

**Biodiversity and community
perception survey of Kadamb Khandi,
Sunehra, Rajasthan**

Submitted by

Ishani Datta

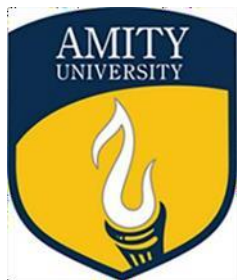


Biodiversity and community perception survey of Kadamb Khandi, Rajasthan



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Abstract

Sacred groves are patches of pristine forest with rich diversity, which have been protected by the local people for centuries for their cultural and religious beliefs and taboos that the deities reside in them and protect the villagers. Every sacred grove carries its own legends and myths which form an integral part of the belief system. This study is the first of its kind for Sunehra Kadam Khandi, in the Bharatpur region of Rajasthan. A biodiversity assessment and community perception study were conducted as part of the project. Respondents from three nearby villages Nagla Harsukh, Nagla Harnarayan, and Kanwara were part of the survey to understand the history, belief system and challenges with respect to the conservation of the grove. Regarding the faunal component, the sacred grove's species diversity as well as relative abundance was assessed. A wide range of families belonging to different genera were observed, 5 species of mammals, 51 species of birds, 3 species of reptiles and 6 species of butterflies were recorded in the grove during the course of the 14 transects. The villagers' worries regarding invasive species and the declining biodiversity were recorded in this study as well as their suggestions for the protection of the grove. The findings of the study can form a baseline for more intensive studies and also strengthen the appeal for the grove's legal protection.

Keywords: Sacred grove, biodiversity, assessment, community perception, Kadamb Khandi

Introduction

Sacred groves

Sacred groves are areas of land with vegetation and wildlife that are protected by human societies in the belief that preserving them expresses a significant relationship to the divine beings present in nature. Different cultures have distinct perspectives on this relationship and thus have different norms of behaviour (often taboos) in regard to the sacred place and its constituents (Malhotra, 2007).

This informal network of nature reserves is critical to the preservation of tree diversity. A comparison of sacred groves and formal reserves revealed that sacred groves contain a greater diversity of medicinal plants and more vigorous tree regeneration than formal reserves (Bhagwat et. al., 2005). Furthermore, sacred groves contain a greater variety of tree species than regular reserves. As the Indian countryside faces increasing strain, sacred groves have become areas of semi-natural forest in an otherwise farmed landscape. Biological research has been limited to biodiversity studies conducted within sacred-grove patches. However, the impact of human-modified landscapes surrounding sacred groves on species richness is rarely investigated (Bhagwat et. al., 2005).

In the physical sense, it is forest land, but in terms of culture, it is associated with deities, rituals, and taboos. Sacred groves are an essential link between modern society and the past in terms of biodiversity, culture, religious legacy, and ethnic heritage. In modern culture, several endogamous populations practise various forms of nature worship. Numerous indigenous communities in our nation practise nature worship in accordance with their unique ethnic customs, on the grounds that all natural creations must be preserved (Khan et.al., 2008).

Over 100,000 groves are estimated to exist in India , but they are vanishing owing to cultural change and pressure to exploit natural resources within the groves (Ormsby, 2011). The names of sacred groves vary according to location and language in India.

Groves vary in size from small plots of less than 1 hectare to huge swaths of land covering hundreds of hectares (Ormsby, 2011). Sacred groves are thought to be "as old as civilization itself," having emerged during the formation of religion. Early people believed that deities lived in stones, trees, animals, and woods at the dawn of religious thought. This animism appears to be a statement of gratitude and respect for nature's contributions to human society in the form of products and services (Deb, 2007).

Since Independence, the taboos surrounding sacred groves have been fading. Deadwood and leaf litter removal has become standard practice in many sacred grove settings. In some cases, it appears that villagers rely on sacred groves for fuel. However, most groves still prohibit the removal of live wood and resources from being carried out of the groves (Borthakur, 2013). A variety of factors contribute to the destruction of sacred groves. The so-called belief system is crucial. Traditional indigenous beliefs and ceremonies are decreasingly valued by younger people in indigenous communities. They frequently find it difficult to believe in folk deities, ancestral spirits, and tree spirits. Being educated and modern entails appreciating sacred groves for their monetary value rather than their cultural, religious, or ecological significance. The younger generation, for example, wishes to sell sacred grove timber in order to fully utilise what they believe they have historically owned. The allure of short-term economic gain, including sacred groves, is thus posing a severe danger to the natural resource base (Borthakur, 2013). Traditional values eroding is the most serious threat to sacred groves. It is extremely difficult to protect these areas without government intervention without such ideas. The traditional communities that rely on these groves will lose some of their rights if they are protected with government assistance. Local people have repeatedly lost their traditional forest management rights to the government over the last few decades. Sacred groves are eventually destroyed for development purposes or encroached upon by people when this occurs. There are many sacred groves near temples or other religious sites. Tourism and other activities, such as pilgrimages, have a negative impact on these groves (Borthakur, 2013).

Biodiversity assessment

When evaluating a region's biodiversity, experts consider species richness (the number of distinct species present) and relative abundance (the number of organisms each species has). A balanced ecology is one that has an appropriate number of producers, decomposers, predators, and prey to maintain a stable food web. That web can easily fall apart when the system is off balance. However, when biodiversity levels are balanced, the ecosystem can be strengthened to withstand stresses like climate change and invading species(<https://serc.si.edu/research/research-topics/biodiversityconservation/biodiversity-assessment>).

Sustainable development policies must assess the state and trends of biodiversity at all levels, from the village to the nation to the region. Biodiversity is essential for human and environmental health. Ecological communities sustain the ecological and evolutionary processes that support life. These are critical for preserving species diversity, regulating climate, renewing soil, and maintaining the world's chemical equilibrium. All animals, plants, and other species have intrinsic value. They supply food, raw materials, medicines, recreational resources, and a wide range of other commodities and services worth billions of dollars each year (IUCN, 2000). They also provide all biological resources. Crop types, livestock breeds, and their wild cousins' genetic stocks supply crucial qualities for raising and improving agricultural output as well as the advancement of biotechnologies. To make sure that actions carry out plans and policies and accomplish goals, assessment is important. Reports help with better decision making and efficient action when assessment is a frequent component of the planning and action cycle (IUCN, 2000).

Community perception

A fundamental element and method in wildlife conservation is understanding how people feel and perceive it. The local population's attitudes and perception of the ideas and tactics proposed by conservation organisations are key factors in the success of animal conservation (Ebua, et.al., 2011). Relationships between unprotected areas and adjacent communities, as well as communities' attitudes, views and perceptions of these areas, are critical for the success of conservation efforts. It is important for area managers and administrators to understand how local communities view these areas and their management, so that they can build sustainable working relationships (Angwenyi, et al., 2021).

This study was conducted to provide a preliminary biodiversity assessment of the Kadamb Khandi in Barsana, Rajasthan and understand the community perceptions of the surrounding villagers with respect to the grove and its uses as well as conservation needs. This particular grove has had no prior papers published about its biodiversity and hence very little information is available in this respect. Therefore, it can form a baseline for more intensive studies in the future as well as to support the appeal for its legal protection.

Aims and objectives

Aim: To survey and understand the status of Sunehra, Kadamb Khandi in Rajasthan.

Objectives:

- To assess the faunal biodiversity of the sacred grove
- To learn the community perception, taboos, and use of resources if any

Materials and methods

Study area

The study has been carried out and coordinated in Kadamb Khandi in the Bharatpur district of Rajasthan and the community perception study was conducted in three of the immediate surrounding villages which participate in protecting the grove which are Nagla Harsukh, Nagla Harnarayan and Kanwara. The grove is estimated to be 200 acres in size and is nestled between two hills with a road running through the middle.

The grove is considered sacred and holy due to the story of the Naga baba who used to preside there. According to the legend, Nagaji baba used to reside here, in the grove. He meditated and performed his rituals in this grove. During his time there, once his hair got entangled in the branches of the trees and he insisted that only Lord Krishna could untangle his hair when people tried to help him. Even after Lord Krishna arrived to help him, Babaji refused to believe that it was Lord Krishna as he was dressed in commoner clothes. He insisted that he should bring along Goddess Radha to prove his identity. After both Lord Krishna and Goddess Radha arrived, he allowed them to untangle his hair. Following which he took samadhi at this very grove. This legend is the main source of reverence towards the grove and the reason why the villagers protect it and consider it to be sacred.

The sacred grove was named Kadamb Khadi due to the numerous Kadamb trees (*Mitragyna parvifolia*) which have however diminished immensely since the naming of the grove. It is a Dry Tropical-Thorn forest with a limited variety of tree species present. There is one main pond in the grove along with multiple other smaller waterholes. There are also many small establishments throughout the grove such as the main temple as well as smaller living quarters for the saints and sadhus living in the grove along with a school near the edge as well.

In Bharatpur, summer lasts from late June until early September. The summer months are June, July, August, and September. August (76.98%) has a highest relative humidity annually and April (26.94%) has the lowest relative humidity. The month with the most

days with rain is July (20.23 days). December had the fewest days with precipitation (0.87 days). This area has a local steppe climate. Throughout the year, there is not much rain. Bharatpur's average temperature is 25.3 °C (77.5 °F). Rainfall totals 698 mm (27.5 inches) per year (<https://en.climate-data.org>).

The villages of Nagla Harnarayan and Nagla Harsukh are situated near the entrance of the sacred grove (towards the north side) and on one side of the hill while Kanwara is a bigger village situated on the other end of the grove (towards the south side). Kanwara is the main presiding village which houses the Gram Panchayat and the Sarpanch under which the grove is protected. The grove is not currently under any governmental or legal protection and is solely protected and taken care of by the 5 surrounding villages. A total of 130 families reside in Nagla Harsukh and Nagla Harnarayan while around 400 households are there in Kanwara.



Figure 1: Screenshot of the Kadam Khandi from Google Earth

Methods

Fourteen transects were laid out throughout the area in order to cover all parts of the grove. Each transect had an average of 6 points at intervals of 60m each with each transect being 360m in total (Figure 2) . 10 days were spent in total at the site to collect the data in the month of July due to time restraints. The coordinates of each point was recorded using Google Earth.

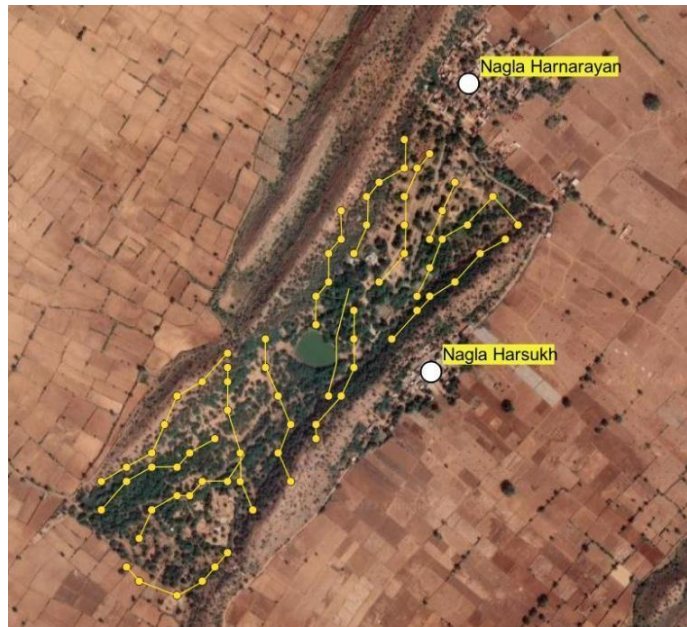


Figure 2: Transects and points laid over the grove as well as Nagla Harsukh and Nagla Harnarayan

Transect-

The transects were walked down once and the mammals and reptiles were registered when encountered, with the species and the abundance being recorded. The visibility distance taken was 20m on either side.

Point count-

A total of 81 points were taken for the point count. At each point the species and their abundance were recorded for a duration of 10 minutes in a radius of 20m. The point count was conducted from 6am-10am every day.

Pollard walk-

Butterfly species composition and relative abundances are sampled using transect counts, modified from Pollard (1977). Butterflies observed within a 5 m band on both sides of a transect were recorded, while walking at a slow and steady pace. The time of observation was between 10 am to 12pm. The same transects were walked.

Sign survey-

It consisted of recording for signs indicating presence of wild animals (such as fresh marks and scats). The same line transects were used for the sign survey. When signs such as scats were found, the signs were recorded with coordinates. The methodology for recording signs (i.e. an indirect detection of a species) was considered for all taxa.

Analytical parameters-

The relative abundance was calculated by using the following formula:

$$= (\text{Abundance of one species} / \text{total abundance of the taxa}) \times 100$$

The data from each transect were examined for diversity indices using Paleontological Statistics (PAST) software version 3.14, which displays several diversity indicators. Utilising PAST software, Fisher Alpha (Species Richness) was computed. This was calculated for both species and family in each taxon.

Correlation was also done between the diversities indices for each taxa (mammals, birds, reptiles and butterflies) as well as the tree diversity using the SPSS software, first a normality test was done using the software to see if the data was normal or not and to decide which correlation test to use. The data was found to be not normally distributed and hence a non -parametric test was used. The Spearman's correlation test was used to determine if there was any correlation between the taxa and tree diversity.

A species accumulation curve was also plotted using Excel for the bird species found throughout the 81 plots surveyed to indicate whether the survey has recorded most of the species in the area.

Questionnaire-

Direct observation and interviewing were used to gather data on the sacred grove's existence, history, socio-religious practices, and ideals. The questionnaire was aimed at collecting information regarding resident's sentiments and sacred grove maintenance in addition to gathering basic demographic data. Individual interviews and focus groups were conducted to collect the required information.

A set questionnaire was used containing questions related to the grove, how its used, its history, its biodiversity and threats. More than 50 people were interviewed from the three villages representing 10% of the population of the three villages. A wide range of ages were represented in the interviewee pool. Semi-structured interviews were conducted in the morning and lasted around 10 to 15 minutes per respondent.



Figure 3: Focus group discussion in Nagla Harnarayan

Results and Discussion

In the survey conducted, 5 species of mammals, 51 species of birds, 3 species of reptiles and 6 species of butterflies were observed in the grove during the course of the 14 transects (Table1).

Table 1: Number of species, genera and families for each taxa recorded in the grove

	No. of species	No. of genera	No. families
Mammals	5	5	5
Birds	51	44	31
Reptiles	3	3	3
Butterflies	6	5	4

Mammals

A total of 5 species were observed that belong to 5 families and 5 genera. The species found were Indian Palm Squirrel (*Funambulus palmarum*), Nilgai (*Boselaphus tragocamelus*), Indian Hare (*Lepus nigricollis*), Indian Jackal (*Canis aureus indicus*) and Rhesus Macaque (*Macaca mulatta*). Squirrels were the most dominant mammal seen in almost every transect. Nilgai was seen only in transects 2,3,4 and 5. Indian hare was only seen in transect 9. Jackals were seen in transect 6 and 11 which were situated at the southern end of the grove. Rhesus Macaques were seen near transect 2 only.

Table 2: Relative abundance of each species in the mammalian taxa

Species	Relative abundance
Indian Palm Squirrel	58.97%
Nilgai	23.07%
Rhesus Macaque	5.12%

Indian Jackal	10.25%
Indian Hare	2.56%

The relative abundance was the highest for Indian Palm Squirrel (58.97%) while the Indian Hare has the lowest relative abundance (2.56%) (Table 2). The species diversity and the family diversity was found the highest in Transect 2 using Fisher Alpha and the lowest in Transect 1 and Transect 7 (Table 3).

Table 3: Fisher's Alpha diversity index for mammals per transect (species wise)

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
FA	0	3.16	1.23	2.62	0.93	0.52	0	0.79	0	0.79	1.59	0	0.52	0.79

Birds

A total of 51 species were observed belonging to 31 families and 44 genera. Yellow-throated Sparrow (*Gymnoris xanthocollis*) was the most abundant bird and was recorded in almost all 81 points. Jungle Babbler (*Turdoides striata*) and Indian Robin (*Copsychus fulicatus*) were the next most abundant bird species seen in the points. Many birds were observed only once throughout the bird counts such as Plain Prinia, Ashy-crowned Sparrow Lark, Common Tailorbird, Yellow-footed Green Pigeon, Brown-headed Barbet, Spotted Owlet, Grey Francolin, Indian Roller, Green Sandpiper, etc. Point 5 in transect 9 showed the maximum number of birds with 41 individuals recorded while a few points had 0 birds observed, especially the ones which were situated at the top of the hills.

Table 4: Relative abundance of each species in the avian taxa

Species	Relative Abundance
Rock Pigeon	5.35%
Green Bee-eater	2.02%
Eurasian Collared-Dove	2.95%
House Crow	0.92%
Indian Robin	9.96%
Asian Pied Starling	0.73%
White-breasted Waterhen	1.84%
Common Myna	3.87%
White-throated Kingfisher	0.55%
Rose-ringed Parakeet	4.79%
House Sparrow	1.84%
Large Gray Babbler	0.92%
White-eared Bulbul	2.95%
Indian Peafowl	7.19%
Jungle Babbler	10.14%
Brahminy Starling	2.21%
Red-vented Bulbul	4.42%

Indian Pond-Heron	2.95%
Oriental Magpie-Robin	2.21%
Yellow-throated Sparrow	16.23%
Purple Sunbird	1.29%

Eurasian Hoopoe	0.73%
Laughing Dove	3.13%
Asian Koel	0.73%
Black Drongo	0.18%
Red-wattled Lapwing	2.76%
Pied Cuckoo	0.55%
Plain Prinia	0.18%
Egyptian Vulture	1.47%
Greater Coucal	0.55%
Shikra	0.36%
Ashy-crowned Sparrow Lark	0.18%
Indian White-Eye	0.18%
Common Woodshrike	0.36%
Common Tailorbird	0.18%
Ashy Prinia	0.36%
Rufous Treepie	0.18%

Yellow-footed Green-Pigeon	0.18%
Brown-headed Barbet	0.18%
Spotted Owlet	0.18%
Coppersmith Barbet	0.36%

Grey Francolin	0.18%
Indian Roller	0.18%
Jungle Crow	0.18%
Baya Weaver	0.18%
Little Grebe	0.55%
Green Sandpiper	0.18%

The relative abundance was the highest for Yellow-throated Sparrow (16.23%) while the birds which were only observed once during the point counts have a relative abundance of 0.18% (Table 4). The species diversity was found the highest in Transect 7 using Fisher Alpha and the lowest in Transect 14 (Table 5). The family diversity was found the highest in Transect 6 using Fisher Alpha and the lowest in Transect 4.

Table 5: Fisher's Alpha diversity index for birds per transect (species wise)

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
FA	8.52	7.06	9.06	6.45	9.22	10.12	13.93	5.77	11.91	8.42	7.72	9.26	7.75	5.44

Butterflies

A total of 6 species were observed that belong to 4 families and 6 genera. The Sind White Arab (*Colotis vestalis vestalis*) was seen the most often in almost all the transects while the Common Grass Yellow (*Eurema hecabe*) was seen the next most often. The Yellow Pansy (*Junonia hierta*) and the Banded Blue Pierrot (*Discolampa ethion*) were only observed once in 1 transect each.

Table 8: Relative abundance of each species in butterflies

Species	Relative Abundance
Sind White Arab	34.14%
Common Grass Yellow	26.82%
Common Tiger Butterfly	17.07%
Yellow Orange Tip	17.07%
Yellow Pansy	2.43%
Blue Pierrot	2.43%

The relative abundance was the highest for Sind White Arab (34.14%) while Yellow Pansy and Banded Blue Pierrot have a relative abundance of 2.43% (Table 8). The family diversity was found the highest in Transect 3 and Transect 9 using Fisher Alpha and the lowest in Transect 13 and Transect 6 (Table 9).

Table 9: Fisher's Alpha diversity index for butterflies per transect (family wise)

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
FA	0.79	0.79	5.45	0.79	1.59	0	0.52	0.52	5.45	1.59	1.59	1.59	0	0.79

Correlation

There was no correlation observed between species diversity indices for birds and reptiles, birds and butterflies, reptiles and mammals, mammals and butterflies or reptiles and butterflies. There was however a negative correlation between mammals and birds. No correlation was observed between the faunal diversity and the tree diversity (Table 10).

Table 10: The Spearman's correlations table given by the SPSS software

Correlations

			Trees	Mammals	Birds	Reptiles	Butterflies
Spearman's rho	Trees	Correlation Coefficient	1.000	-.116	.152	.447	.
		Sig. (2-tailed)	.	.692	.605	.109	.
		N	14	14	14	14	14
	Mammals	Correlation Coefficient	-.116	1.000	-.624*	-.140	.
		Sig. (2-tailed)	.692	.	.017	.633	.
		N	14	14	14	14	14
	Birds	Correlation Coefficient	.152	-.624*	1.000	-.103	.
		Sig. (2-tailed)	.605	.017	.	.726	.
		N	14	14	14	14	14
	Reptiles	Correlation Coefficient	.447	-.140	-.103	1.000	.
		Sig. (2-tailed)	.109	.633	.726	.	.
		N	14	14	14	14	14
	Butterflies	Correlation Coefficient	.	.	.	.	1.000
		Sig. (2-tailed)	.	.	.	.	.
		N	14	14	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

Species Accumulation Curve

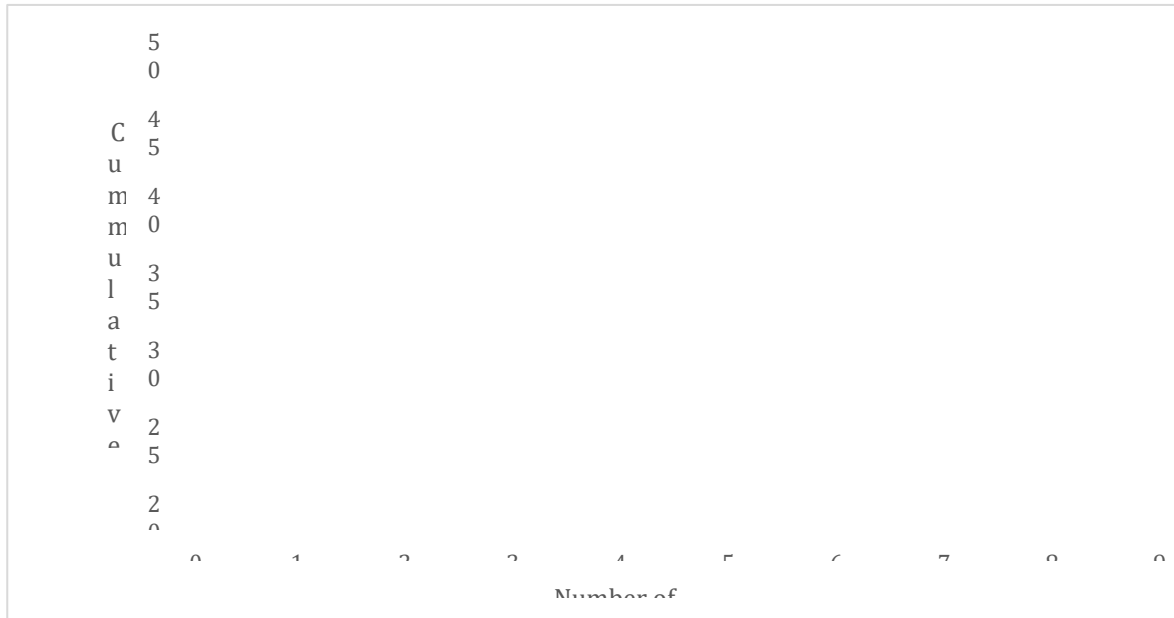


Figure 4: Species Accumulation Curve plotted on MS Excel

The species accumulation curve showed a decrease in new bird species from plot wise to transect wise, however it has not completely plateaued yet (Figure 4).

Community Perception

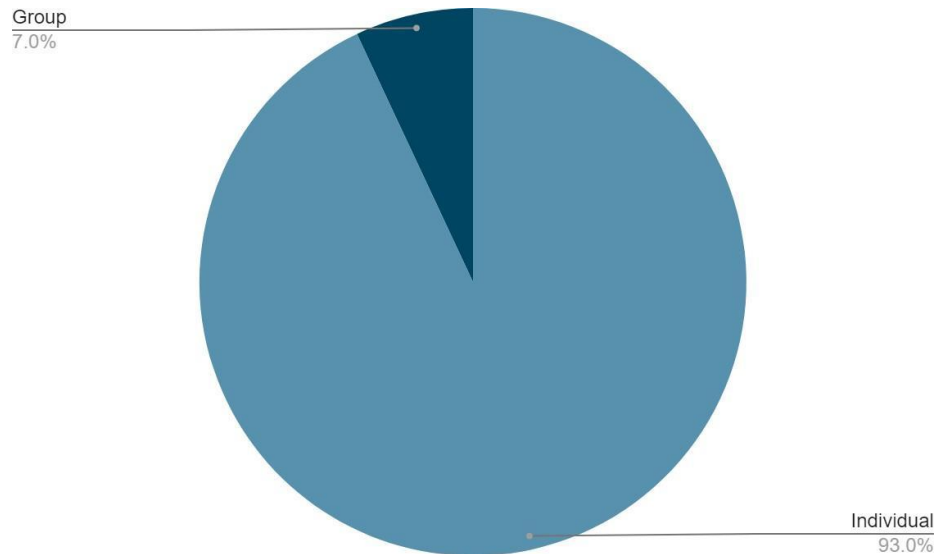


Figure 5: Pie chart of the responses given as individuals and in focus groups

7% of the responses were gathered through focus groups while the other 93% of responses were given individually (Figure 5). A total of 43 interviews were conducted with three interviews consisting of the focus group respondents.

Age distribution

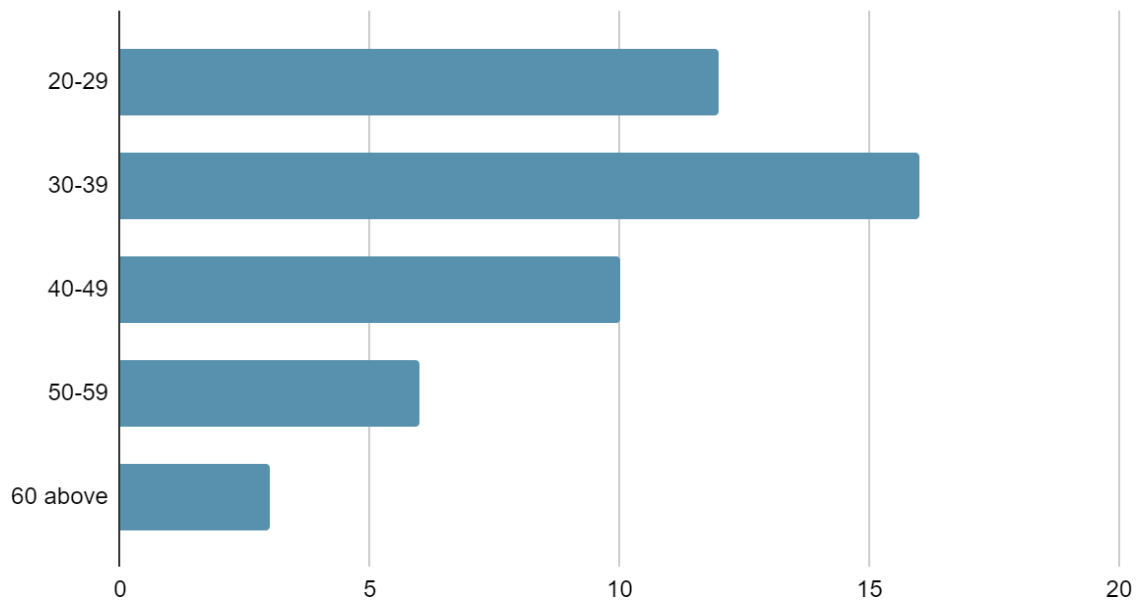


Figure 6: Bar chart of the age distribution of the respondents

The age range varied from 20 to above 60. Majority of the people interviewed were between the 30-40 age group and people above 60 were the least among the respondents (Figure 6).

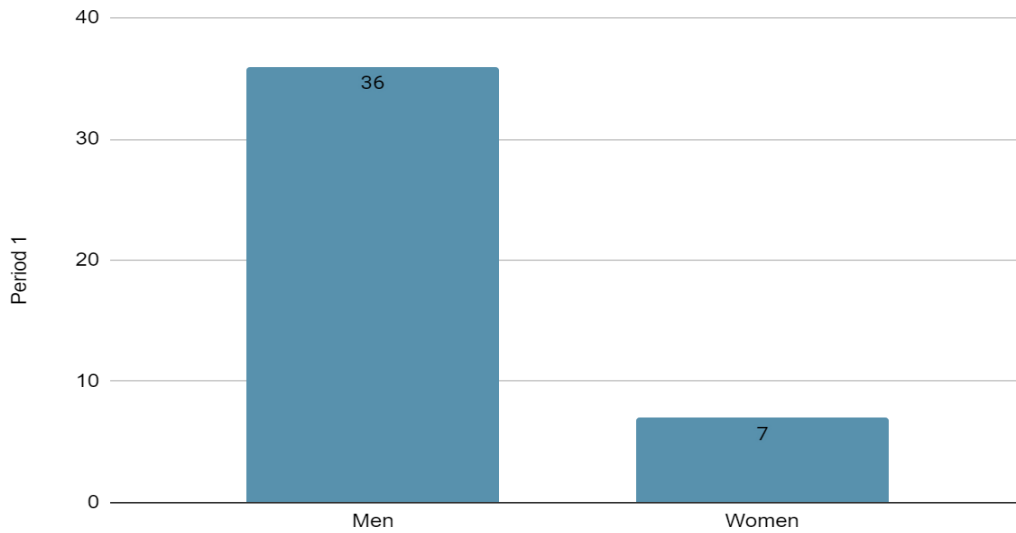


Figure 7: Bar chart of the number of men and women respondents

84% of the interviewees were men while 16% were women, due to the culture and traditions of the area as women were less approachable and open to talking and are usually in the background while the men are the ones expected to do the talking and give information (Figure 7).

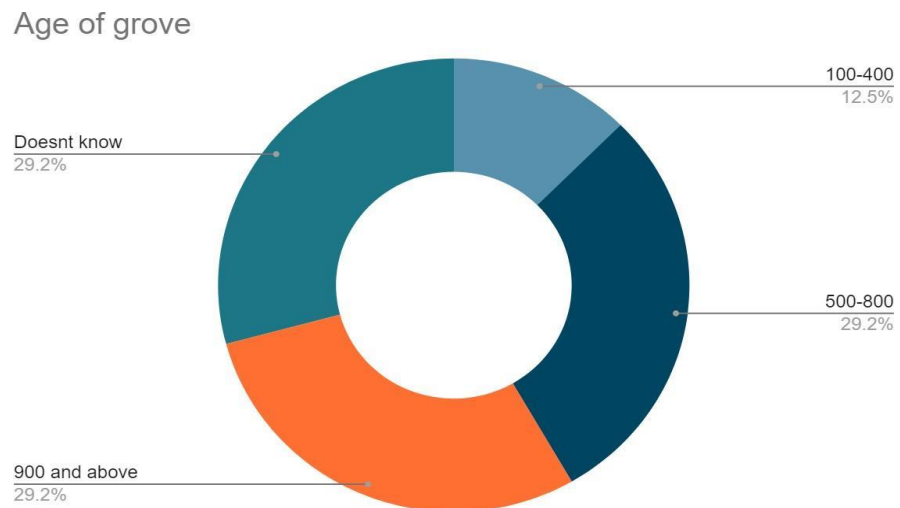


Figure 8: Doughnut chart of the age of the groves given by the respondents

Equal percentage of respondents placed the age of the grove between 500-800 years and above 900 years, and an equal percentage were not aware of this information (Figure 8).

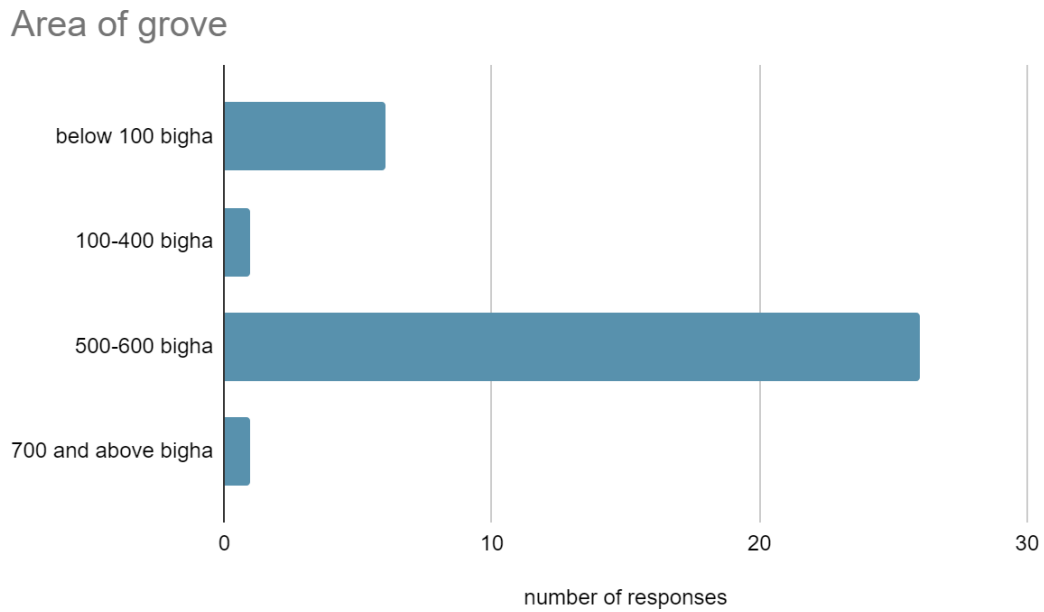


Figure 9: Bar chart of the area of the grove told by the respondents

The majority of respondents stated that the area of the grove was between 500-600 bigha, which is approximately 200-300 acres (Figure 9).

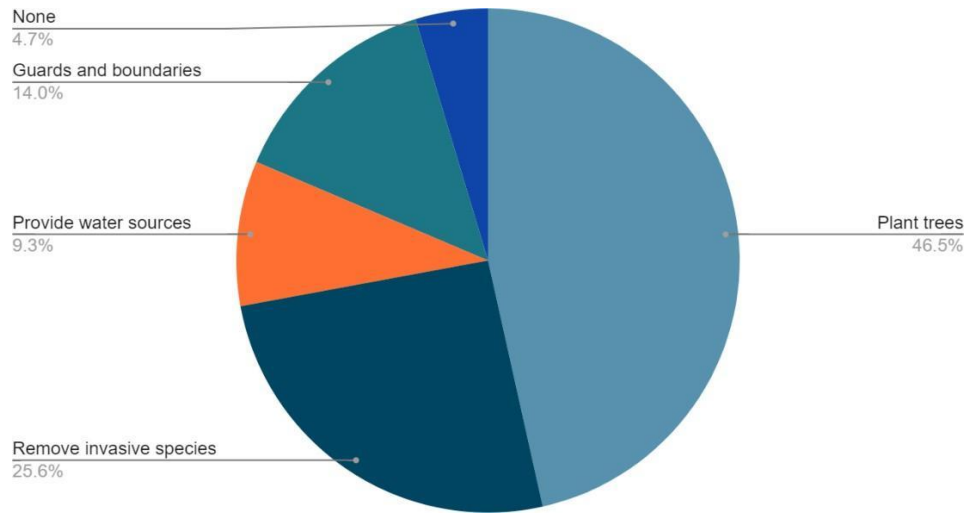


Figure 10: Pie chart comparing the different forms of help wanted by the villagers

When asked what type of help would be appreciated for the grove, the majority leaned towards planting trees and yet 2.7% people also said that no help was needed (Figure 10).

Discussion

The grove supported a wide variety of birds as well as a few different mammals, reptiles and butterfly species. All the transects showed a different diversity for each taxon owing to the location of different transects, for instance the diversity observed at the transect laid in the valley was very different from the transect laid in the hills or near establishments. The hilltops showed the least diversity which may have been due to less trees as well as a harsher climate. Most of the species observed were in the least concerned category according to IUCN and in the Schedule IV of the WPA status. However, the Egyptian Vulture was found to be Endangered in status and the reptiles were found to be near threatened and vulnerable (Appendix Table 1).

Mammals had the least diversity in transect 1 (with birds and butterflies showing relatively low diversity as well) and transect 9 which may be due to the fact that the transects were very close to the village as well as the road. It also had sparser vegetation as compared to the rest of the grove. However, transect 9 showed very high bird diversity and one of the highest butterfly diversities which could be due to the relatively higher tree diversity as well (Anderson, 1974; Bajpai, 2022). Transect 7, 8 and 10 also had low mammalian diversity and butterfly diversity especially in transects 7 and 8 and low bird diversity in transect 8 and 10, which may have been due to the fact that these transects were all on the hilly slopes and as well as the fact that there was low diversity of trees as well in those areas (Abrahamson, 1989; Bajpai, 2022). However transect 7 proved to have the highest bird diversity which may have been due to the proximity to the pond as well as the denseness of the trees present and transect 10 showed higher butterfly diversity as well which may be due to the presence of a few flowering plants on the hills. Transect 13 also had very low diversity of mammals, birds and butterflies which may be due to the presence of very dense thickets obstructing and the pond obs which affected the sighting and it went across the pond however these reasons probably led to the highest reptilian diversity in this transect. Transect 6 also is seen to have low mammalian and butterfly diversity. Jackals were observed only in the area near this transect and the presence of these carnivores may be the reason for the low diversity, as the smaller mammals which are found in the grove,

would try to avoid the predator, and the Nilgais seemed to avoid that area as well. In contrast transect 6 also showed a high diversity index for birds which may be due to the multiple watering holes present as well as dense vegetation. Transect 12 has relatively low mammalian diversity as well which may be due to the presence of multiple small establishments along the transect however it showed high bird and butterfly density perhaps due to the various flowering trees planted by the small establishments seen. Transect 14 showed low diversity for all taxa which may be due to the presence of the school establishment.

Transect 5 had relatively higher diversity in mammals, birds and butterflies which could be attributed to the higher diversity of trees (Abrahamson, 1989; Bajpai, 2022). Transect 3 and 4 also showed quite high diversity indices for mammals and the highest for butterflies in transect 3, as they were in the valley region as well as parts of the hills and had a high tree diversity (Abrahamson, 1989; Bajpai, 2022) which is once again in opposition to the bird diversity, which was seen to be quite low in these transects. Transect 11, despite being on the hilly area, showed high diversity in mammals and butterflies which may be due to the isolation from the human settlements and the few flowering plants yet again low diversity in birds due to the sparse vegetation on the hilltops. Transect 2 showed the highest diversity in mammals, and yet the lowest diversity in birds (relatively low in butterflies as well) however as this transect went past the temple, pond and was slightly uphill it is hard to pinpoint a certain reason though all of them could contribute to the diversity seen. Reptiles were shown to have no diversity in any of the transects except for transect 13. However, the lack of diversity on other transects may also be due to the timings of the survey done as they were all conducted in the morning and no evening surveys were conducted, which is when more reptiles may have been spotted.

The correlation result proved to be interesting due to the negative correlation seen between mammals and birds. The negative correlation indicates that the diversity of mammals and birds are inversely proportional to each other in an area. One reason for this could be the similar resources utilized by both the taxa. As most of the mammals are herbivores, they may deplete the plants that are also needed by the birds for their food as well as shelter purposes hence causing only generalist birds to stay in that area and more specialist birds to look for places with less mammalian diversity. Another interesting observation was that there was no correlation seen between the diversity of trees and the faunal diversity. This may have occurred due to the low amount of data collected or it may also be an indicator that the animals depend more on the shrubs and herbs present instead of the trees. The high amount of *villaiti kikar* (*Prosopis juliflora*) present in every transect may also be a reason for this result.

The species accumulation curve had not plateaued yet, showing that there are more species of birds yet to be observed. However, the number of new species per plot had decreased significantly and new species were being observed per transect instead of per plot by the end of the curve. This curve indicates that if sampling efforts were increased more species may be observed.

When the villagers were questioned about the sacred grove most of their responses were unanimous but some variance within their answers also recorded. Regarding the age of the grove, no one seemed to have a clear idea but a majority stated that it was incredibly old and long and had existed before any villages were established. This could be one of the reasons why there are no official records of the grove's establishment. All the stories around the grove revolve around the aforementioned Naga babaji and his meditations there along with the arrival of Radha and Krishna. It was said that the Naga ji Maharaj left the Kokila forest and came there and did 'Tapasya'. Some people also mentioned believing that the Nagajis body is part of the grove itself and that he has not died. A Heens (*Capparis sepiaria*) tree near the pond is said to be where his spirit resides. A fair is also said to be organized in honor of the Nagaji baba and is considered to be a big event in the grove during the ending of Bhadra which is the month of September.

Majority of the responses regarding the size of the grove confirmed that it is 500 bigha which corresponds to 200 acres. However, it must be emphasized that no actual measuring of the grove had been done and this number was only what the villagers knew through word of mouth. There also happened to be some outliers among the respondents who said that the size of the grove was between 40-100 bigha as well as one person saying 1000 bigha as well. According to the sarpanch, the grove is 70 bigha as written in the records which is contradictory to the response given by a majority of the respondents. The grove was established to be only between the two hills and not on the outer sides of the hills. There was also a general consensus that no area had been reduced or only very little reduction had occurred due to agriculture, but the main area of the grove has remained the same since its beginning.

There were varied responses regarding the difference between the previously seen biodiversity and the present biodiversity of the grove. A few people agreed that there was a reduced number of Kadamb trees in the forest, due to Vilayati kikar (*Prosopis juliflora*) and other competitive trees. Many people were adamant that it had not changed significantly with Siyar (Jackals), Jarakh (Hyenas), Nilgai, wolf and deer among the common large animals mentioned being there and snakes being common. Some also agreed that the abundance of fauna may have decreased from before such as numbers of deers and other large animals being reduced. It was stated by a few villagers that Kadamb (burflower), Dumar (cluster fig), Karir or Kareel (*Capparis decidua*) used to be the main trees but now there are invasive species that have fruit that no animal eats and is thorny and dominates the area. It was also said that bears and hyena were common once. Some of the reasons cited for possible decrease in biodiversity were less rainfall and increasing human population. However, there were mostly a lot of contradictory statements regarding which animals used to be present and which animals are currently present, especially regarding large felines, wolves, and deer. Birds were also said to have decreased with yet more contradictory statements regarding the abundance of peacocks.

Regarding the use of the grove, it was noted that nothing is allowed to be taken from the grove, and that only the sadhus living in the grove were allowed to use the resources of the forest. Some specified that dried and already fallen wood was allowed to be collected but absolutely no fresh/green wood was allowed to be cut and taken. The grove is mostly used for the grazing of livestock which corresponds with most of the sacred groves in Rajasthan where the vegetation is used as grazing ground for the livestock, watering place for the livestock and resting place for the livestock (Pandey et.al, 2017).

The taboos around the grove consist of prohibition to collect wood and indulging in any sort of misconduct such as disrespecting the grove and its rules. Drinking and doing other “indecent” actions are also prohibited inside the grove, even though alcohol bottles were observed in the groves, especially near the edges. Everyone is allowed to enter the grove regardless of caste, religion or gender. Starting a family or constructing a house however is also banned inside the premises of the grove hence only sadhus are allowed to live inside. The villagers believe that the Nagaji baba’s spirit itself or God will punish the wrongdoers if they are found to be acting indecently or with harmful intentions and hence, they do not bother themselves with trying to guard the grove. Fireworks were also mentioned to be banned from the grove due to the possibility of the noise scaring off the wildlife.

When questioned about the help they would want to protect the grove, most of the villagers answered that planting trees would be enough. Many of them mentioned they wanted more fruiting trees while few of them said that the original trees of the sacred grove should be increased again. The main problem was the invasive species of Villaiti kikar, and many of the interviewees wanted them to be removed, either by fully uprooting them or by killing them with chemicals. They believed that many problems would be solved once the invasive species was removed from the area. A water source was also suggested by many respondents due to the inconsistent and sparse rains in the area. Many plants were not able to grow due to the lack of water and hence a consistent water source was seen as a need. Guards and the clear boundary were also advised by a few people as they believed that it would keep the area of the sacred grove safe and protected. A few people did however seem

to think that the grove is fine as it is and does not need any outside help. Some villagers also seemed to be against the thought of too much attention being given to the grove, whether from outsiders or from the government. They did not think that the government could make any good decisions for the welfare of the grove. The Sarpanch from Kanwara also mentioned that there were plans to open a park and playground in the grove in order to make it a more accessible and popular place for tourists.

Alipur Badri, Jadhkar and Mullaka have other sacred groves near this location, however this Kadamb Khandi is considered to be the “mother grove” from which all the smaller groves have originated.

Conclusion

The Faunal biodiversity assessment revealed that the grove harbored 5 species of mammals, 51 species of birds, 3 species of reptiles and 6 species of butterflies from varied families and genera. This is however based on the data collected in only 10 days during the summer season as well as only during the mornings hence it isn't a comprehensive representation of the grove. Multi Seasonal studies could reveal an even richer biodiversity. However, it should be noted the biodiversity has decreased from before and is still decreasing due to the low rainfall and the change in climate as well as the increase in the human populations nearby as per the community. The observation of vilaiti kikar (*Prosopis juliflora*), an invasive species, is worrying as it is hindering the growth and diversity of other native trees which impacts the diversity in fauna as well.

The nearby villages wanted the vilaiti kikar (*Prosopis juliflora*) removed, as well as introduction of guards to protect the area as well as better water sources, all in an attempt to protect the grove. However, they believe that no harm can be done to the grove from outside people due to the spirit of the Naga baba who protects the grove. The plans to create a potential park inside the grove by the gram panchayat in an attempt to draw tourist attention could lead to a disaster if done unscientifically. This study has provided baseline information regarding this nearly 200 acre sacred grove for which no previous studies exist, Therefore can be instrumental in future studies and can be utilized in the appeal to legally protect this grove.

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Appendix

Table 2: IUCN and WPA status for each species recorded in the grove

	Species	IUCN status	WPA status
Mammal	Indian Palm Squirell	Least Concern	-
Mammal	Nilgai	Least Concern	Schedule III
Mammal	Rhesus Macaque	Least Concern	Schedule II
Mammal	Indian Jackal	Least Concern	Schedule II
Mammal	Indian Hare	Least Concern	Schedule IV
Bird	Rock Pigeon	Least Concern	-
Bird	Green Bee-eater	Least Concern	-
Bird	Eurasian Collared-Dove	Least Concern	Schedule IV
Bird	House Crow	Least Concern	Schedule V
Bird	Indian Robin	Least Concern	-
Bird	Asian Pied Starling	Least Concern	Schedule IV
Bird	White-breasted Waterhen	Least Concern	-
Bird	Common Myna	Least Concern	Schedule IV
Bird	White-throated Kingfisher	Least Concern	Schedule IV
Bird	Rose-ringed Parakeet	Least Concern	Schedule IV
Bird	House Sparrow	Least Concern	-

Bird	Large Gray Babbler	Least Concern	Schedule IV
Bird	White-eared Bulbul	Least Concern	Schedule IV
Bird	Indian Peafowl	Least Concern	Schedule I
Bird	Jungle Babbler	Least Concern	Schedule IV
Bird	Brahminy Starling	Least Concern	Schedule IV
Bird	Red-vented Bulbul	Least Concern	Schedule IV
Bird	Indian Pond-Heron	Least Concern	Schedule IV
Bird	Oriental Magpie- Robin	Least Concern	Schedule IV
Bird	Yellow-throated Sparrow	Least Concern	-
Bird	Purple Sunbird	Least Concern	Schedule IV
Bird	Eurasian Hoopoe	Least Concern	-
Bird	Laughing Dove	Least Concern	Schedule IV
Bird	Asian Koel	Least Concern	-
Bird	Black Drongo	Least Concern	Schedule IV
Bird	Red-wattled Lapwing	Least Concern	-
Bird	Pied Cuckoo	Least Concern	Schedule IV
Bird	Plain Prinia	Least Concern	-
Bird	Egyptian Vulture	Endangered	-
Bird	Greater Coucal	Least Concern	-

Bird	Shikra	Least Concern	-
Bird	Ashy-crowned Sparrow Lark	Least Concern	Schedule IV
Bird	Indian White-Eye	Least Concern	-
Bird	Common Woodshrike	Least Concern	-
Bird	Common Tailorbird	Least Concern	-
Bird	Ashy Prinia	Least Concern	-
Bird	Rufous Treepie	Least Concern	Schedule IV
Bird	Yellow-footed Green-Pigeon	Least Concern	Schedule IV
Bird	Brown-headed Barbet	Least Concern	Schedule IV
Bird	Spotted Owlet	Least Concern	Schedule I
Bird	Coppersmith Barbet	Least Concern	Schedule IV
Bird	Grey Francolin	Least Concern	-
Bird	Indian Roller	Least Concern	Schedule IV
Bird	Jungle Crow	Least Concern	-
Bird	Baya Weaver	Least Concern	Schedule IV
Bird	Little Grebe	Least Concern	Schedule IV
Bird	Green Sandpiper	Least Concern	Schedule IV
Bird	Common Moorhen	Least Concern	-
Bird	Blue-tailed Bee-eater	Least Concern	-

Bird	Indian Grey Hornbill	Least Concern	-
Bird	Knob-billed Duck	Least Concern	
Reptile	Oriental Garden Lizard	Least Concern	-
Reptile	Common Indian Monitor Lizard	Near Threatened	Schedule I
Reptile	Indian Flapshell Turtle	Vulnerable	Schedule I
Butterfly	Sind White Arab	-	-
Butterfly	Common Grass Yellow	-	-
Butterfly	Common Tiger Butterfly	-	-
Butterfly	Yellow Orange Tip	-	-
Butterfly	Yellow Pansy	Least Concern	-
Butterfly	Banded Blue Pierrot	-	-