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Mammalian diversity and conservation status in and around Ranga Reserve Forest, Lakhimpur, Assam, India

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DISCOVERY
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ABSTRACT

The study has been carried out in the Ranga Reserve Forest of Assam to find out the mammalian diversity during our study period from March 2021 to June 2022 spread over the four distinct seasons: Summer (March to May), followed by the monsoon season (June to August), post-monsoon season (September to November), and winter (December to February) using Visual Encounter Survey, Randomized Walk and Camera Trapping Method at the fringe villages of the forest. The study revealed 24 species of Mammals belonging to 22 genera under 16 families and eight orders recorded from the study site during the study period. During the study period, it was found that the Sciuridae family exhibited the highest species richness, constituting 17% with four species. On the other hand, the families Elephantidae, Lorisidae, Muridae, Hystricidae, Leporidae, Pteropodidae, Manidae, Canidae, Mustelidae, Suidae, and Cervidae displayed the lowest species richness, comprising 4% each with one species. The Ranga Reserve Forest is home to the Critically Endangered *Manis pentadactyla* (Linnaeus) and the Endangered *Elephas maximus* (Linnaeus), along with other threatened mammals such as the *Nycticebus bengalensis* (Lacepede) and *Viverra zibetha* (Linnaeus). According to the Wildlife (Protection) Act, 1972, the recorded mammals fall in different schedules: six species of mammals in Schedule I, 14 species in Schedule II, two species in Schedule III, one species in Schedule IV and two species in Schedule V. In this paper, an attempt was made to provide the inventory, status and conservation of mammalian diversity of Ranga Reserve Forest, Assam. Mammal populations in the study area face immediate and substantial threats from various human-induced activities and environmental challenges, including habitat degradation, pollution, hunting, and climate change. These multifaceted issues demand immediate and comprehensive conservation efforts to ensure the well-being and sustainability of these populations in the region.

Keywords: Mammal, Diversity, Ranga Reserve Forest, Assam, India

1. INTRODUCTION

The Northeastern region is considered one of the two biologicals 'Hot Spots' in India. North-east India forms a significant portion of the Himalayas and Indo-Burma biodiversity hotspots. Assam, 59.4% of the total forest area of the state is categorized as Reserve Forest, which harbors biodiversity. Therefore, to study of biodiversity of the region, it is convenient to concentrate on the Reserve Forests. Ranga Reserve Forest is situated between the Ranganadi River and the Dikrong River in Lakhimpur district of Assam, sharing its northern boundary with the Papum Pare district of Arunachal Pradesh. Within this district range, two other adjacent reserve forests—Kakoi and Dulung—lie. This forest area serves as the southwestern extension of Arunachal Pradesh, stretching in an upward eastern direction along the interstate border of Arunachal.

The highest geographical location covers the range within Dulung Reserve Forest, spanning 9900.03 hectares. Mammals act as critical components as they are potential indicators for the health of the ecosystem and provide crucial services for the ecosystem (Ahumada et al., 2011). Terrestrial mammals are the vital element for the communities of tropical forests as ecosystem service providers and indicators of ecosystem health, which often makes them of particular conservation and management concern (Kitamura et al., 2010). According to the updated checklist of Indian Mammals, India is providing habitat to 428 mammalian species under 48 families, out of which 193 species of mammals belonging to 32 families are found only in the state of Assam, thereby representing about 60% of the country's mammalian diversity (Choudhury, 1997).

Ranga Reserve Forest is one of the important reserve forests of the Lakhimpur district of Assam. But the Ranga Reserve Forest was not previously studied on any mammalian and faunal diversity as well. Due to lack of scientific information about any of the faunal diversity of the reserve forests, the conservation status and importance of the area has not been evaluated to date. This study attempts to prepare a checklist of mammalian fauna based on recent records from the reserve forest, which will help in understanding the importance of the reserve forest and further help in conservation evaluation.

2. MATERIALS AND METHODS

Study Area

The research was conducted in the Ranga Reserve Forests, located in the Lakhimpur district of Assam, India. This area spans 85.2871 km2 and lies between longitudes 93°47'37.48" E to 94°01'12.75" E and latitudes 27°07'04.50" N to 27°19'21.02" N. A significant portion of this land, about approximately 88.14% is covered by dense and open forests (Saikia and Saikia, 2020). Specifically, within the reserve forest, sampling sites were designated in Gulajuli, Bogoli, Kachajuli, Dhekiajuli, Rampur, and Kimin during the survey period (Figure 1). The Ranga Reserve Forest features a diverse landscape characterized primarily by riverine and hilly terrain. The vegetation within the reserve encompasses a spectrum, ranging from riverine grassland to lowland tropical rainforest. The lowland ranges extend across the entirety of the Ranga Reserve, merging in a northern direction with low hill ranges that connect seamlessly to the state of Arunachal Pradesh. The predominant forest type in this region is semi-deciduous.

Methods of the study

The survey was designed with the aim to create a checklist of Mammals from the Ranga Reserve Forest of Lakhimpur district, Assam. During the study period, the objectives were studied in the field by applying the following methodologies. Numerous techniques and methods are being used to survey mammals. We have applied Visual Encounter Survey Heyer et al., (1994) and Randomized Walk Lambert, (1984) methods to encounter mammalian species. Due to differential detection probability coupled with their habits such as diurnal and nocturnal, it isn't easy to use one approach to study all mammals in any eco-system. In this regard, monitoring these animals using Camera Trapping Method Karanth and Nichols, (1998) is an alternative, popular and effective method. We have used Camera Trapping Method in the fringe villages of the Ranga Reserve Forest.

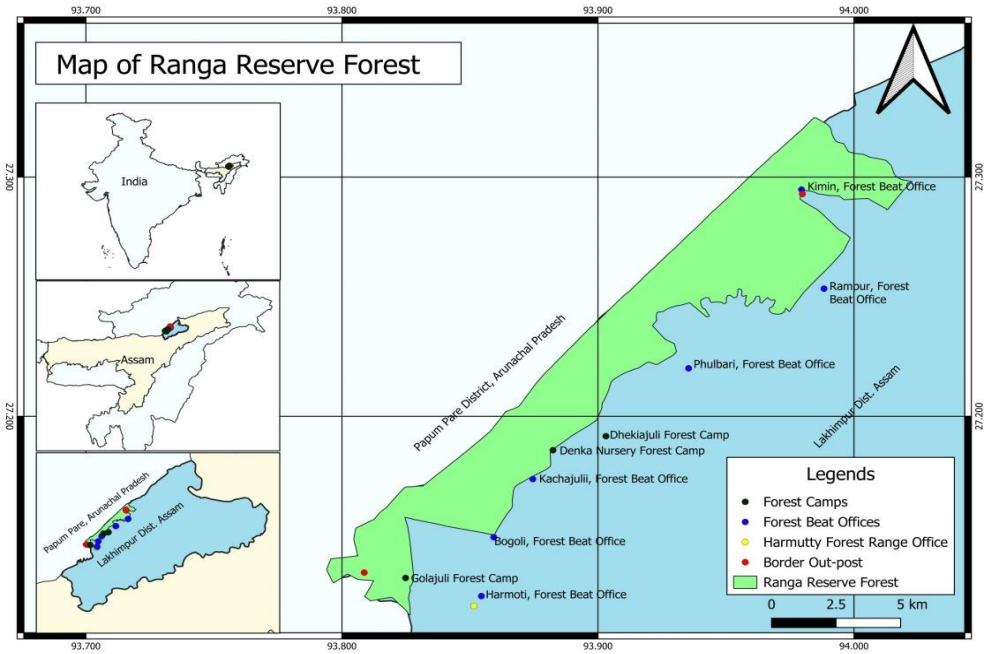

Figure 1 The map showing the study area (Ranga RF).

Study Design

Multiple field days were spent in Ranga Reserve Forest throughout the all seasons of March 2021 to June 2022 to document the mammalian diversity of the study area. The year was divided into four distinct seasons: Summer (March to May), monsoon season (June to August), post-monsoon season (September to November), and winter (December to February). Our observations were conducted during favorable weather conditions (except rain or strong winds). The entire survey was conducted during day time for diurnal animals and during night time in the vicinity of human habitation or near the forest for nocturnal mammals. A total of six localities were covered during the study period. The data collection was carried out for eight hours per day, from 06:00 hours to 10:00 hours and from 14:00 hours to 18:00 hours.

Data Collection and Identification

Data collection occurred during fieldwork, with comprehensive details recorded on a field data sheet. Information such as locality, date, time, and the habitat of each data was documented. The collection of data occurred randomly along foot trails, stream and river beds, grasslands, and other locations recognized for the presence of the targeted faunal species. Photographic evidence was systematically captured using a DSLR Camera (Nikon D5600) and Camera Trap (Cuddeback 20MP). The identification of mammalian species was based on visual examination and color photographs.

The species was also identified by studying footprints, pugmarks on the forest track and near water bodies. The species identification and classification are also done by published journals or guide books to mammals, supplement with personal data and expertise. For identification of the mammalian species, the photographic guide books of Choudhury, (1997), Menon, (2014) was used. To accurately pinpoint survey sites, geographic coordinates were recorded using an Android mobile app (Note Cam). The map of the study area (Figure 1) was prepared using Q-GIS software version 3.18, and data analysis was performed using Microsoft Office Excel 2010 (Figure 2).

3. RESULTS

About 24 species belonging to 22 genera under 16 families and eight orders of mammals were recorded from the study site during the study period. As per IUCN status, 1 species listed as Critically Endangered- *Manis pentadactyla* (Linnaeus); one species as Endangered- *Elephas maximus* (Linnaeus); 2 species are Vulnerable- *Trachypithecus pileatus* (Blyth) and *Nycticebus bengalensis* (Lacepede); one species of Near Threatened- *Viverra zibetha* (Linnaeus) and rest species are listed as Least Concern. According to the Wildlife (Protection) Act,

1972, among the recorded mammals, six species are listed under Schedule I, 14 species under Schedule II, two species under Schedule III, one species under Schedule IV, and two species under Schedule V (Table 1).

Table 1 Recorded Mammals of Ranga Reserve Forest, Assam, with their Conservation Status.

Sl. No.	Common Name	Scientific Name	Conservation Status		
			IUCN Status	WPA (1972)	CITES (Appendix)
I. Order: Proboscidea					
1	*Family: Elephantidae* Asiatic Elephant	*Elephas maximus* Linnaeus, 1758	EN	I	I
II. Order: Primates					
2	*Family: Cercopithecidae* Rhesus Macaque	*Macaca mulatta* (Zimmermann, 1780)	LC	II	II
3	Capped Langur	*Trachypithecus pileatus* (Blyth, 1843)	VU	I	I
4	*Family: Lorisidae* Bengal Slow Loris	*Nycticebus bengalensis* (Lacepede, 1800)	VU	I	I
III. Order: Rodentia					
5	*Family: Sciuridae* Hoary-Bellied Squirrel	*Callosciurus pygerythrus* (I. Geoffroy Saint-Hilaire, 1831)	LC	II	
6	Pallas's Squirrel	*Callosciurus erythraeus* (Pallas,1779)	LC	II	-
7	Himalayan Striped Squirrel	*Tamiops macclellandi* (Horsfield, 1840)	LC	II	-
8	Parti-Coloured Flying Squirrel	*Hylopetes alboniger* (Hodgson, 1836)	LC	II	-
9	*Family: Muridae* House Mouse	*Mus musculus* (Linnaeus, 1758)	LC	V	-
10	*Family: Hystricidae* Himalayan Crestless Porcupine	Hystrix brachyura (Linnaeus, 1758)	LC	II	-
IV. Order: Lagomorpha					
11	*Family: Leporidae* Indian Hare	*Lepus nigricollis* (F. Cuvier, 1823)	LC	IV	-
V. Order: Chiroptera					
12	*Family: Pteropodidae* Indian Flying Fox	*Pteropus giganteus* (Brünnich, 1782)	LC	V	-
VI. Order: Pholidota					
13	*Family: Manidae* Chinese Pangolin	*Manis pentadactyla* (Linnaeus, 1758)	CR	I	I
VII. Order: Carnivora					
14	*Family: Felidae* Jungle Cat	*Felis chaus* (Schreber, 1777)	LC	II	II
15	Leopard Cat	*Prionailurus bengalensis* (Kerr, 1792)	LC	I	I
16	*Family: Viverridae* Asian Palm Civet	*Paradoxurus hermaphroditus* (Pallas, 1777)	LC	II	III
17	Small Indian Civet	*Viverricula indica* (E. Geoffroy Saint Hilaire, 1803)	LC	II	III

18	Large Indian Civet	*Viverra zibetha* (Linnaeus, 1958)	NT	II	III
19	*Family: Herpestidae* Small Indian Mongoose	*Herpestes auropunctatus* (Hodgson, 1836)	LC	II	III
20	Crab-eating Mongoose	*Herpestes urva* (Hodgson, 1836)	LC	II	III
21	*Family: Canidae* Golden Jackal	*Canis aureus* (Linnaeus, 1758)	LC	II	II
22	*Family: Mustelidae* Yellow-throated Marten	*Martes flavigula* (Boddaert, 1785)	LC	II	III
VIII. Order: Artiodactyla					
23	*Family: Suidae* Wild Pig	*Sus scrofa* (Linnaeus, 1758)	LC	III	-
24	*Family: Cervidae* Indian Muntjac	*Muntiacus muntjak* (Zimmermann, 1780)	LC	III	-

Family-wise diversity of mammals in the study area

During the period of study, it has been found that among all the families, the Sciuridae family showed the maximum species richness, comprising 17% with four species, and the family Elephantidae, Lorisidae, Muridae, Hystricidae, Leporidae, Pteropodidae, Manidae, Canidae, Mustelidae, Suidae, and Cervidae showed the least number of species, comprising of 4 % with one species (Figure 2).

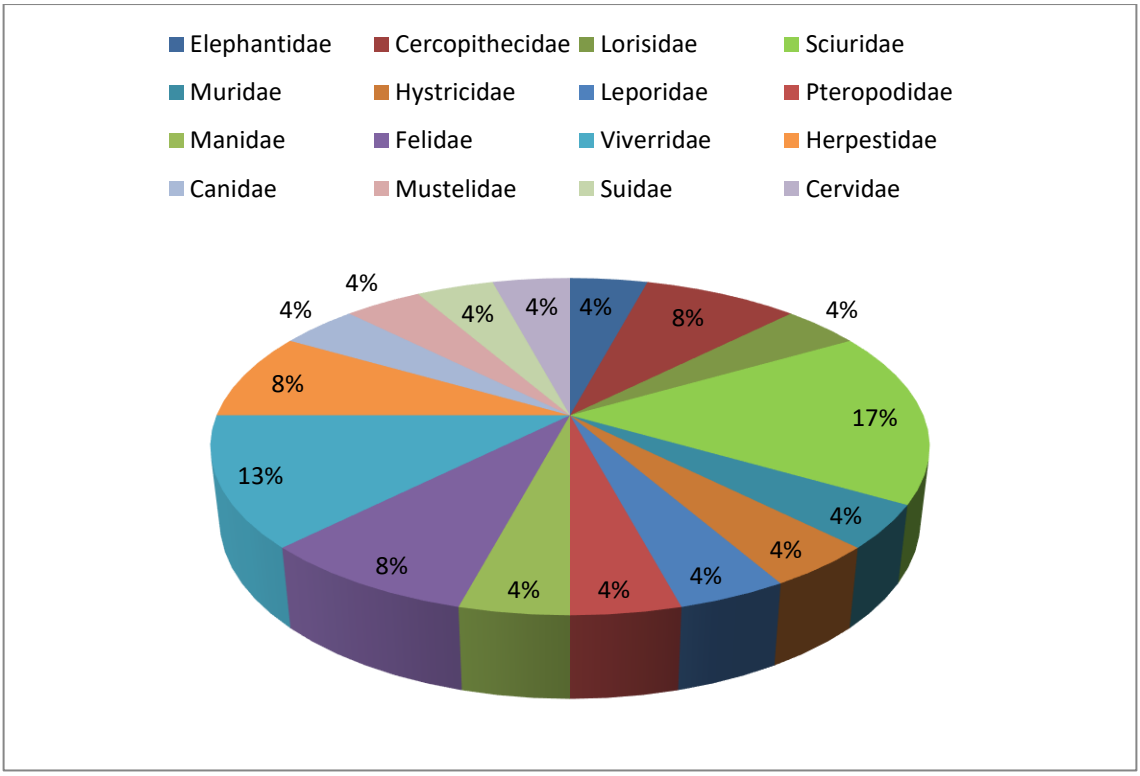

Figure 2 Family-wise distribution of mammals in Ranga Reserve Forest, Assam, India.

Notes on significant records

In addition to the summary and preliminary analyses of mammalian diversity presented above and in associated tables and figures, we now offer notes relevant to our significant sightings of mammals in the Ranga Reserve Forest. The important results found are discussed below.

Asiatic Elephant *Elephas maximus* Linnaeus, 1758

Asiatic Elephants are very common in the reserve forest, often encountering villages, leading to human-elephant conflicts in the study area. During the paddy season (October to December), elephants predominantly venture into village areas and also destroy paddy fields and human houses (Figure 3a). Sometimes, this results in life-threatening consequences for both humans and elephants. Therefore, people use electric fences, shot guns to mitigate with elephants. The Asian Elephant is an Endangered species according to IUCN Red List and is listed as a Schedule I species under the Indian Wildlife (Protection) Act, 1972 and Appendix I to CITES (Table 1).

Capped Langur *Trachypithecus pileatus* (Blyth, 1843)

Capped langur is distributed in dense, deciduous, evergreen forests throughout the state of Assam. This species was sighted many times, ranging from six to eight individuals in one herd during the study period near the village areas and Bogoli beat office (Figure 3c). But it should be noted that we also observed 10 to 15 individuals in one herd before the study period in the study area. Habitat fragmentation, decreasing the number of food trees, various anthropogenic activities and conflict with humans may be the reasons for reducing the population of this species. This Vulnerable primate species is expected in the forest and is a Schedule I species under Indian Wildlife (Protection) Act, 1972 and Appendix I in CITES (Table 1). The conservation of this species is primarily challenged by conflicts between humans and wildlife.

Bengal Slow Loris *Nycticebus bengalensis* (Lacepede, 1800)

Bengal Slow Loris is a common species in the study area, having been recorded only once at the Kachajuli camp site. Still, forest department rescued this species many times from the village areas (Figure 3d). It prefers sub-tropical and tropical semi-evergreen and evergreen forests and is sometimes found near the human habitation areas. This species often visits human habitation areas in search of food. But, due to lack of knowledge people kill them. This Vulnerable primate species is a Schedule I under Indian Wildlife (Protection) Act, 1972 and Appendix I in CITES (Table 1).

Pallas's Squirrel *Callosciurus erythraeus* (Pallas, 1779)

Pallas's Squirrel is mainly found in primary and secondary forests, distributed throughout North-east India. This medium sized squirrel was seen thrice at Bogoli and Dhekiajuli camp sites (Figure 3e). Pallas's Squirrel confronts threats including habitat loss due to deforestation, urbanization, poaching and predation by domestic animals. These challenges endanger their populations, necessitating conservation measures to safeguard their habitats and mitigate the conflicts. This species is a Least Concern according to the IUCN Red List and is listed as Schedule II species under Indian Wildlife (Protection) Act, 1972 and Appendix II in CITES (Table 1).

Himalayan Crestless Porcupine *Hystrix brachyura* (Linnaeus, 1758)

Himalayan Crestless Porcupine is common species in the Ranga Reserve Forest and distributed in the whole of North East India. It prefers primarily forests and forest fringe habitats. During the study period, this species was observed several times in different sampling sites (Gulajuli, Bogoli, Kachajuli, Dhekiajuli and Kimin) (Figure 3h). This species is facing threats such as habitat destruction, conflict with livestock, hunting for meat and various anthropogenic activities. These pose challenges to both agricultural livelihoods and wildlife conservation efforts, requiring balanced mitigation strategies for human-porcupine coexistence. The Himalayan Crestless Porcupine is of Least Concern according to IUCN Red List and is listed as a Schedule II species under the Indian Wildlife (Protection) Act, 1972 (Table 1).

Chinese Pangolin *Manis pentadactyla* (Linnaeus, 1758)

Among the mammals of Ranga Reserve Forest, as well as Assam, this species is facing the most severe threat from the local poachers and hunters. The species was spotted unexpectedly by villagers in Rampur village during the study period and they informed the forest department. After that the species was rescued by the members of AWRRO with the help of the forest department (Figure 3k). Chinese Pangolin is Critically Endangered according to the IUCN Red List, listed as a Schedule I species under the Indian Wildlife (Protection) Act, 1972 and Appendix I in CITES (Table 1). Very often, it is captured from forest areas for consumption of its meat and the use of various parts of its body for medicinal purposes.

Photo Sources: Forest Department, AWRRO

Figure 3 Photographs shows the Mammals recorded in Ranga Reserve Forest, Lakhimpur during the study period (a. *Elephas maximus*, b. *Macaca mulatta*, c. *Trachypithecus pileatus*, d. *Nycticebus bengalensis*, e. *Callosciurus erythraeus*, f. *Tamiops macclellandi*, g. *Hylopetes alboniger*, h. *Hystrix brachyura*, i. *Lepus nigricollis*, j. *Pteropus giganteus*, k. *Manis pentadactyla*, l. *Felis chaus*, m. *Prionailurus bengalensis*, n. *Paradoxurus hermaphroditus*, o. *Viverra zibetha*, p. *Herpestes urva*, q. *Canis aureus*, r. *Martes flavigula*)

Jungle Cat *Felis chaus* (Schreber, 1777)

Distributed in the Himalayas and North East India, this cat species mostly prefers grasslands, scrub, dry deciduous and evergreen forests. Sometimes, it appears near to semi-urban and village areas. This species was recorded once near the Riparian Habitat of Gulajuli camp during the study period (Figure 3l). The main threats to Jungle Cats in the study area as well as the state include habitat loss due to human encroachment and deforestation, human-wildlife conflict leading to killings, poaching for fur and body parts and also road mortality. Conservation efforts focus on habitat protection and mitigating conflicts. This species is recognized as Least

Concern category as per the IUCN Red List, it is listed as a Schedule II species under the Indian Wildlife (Protection) Act, 1972 and Appendix II in CITES (Table 1).

Large Indian Civet *Viverra zibetha* (Linnaeus, 1958)

The Large Indian Civet is distributed in North East India, commonly found in low hills, moist deciduous and evergreen forests, as well as near human habitation. This species was recorded once near human habitation during the study period (Figure 3o). The main threats to Large Indian Civets include habitat loss due to deforestation and conversion of forests for agriculture. Human-wildlife conflict arises from killings due to predation on poultry. Poaching for fur and meat and road mortality are additional concerns. Conservation efforts target habitat preservation and conflict mitigation. This species is recognized as Near Threatened according to the IUCN Red List, listed as a Schedule II species under the Indian Wildlife (Protection) Act, 1972 and included in Appendix III of CITES (Table 1). Poaching is the main threat to this species.

Crab-eating Mongoose *Herpestes urva* (Hodgson, 1836)

Crab-eating Mongooses are mostly found in paddy fields and moist deciduous forests of North-east India. This species is seen at the border point of Bogoli camp and the village area near the Riparian fringing Forest (Figure 3p). The primary challenges facing the crab-eating mongoose include habitat loss and degradation, primarily caused by deforestation and conversion of wetlands to agricultural land. Human-wildlife conflict can mainly occur due to poultry farming. Conservation focuses on habitat protection and conflict resolution. This species is recognized as Least Concern according to the IUCN Red List, listed as a Schedule II species under the Indian Wildlife (Protection) Act, 1972 and included in Appendix III of CITES (Table 1).

Yellow-throated Marten *Martes flavigula* (Boddaert, 1785)

Yellow-throated Marten is uncommon in the Ranga reserve forest, primarily found in hilly terrain. This species was sighted two times at the Kimin forest camp near the forested area (Figure 3r). The main threats to Yellow-throated Martens in Assam as well as the study area include habitat loss and fragmentation from deforestation, logging and conversion of forests to agricultural land. Poaching and trapping for fur and body parts also pose significant threats. Conservation efforts are aimed at habitat protection, law enforcement against poaching, and community awareness. The Yellow-throated Marten is recognized as Least Concern as per the IUCN Red List, listed as a Schedule II species under the Indian Wildlife (Protection) Act, 1972 and Appendix III in CITES (Table 1).

Indian Muntjac *Muntiacus muntjak* (Zimmermann, 1780)

Indian Muntjac is distributed throughout the state of Assam in deciduous, evergreen and secondary forests. But this species was observed only once during the study period near the village areas under Kimin Beat office. This species is recognized as a species of Least Concern as per the IUCN Red List and is listed as a Schedule III species under the Indian Wildlife (Protection) Act, 1972 (Table 1). Local hunters often target Muntjac for its meat and skin, commonly traded in local village markets. Additionally, the species faces significant threats from anthropogenic activities like deforestation.

4. DISCUSSION

The present survey is the first survey in Ranga Reserve Forest in which several species of mammals were recorded. About 24 species belonging to 22 genera under 16 families and eight orders of Mammals were recorded from the study site during the study period. Among them, some are common, and few are exclusive or rare. Most Indian mammals are protected under various Schedules of the Indian Wildlife (Protection) Act, 1972 and are also listed in the IUCN Red List of Threatened Species and CITES (Table 1). A crucial consideration is to enhance the measurement, monitoring, and management of biodiversity. We need to evaluate our conservation strategies in the context of human biomass requirements, emphasizing a coordinated approach that sustains the protection of both ecosystems and overall biodiversity (Sharma et al., 2015). Encroachment by people on the periphery has led to reduced forest cover and loss of habitat (Sharma, 2018).

Road kill, habitat fragmentation, conflict between Human and Wildlife, poaching and hunting for fur and meat are the primary concern. Efforts to preserve the diversity of these mammals have prioritized habitat conservation, strict enforcement against poaching, and community awareness initiatives. By protecting their habitats, combating illegal activities, and engaging local communities, we

strive to ensure the survival and prosperity of these valuable mammalian species. And also, the low number of mammals indicates that the survey needs to be conducted at night inside the forest area and with appropriate experts. However, the exploration of this unexplored reserve forest helps us to understand the diversity of mammals and distribution of this region, as well as revealing new aspects of their behavior, diet, breeding, habitat and micro habitat they use.

5. CONCLUSION

The fauna of the Ranga Reserve Forest has been adversely affected by the combined effects of habitat destruction, hunting, poaching, deforestation, pesticides use and other factors. The present need is sincere, collective efforts and action-oriented strategies for conservation of Biodiversity and different habitats of the forest to restore degraded ecosystems to be accelerated. Additional survey in this rich biogeographic region may add more number of mammals on this list.

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Author Contributions

MKT: Conceptualization, data collection, fieldwork, data curation, formal analysis, methodology, visualization, writing—original draft and editing; SD, HJD: Conceptualization, data collection, fieldwork, formal analysis; TKP, DM, SJ, RK, KS: Conceptualization, data collection, fieldwork.

Informed consent

Not Applicable

Ethical approval

Mammals from Ranga Reserve Forest, Lakhimpur, Assam, India was observed in the study. The animal ethical guidelines are followed in the study for species observation and identification.

Conflicts of interests:

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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