.60	1.51	1.52	1.75	4.77
<i>Tamarindus indica</i>	0.23	10.0	2.25	1.70	1.21	2.21	5.12
<i>Terminalia arjuna</i>	0.28	20.0	1.38	2.08	2.42	1.71	6.21
<i>Terminalia belerica</i>	0.13	7.5	1.67	0.94	0.91	0.06	1.91
<i>Trewia polycarpa</i>	0.05	2.5	2.00	0.38	0.30	0.38	1.06
<i>Zizyphus jujube</i>	0.18	12.5	1.40	1.32	1.52	0.77	3.60
Unidentified 1	0.08	5.0	1.50	0.57	0.61	0.46	1.63
Unidentified 2	0.13	10.0	1.25	0.94	1.21	1.06	3.22

Note: D= Density, F= Frequency, A= Abundance, RD= Relative Density, RF= relative frequencies, RDo= Relative Dominance and IVI= Importance value Index.

Table S4: List of shrubs found in the sacred places

Sl. No.	Botanical name	Local name	Family
1	<i>Abroma augusta</i>	Ulatkombol	Sterculiaceae
2	<i>Acalypha wilkesiana</i>	Patabahar	Euphorbiaceae
3	<i>Adhatoda vasica</i>	Bashok	Acanthaceae
4	<i>Cajanus cajan</i>	Arohor	Fabaceae
5	<i>Calotropis gigantea</i>	Akand	Asclepiadaceae
6	<i>Cestrum Nocturnum</i>	Hasnahena	Solanaceae
7	<i>Citrus hystrix</i>	Satkora	Rutaceae
8	<i>Clerodendrum enerve</i>	Vat	Verbenaceae
9	<i>Dalbergia spinosa</i>	Anonto kata	Papilionaceae
10	<i>Datura metel</i>	Dutura	Solanaceae
11	<i>Dracaena spicata</i>	Dressina	Liliaceae
12	<i>Duranta repens</i>	Katamehedi	Verbenaceae
13	<i>Eupatorium odoratum</i>	Asamlata	Compositae
14	<i>Gardenia jesminoides</i>	Gandharaj	Rubiaceae
15	<i>Hibiscus rosa-sinensis</i>	Joba	Malvaceae
16	<i>Ixora lutea</i>	Halud Ronggon	Rubiaceae
17	<i>Jasminum sambac</i>	Bely	Oliaceae
18	<i>Kalanchoe pinnata</i>	Patharcuchi	Crassulaceae
19	<i>Lantana camara</i>	Lantana	Verbenaceae
20	<i>Lawsonia inermis</i>	Mehedi	Lythraceae
21	<i>Melastoma melabatricum</i>	Bontejpata	Melastomaceae
22	<i>Murraya paniculata</i>	Kamini	Rutaceae

Sl. No.	Botanical name	Local name	Family
23	<i>Nyctanthes arbortristis</i>	Sheuli	Oliaceae
24	<i>Ocimum tenuiflorum</i>	Tulsi	Lamiaceae
25	<i>Quisqualis indica</i>	Madhumalati	Combretaceae
26	<i>Sesamum indicum</i>	Til	Pedaliaceae
27	<i>Solanum indicum</i>	Bonbegun	Solanaceae
28	<i>Urena lobata</i>	Bonukra	Malvaceae
29	<i>Vitex negunda</i>	Nishinda	Verbenaceae
30	Unidentified 1	-	-

Table S5: Quantitative structure of shrubs in sacred places

Botanical name	Total No. of individuals in all plots	Total No. of plots in which it occurred	D	RD	F	RF	A
<i>Acalypha wilkesiana</i>	47	21	0.59	7.64	26.25	8.57	2.24
<i>Cajanus cajan</i>	13	3	0.16	2.11	3.75	1.22	4.33
<i>Citrus hystrix</i>	1	1	0.01	0.16	1.25	0.41	1.00
<i>Duranta repens</i>	209	17	2.61	33.98	21.25	6.94	12.29
<i>Dalbergia spinosa</i>	3	3	0.04	0.49	3.75	1.22	1.00
<i>Ocimum tenuiflorum</i>	37	12	0.46	6.02	15.00	4.90	3.08
<i>Quisqualis indica</i>	1	1	0.01	0.16	1.25	0.41	1.00
<i>Sesamum indicum</i>	36	6	0.45	5.85	7.50	2.45	6.00
<i>Solanum indicum</i>	37	4	0.46	6.02	5.00	1.63	9.25

Note: D= Density, F= Frequency, A= Abundance, RD= Relative Density, RF= relative frequencies.

Table S6: List of herbs and grasses found in the sacred places

Sl. No.	Botanical name	Local name	Family
1	<i>Alocasia indica</i>	Mankachu	Araceae
2	<i>Asparagus recemosus</i>	Satamuli	Liliaceae
3	<i>Bambusa spp.</i>	Bans	Graminae
4	<i>Centella asiatica</i>	Thankoni	Umbelliferae
5	<i>Colocasia esculenta</i>	Kochu	Araceae
6	<i>Cymbopogon citratus</i>	Lemon grass	Graminae
7	<i>Cynodon dactylon</i>	Durba Grass	Graminae
8	<i>Derris trifoliata</i>	Pan lota	Papilionaceae
9	<i>Dioscorea bulbifera</i>	Bon alo	Dioscoreaceae
10	<i>Erythraea roxburghii</i>	Gima	Gentianeae
11	<i>Imperata cylindrica</i>	Sungrass	Graminae
12	<i>Ipomoea batatas</i>	Misti alo	Convolvulaceae
13	<i>Ipomoea fistulosa</i>	Dolkolmi	Convolvulaceae
14	<i>Mikania cordata</i>	Asham lota	Compositae
15	<i>Mimosa pudica</i>	Lojjaboti	Leguminosae
16	<i>Musa sapientum</i>	Kola	Musaceae
17	<i>Pisum sativum</i>	Motor	Leguminosae
18	Unidentified 1	-	-
19	Unidentified 2	-	-

Table S7: Quantitative structure of herbs and grasses in sacred places

Botanical name	Total No. of individuals in all plots	Total No. of plots in which it occurred	D	RD	F	RF	A
<i>Bambusa spp.</i>	43	23	0.54	3.01	28.75	13.53	1.87
<i>Centella asiatica</i>	210	17	2.63	14.69	21.25	10.00	12.35
<i>Cynodon dactylon</i>	708	31	8.85	49.51	38.75	18.24	22.84
<i>Cymbopogon citratus</i>	9	1	0.11	0.63	1.25	0.59	9.00
<i>Dioscorea bulbifera</i>	4	4	0.05	0.28	5.00	2.35	1.00
<i>Imperata cylindrica</i>	14	1	0.18	0.98	1.25	0.59	14.00
<i>Mimosa pudica</i>	213	16	2.66	14.90	20.00	9.41	13.31
<i>Musa sapientum</i>	7	5	0.09	0.49	6.25	2.94	1.40
<i>Pisum sativum</i>	37	2	0.46	2.59	2.50	1.18	18.50

Note: D= Density, F= Frequency, A= Abundance, RD= Relative Density, RF= relative frequencies.

Table S8: List of faunal species found in the sacred places

Sl. No.	Scientific name	Species name	Class ¹	Availability ²	Spiritual beliefs or Myths ³	Community ⁴	Places ⁵
1	<i>Acridotheres tristis</i>	Indian myna	A	**	N	Mu	M
2	<i>Anabas testudineus</i>	Climbing perch	Ac	**	N	Mu, Hi	M, A
3	<i>Anas poecilorhyncha</i>	Duck	A	**	N	Mu, Hi	M, A
4	<i>Bos indicus</i>	Cow	M	***	Y	Mu, Hi	Sg, T
5	<i>Callosciurus pygerythrus</i>	Squirrel	M	***	N	Mu, Hi	M, T, Sg, Ms, A
6	<i>Canis aureus</i>	Jackal	M	***	N	Mu, Hi	Sg, T, Ms
7	<i>Canis familiaris</i>	Dog	M	***	N	Mu, Hi	M, Sg, T, Ms
8	<i>Capra aegagrus hircus</i>	Goat	M	***	N	Mu, Hi	M, Sg, Ms
9	<i>Carassius auratus</i>	Gold fish	Ac	*	N	Mu	M
10	<i>Casmerodius albus</i>	Heron	A	**	N	Mu, Hi	M, Ms
11	<i>Channa marulius</i>	Snakehead	Ac	***	Y	Mu	M
12	<i>Channa striata</i>	Snakehead murrel	Ac	***	N	Mu, Hi	M, A
13	<i>Chitala chitala</i>	Knife fish	Ac	**	N	Mu	M
14	<i>Clarias batrachus</i>	Walking catfish	Ac	***	N	Mu, Hi	M, A
15	<i>Columba livia</i>	Rock pigeon	A	***	Y	Mu	M
16	<i>Copsychus saularis</i>	Oriental magpie-robin	A	*	N	Mu, Hi	Sg, T
17	<i>Corvus macrorhynchos</i>	Large-billed crow	A	***	N	Mu, Hi	Sg, T,
18	<i>Corvus splendens</i>	Crow	A	**	N	Mu, Hi	M, Sg, Ms, T
19	<i>Dicrurus macrocercus</i>	Black Drongo	A	**	N	Mu, Hi	Sg, T
20	<i>Duttaphrynus melanostictus</i>	Asian common toad	Am	***	N	Mu, Hi	M, Sg, T, Ms
21	<i>Eudynamys scolopacea</i>	Cuckoo	A	***	N	Mu, Hi	M, T, Sg, Ms
22	<i>Euphlyctis cyanophlyctis</i>	Skipper frog	Am	**	N	Mu, Hi	M, Sg, T, Ms
23	<i>Felis catus</i>	Cat	M	**	N	Mu, Hi	M, T, A, Ms
24	<i>Gracula religiosa</i>	Common hill myna	A	***	N	Mu	M
25	<i>Grus antigone</i>	Crane	A	**	N	Mu, Hi	M, A

Sl. No.	Scientific name	Species name	Class ¹	Availability ²	Spiritual beliefs or Myths ³	Community ⁴	Places ⁵
26	<i>Haliaeetus leucoryphus</i>	Eagle	A	*	N	Mu, Hi	Sg, T
27	<i>Herpestes edwardsii</i>	Indian grey mongoose	M	***	N	Mu	Sg
28	<i>Heteropneustes microps</i>	Airsac catfish	Ac	**	N	Mu, Hi	M, A
29	<i>Lepus nigricollis</i>	Rabbit	M	*	N	Mu	M
30	<i>Macaca mulatta</i>	Rhesus macaque	M	*	Y	Mu, Hi	M, T
31	<i>Milvus migrans</i>	Hawk	A	***	N	Mu, Hi	M, Sg, Ms
32	<i>Oreochromis niloticus</i>	Nile tilapia	Ac	**	N	Mu, Hi	M, A
33	<i>Orthotomus sutorius</i>	Common tailor bird	A	***	N	Hi	T
34	<i>Pangasius pangasius</i>	Yellowtail catfish	Ac	**	N	Mu	M
35	<i>Passer domesticus</i>	House Sparrow	A	**	N	Mu, Hi	M, Sg, T, A
36	<i>Polypedates leucomatsyx</i>	Asian Brown Tree Frog	Am	**	N	Mu, Hi	M, Sg, T, Ms
37	<i>Psittacula krameri</i>	Roseringed parakeet	A	**	N	Mu, Hi	M, T
38	<i>Psittacula krameri</i>	Roseringed parakeet	A	**	N	Mu, Hi	M, T
39	<i>Pteropus giganteus</i>	Bat	M	***	N	Mu, Hi	M, Sg, T
40	<i>Pycnonotus cafer</i>	Bulbul	A	**	N	Mu, Hi	Sg, T, M
41	<i>Spilopelia chinensis</i>	Spotted dove	A	**	N	Mu, Hi	M, Sg, T, Ms
42	<i>Systomus sarana</i>	Barb fish	Ac	**	N	Mu, Hi	M, A
43	<i>Tyto alba</i>	Barn owl	A	*	N	Mu	M
44	<i>Xenochrophis piscator</i>	Checkered keelback	R	**	N	Mu, Hi	M, Sg, T

Note: ¹Class, M=Mammal, A= Aves, R= Reptiles, Am= Amphibians, Ac= Actinopterygii (fish); ²Availability was measured based on respondents opinion, ‘*’= low availability, ‘**’= medium availability, ‘***’= high availability; ³Spiritual beliefs or Myths, ‘Y’= yes, ‘N’= no; ⁴Community, Hi= Hindu, Mu=Muslim; ⁵Places, A= Ashrom, M= Mazar, Ms= Moha Shoshan, Sg= Sacred grove.