Bangladesh J. Zool. ***52****(3): 269-280, 2024* *Article*
ISSN: 0304-9027
eISSN: 2408-8455

MAMMALIAN DIVERSITY AND CONSERVATION IN THE MIXED-EVERGREEN FOREST OF BARAIYADHALA NATIONAL PARK, CHATTOGRAM, BANGLADESH

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ABSTRACT: The study was carried out to assess the mammalian diversity and conservation in Baraiyadhala National Park between October 2021 and June 2023 spanning a total of 78 field days. Field data were collected following a combination of different methods including transect walk, night survey, mist netting and camera trapping. Ten automated, infrared sensor camera traps were set up at 48 camera trap station for 14 months covering a total of 2793 camera days. Fifty-five species of mammals were recorded of which 41.82% was rare, followed by 29.09% common, 16.36% uncommon and 12.73% very common. Mammalian community of this national park were mostly nocturnal (32.73%), followed by metaturnal (23.64%), crepuscular (21.82%) and diurnal (21.82%). Overall mammalian diversity of this national park was very high (D = 0.06, H' = 3.35). Among the recorded mammals, 17 species are threatened in different categories. Hunting and poaching with intentional forest fire were the major threats to the mammals of this national park. Effective management plan involving local community, habitat restoration and introducing Spatial Monitoring and Reporting Tool (SMART) patrolling could minimize the threats to mammals in this national park.

Key words: Mammals, Camera Trap, Species Diversity, Mist nesting, Threats.

INTRODUCTION

Mammals play a vital role in the forest ecosystem by controlling prey population, plant pollination, and dispersion (Magioli *et al.*, 2015, Galetti *et al.*, 2015, Derhe *et al.*, 2017). Terrestrial mammals are a vital component of forest ecosystem being ecosystem service providers and ecological health indicators (Kitamura *et al.*, 2010). Due to the increasing anthropogenic pressure on the biodiversity, the geographic distribution of terrestrial mammals has been reduced to 83% (WWF, 2020). Bangladesh is one of the most densely populated countries on earth with 1119 people /km^2 (BBS, 2022), it is also the home a diverse mammalian population. Currently a total of 130 species of mammals

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 DOI: https://doi.org/10.3329/bjz.v52i3.807857

have been recorded from Bangladesh including 10 new record of mammals after IUCN 2015 (Islam *et al.*, 2008, Saha *et al.*, 2015, Khan, 2018, Ahmed *et al.*, 2020, Saha *et al.*, 2017 a,b,c, Mia *et al.*, 2019, Aziz *et al.*, 2024). Mammals of the country have been facing continuous threat of extinction and 11 species have been extinct from the country (IUCN Bangladesh, 2015). Most of the mammals of the country are found in the forest areas of three regions, *viz.* Sundarbans mangrove forest in the south west, mixed-evergreen forests in the northeast and southeast regions of Bangladesh (Rahman *et al.*, 2021). Thirty-eight species of mammals are threatened in different categories (IUCN Bangladesh, 2015). So, it is critical to document their diversity, species richness in a particular area, and composition in different habitat conditions in a forest for their better conservation (Bernard *et al.*, 2013). However, monitoring these animals in tropical forest habitats is extremely challenging because they are elusive, mainly nocturnal, prefer dense vegetation, occurs in low abundance and avoid human presence (Datta *et al.*, 2008, Mohd-Azlan, 2009, Gonthier and Castaneda, 2013). In this circumstance, a combination of different methods including visual observation, camera trapping, mist netting, box trapping and night survey were used to assess the mammalian diversity in Baraiyadhala National Park.

MATERIAL AND METHODS

Study Area: Baraiyadhala National Park is located at 172 km southeast of Dhaka (the capital of Bangladesh) and 45 km northwest of Chittagong City (22˚40.489'N - 22˚48'N and 90˚40'E -91˚55.979'E) covering an area of 2,933.61 hectares and have a diverse habitat type. The topography of the park is very undulating with a linear hill range (expanded towards north-south). The hill topography constitutes with high (152m to 365m), medium high (76m – 172m) and lower hills (15m – 76m). The national park is interspersed with waterfalls, streams, valleys, creeks, steep hills, natural forests, bushlands and bamboo thickets which made a unique composite habitat for many wildlife species. The national park covered a moist tropical climate with frequent and heavy rain during monsoon (May – October) ranging between 115.2mm to 561.1mm with the total rainfall 1891mm. The average maximum annual temperature was 31.50˚C and the minimum 20.67˚C, whereas the average maximum and minimum range of relative humidity were respectively 99.10% and 49.86% (Karim and Ahsan, 2016).

The forest of the national park is mixed-evergreen type with the dominating vegetation type includes *Artocarpus chama* (Chapalish), *Acacia auriculiformis* (Akashmoni), *Chukrasia tabularis* (Chikrassi), *Eucalyptus* sp. (Eucalyptus), *Gmelina arborea* (Gamar), *Dipterocarpus turbinatus* (Garjan), *Swietenia mahagoni*

(Mehogini), *Azadirachta indica* (Neem), *Aphanamixis polystachya* (Pitraj), *Tectona grandis* (Segun), *Hopea odorata* (Telsur), *Toona ciliata* (Toon) etc. The palms, rattans and bamboos mostly occupy the valleys. Common shrubs, herbs, grasses and babanas are found in fragmented to degraded habitats. A few individuals of Boilam (*Anisoptera scaphula*), Civit (*Swintonia floribunda*) and Lohakat (*Xylia xylocarpa*) are also available in the forest (Rashid *et al.*, 2018).

Field Survey: The field surveys were conducted in different habitats of Baraiyadhala National Park between 6 October 2021 and 3 June 2023. A total of 78 days comprised of 389 man-days were spent in the field for data collection. A team of three experts and two/three field assistants were involved in data collection. A total of 14 permanent line transects covering all kinds of habitats were surveyed for 4 to 6 days in each month. In addition to that, 12 permanent survey points were selected where line transect was not possible due to the physical feature of the study site. Surveys were conducted within 100 meter-radius of the survey point (Map 1). Mammals in the study area were both diurnal and nocturnal, therefore, survey was conducted both during day and night by walking through the transects and surveying at sampling points. Night survey was conducted using high power torch light. Mammals those were visually encountered were noted along with capturing them with high resolution camera. Ten automated, infrared sensor camera traps were set up at 48 camera trap station for 14 months covering a total of 2,793 camera days. Camera trap locations were un-baited and selected based on accessibility, terrain features, animal trails and animal signs (Ramesh *et al.*, 2015, Marinho *et al.*, 2018). At each camera trap station, we deployed a single camera trap (Bushnell Outdoor Trophy Trail Camera HD). We mounted each camera to a tree, approximately 50 cm above the ground, with a metal chain and theft-proof steel box. The camera sensor was aimed parallel to the ground to maximize the extension of the detection zone. Mist netting was carried out to know the diversity of bats. Box traps with appropriate baits were used to capture rodents. In addition to that, indirect signs like foot print, pugmark, scats, feces, feathers, burrows, holes and leftover food of animals were used to confirm the presence of that particular animal in Baraiyadhala National Park.

Analysis of data: Local status of the animals was calculated from their relative abundance in the project area and expressed in four categories (Khan, 2018).

Very Common (VC): Species found 76-100% of encounter in its habitats at the time when it was most active.

Common (C): Species found 51-75% of encounter in its habitats at the time when it was most active.

Uncommon (UC): Species found 26-50% of encounter in its habitats at the time when it was most active.

Rare (R): Species found with 25% or less of encounter in its habitats at the time when it was most active.

The national threat status of the species was taken from IUCN Bangladesh (2015) while the global status was taken from the global red list of the threatened species (https://www.iucnredlist.org/).

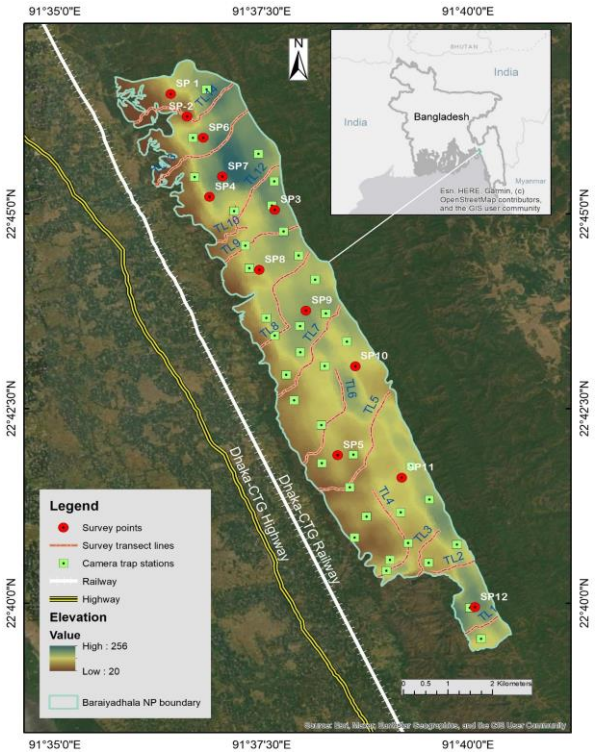
Two diversity indices were calculated from the collected data.

$$\text{Simpson Index (D)} = \frac{\sum n(n-1)}{N(N-1)}$$

Where, n= number of individual, N = total number of individuals. The values of D ranged between 0 to 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity.

$$\text{Shannon-Weiner Inde} \quad H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where, Pi = n/N, ln = natural log. The value of H' in the natural population, usually varies from 1.5 to 3.5. The values of H' < 1.5 indicates low diversity, 1.5 to <2.5 indicates medium diversity and > 2.5 indicates high diversity.



Map 1. Location of transects, survey points and camera trap stations in Baraiyadhala National Park.

RESULTS AND DISCUSSION

A total of 55 species of mammals under 22 mammalian families were recorded during the study period (Table 1). Most of the mammals of Baraiyadhala National Park were rare (41.82%) and uncommon (16.36%), while 29.09% mammals were common (Fig. 1). Family Muridae has the highest number of species (8 species) followed by Mustelidae and Cercopithecidae (5 species each) (Fig. 2). Among the recorded mammals, most of the species were nocturnal (32.73%, n = 18), followed by metaturnal (23.64%, n = 13), crepuscular (21.82%, n = 12) and diurnal (21.82%, n = 12) (Fig. 3). A total of 17 mammal species are threatened in different categories; four Critically Endangered, nine Endangered and four Vulnerable. Overall mammalian diversity of this national park was very high (D = 0.06, H' = 3.35).

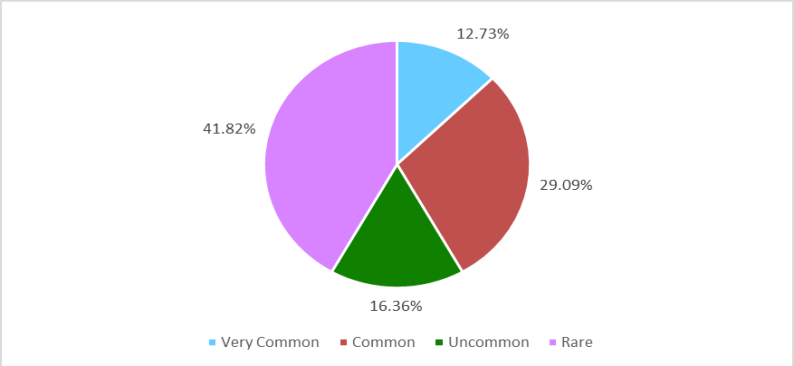


Fig. 1 Status of mammals in Baraiyadhala National Park.

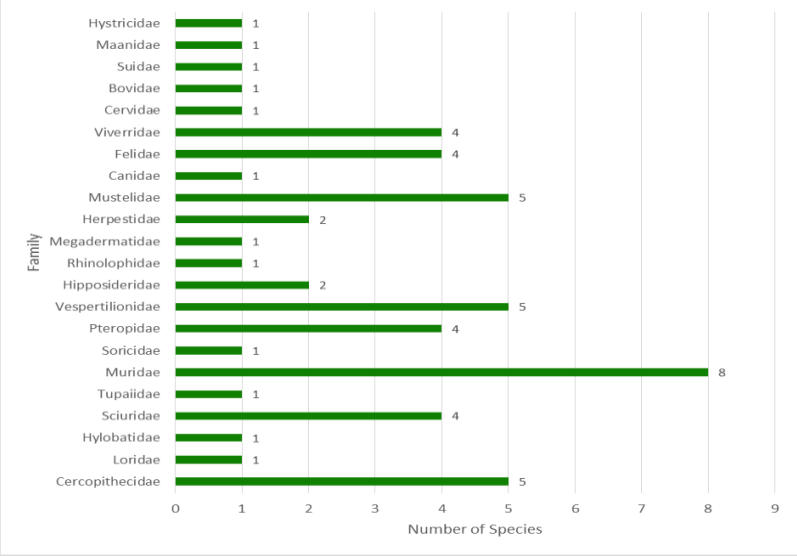


Fig. 2 Number of species in different mammalian families in Baraiyadhala National Park.

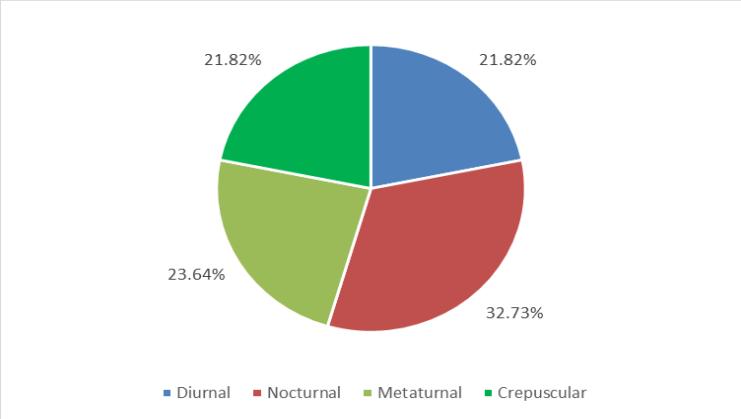


Fig.3 Active time of the mammals in Baraiyadhala National Park.

Table 1. List of mammalian species recorded in Baraiyadhala National Park

Family	Common Name	Scientific Name	Local Status	IUCN Threat Status	
				National	Global
Cercopithecidae	Assamese Macaque	*Macaca assamensis*	C	EN	NT
	Pig-tailed Macaque	*Macaca leonina*	UC	EN	EN
	Rhesus Macaque	*Macaca mulatta*	C	VU	LC
	Phayre's leaf monkey	*Trachypithecus phayrei*	UC	CR	EN
	Capped Langur	*Trachypithecus pileatus*	R	EN	VU
Loridae	Bengal Slow Loris	*Nycticebus bengalensis*	R	EN	EN
Hylobatidae	Hoolock Gibbon	*Hoolock hoolock*	R	CR	EN
Sciuridae	Hoary-bellied Squirrel	*Callosciurus pygerythrus*	C	LC	LC
	Orange-bellied Himalayan Squirrel	*Dermomys lokriah*	UC	LC	LC
	Pallas's Squirrel	*Callosciurus erythraeus*	R	LC	LC
	Particoloured Flying Squirrel	*Hylopetes alboniger*	R	EN	LC
Tupaiidae	Northern Tree Shrew	*Tupaia belangeri*	C	NT	LC
Muridae	Lesser Bandicoot Rat	*Bandicota bengalensis*	VC	LC	LC
	Greater Bandicote Rat	*Bandicota indica*	C	LC	LC
	Brown rat	*Rattus norvegicus*	C	LC	LC
	Eastern House Mouse	*Mus musculus*	C	LC	LC
	Common Indian Field Mouse	*Mus booduga*	UC	LC	LC
	House Rat	*Rattus rattus*	C	LC	LC

Family	Common Name	Scientific Name	Local Status	IUCN Threat Status	
				National	Global
	Long-tailed Climbing Mouse	*Vandeleuria oleracea*	C	LC	LC
	Lesser bamboo Rat	*Cannomys badius*	R	LC	LC
Soricidae	Asian House Shrew	*Suncus murinus*	VC	LC	LC
	Indian Flying Fox	*Pteropus giganteus*	VC	LC	LC
Pteropidae	Fulvous Fruit Bat	*Rousettus leschenaultii*	UC	LC	NT
	Greater Short-nosed Fruit Bat	*Cynopterus sphinx*	VC	LC	LC
	Lesser Dawn Bat	*Eonycteris spelaea*	C	DD	LC
	Greater Asiatic Yellow Bat	*Scotophilus heathii*	C	LC	LC
Vespertilionidae	Lesser Asiatic Yellow Bat	*Scotophilus kuhlii*	UC	LC	LC
	Indian Pipistrelle	*Pipistrellus coromandra*	UC	LC	LC
	Javan Pipistrelle	*Pipistrellus javanicus*	R	NE	LC
	Least Pipistrelle	*Pipistrellus tenuis*	C	LC	LC
Hipposideridae	Intermediate Roundleaf Bat	*Hipposideros larvatus*	R	LC	LC
	Grand Leaf-nosed Bat	*Hipposideros grandis*	R	NE	LC
Rhinolophidae	Blyth's Horseshoe Bat	*Rhinolophus lepidus*	R	LC	LC
Megadermatidae	Greater False Vampire Bat	*Lyroderma lyra*	C	LC	LC
Herpestidae	Small Indian Mongoose	*Herpestes auropunctatus*	UC	LC	LC
	Crab-eating Mongoose	*Herpestes urva*	R	NT	LC
	Smooth-coated Otter	*Lutrogale perspicillata*	R	CR	VU
	Small-clawed Otter	*Aonyx cinerea*	R	EN	VU
Mustelidae	Large-toothed Ferret Badger	*Melogale personata*	R	NE	LC
	Yellow-throated Marten	*Martes flavigula*	R	VU	LC
	Hog Badger	*Arctonyx collaris*	C	VU	VU
Canidae	Golden Jackal	*Canis aureus*	VC	LC	LC
	Jungle Cat	*Felis chaus*	R	NT	LC
Felidae	Fishing Cat	*Prionailurus viverrinus*	R	EN	VU
	Marbled Cat	*Paradofelis marmorata*	R	DD	NE
	Leopard Cat	*Prionailurus bengalensis*	R	NT	LC
Viverridae	Large Indian Civet	*Viverra zibetha*	R	NT	LC

Family	Common Name	Scientific Name	Local Status	IUCN Threat Status	
				National	Global
	Small Indian Civet	*Viverricula indica*	R	NT	LC
	Common Palm Civet	*Paradoxurus hermaphroditus*	VC	LC	LC
	Masked Palm Civet	*Poguma larvata*	UC	VU	LC
Cervidae	Barking Deer	*Muntiacus muntjak*	C	EN	LC
Bovidae	Red Serow	*Capricornis rubidus*	R	EN	VU
Suidae	Wild Boar	*Sus scrofa*	VC	LC	LC
Manidae	Chinese Pangolin	*Manis pentadactyla*	R	CR	CR
Hystricidae	Indian Crested Porcupine	*Hystrix indica*	C	LC	LC

The present study recorded 55 species of mammals from Baraiyadhala National Park (BNP) of which 28 species were encountered in camera traps. In a previous study Karim and Ahsan (2016) reported 29 mammalian species from this National Park. They reported the presence of Wild Dog (*Cuon alpinus*), Bengal Fox (*Vulpes bengalensis*), Brush-tailed Porcupine (*Atherurus macrourus*) and Indian Hare (*Lepus nigricollis*) based on the perceptions of the local people but in the present study none of these species was recorded. These species may have become locally rare with very low population due to hunting and various anthropogenic activities. Two species of non-human primates were reported from a previous study (Karim and Ahsan, 2016) while the present study recorded eight species of non-human primates from this National Park. The country's stronghold for Assamese Macaques (*Macaca assamensis*) is Baraiyadhala National Park, where four groups comprising 39 individuals have been documented (Hasan *et al.*, 2022).

Moreover, the present study also recorded Small-clawed Otter (*Aonyx cinerea*), Smooth-coated Otter (*Lutrogale perspicillata*), Large-toothed Ferret Badger (*Melogale personata*), Hog Badger (*Arctonyx collaris*), Leopard Cat (*Prionailurus bengalensis*) and Marbled Cat (*Paradofelis marmorata*). Mammalian species diversity in Baraiyadhala National Park is relatively higher (55 species) than Sheikh Jamal Inani National Park (39 species), Chunati Wildlife Sanctuary (40 species), Teknaf Wildlife Sanctuary (43 species), Rema-Kalenga Wildlife Sanctuary (44 species), Dudpukuria-Dhopachari Wildlife Sanctuary (50 species), (Feeroz *et al.*, 2011, 2012; Feeroz, 2013, 2014, 2016) but a bit less than Kaptai National Park (62 species) (Khan *et al.*, 2016).

In this study it was revealed that species richness and species composition of mammals in this mixed evergreen forest are influenced by different habitats. Species richness is higher in those areas with perennial water source (stream

water) compared to forest edge, forest floor and steep hill area. A variable degree of species composition was found along habitat categories. Although species overlap with forest floor, unique composition clearly evident for the steep hill, stream area and forest edge. Beta diversity was found relatively high in the stream area followed by the forest floor, forest edge and steep hills. This finding indicate that species diversity is associated with the water availability, whether they occupied in different niche for other resources.

Red Serow (*Capricornis rubidus*) was recorded from this National Park. Our camera trapping efforts captured 25 individual events, which indicates a small population of this species (Hasan and Datta 2024). Barking Deer was found to be the signature species in BNP occupying in forest floor, steep hill and stream area as well. This finding indicates the quality of the vegetation cover for different micro-habitats which were consumed by Barking Deer. Floral composition especially, species richness of trees, herbs and shrubs were found to be high in the BNP (Rashid *et al.*, 2018) indicated an ideal landscape for browsing and grazing animal, such as Barking Deer. Seasonal pattern of browsing nature was described by Habiba *et al.* (2021), trees were favorable both summer and winter where shrubs were higher in winter. Along with vegetation, terrain features such as elevation and slope and anthropogenic factors might affect the presence of Barking Deer (Neupane *et al.*, 2022).

Species those living the forest edge showed unique species composition such as Asiatic golden jackal and Jungle cat, have never been found through camera traps inside the core forest area in the BNP. Our finding suggested that these mammals showed opportunistic behavior who sheltered in the periphery area of the forest but forage outside in the cultivated area and around local households. The western periphery of the forest is without any buffer zone and encroached by local people mainly for cultivation. Besides, tourism is getting popular these days attracts immense number of people throughout the year. Thus, opportunistic wild mammals get access easy food from the left over from the restaurants at nights (Hasan *et al.,* 2024).

CONCLUSION

Mammals of Baraiyadhala National Park are facing different kinds of anthropogenic threats like poaching and intentional forest fire. Poachers use snare trap and firearm, also found to excavate holes and burrows. A major portion of the forest was found to burn every year due to intentional forest fire which creates additional hunting opportunity for the poachers. To overcome this situation, effective management plans involving local community is needed. Poaching can be controlled with modern approaches like SMART patrolling in this national park.

Acknowledgements: We sincerely thank Bangladesh Forest Department for their assistance and financial support for this study through SUFAL innovation grant (SIG-Phase 1) of The World Bank. Special thanks to Mr. Prosenjit Debbarman, Mr. Ripon Biswas and Mr. Indrojit Bonik for executing the field work.

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(Manuscript received on 19 October 2024 revised on 26 December 2024)