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Mammalian and Avian Diversity and Lurking Threats at Guda Vishnoiyan Conservation Reserve in the Bank of Luni River, Jodhpur, Rajasthan

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Abstract

Objectives: This study investigates the biodiversity of Guda Vishnoiyan Conservation Reserve (GVCR), focusing on mammalian and avian diversity and their threats. **Methods:** The region was assessed using the line transect method for mammals and the point count method for avian fauna. Garmin eTrex GPS, Bushnell binoculars, Canon 90 D camera, and Range finder were used. The Q-GIS and Google Earth Pro were used for map development and analyzing GPS data. The PAST 4.03 and MS-Excel were used to analyze the region's diversity indices. **Findings:** This study recorded 114 avian species with 43 families of birds of 18 orders from the GVCR area. Passeriformes order had 40 species along with the Anatidae family consisting of 12 species in the study area, which is the maximum. The highest avian density was recorded at P7, with 93 species and 1713 individuals, while P1 exhibited the lowest dominance and highest species evenness. The Simpson Index revealed P1 as the most diverse point, while P7 had the least diversity. The area had an overall avian diversity of $667.2 \pm 137.1/\text{sq. Km}$. A total of 17 species from six orders of mammals were recorded. A maximum of six species was observed from Carnivora order and the lowest with single species in Chiroptera, Lagomorpha and Insectivora. The overall mammalian density of the region is 91.1 ± 30.68 per sq. Km. The GVCR faces severe threats from habitat degradation, invasive species such as *Prosopis juliflora*, feral dogs and human activities like illegal mining, stone crushing, constant vehicular disturbances, construction of boundary walls and wired fencing. **Novelty:** A record sighting of the winter migratory bird Black Stork (*Ciconia nigra*) was seen here for the first time in Jodhpur.

Keywords: Guda Vishnoiyan Conservation Reserve; Threats; Luni River; Bishnoi; Thar Desert

1 Introduction

The Thar Desert, the western part of India, supported good biodiversity due to low human density compared to the central and eastern districts of Rajasthan^(1,2). The desert exhibits a distinctive socio-ecological dynamic, where certain communities, notably the Bishnoi people, are exceptionally protective of wildlife, with a strong emphasis on safeguarding species⁽³⁾. The Thar desert has a variety of fauna, and an estimated 2043 animal species were recorded by Sharma⁽⁴⁾ but the growing human population has been significantly impacting wildlife, primarily through the change in land use patterns of habitats⁽³⁾. Protected areas play a pivotal role in the conservation of biodiversity. The richness of biodiversity is an ecological indicator of ecosystem health and resilience⁽⁵⁾. To conserve this richness of biodiversity the Wildlife Protection Act, 1972 India has created national parks, and wildlife sanctuaries⁽⁶⁾. Despite forming these protected areas, several small wildlife-rich areas remain secluded. In this regard, Rajasthan state has declared 3 national parks, 26 wildlife sanctuaries, and 37 conservation reserves, including the Guda Vishnoiyan Conservation Reserve (GVCR) by the Forest Department of Rajasthan issued the official gazette notification dated January 03, 2012⁽⁷⁾. This region characterized by its semi-arid landscape and riparian ecosystems, offers a unique habitat for wildlife against the challenges of habitat loss. The GVCR nested along the banks of the Luni River of Rajasthan is a critical habitat for diverse mammalian and avian species⁽⁸⁾. The Luni River is the vast integrated and only west-flowing river of Western Rajasthan and contains vast faunal diversity and this river is known as the “Maruganga of Desert”^(9,10). This region was also a stronghold of the Blackbuck (*Antelope cervicapra*), Chinkara (*Gazella bennettii*) and Nilgai (*Boselaphus tragocamelus*). Dhawa Doli and Guda Vishnoiyan are the regions where one can witness the highest number of blackbucks in the Outside Protected Areas (OPA)⁽¹¹⁾. Numerous carnivores like the Indian wolf (*Canis lupus pallipes*), Jackal (*Canis aureus*), Afro-Asiatic wildcat (*Felis lybica*), Bengal Fox (*Vulpes bengalensis*), and Desert Fox (*Vulpes vulpes*) also inhabited this region⁽¹²⁾. Now, understanding the diversity and distribution of wildlife in the conservation reserve is essential for effective conservation planning and management. Various factors such as encroachment, poaching, deforestation, pollution, and mining contribute to the degradation of forested protected areas⁽¹³⁾. Despite its protected status, this reserve faces several threats to its wildlife. Water availability is crucial for the wildlife in Guda Vishnoiyan, especially during the summer when the region faces arid conditions. But the ponds of Guda Vishnoiyan are consistently replenished by local Bishnoi people. Bishnoi community, who are recognized for their fierce love for wildlife conservation. Amrita Devi Bishnoi along with 363 others has laid their lives for the protection of the Khejri tree⁽¹⁴⁾. Threats to the fauna of the area include habitat degradation due to activities viz. stone crusher, the presence of feral dogs, wired fencing disrupting natural movement patterns, invasive *Prosopis juliflora* and illegal mining operations⁽⁸⁾. This paper aims to explore and document the mammalian and avian faunal diversity within the GVCR, providing insights into species diversity, major threats and conservation strategies.

2 Methodology

2.1 Study Area

The Guda Vishnoiyan Conservation Reserve (GVCR) encompasses a total area of 231.87 hectares. It is situated in the village Guda Vishnoiyan of Jodhpur district, located at N 26.117413° & E 73.090530°. Along with GVCR, this study also took into account the floral and faunal diversity of Bada Talab (Hindi: Big Pond) and some parts of the Luni River. The GVCR is bisected by State Highway No. 68, dividing the area into two parts Figure 1. The study area is situated in the eastern direction of Jodhpur and elevation lie between 250 to 300 meters above mean sea level. The temperature of this area rose up to 50° to 10° C in winter. Rainfall is scanty with an average of 365mm per year⁽¹²⁾. The major flora of the study area includes shrub species like *Ziziphus nummularia* (Ber), *Prosopis juliflora* (Vilayati babul), and *Capparis decidua* (Ker). The area also supports several other floral species, including *Tecomella undulata* (Rohida), *Salvadora persica* (Khari jaal), *Salvadora oleoides* (Mithi jaal), *Prosopis cineraria* (Khejri), and *Acacia senegal* (kumat)⁽¹⁵⁾. The major mammalian fauna of the area includes Indian Antelope (*Antelope cervicapra*), Bengal Fox (*Vulpes bengalensis*), Desert Fox (*Vulpes vulpes pusilla*), Nilgai (*Boselaphus tragocamelus*), Indian Desert Hare (*Lepus nigricollis dayanus*)^(8,12,16). The Bada Talab welcomes winter migratory species like Demoiselle Crane (*Anthropoides virgo*), which is also the mascot species of the Jodhpur district of Rajasthan⁽¹⁷⁾. Besides these, many residential and migratory birds also inhabit.

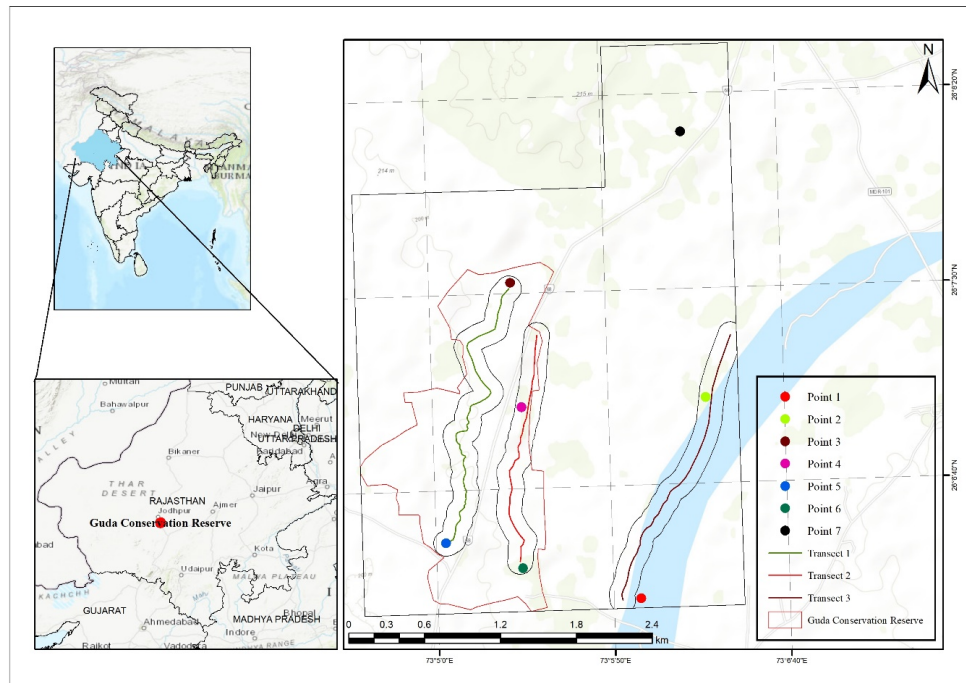


Fig 1. Study Area

2.2 Material and method

Preliminary surveys were conducted using available literature, books, and journal papers. The point count method was used for surveying avian diversity⁽¹⁸⁾. Similarly, three walking transects were assessed for mammalian diversity⁽¹⁹⁾ i.e. two in GVCR and one in the Luni River. For mammalian diversity, seasonal transects were assessed i.e. Summer, Winter, and Monsoon. The study was conducted from March 2022 to February 2024 between 07-10 AM and 04-06 PM. Garmin eTrex GPS, Bushnell binoculars, Canon 90 D camera and Range finder were used during the study. The PAST 4.03 and MS-Excel software were used for analyzing the diversity indices of the region. The Q-GIS and Google Earth Pro software were used for map development and analyzing GPS data of the study area.

2.2.1 Statistical analysis/ diversity indices

The study also tried to assess the diversity indices of the region. For diversity assessment considered indices were Dominance, Simpson, Shannon, Evenness, and Margalef⁽²⁰⁾. The dominance index (D) measures the abundance of the most common species. Both Simpson and the Dominance index always weigh towards the most abundant species of any region and are often formulated as

$$Domianance (D) = \sum \left(\frac{n_i(n_i - 1)}{N(N - 1)} \right)$$

Where n_i =total individuals in ith species and N = total individuals

Simpson index is usually formulated as

$$Simpson's Index = 1 - D \text{ or } Simpson's Index = \frac{1}{D}$$

Shannon index is a measure of diversity that assumes individuals are randomly sampled from a very big population and represented. It is formulated as below,

$$H' = - \sum p_i \ln p_i$$

Where:

p_i is considered as a proportional abundance of i th species and often formulated as $= (\frac{n_i}{N})$

Shannon index also takes account of Evenness (E). It is expressed in ratio to the maximum diversity. Value of E always lies between 0 and 1 expressed as

$$E = \frac{H'}{H_{max}} = \frac{H'}{\ln S}$$

Margalef index measures diversity based on environmental disturbances rather than species richness alone. It can be formulated using S (the number of species recorded) and N (the total number of individuals of all species) and expresses as follows

$$D_{mg} = \frac{(S-1)}{\ln N}$$

3 Results and discussion

The Guda Vishnoiyan Conservation Reserve (GVCR) along with the Luni River flows in the reserve's periphery within the 10 sq. Km. was considered for the intensive study. The area was covered for assessing mammalian diversity using three transects T1, T2, and T3 of 2.5 km, 1.8 km, and 2.3 km respectively. Winter months were chosen to assess avian diversity using seven-point locations (four within GVCR, two near Luni River and one near Bada Talab), as winter congregates migratory and resident species in this region. The GVCR lies between Kankani and Guda-Vishnoiyan villages. As SH-68 bifurcates the GVCR, the T1 transect lies on the western side of the GVCR, the T2 transect lies on the eastern side of the GVCR and the T3 transect lies on the riverine area of the Luni River.

3.1 Avian diversity

This study recorded 114 avian species with 43 families of birds of 18 orders from the GVCR area. Passeriformes order had 40 species along with the Anatidae family consisting of 12 species in the study area, which is the maximum. Similarly, the lowest count was observed in the orders viz. Bucerotiformes, Podicipediformes, Psittaciformes, Pterocloriformes and Strigiformes consist only single species Figure 2. Moreover, it was also observed that in 17 families, there is only one species. The study assessed avian species in each point, P1 had 70 species with 788 individuals, P2 had 62 species with 808 individuals, P3 had 64 species with 893 individuals, P4 had 84 species with 1090 individuals, P5 had 58 species with 651 individuals, P6 had 60 individuals with 729 species, and P7 had 93 species with 1713 individuals. P1 had the lowest dominance value (0.038) and P7 had the highest dominance (0.2285). Simpson index (1-D) has also been assessed and recorded that the diversity decreased in the following order P1>P6>P5>P3>P2>P4>P7. In the study area, the highest and the lowest values for the Simpson Index are 0.962 and 0.7715 respectively. Similarly, the study assessed the Shannon diversity Index (H') which showed little contradictory result to the Simpson's. According to Shannon, the diversity in the study area decreased in the following order P1>P4>P6>P5>P3>P2>P7. Margalef (D_{mg}) index had shown an interesting trend, the more the number of species, the more the D_{mg} value. So, the D_{mg} value decreases in the following order P7>P4>P1>P3>P2>P6>P5. Evenness (E) showed a relatively different trend than all the richness as mentioned earlier index and decreased in the following order P1>P6>P5>P2>P3>P4>P7 Table 1. The area had an overall avian diversity of $667.2 \pm 137.1/\text{sq. Km}$.

Table 1. Diversity and Evenness Index for Avian Species in the GCR Area

	Total Number of Species	Total Number of Individuals	Dominance (D)	Simpson (1-D)	Shannon (H')	Evenness (E)	Margalef (D_{mg})
P1	70	788	0.038	0.962	3.654	0.5517	10.35
P2	62	808	0.06064	0.9394	3.339	0.4547	9.112
P3	64	893	0.05993	0.9401	3.367	0.4529	9.272
P4	84	1090	0.07051	0.9295	3.533	0.4076	11.87
P5	58	651	0.05054	0.9495	3.429	0.5318	8.798
P6	60	729	0.04789	0.9521	3.482	0.5418	8.951
P7	93	1713	0.2285	0.7715	2.739	0.1663	12.36

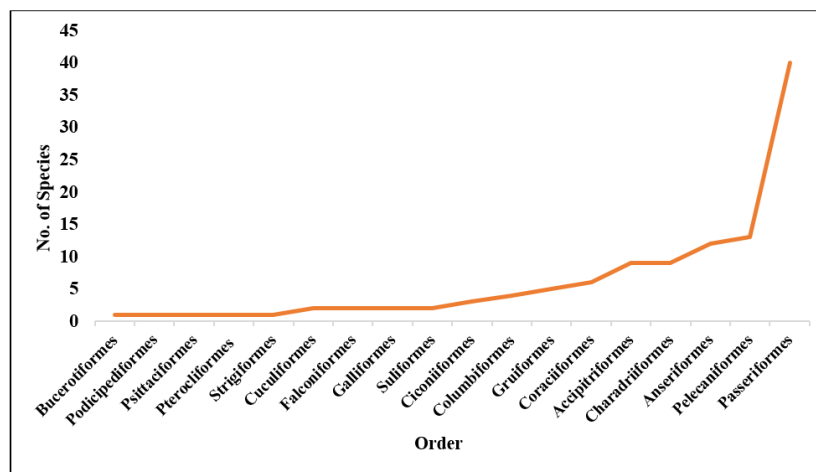


Fig 2. Number of Avian Species along with Order

3.2 Mammalian diversity

Similarly, the study has also assessed mammalian diversity. A total of 17 species of mammals were recorded from the area which belongs to 06 orders. The maximum fauna (6 species) was observed from the Carnivora order and the lowest with single species was observed in Chiroptera, Lagomorpha and Insectivora. Similarly, 4 species were noted from Rodentia and 3 from Artiodactyla order. The family-wise distribution of mammalian species is depicted in Figure 3. The Recorded mammals are Indian Hedgehog (*Paraechinus micropus*), Golden jackal (*Canis aureus*), Bengal fox (*Vulpes bengalensis*), Desert fox (*Vulpes vulpes*), Small Indian Mongoose (*Urva auropunctata*), Indian Grey Mongoose (*Urva edwardsii*), Afro-Asiatic wildcat (*Felis lybica*), Nilgai (*Boselaphus tragocamelus*), Blackbuck (*Antelope cervicapra*), Chinkara (*Gazella bennettii*), Indian desert hare (*Lepus nigricollis dayanus*), Five-striped Palm Squirrel (*Funambulus pennantii*), Indian Crested Porcupine (*Hystrix indica*), Indian Desert Gerbil (*Meriones hurrianae*), House rat (*Rattus rattus*), Indian gerbil (*Tatera indica*), Indian flying fox (*Pteropus medius*). The density of mammals at the GVCR in summer, winter, and monsoon is 27.5 ± 4.05 , 36.5 ± 5.27 and 27.1 ± 4.19 (per sq. Km) respectively. The overall mammalian density of the region is 91.1 ± 30.68 per sq. Km. The individual density of the mammals in all three seasons is depicted in Figure 4. The study also assessed diversity Indices for the mammal in three seasons for each transect, which is shown in Tables 2, 3 and 4.

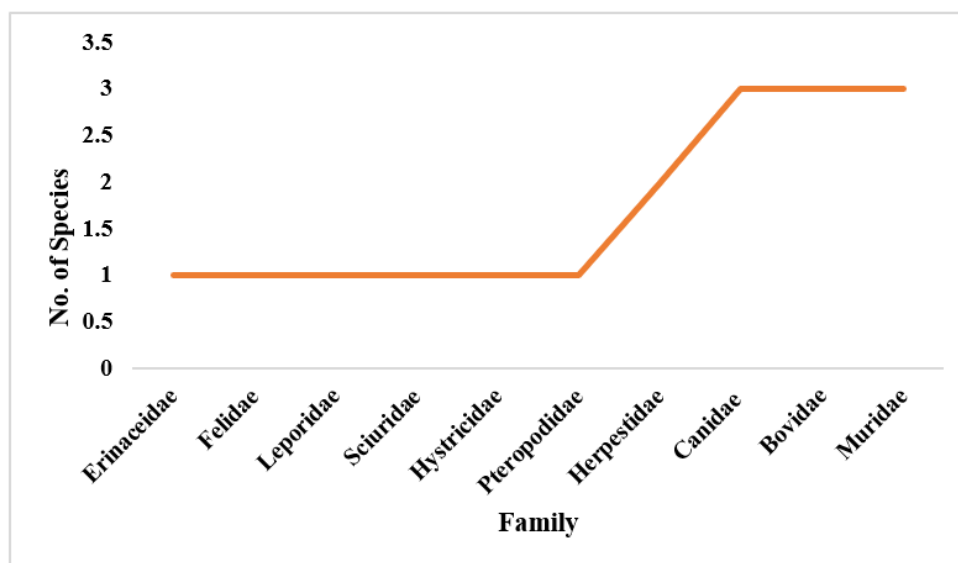


Fig 3. Number of Mammalian Species along with family

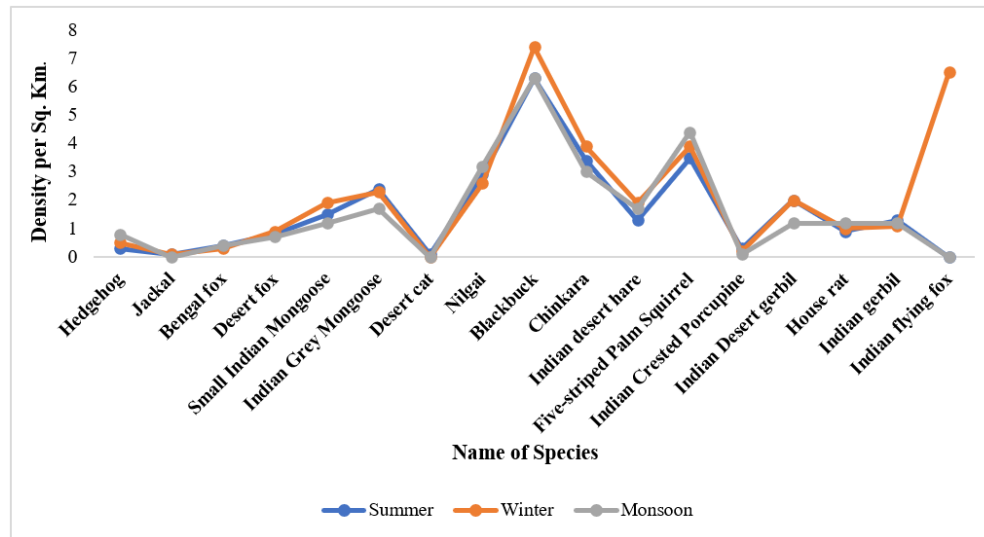


Fig 4. Density of mammals in all three seasons

Table 2. Diversity Indices for the Mammal in Summer

Transect	No. of Species	Individuals	Dominance (D)	Simpson (1-D)	Shannon (H')	Evenness (E)	Margalef (D_{mg})
T 1	12	92	0.1652	0.8348	2.115	0.6909	2.433
T 2	12	108	0.132	0.868	2.222	0.7692	2.349
T 3	14	75	0.1026	0.8974	2.433	0.814	3.011

Table 3. Diversity Indices for the Mammal in Winter

Transect	No. of Species	Individuals	Dominance (D)	Simpson (1-D)	Shannon (H')	Evenness (E)	Margalef (D_{mg})
T 1	12	113	0.1551	0.8449	2.154	0.7185	2.327
T 2	14	169	0.2051	0.7949	1.999	0.5274	2.534
T 3	13	83	0.09595	0.904	2.428	0.8724	2.716

Table 4. Diversity Indices for the Mammal in Monsoon

Transect	No. of Species	Individuals	Dominance (D)	Simpson (1-D)	Shannon (H')	Evenness (E)	Margalef (D_{mg})
T 1	11	93	0.1745	0.8255	2.066	0.7173	2.206
T 2	12	101	0.1417	0.8583	2.175	0.7332	2.383
T 3	13	77	0.09934	0.9007	2.416	0.8614	2.763

3.3 Historical background

GVCR is one of the biodiverse areas of Jodhpur district. Before constituting a conservation reserve, it was part of a Closed Area meaning “Shikar Nishedh Kshetra” or hunting prohibited zone declared by the Forest Department of Rajasthan on 03 December 1980 which was a cluster of 24 villages. Most of the wildlife diversity recorded from the area is attributed to the presence of the Bishnoi community of Rajasthan. Bishnoi people are known for their ferocious nature when it comes to saving the fauna or flora of the region. The Bishnoi community's affection towards wildlife was observed by Gehlot and Moolaram⁽¹⁴⁾ who noted that the community is actively engaged in wildlife rescue efforts within desert ecosystems. In the event of injury or

death of wild animals, Bishnoi members promptly notify local forest authorities and assist in transporting the animals to rescue centers or nearby veterinary hospitals for medical treatment. It started by Amrita Devi Bishnoi when she laid her life along with 363 individuals for the protection of the Khejri tree (*Prosopis cineraria*) in Khejarli village of Jodhpur. This village lies in the vicinity of Guda village and is inhabited by the Bishnoi community. Bishnoi follows their inception by the Jamboji sect, which inspires them to conserve animals of nature. Rahmani also stated that the Guda Vishnoiyan and Dhawa-Doli region of Jodhpur is known for their highest blackbuck concentration at any Outside Protected Areas of Rajasthan⁽¹¹⁾. But recent sightings had yielded a very derogatory result. A decade earlier, in 2012 Guda closed area was reduced and limited to only 231.87 ha area of Guda Vishnoiyan village and renamed GVCR.

Historically, The Guda area is known for blackbuck conservation and many scientists have worked. Sinha (1966) noted 5397 individuals of Blackbuck⁽²¹⁾ while after 15 years Sharma (1980) recorded 980 individuals of Blackbuck in the Guda Vishnoiyan⁽²²⁾. As per the observation of Gehlot (2006), the blackbuck was noted 9.6 individuals per sq. Km.⁽³⁾. During 2015 the population of Blackbuck was much less and recorded 3.47 per sq. Km.⁽¹⁵⁾. Due to the alarming increase in sand mining along the banks of the Luni River, the top carnivores, desert wolves, are at risk of disappearing from this riverine area. Many wolf pups have been rescued over the last 10 years. Some orphaned wolf pups were rescued from the adjoining area of the GVCR and were hand-reared at the Machia Biological Park in Jodhpur⁽²³⁾.

The proposed conservation reserve is home to Chinkara (*Gazella bennettii*) and Indian Antelope (*Antelope cervicapra*). Earlier Guda was home to only two wolves in 2013. According to the recent wildlife census by the Rajasthan Forest Department in 2024, this area is home to 6 wolves. It is also known for the winter migrating Demoiselle crane (*Anthropoides virgo*). This study also had a record sighting of the winter migratory bird Black Stork (*Ciconia nigra*) Figure 5. In the last few decades, several scientists recorded the Guda Vishnoiyan region's diversity^(3,15,21,22). The sighting of blackbucks had drastically decreased. It can be attributed to several threats that are lurking at the GVCR. Carnivores like Indian Wolf (*Canis lupus pallipes*), Bengal fox (*Vulpes bengalensis*), Desert fox (*Vulpes vulpes*), Indian Grey Mongoose (*Urva edwardsii*), and Afro-Asiatic wildcat (*Felis lybica*) once abundant in the GVCR area, now declined or migrated towards the nearby undisturbed locations.

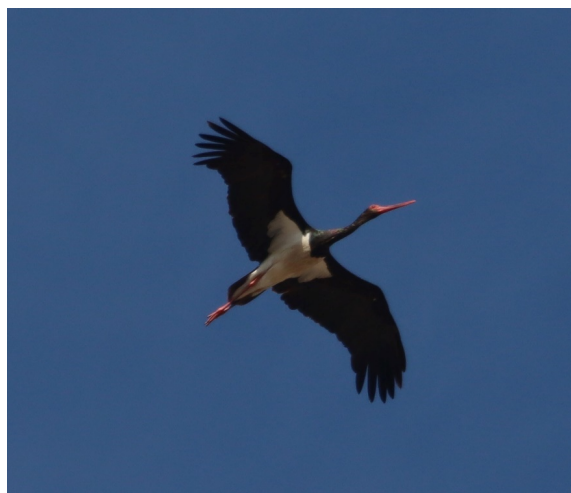


Fig 5. Record sighting of Black stork (*Ciconia nigra*)

3.4 Major threats and conservation strategies

Due to the invasion of *Prosopis juliflora*, the grassland of the GVCR becomes unproductive and the ungulate population has migrated towards the Nimbli region of Pali. The *Prosopis juliflora* and *Lantana camara* represent significant issues affecting river flow, with detrimental impacts on biodiversity, as well as on the forest's growing stock, sacred groves, and community lands⁽²⁴⁾. *Prosopis juliflora* is a major threat to good habitats so it should be removed using the uproot method, but this requires high cost. The reforestation of native species in the place of *Prosopis juliflora* will be beneficial for habitat restoration in the study area. Illegal sand mining activities at the Luni River bank have led to destroy the several dens thus its impact on the population of desert foxes and wolves as well as a decrease in the population of ungulates. To prevent illegal sand mining, strict monitoring must be done by the administration authority as well as to control the population of stray dogs, they should be sterilized. Constant vehicle movements and high-speeding vehicles pass through the middle of GVCR often making loud noises and

increasing the chance of collision with ungulates. During the study, three hits of the vehicle with ungulates were recorded. The State Highway Authority should put up signages on the road like pictures depicting wild animals and speed breakers. Barbed wire fencing is another threat to the wild fauna. The government also gives subsidies for this type of fencing. Therefore, the government should not give subsidies on barbed wire in nearby wildlife-rich areas and be aware of local people for bio-fencing for agricultural fields.

The release of municipal waste and industrial effluents into the Luni River and its tributaries leads to a significant deterioration in the water quality of both surface and groundwater resources⁽²⁵⁾. Due to the good wildlife wealth of this area, presently tourism activity has also increased and the Forest Department is trying to establish a potential site for ecotourism but sometimes few people are punished for poaching of blackbuck in this region. This area was famous in the country when a poaching case of blackbuck was also registered against the famous Bollywood actor Salman Khan in this region in 1998 and this incident sparked widespread indignation, especially within the Bishnoi community, for whom the blackbuck is considered a sacred species.

The construction of a boundary wall by the Air Force around the Bada Pond of Guda restricts the natural movement of wildlife. The ownership of the conservation reserve is with the Jodhpur Development Authority (JDA) and has yet to be transferred to the Forest Department of Rajasthan. Ownership arrangement hinders efficient management and development of this conservation reserve thus slowing down essential activities such as habitat restoration, wildlife monitoring, and ecological management practices like plantation. The lack of adequate attention and investment from the state government has resulted in insufficient infrastructure and facilities within the reserve. So, this study emphasizes about the assessment of diversity of avian and mammalian faunal diversity along with its major threats and conservation strategies.

4 Conclusion

The Guda Vishnoiyan Conservation Reserve (GVCR) and its periphery, including the Luni River, were intensively studied for mammalian and avian diversity. The study identified 114 avian species family from 43 families, with the order Passeriformes (40 species) and the family Anatidae (12 species) being the most dominant. The mammalian diversity included 17 species across six major orders, with the order Carnivora being the most prominent, represented by six species. The highest avian diversity was recorded at P7, with 93 species and 1713 individuals, while P1 exhibited the lowest dominance and highest species evenness. The Simpson Index revealed P1 as the most diverse point, while P7 had the least diversity. Mammalian density was also analysed seasonally, with the highest density in winter (36.5 ± 5.27 per sq. km). The GVCR is home to species such as the Blackbuck (*Antelope cervicapra*), Chinkara (*Gazella bennettii*), and many migratory birds. Apart from rich faunal diversity, there are several threats to faunal biodiversity in the GVCR. The invasion of *Prosopis juliflora* has reduced the productivity of grasslands and it is a major cause to migrate ungulates toward the Nimbli region of Pali. There is habitat fragmentation due to boundary wall construction by the Indian Air Force, and illegal sand mining activities at the Luni Riverbank have led to the decline of carnivores as well as a decrease in the population of ungulates. The ownership of the reserve by the Jodhpur Development Authority, instead of the Forest Department, has hindered effective management, resulting in delays in essential conservation efforts such as habitat restoration and wildlife monitoring. If these threats are not paid attention timely to then biodiversity will be degraded in the future. Despite these challenges, the study recorded rare sightings such as the winter migratory Black Stork (*Ciconia nigra*) and confirmed the winter presence of Demoiselle cranes (*Anthropoides virgo*). Based on the present study, the main recommendations are to stop illegal mining, eradicate *Prosopis juliflora*, replace barbed wire fences, community involvement for wildlife conservation, control the population of feral dogs, reforestation with native species, and collaborate with scientific institutes for assessment of biodiversity and aware local peoples, etc. These findings highlight the urgent need for coordinated conservation efforts, habitat management, and community engagement to address the emerging threats and conserve the GVCR's biodiversity.

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