Uttar Pradesh Journal of Zoology

Volume 44, Issue 15, Page 34-54, 2023; Article no.UPJOZ.2640
ISSN: 0256-971X (P)

Carnivores in Peril in the 'Valley of Extinction': A Review on Diversity, Distribution Status and Conservation in Southern Assam, India

Sanker Paul [a], Amir Sohail Choudhury [b], Utsab Singha [c], Purbajyoti Saikia [a], Imrana Begam Choudhury [d] and Muhammed Khairujjaman Mazumder [a*]

[a] Department of Zoology, Dhemaji College, Dhemaji, Assam–787057, India.
[b] Department of Ecology and Environmental Sciences, Assam University, Silchar, Assam–788011, India.
[c] Department of Zoology, The Assam Royal Global University, Guwahati, Assam–781035, India.
[d] Sayedpur Appleswamy Memorial Lower Primary School, Kanchanpur, Hailakandi, Assam–788155, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors MKM and ASC designed the study. Authors SP, PS and IBC managed the literature searches and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i153567

Editor(s):
(1) Prof. Juan Carlos Troiano, University of Buenos Aires, Argentina.
Reviewers:
(1) Tahani Ali Hassan Elhaj, University Of Bahri, Sudan.
(2) Mohammadreza Mohammadabadi, Shahid Bahonar University of Kerman, Iran.

Review Article

Received: 07/05/2023
Accepted: 08/07/2023
Published: 24/07/2023

ABSTRACT

Southern Assam (in Northeast India), also known as Barak valley, is a part of the Indo-Burma biodiversity hotspot. With some magnificent species already extinct from the region, and some on the verge of extinction, the valley is rightly called the 'Valley of Extinction'. The region has two

**Corresponding author: Email: khairujjaman1987@gmail.com;*

wildlife sanctuaries (WLS): Barail WLS and Barak-Bhuban WLS; one proposed WLS (Patharia), and a network of reserve forests (RF) which serve as strongholds of several wild species. However, due to rapid deforestation and decrease in their suitable habitats, encroachment into the wildlife sanctuary and RFs, depletion of prey and food trees, expansion of agriculture, changes in land use and land cover, road kills, etc., most of the wildlife are severely threatened, while others have now adapted to human dominated habitats thereby becoming pests, and vulnerable to prosecution. Moreover, research on the wildlife of the region, excluding a few species, is extremely limited, more so in the case of carnivores owing to their elusive and nocturnal behaviour. The present article focuses on the diversity, status, distribution, threats and conservation of the carnivores of southern Assam. We hereby report a total of 33 species of carnivores from the region, of which 2 are extinct, 2 are probably extinct with only stray individuals. Of the species reported hereby, three are 'Endangered', ten are 'Vulnerable', and another three are 'Near threatened', as enlisted by IUCN. In the beginning of the last century, most of these carnivore species were abundant in southern Assam, which is however decreasing alarmingly. Thus, strict enforcement of Wildlife (Protection) Act, 1972 and Indian Forest Act, 1927; along with awareness campaigns, research on ecology, and population censuses of these species should be carried out to save the remaining populations in the region.

Keywords: Barak valley; conservation; Indo-Burma biodiversity hotspot; North-East India.

ABBREVIATIONS

RF : Reserve forest
WLS : Wildlife Sanctuary
LULCI : Land Use and Land Cover Information
IUCN : World Conservation Union (formerly International Union for the Conservation of Nature and Natural Resources)
CITES : Convention on International Trade in Endangered Species

1. INTRODUCTION

The southern Assam (in Northeast India) comprises of the districts Cachar, Karimganj, and Hailakandi, and is a part of the Indo-Burma Biodiversity hotspot, thereby harboring enormous wildlife wealth [1]. Southern Assam is geographically located between $92^0$15'E and $90^0$15'E, and $24^0$8'N and $26^0$8'N, comprising 8.9% of the geographic area of Assam, with an area of 6922 sq. km (Fig. 1). The southern Assam falls in the Oriental or Indo-Malayan region, and Indo-Chinese sub-region. The southern Assam is bordered by the Barail range in the north (Dima Hasao district of Assam, and *Jaintia* Hills district of the state Meghalaya), Manipur Hills in the east, *Mizo* Hills in the south, Tripura Hill tracts in the south and west, and *Jaintia* Hills of Meghalaya and the Sylhet district of Bangladesh in the west. While the region is broadly the Barak plain – the upward extension of the Bengal plain, there are hills, hillocks and plateau along its all borders, except the north-west [2,3]. The hills to the south run in north-south directions. The highest peak in the region is the Sherpai peak of Cachar district (1657 m), which falls in the Barail range in the north [4]. A part of the Barail range, within southern Assam (Cachar), has been designated as the Barail Wildlife Sanctuary (WLS) covering an area of 326.24 sq. km, 4.71% of the total geographic area of southern Assam. The Barail WLS is contiguous with the Barail reserve forest (RF) (Dima Hasao, Assam), and Saipung RF, Narpuh RF Block – I & II of Meghalaya, and thus has a good wildlife assemblage [2]. Another WLS has recently been declared, the Barak-Bhuban WLS in Cachar, covering an area of 320 sq. km., which is also a stronghold of wildlife including carnivores.

Parts of Manipur Hills, *Mizo* Hills, and Tripura Hill Tracts along the eastern, southern and western boundaries of the southern Assam form the most important RFs network of the region. The RFs of southern Assam are Patharia RF, Adorkuna RF, Tilbhum RF, Badshahitila RF, Duhalia RF, Singla RF and Longai RF in Karimganj district; Innerline RF and Katakhal RF in Hailakandi district; and Innerline RF (Parts), Sonai RF, Lower Jiri RF and Upper Jiri RF in Cachar district (Fig. 1A). Innerline RF is the largest RF of Assam, and is contiguous with the Barak-Bhuban WLS, Katakhal RF, Longai RF, and Singla RF. The total area of 2010.64 sq. km. under RF network of southern Assam is 29% of the total geographic area of the region. The main river of the region is the Barak, and thus, southern Assam is also known as Barak valley. The region receives annual rainfall of more than 300 cm. While the southern Assam broadly falls in the Cachar

tropical evergreen and semi-evergreen vegetation zones, the ecosystem diversity of the region include tropical evergreen, semi-evergreen, deciduous, and scrub forests, tea gardens, fruit orchards, monoculture plantations, bamboo orchards, crop fields, rivers, valleys, flood-plains, wetlands, etc. [2,3,5,6].

Some of the magnificent species of the region have become locally extinct in the last century including the Gaur *Bos gaurus,* Indian One-horned Rhino *Rhinoceros unicornis,* Sumatran Rhino *Dicerorhinus sumatrensis,* Javan Rhino *R. sondaicus*, Asiatic Water Buffalo *Bubalus arnee,* etc. [2,7]. Other species had become extinct from the region including the Gharial *Gavialis gangeticus* and Mugger *Crocodilus palustris* [8]. Moreover, other charismatic species are on the verge of extinction like the Ganges dolphin *Platanista gangetica* [9,10], and Asiatic Elephant *Elephas maximus* [2,11,12]. This shows that the wildlife wealth of southern Assam is vanishing, and is even tagged with the name 'The Valley of Extinction'.

Studies on wildlife of the region in general, and carnivores in particular, are very limited, and thus an extensive report on the carnivores of southern Assam has been a long due. As a consequence, research, conservation efforts, and attention of scientific community to the region with respect to the carnivores is scanty. The present article details the diversity, status, distribution, threats and conservation of the carnivores of southern Assam. Information presented in the present study includes extensive literature survey, field studies and interactions with past hunters, villagers, forest dwellers and elderly people. Some of the literature which have been useful in understanding the diversity and distribution of the wildlife of Assam include Finn [13], Pocock [14-17], Ellerman & Morrison-Scott [18], Prater [19], Corbet and Hill [20], and Wilson and Reeder [21]. Some useful literature on the wildlife of Northeast India in general, and carnivores in particular, published since 1980s include Choudhury [2,7,22-33] and Menon [34]. Conservation of genetic diversity in animal species requires the proper performance of conservation superiorities and sustainable plans which should be based on universal information on population structures, including genetic diversity resources among and between breeds [35,36]. Genetic diversity is an essential element for genetic improvement, preserving populations, evolution and adapting to variable environmental situations [37,38]. On the other hands determination of diversity is important [39,40] in order to define genotypes of animals and their associations with productive, reproductive and economic traits [41-43]. The study of breeds is very important and useful for their characterizing [44,45].

It needs to be mentioned here that the Indian state Assam included the states Meghalaya, Nagaland, Mizoram and Arunachal Pradesh in the past. Thus, in older literatures, like Prater [19], mention of distribution of a species in Assam does not essentially mean present Assam or southern Assam, although we have referred to those literatures in our present work. To specify the same, and detail current distribution in southern Assam, we have explicitly mentioned the distribution of individual species in our study area.

The present article is based on an extensive literature review and field studies performed since 2014, and include interactions with forest officials, local experts, villagers and past hunters. The article aims to decipher the diversity of the order Carnivora, along with their distribution, status, threats and conservation in southern Assam. Based on the study, we have provided recommendations for conservation of the carnivores in the region.

2. DIVERSITY, DISTRIBUTION AND STATUS

The southern Assam has a very high diversity of carnivore species, numbering 33, belonging to seven families and 28 genera. Of them, two species are locally extinct now, and another two are probably extinct. The IUCN (https://www.iucnredlist.org/) enlisted 3 of the species as 'Endangered', 10 as 'Vulnerable', 3 as 'Near Threatened' and rest of them as 'Least Concern' (Table 1). The other details, including Schedule of Indian Wildlife (Protection) Act, 1972, and Appendices of CITES (https://www.speciesplus.net/) are also given in Table 1. For schedule of the WPA, data was obtained from http://www.wiienvis.nic.in/WriteReadData/UserFiles/file/schedule_species_mammals.pdf. The current status as on May 02, 2023, is reported here. Choudhury [2] detailed diversity and mapped the distribution of all mammals of Northeast India, which includes southern Assam. Further details can be found in Choudhury [7,33].

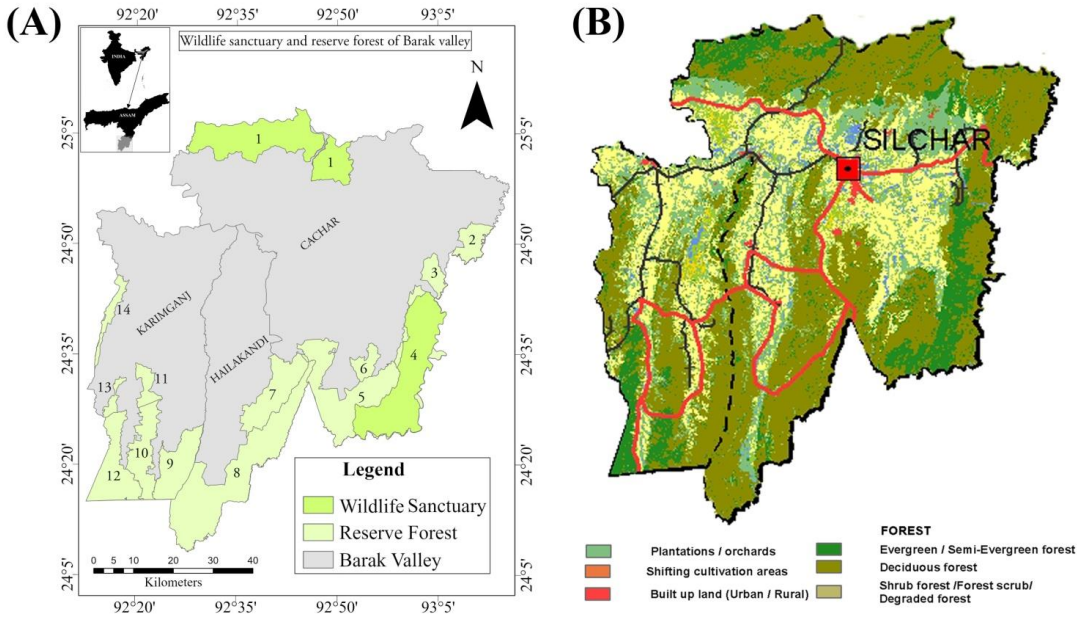

Fig. 1. (A) Wildlife Sanctuaries (WLS) and reserve forests (RF) network of southern Assam, Northeast India: 1 – Barail WLS, 2 – Upper Jiri RF, 3 – Lower Jiri RF, 4 – Barak-Bhuban WLS, 5 – Innerline RF (Cachar part), 6 – Sonai RF, 7 – Katakhal RF, 8 – Innerline RF (Hailakandi part); 9 – Singla RF, 10 – Badshaitilla RF, 11 – Duhalia RF, 12 – Longai RF, 13 – Tilbhum RF, 14- Patharia RF. Inset: Map of India highlighting Assam, and Map of Assam highlighting southern Assam. (B): The land use and land cover map of southern Assam in 2011-12. Map 'A' by Dr. A. S. Choudhury; Map 'B' was obtained from Land Use and Land Cover Information 2011-12. www.bhuvan.nrsc.gov.in

Table 1. Details of the carnivore species of southern Assam with their conservation status

Family	Sub-Family	Common name	Scientific name	IUCN status	WPA schedule	CITES
Canidae		Bengal fox	*Vulpes bengalensis*	LC	II(I)	III
		Golden Jackal	*Canis aureus*	LC	II(I)	III (India)
		Dhole	*Cuon alpinus*	EN	II(I)	II
Ursidae		Asiatic black bear	*Ursus thibetanus*	VU	II(I)	I
		Malayan sun bear	*Helarctos malayanus*	VU	I(I)	I
		Sloth bear	*Melursus ursinus*	VU	I(I)	I
Ailuridae		Red Panda	*Ailurus fulgens*	EN	I(I)	I
Mustelidae	**Mustelinae**	Yellow-bellied weasel	*Mustela kathiah*	LC	II(I)	III (India)
		Stripe-backed weasel	*Mustela strigidorsa*	LC		
		Yellow-throated marten	*Martes flavigula*	LC	II(I)	III
	Melinae	Hog Badger	*Arctonyx collaris*	VU	I(I)	
		Burmese ferret-badger	*Melogale personata*	LC	II(I)	
		Chinese ferret-	*Melogale*	LC	II(I)	

Family	Sub-Family	Common name	Scientific name	IUCN status	WPA schedule	CITES
		badger	*moschata*			
	Lutrinae	Common otter	*Lutra lutra*	NT	II(I)	I
		Smooth-coated otter	*Lutrogale perspicillata*	VU	II(I)	I
		Oriental small-clawed otter	*Aonyx cinereus*	VU	I(I)	I
Viverridae	**Viverrinae**	Small Indian civet	*Viverricula indica*	LC	II(I)	III
		Large Indian civet	*Viverra zibetha*	LC	II(I)	III
		Spotted Linsang	*Prionodon pardicolor*	LC	I(I)	I
	Paradoxurinae	Common Palm civet	*Paradoxurus hermaphrodites*	LC	II(I)	III
		Himalayan Palm Civet	*Paguma larvata*	LC	II(I)	III
		Binturong	*Arctitis binturong*	VU	I(I)	III
		Small-toothed Palm civet	*Arctogalidia trivirgata*	LC	II(I)	
Herpestidae		Small Asian mongoose	*Herpestes javanicus*	LC	II(I)	III (India)
		Crab-eating mongoose	*Herpestes urva*	LC	II(I)	III
Felidae	**Felinae**	Jungle cat	*Felis chaus*	LC	II(I)	II
		Leopard cat	*Prionailurus bengalensis*	LC	I(I)	I (India)
		Fishing cat	*Prionailurus viverrinus*	VU	I(I)	II
		Asian Golden cat	*Catopuma temminckii*	NT	I(I)	I
		Marbled cat	*Pardofelis marmorata*	NT	I(I)	I
	Pantherinae	Clouded leopard	*Neofelis nebulosa*	VU	I(I)	I
		Leopard	*Panthera pardus*	VU	I(I)	I
		Bengal tiger	*Panthera tigris*	EN	I(I)	I

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora)
EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern
WPA: Wildlife (Protection) Act, 1972

Table 2. Land use and land cover in southern Assam in 2005-06 and 2011-12, showing changes in the pattern in the 6 years

Land Class	Year	
	2005-06	**2011-12**
Crop land	1509.58	1491.36
Urban Builtup	36.11	35.64
Plantation Agriculture	649.14	569.14
Shifting cultivation	68.48	40.76
Scrub Forest	180.74	254.09
Deciduous Forest	746.09	1092.66
Evergreen and Semi-evergreen Forest	3322.74	2993.41

Source: Land Use and Land Cover Information (LULCI), 2005-06; LULCI, 2011-12. www.bhuvan.nrsc.gov.in.

2.1 Canidae

The family is represented by three species in southern Assam, of which the Bengal fox (*Vulpes bengalensis*) is most likely extinct, while Dhole (*Cuon alpinus*) has become rare, and the population of Golden Jackal (*Canis aureus*) is rapidly declining despite being common.

The Bengal fox, locally called *Feu-ali,* was previously reported from this region [46]. The local people consider this species associated with the Royal Bengal tiger wherein its calls are regarded as alarms to the arrival of the tiger. In the 1950s, the species was common throughout southern Assam [2]. However, there is no recent record and it is most probably extinct from the region. Mazumdar et al*.* [47] reported that the species is common in the eco-forests in and around Assam University, Silchar (Cachar). However, this report on the species is a misidentification for some other species, possibly *Canis aureus*, which is very common in the area. Choudhury [48] provided photographic evidences on its occurrence in Northeast India.

Dhole or Asian wild dog is locally called *Ram-kutta* and *Ram-bhingul.* It lives in forests. The species has been recorded from Innerline RF as well as the Barail WLS. The species, in packs, is known to attack domestic animals [2]. The Dhole was frequently seen in the Innerline RF and adjoining areas in the 1980s in packs of 10-12 individuals (*pers. comm.* Abdur Razak Mazumder, Hailakandi – a past hunter). Although the present status is unknown, the population is declining.

The Golden Jackal is one of the commonest carnivores of the region, found in countryside, towns and forests, as well as in all the RFs and WLSs (Fig. 2A). The species is locally called *Hiyal, Shiyal.* The species is prosecuted for lifting poultry, and is also poached for pelt and meat [2]. The population estimation of the species in Cachar has been performed by Debnath and Choudhury [49]. They reported tea gardens as important habitats for the jackal, and found a population density as high as 1.85 individuals / sq. km. They have found lesser density in RFs, which may be due to lesser efforts given in RFs or difficulties in observing due to their nocturnal behavior. Moreover, jackals have a tendency to flee and camouflage themselves amidst the forest cover with just a slight hint of movement. Nevertheless, it is evident that tea gardens are among important habitats for the species, and any conservation effort should include such areas, and their stakeholders.

2.2 Ursidae

The state of Assam is unique in having three of the eight bear species of the world, a diversity not found elsewhere on the globe [50]. Assam, including parts of Meghalaya, Arunachal Pradesh, Nagaland and Mizoram, is the north-western distribution limit of the Malayan sun bear, and is also the eastern-most distribution limit of the Sloth bear. The third bear species of southern Assam is the Asiatic black bear. All the bear species are locally called *Bhalluk.*

North Karbi Anglong WLS, East Karbi Anglong WLS and Marat Longri WLS of Assam (adjoining, and extra-limit to the present study area), are the protected areas where all these three species currently occur [32,51]. It is likely that all of them currently occur in the Barail range, including the Barail WLS. While bears have been reported by the locals from the Barail WLS in recent years, past hunters reported that bears were frequently seen in the Innerline RF (Gharmura, Hailakandi) in 1970s, 1980s (*pers. comm.* Abdul Kadir Mazumder, Hailakandi). However, they could not distinguish the species.

The nominate sub-species of Asiatic black bear (*Ursus thibetanus thibetanus*) occurs in southern Assam. The species occurs in forests, from plains to hills. It is rare now with limited recent records. The Barail range, including the Barail WLS, and Barak-Bhuban WLS are among the strongholds of the Asiatic black bear [2,24,51]. One individual was caught from Katakhal RF in 2004 [2,51], thereby indicating its continued existence. In 2013, one cub strayed out, probably from the Barail WLS, in the village near Ghumra (Cachar), and was unfortunately killed [2,51,52].

The Malayan Sun bear (*Helarctos malayanus*) is extremely rare in southern Assam, and the sub-species *annamiticus* occurs in the region. The species occurs in hill forests. The Brahmaputra river acts as a geographic barrier of Malayan sun bear, restricting it to the south of it, and thus in the southern Assam. It is limited by colder climate in the north, and sloth bear in the south and west. The species is sympatric with Black bear, and prefers lower elevations [50,53,54]. The Barail range remains to be the main stronghold of the species, including the Barail WLS. There are stray records from other parts of southern Assam [24,32,50]. The species has

been photographed from Cachar in 2009 [32] as well as confirmed records from the Innerline RF [32,51]. As reported in Gee [55], the species has been seen by tea planters in tea gardens in Cachar and Hailakandi districts, mainly along the Mizoram border. There are several reports of occurrence of the bear species in tropical habitats of Assam [17,55-57].

Fig. 2. Photographs pertaining to different conservation issues of the carnivores of southern Assam (Northeast India): (A) A Golden Jackal in the countryside of Hailakandi – it often lifts poultry and thus prosecuted; (B) *Jhum* cultivation being performed by the *Khasi* tribes at Shahpur (Cachar) – which is one of the prime reasons for the decline of ample habitats of the carnivores; (C) Three Common palm civets killed by the villagers at Kanchanpur, Hailakandi– such practices are common in southern Assam; (D) A Jungle cat caught at Narainpur, Hailakandi, by the villagers which was then physically before being released; (E) The collections of a traditional healer for sale in Hailakandi town, which includes stuffed skin of an otter (most likely the Common otter), skull and skin of an Indian Muntjac, skin of an bear (species identification could not be done), and spines of a porcupine – all of which are used in various ailments as well as to keep evil spirits away. As stated by the traditional healer, the skin of the bear was collected by him from Dimapur of the state Nagaland, and the rest were from Innerline RF of Hailakandi. Photograph 'A' by Dr. A. S. Choudhury; photograph 'C' by Saifur Rahman Laskar, Hailakandi; photograph 'D' by Hannan Uddin Laskar, Narainpur, Hailakandi; and rest by Dr. M.K. Mazumder

The nominate sub-species of Sloth bear (*Melursus ursinus ursinus*) used to occur throughout the plains and foothills of southern Assam, mainly along the Assam-Mizoram border [14,19,50,58]. There were unconfirmed reports from the Barail WLS, Innerline RF, Katakhal RF, and Patharia RF [2,32]). With no recent record, the species is probably extirpated from the region.

All the bear species are poached for their gall bladder that contains ursodeoxycholic acid, which is used in Chinese traditional medicine for the treatment of gall bladder stones. Further, their body parts, including skin and paws, are also used for decorative purposes [59].

2.3 Ailuridae

The family is represented by one species, the Red Panda (*Ailurus fulgens*), of which the nominate sub-species occurs in southern Assam. The panda is a sub-Himalayan species of sub-tropical and temperate forests with bamboo thickets [60]. In northeast India, it has good and potential habitats with viable populations in Sikkim and Arunachal Pradesh [30,51,61]. With records from the Meghalaya and the Barail range [25], it seems that the species migrated through the Barail range to Meghalaya. There are past records from the Cachar; in Dewan Tea Estate and Kalain Tea Estate in 1950s-60s, both of which although plain areas fall at the foot of the Barail range [62]. This suggests that the species might have lived in the Barail range in the last century, and the two recorded cases being in colder months, further indicate that the species descends to the plains during those months. During those times, the two areas were contiguous in habitat with the Barail range, and had bamboo thickets as well. On the contrary, it is argued that the species is unlikely to occur naturally in such warm climates, and the recorded specimens might have been feral individuals, which were kept captives by tea planters or others. However, looking at those records in colder months, and given the confirmed records from *Khasi* and *Garo* hills of Meghalaya-which are extensions of the Barail range itself, the species might have been a natural dweller of the Barail range in the past [2]. With no recent or other record, it is regarded extinct from southern Assam.

2.4 Mustelidae

The mustelids are the least studied carnivores of southern Assam, and there is extremely limited numbers of records in the past as well as in recent years, except a few literatures on their occurrences. The family is represented by three sub-families, namely Mustelinae, Melinae and Lutrinae.

2.4.1 Mustelinae

The sub-family is represented by three species in southern Assam.

Yellow-bellied weasel, *Mustela kathiah*: This species has been reported to prefer higher elevations. Prater [19] and Choudhury [26] mentioned the distribution of this species in Assam wherein it probably occurs in the Barail range, including the Barail WLS. However, further details on its distribution from the region are lacking. Present status of the same is unknown. However, Choudhury [26] considered it to be rarer than *M. flavigula*.

Back-striped weasel, *Mustela strigidorsa*: Like the yellow-bellied weasel, the Back-striped weasel is also known to prefer hilly areas. Prater [19] mentions that the species occurs mainly in temperate forests. It occurs in the Barail range, and most likely in the Barail WLS [26]. However, present status is unknown, and recent records of the same is lacking.

Yellow-throated marten, *Martes flavigula*: The species is common in the forests of southern Assam. The nominotypical sub-species *M. f. flavigula* occurs here. Prater [19] mentions the distribution of the species in the hill ranges of Assam. It has been reported from the Barail WLS, Barak-Bhuban WLS, Innerline RF, and Katakhal RF [26]. However, it is likely in other RFs as well. A solitary individual has been sighted in the Iringmara Tea Estate of Cachar on 26th January, 2017 (Local daily, *Dainik Jugasankha*, January 31, 2017). This indicates that the species is likely to be present in other tea estates, RFs as well as WLS. It feeds both at night and day, on ground and sometimes on trees, and takes small animals, birds, eggs, flowers and nectar. Unlike other small omnivorous carnivores which are dispersers of seed, the *M. flavigula* is known to be a pollinator.

2.4.2 Melinae

The sub-family is represented by three species in southern Assam.

Hog Badger, *Arctonyx collaris*: The Hog Badger has been reported from forests as well as

countryside, from plains to hills. The species is locally called *'Bali Suor'.* The sub-species *A. c. consul* occurs in the region. There are limited records of the species from the region, and the species is uncommon [26]. Choudhury [2] reported killing of an individual from Hailakandi (Hasiura, Joshnabad) in 1998. So far, the species has been recorded from the Barail WLS, and other RFs. The species has been reported by the villagers to make burrows, damage crops, mainly vegetables, and was fairly common in the forests in hills, foothills and plains in 1990s (*pers. comm.* Kamrul Hussain Mazarbhuiya, Sibuttor, Hailakandi).

Burmese ferret-badger, *Melogale personata*: The global distribution of the species extends from Nepal to Burma, through Assam [19]. The nominotypical sub-species *M. p. personata* occurs in southern Assam. It has been reported from hill forests as well as grasslands. The species is nocturnal, lives in burrows, holes and crevices, and seeks food on ground that includes fruits, insects, worms, small mammals, birds, insects, etc. Blanford [57] reported its occurrence from Cachar district (which includes present Hailakandi district as well) and Choudhury [26] reported its continued occurrence in southern Assam; in the Barail WLS, and other RFs. However, sightings are very rare.

Chinese ferret-badger, *Melogale moschata*: The species is distributed in Assam, and to the east [19]. Ecologically, it is quite similar to *M. personata.* It is another very elusive species of the region, and is largely nocturnal. The sub-species *M. m. millsi* occurs in the region. Choudhury [26] reported several live specimens from southern Assam, mainly from Innerline RF [2]. Probably, the species occurs in the other RFs and the two WLSs as well.

2.4.3 Lutrinae

There are three species of this sub-family in southern Assam. Otters are known to fish in ponds. Villagers and forest dwellers have reported that two species of otters occur in southern Assam, commonly seen in 1990s. They fish in ponds, at night and early morning, in groups of 3-4 individuals (*pers. comm.* Kamrul Hussain Mazarbhuiya, Balikandi, Hailakandi). However, they could not distinguish the species. The two species are most likely Common otter and Smooth-coated otter.

Common otter, *Lutra lutra*: This species is locally called *Udh*. This palaearctic species has one of the widest global distributions [63]. The sub-species *L. l. monticolus* occurs in southern Assam. It is well-distributed in rivers, streams, and wetlands; although rarely sighted now. It is relatively more common in hilly areas, and RFs, as well as the foothills of the Barail range [26]. However, it is known to ascend and descend between low and high altitudes with season. Food includes fishes, crabs, frogs, crustaceans and rodents, and may also include leaves and other plant matter.

Smooth-coated otter, *Lutrogale perspicillata*: The Smooth-coated otter was a common species of the Barak basin in the past. However, the species is now extremely rare. The nominotypical sub-species *L. p. perspicillata* occurs in southern Assam [2,33]. It occurs in wetlands, rivers and streams, generally in foothills. The species is known to steal fishes caught in fishing gears, and is thus prosecuted (*Pers comm.* Sultan Ahmed Barbhuiya, Serispore, Hailakandi).

Oriental small-clawed otter, *Aonyx cinereus*: Prater [19] mentions the distribution of the species in the hill ranges and plains of Assam. However, the then Assam also included nearby states like Arunachal Pradesh, Meghalaya, Mizoram, and Nagaland. Although there is no hard report, the Oriental small-clawed otter sub-species *A. c. concolor* probably occurs in the wetlands, rivers and streams of southern Assam, in Cachar along the Assam-Meghalaya border.

2.5 Viverridae

2.5.1 Viverrinae

The sub-family is represented by 3 extant species from different genera in southern Assam.

Small Indian civet, *Vevirricula indica*: The species is locally known by the names *Tola* and *Khatash,* and is nocturnal. It is the commonest civet of southern Assam, as well as India (Choudhury [2,7]. The subspecies *V. i. baptistae* occurs in southern Assam.

The distribution of the species has been mentioned in the past by Ellerman & Morrison-Scott [18], Pocock [16], Prater [19]; and a recent distribution map in NE India, including southern Assam, can be found in Choudhury [2]. The species occurs throughout southern Assam, including all the RFs and the Barail WLS. The species has been reported to be more common in the secondary and open forests than closed

forests, and avoids dense forests [64,65]. The civet is highly adapted to habitat degradation and often lives in proximity to human habitations. In southern Assam, it occurs in semi-evergreen, deciduous, mixed and bamboo forests, scrubby areas, open forest, forest edge, grasslands, countryside and riverine habitats, and also in the neighborhood of human habitation, in towns and villages, in plains and hills. Solitary individuals are often seen in Hailakandi town areas seeking food at night, on ground and trees, in bushes and graveyards, and seem not much wary of human presence.

Being an omnivore and a generalized feeder, the species takes small mammals, other vertebrates and invertebrates as well as roots and fruits. It is a known lifter of domestic poultry from human habitations. The species is nocturnal and terrestrial, and finds refuges in holes (on ground), under bushes and rocks, and often climbs trees [66].

Large Indian civet, *Viverra zibetha*: It is a large civet, and is locally known by the names *Tola, Bagdash* and *Hupi-bagh*. Few decades back, it was commonly encountered; however its status has declined and is now a rare species of southern Assam. Two subspecies are reported from Assam (India) including the *V. z. picta,* which occurs in southern Assam [2,7].

The distribution of this species has been mapped in Ellerman & Morrison-Scott [18], and Pocock [16], Corbet and Hill [20]. Prater [19] mentioned the distribution of the species in Assam. Recent distribution maps are available in Choudhury [2]. It occurs in the Barail WLS, and Innerline, Katakhal and Barak RFs but is rare elsewhere in southern Assam.

It occurs in the foothills, primary forests (both evergreen and semi-evergreen), secondary forests, and plantations. Moreover, it has been recorded from tea gardens and countryside with forested areas. It hides in holes on ground, bushes, thick grass and woods during day time, and wanders into open country, often entering houses at night. The species is active during night, and is generally solitary. It feeds on animals, including frogs, snakes, fishes, insects, eggs, rats, shrews, birds and poultry. Food of the civet also includes roots and fruits, and thus is an important seed disperser [67]. It is probably a scavenger as well [68].

Both small and large Indian civets are often hit by speeding vehicles. One large Indian civet was hit on 22 March, 2020 on the National Highway 37, in Hojai (Assam; Extra-limital), by a speeding car at midnight, indicating road kills as a potential threat of the species. Fortunately, the individual survived (Dr. M. K. Mazumder).

Spotted Linsang, *Prionodon pardicolor*: The species is very elusive, which is one of the reasons that its records are extremely limited. It is an uncommon species of southern Assam, which has also been mentioned by Prater [19]. It prefers hills, forests, bamboo forests, secondary forests, riverine forests and foothills, and is not known to prefer plains [69]. It is largely arboreal, and less tolerant to human disturbances. It is occasionally killed in the Barail WLS by villagers for lifting poultry. Elsewhere in the southern Assam, the species likely occurs in Barak RF, Innerline RF, and others. It feeds largely on vertebrates, while it is also an opportunistic scavenger [2].

2.5.2 Paradoxurinae

There are four species of this sub-family in southern Assam.

Common Palm civet, *Paradoxurus hermaphrodites*: The Common Palm civet or Toddy Cat is locally known by the names '*Khatas', Bazro-batul*, and '*Mekhom*'. It is the second most common civet of southern Assam, next only to the Small Indian civet. Out of the six sub-species recorded from India, *P. h. pallasii* occurs in southern Assam, India [2,7, 20,70]. Ellerman & Morrison-Scott [18] and Pocock [16] mapped the distribution of the species, and a recent distribution map in NE India (including southern Assam) can be found in Choudhury [2,33]. The species is found throughout southern Assam, and has been recorded from all the RFs as well as the Barail WLS. It has been recorded from all types of terrestrial habitats in southern Assam, including evergreen, semi-evergreen and deciduous forests, well-wooded countryside, plantations, human habitations, crop fields, fruit orchards, tree-tops, roofs of buildings [2]. It is well adapted to human-modified habitats, and lives in proximity to human habitations. It has often been seen in bamboo orchards. Mazumdar et al. [47] reported the species from the eco-forests of Assam University, Silchar (Cachar).

The Toddy Cat is nocturnal often haunting houses at night, and arboreal, although often seeks food on ground [19]. It is an omnivore, and its foods include small animals, vertebrates,

invertebrates, birds, and lives largely on fruits and berries. Papaya, pineapple, coffee, palm and mango are among the most preferred fruits [19]. Few studies have demonstrated that the preferred food of this species is fruit, comprising more than 90% of the total feces, *Carica papaya* being the most commonly consumed fruit [71,72]. It is an effective seed disperser in forests as well as human habitations [67,71,73].

Himalayan or Masked Palm Civet, *Paguma larvata*: In Assam, two sub-species have been reported: the *P. l. grayi* in the north of the Brahmaputra, and *P. l. neglecta* in the southern part including the southern Assam. The species has been reported from hills as well as foothills, from evergreen, semi-evergreen, deciduous, riverine forests, etc., and is known not to prefer plains [19]. It has been recorded from the Barail WLS and probably occurs in the other RFs including the Innerline RF, Katakhal RF, Patharia RF, Barak-Bhuban WLS, Upper Jiri RF, Lower Jiri RF, etc. The species is not uncommon and rarer than the Toddy cat [26]. It is sometimes seen near human habitations, as it is less tolerant to human disturbances, compared to the Toddy cat or Small Indian civet. The species is largely nocturnal, although often active in the day. It leads a more vegetarian life, however diet also includes vertebrates, and invertebrates.

Binturong, *Arctitis binturong*: Commonly called Bear-cat, Binturong is the largest civet of southern Assam. The subspecies *A. b. albifrons* occurs in the study area. It is a rare and elusive civet of the region. Prater [19] mentions the distribution of this species in Assam. Distribution of the species in southern Assam has not been shown by Corbet and Hill [20], while Choudhury [2,33] provided a recent distribution. It has been recorded from the Barail WS [2], however occurrence in other RFs of southern Assam is not unlikely, considering the current distribution of the species. The species does not occur in the floodplains of the Barak river basin.

It occurs in hills and foothills, and has a higher preference for mature forests, including evergreen and semi-evergreen. The species is nocturnal, and largely arboreal, but is often found on ground mainly when moving between trees and seeking food. It is often seen sleeping on large branches of big trees. It does not prefer monoculture plantations such as rubber. It is nocturnal, however often sighted to be active during day time, especially early morning hours. It is predominantly frugivorous, although diet includes animals also.

Small-toothed Palm civet, *Arctogalidia trivirgata*: The Small-toothed Palm civet is extremely rare in southern Assam. The sub-species *A. t. millsi* occurs in the area. In India as a whole, the species is distributed to the south of Brahmaputra river, indicating the river to be the geographic barrier of the species [27]. There is a past record from Sylhet district, approximately India-Bangladesh border, from the present Karimganj district of southern Assam [74]. Although recent confirmatory records are lacking, considering the nocturnal, elusive, arboreal and dense forest dwelling habits of the species, and its present distribution in the nearby regions, it may probably be present in the two WLSs and other RFs of southern Assam.

Small-toothed Palm civet occurs in forests, hills and foothills, in evergreen, semi-evergreen and deciduous forests, and requires good forests. Within southern Assam, the species probably occurs in the Barail WLS, Innerline RF, Katakhal RF, and likely in other RFs [2,27]. The species is largely arboreal, frugivorous but feeds on animals as well.

2.6 Herpestidae

The family of mongoose is represented by two species: *Herpestes javanicus* and *H. urva*. Although Mazumdar et al. [47] reported Indian Grey Mongoose (*H. edwardsii)* from the forests and villages around Assam University, Silchar (Cachar), it is however a misidentification, of most probably *H. javanicus,* which occurs in the region.

Small Asian mongoose, *Herpestes javanicus*: It is locally known as '*Newul*'. The sub-species *H. j. auropunctatus* occurs in southern Assam. Prater [19] mentions its distribution in Assam, and a recent distribution map is provided by Choudhury [2]. It is a very common mongoose, and is found in forests, countryside, plains, along river banks, human habitations, including towns. It is more frequently seen near human habitations and towns during floods, when the river banks and other habitable areas are flooded, thereby falling victim of conflicts as well as road kills. It occurs in all the RFs as well as the Barail WLS. It lives in burrows, and crevices, and is diurnal. It often kills domestic poultry, and drags the kill to holes and burrows (*pers. comm.*

Badrun Nehar Laskar, Ujankupa, Hailakandi, Assam).

Crab-eating mongoose, *Herpestes urva*: The crab-eating mongoose is a less common mongoose of southern Assam. It is commonly associated with wetlands, streams and rivers, in forests and plains. It is found in the Barail WLS, and has also been reported from Innerline RF, although occurrence in other RFs is not unlikely [2]. It feeds on fishes, crabs, and other animals.

2.7 Felidae

A general account of the cat species of northeast India is given in Choudhury [31] and Menon [34].

2.7.1 Felinae

The sub-family of lesser cats is represented by five species in southern Assam.

Jungle cat, *Felis chaus*: The Jungle cat is locally known as '*Pat-biral*', *'Bon-biral'*. The sub-species *F. c. fulvidina* occurs in the region. It is the commonest cat in southern Assam [2]. It has been recorded from all types of habitats, grasslands, scrubs, river banks, forests, human habitations, countryside, towns, from plains to hills. It hides in bushes and often lifts domestic fowl, often active in the day, which is why it is often prosecuted. In December 2016, one jungle cat seized a domestic bird at dusk near the poultry shed in front of the owner (*pers. comm.* Badrun Nehar Laskar, Hailakandi), which indicates how swift and bold the species is. Such behavior of the species has also been mentioned by Prater [19]. The species is often seen in schools of a few individuals comprising mother and offspring, and in paddy crop fields (*pers. comm.* Abdur Razak Mazumder, Hailakandi). One individual was caught by the villagers at North Narainpur – II (Hailakandi, Assam), and then released. Mazumdar et al. [47] reported the species from the campus of Assam University, Silchar (Cachar). Carcass of one individual was found in the Hailakandi town area on June 06, 2010 (Dr. A.S. Choudhury). The individual was crushed by a speeding motorcycle.

Leopard cat, *Prionailurus bengalensis*: The Leopard cat is locally called '*Bon-Biral', 'Jongli Mekur'.* The nominotypical sub-species *P. b. bengalensis* occurs in southern Assam. It is common felid in the area, commonly found in forests, and in hills and foothills. The species also frequents grasslands, and scrubs. If the Jungle cat is more common in the human-dominated habitats, the Leopard cat is more common in forests. It lives in tree hollows, and often lifts poultry. It occurs in the Barail WLS, and other RFs of the region [2]. A solitary individual was recovered from Patiala village, located within Lowairpoa range of Longai RF (https://www.barakbulletin.com/en_US/a-leopard-cat-found-in-karimganj-forest-officials-released-it-back-to-the-forest/), additional, information regarding the death of leopard cat was acquired from Haritikor, near to Barail WLS (https://www.barakbulletin .com/en_US/leopard-cat-found-dead-in-cachar-locals-suspect-a-truck-ran-over-it/), which provide further indication of their presence. It was recently camera-trapped from Innerline RF (Dr. A. S. Choudhury). The species is very common in the Rowa WLS of Tripura, India, adjacent to southern Assam, and cubs are frequently seen by locals and forest staff (Dr. Rajib Paul, PDUAM, Eraligool, Karimganj).

Fishing cat, *Prionailurus viverrinus*: The species is locally called *'Mecho-biral'*. The nominotypical sub-species *P. v. viverrinus* occurs in southern Assam. It is a rare cat of the region, and is often associated with water bodies and wetlands. Thus, it is more common in areas which are near to water bodies (wetlands, swamp, streams) especially small streams covered with dense foliage. The species has been reported by the locals to attack poultry, sheep, goat, as well as calves of cattle. Prater [19] reports attacks on children as well. The species has been recently caught by forest official and released s at Saidpur, Batai village near Patharia RF for preying on their domestic livestock (https://assamtribune.com/assam/forest-officials-rescue-release-fishing-cat-in-barak-valley-1093268). Further, recent evidence were acquired from *Son beel* (a wetland) of Karimganj. The species most likely occurs in the other wetlands of southern Assam, including Bakri *Hawr* (Hailakandi) and Chatla *Hawr* (Cachar).

Asian Golden cat, *Catopuma temminckii*: The Asian Golden cat is locally called *'Lal Bagh'*. The nominotypical sub-species *C. t. temminckii* occurs in the region. The species prefers evergreen, semi-evergreen, deciduous forests, grasslands, in hills as well as plains. It has been recorded from the Barail WLS, Barak-Bhuban WLS, Innerline RF, Patharia RF and may occur in other RFs as well. The distribution of this species in Assam was mentioned by Prater [19], while Choudhury [2] provided a detailed distribution map.

Marbled cat, *Pardofelis marmorata*: Although there are no hard reports, the sub-species *P. m. charltoni* probably occurs in southern Assam in the Barail WLS, Innerline RF, Katakhal RF, Barak-Bhuban WLS, Upper Jiri RF, Lower Jiri RF, etc. since the species is widely distributed in the Dima Hasao of Assam, and along the state borders of Meghalaya, Manipur and Mizoram [75]. The distribution of this species in Assam was mentioned by Prater [19], while Choudhury [2] provided a detailed distribution map of NE India, including southern Assam.

2.7.2 Pantherinae

There are three large cats, both extant and extinct, in southern Assam.

Clouded leopard, *Neofelis nebulosi*: The clouded leopard is locally called *'Betangi bagh*'. The sub-species *N. n. macroselloides* occurs in the region. It has been reported from forests in the hills, and foothills. It is a rare large cat of southern Assam. The Barail range, including the Barail WLS and its adjoining RFs (in Assam and Meghalaya) is the main strong-hold of the species in southern Assam [76]. Choudhury [2,77]) reported some past records, including cases of poaching, carcasses, etc. from the region; from the Barail WLS (one individual killed in 1980s at Maroacherra, Cachar), the Katakhal RF (one killed in the 1970s at Hasiura, Hailakandi), Patharia RF (one killed in 1980s), Innerline RF of Cachar (one killed in the 1980s at Khulicherra), Innerline RF of Hailakandi (one individual sighted in the late 1980s at Gharmura). Looking at the current distribution of the species in the Mizoram state in the south, the distribution and current occurrence of the species along Innerline RF, Barak-Bhuban WLS, Patharia RF, Longai RF, Singla RF, etc. are very likely.

Leopard, *Panthera pardus*: The species is locally called *'Cheeta bagh', 'Kala bagh'*. The sub-species *P. p. fusca* occurs in the region. So far, there are no hard report of Panther from southern Assam. It is a very rare species in southern Assam, although common in certain areas. It has been reported from forests, woodland, tea gardens, in hills and plains. It has been recorded from all the districts, and is often encountered in the Barail WLS and Barak-Bhuban WLS. Its distribution largely coincides with the Clouded leopard in southern Assam. With widespread distribution of the species in the adjoining state Mizoram, Manipur, Meghalaya, and the Barail range, the species most likely occurs in the RFs of the region, notably Innerline RF, Katakhal RF, Patharia RF, Singla RF, Longai RF, Upper Jiri and Lower Jiri RFs, etc. [2,33]. It often ventures in human habitations, and takes away domestic animals. During field studies, several villagers have reported that Bengal tiger often preys on domestic cattle, and dogs, which is however a misidentification of the leopard. The last reported case of such predation is in 2015 (*pers. comm.* Piarun Nessa Mazarbhuiya, Hailakandi).

Bengal tiger, *Panthera tigris*: The species is locally called *'Bodo Bagh*'. It is known to prefer grasslands and forests, both in the hills and plains. The species used to prey occasionally on domestic cattle, and as per local reports the species used to wander out in the plains in the winter months. The nominotypical sub-species *P. t. tigris* is known to occur in the region. It has been recorded from the Barail WLS and Innerline RF, and likely the other RFs, in the past. However, it has now vanished from the RFs of southern Assam [22,28,78], and the species is most likely extinct from the region, and only stray individuals may be encountered in the Barail range, including the Barail WLS. One stray individual was shot by Abdul Haque Mazumder from village Ujankupa (Hailakandi) in 1945-46 (*pers. comm.* Abdur Rahim Mazumder, Ujankupa, Hailakandi). Past hunters have reported the species from Damcherra Tea Estate and Innerline RF (Hailakandi) in 1970s (*pers. comm.* Abdur Razak Mazumder, Hailakandi).

3. CONSERVATION CONCERNS

The wildlife of southern Assam in general, and the carnivores in particular, are among the most disliked species and are regarded as pests by the locals. While species inventories have been recorded, further details on their status, ecology, and threats have not been elucidated. Moreover, most of the carnivores are extremely elusive and nocturnal, which is one of the reasons why they were not been studied to a sufficient extent. However, threats to these carnivores exist to a staggering extent, and the status of all the species is on decline in the region. Some of the major threats to the carnivores of the region are listed below.

3.1 Habitat Destruction

Logging and deforestation for developmental, agricultural and other activities, including *Jhum* cultivation (a slash-and-burn type of shifting cultivation) have increased in last few decades in southern Assam (Fig. 2B). In addition, extensive

deforestation for establishment of tea gardens in the last century has destroyed habitats of the carnivores of the region, along with prey and food trees [3]. While prey species have declined, fruits are among the most frequently collected forest produce by the villagers, and thus the frugivorous carnivores face shortage of the same. While some species have perished in southern Assam, others like the Common Palm civet, Jungle cat, Small Indian civet, Golden Jackal, etc. have adapted to human-modified and human-dominated habitats. In human-dominated places, villages and towns, these species get a relatively easy access to food but they have become pests and are often prosecuted in retaliation. On the other hand, the status of the true forest dwelling carnivores is rapidly declining.

In 2001-2011, the human population of southern Assam had increased by 20.78%, with increase in density from 449.33 to 543 persons per sq. km [79,80]. This increase in the density further adds to encroachment of the forest land, monoculture plantations, collection of forest produce, etc. Recent border issues of Assam with Mizoram, and felling of trees, deforestation and encroachment in the Innerline RF has led to large scale destruction of the habitat of the carnivores, and the wildlife as a whole.

A 162 m high dam is proposed to be built on Barak river upstream to the Barak plains at Tipaimukh, Manipur-Mizoram border [9,81,82]. Once the dam is constructed, a large portion of the habitats of the carnivores, and also several other species, will be lost with felling of trees, submergence of suitable habitats, etc. Further, this will lead to increase in the human disturbances, and invite poaching [9].

3.2 Changes in Land Use and Land Cover

From 2005-06 to 2011-12, there has been a tremendous increase in the scrub forest and deciduous forest area in southern Assam by 28.87% and 31.72% respectively, while the evergreen and semi-evergreen forests has declined by 11%, and plantation agriculture has also declined by 14.06%. On the other hand, shifting cultivation has significantly reduced by 68.01% (Table 2). This shows that shifting cultivation had largely caused the decrease in evergreen and semi-evergreen forests but leaving the land to fallow, such areas have turned into scrub and deciduous forests, largely dominated by bamboo. Such scrub and deciduous forests are least preferred by the carnivores or any other wildlife. Presently, southern Assam has 43.25% (2993.41 sq. km.) of its total geographic area (6922 sq. km) under evergreen and semi-evergreen forests but not all belong to the Barail WLS or RFs. Moreover, at the present rate at which the evergreen and semi-evergreen forests are being lost in southern Assam (329.33 sq. km in 6 years), these forests will vanish within 54.5 years, i.e., by 2065-66, unless provided with protection. Thus, there is immense need that the present forest patches in the Barail WLS and RFs are provided with ample protection from forest cover change by strictly prohibiting *Jhum* cultivation, and by incorporating adjoining areas within the RFs or WLS. The LULC map of 2011-12 is shown in Fig. 1B.

3.3 Human-Carnivore Conflicts

There are 104 forest villages within the area of the RFs in southern Assam. A survey of these villages revealed that Golden jackal, small Indian civet, large Indian civet, common palm civet and Himalayan palm civet are the commonest carnivores found to be in conflict with man, mainly for livestock predation [83]. While the study highlights these threats to the species, it also demonstrates that these carnivores are still frequently seen in the forest villages of southern Assam. The study also recorded an attack on human by Golden jackal. Another similar study [84] in 24 forest fringe villages of southern Assam provided similar findings. As several carnivore species have adapted to human-dominated habitats including crop fields, fruit orchards, etc., they often predate on poultry, pigeon, goats, cattle, and infest fruit trees and orchards. The civets are reported by the locals to frequently visit the same cultivar and fruit trees while larger carnivores including leopard, tiger, bears, etc. often kill cattle, goats, etc. The smaller ones attack poultry. Otters are known to infest ponds and fish tanks, hog badger and other omnivorous carnivores have been reported to damage vegetables, fruits, etc. These have led to human-carnivore conflicts, the worst result being the killings of carnivores in retaliation. Killing of the carnivores are frequently reported, using several techniques, including traps, snares, poisoning, and fire arms. Killing of the jungle cat, common palm civet, small Indian civet, golden jackal, mongooses, etc. are very common in southern Assam. The villagers in southern Assam, mainly the forest dwellers keep dogs as pet to scare away the carnivores, and the dogs may even kill any carnivore that they can catch.

Mazumdar et al. [47] reported killings of the common palm civet from the neighborhood of Assam University, Silchar (Cachar).

3.4 Deliberate Killings and Poaching

The local people often kill the animals for no apparent conflicts, thinking them to be pests and being unaware of their role in seed dispersal. When with litters and juveniles, the carnivores become easy victims. The local people also have tendencies to harm or kill any wild species which they can catch hold of. In 2013, one stray Asiatic Black bear cub was killed by the locals at Gharmura (Hailakandi) for a supposed conflict [51]. On 25th June, 2015, three common palm civets, two cubs and their mother, were killed by the villagers at Kanchanpur-II, Hailakandi, Assam (Fig. 2C). One jungle cat was caught by the villagers at North Narainpur – II (Hailakandi, Assam) on 25th January, 2015, injured and then released (Fig. 2D).

The tribal people of southern Assam, mainly the forest dwellers, consume the meat of the carnivores, and use the pelt for making covers of armors. Large cats are often poached for bone, teeth and skin, while small carnivores are poached for pelt and meat. Game hunting of the large cats, mainly the tiger, panther and the bears, was a common practice in the past. Bears are poached for their gall bladder, which is used in traditional Chinese medicine, and the poachers smuggle the gall. Moreover, the body parts of different carnivores (especially bone and teeth of tiger and leopard) are believed to keep evil spirits and ghosts away while skin and hair of otters are used against asthma and other diseases in children. Fig. 2E shows a traditional healer with skin of a bear (which he collected from Nagaland), a stuffed skin of otter (collected from Innerline RF, Hailakandi), and spines of a porcupine, which are used against different diseases [12].

3.4 Diseases

As many as 194 parasite species are known to occur in golden jackal [85]. It is very likely that these parasites spread between domestic and the wild species, which is detrimental to both. Carnivores are at a higher threat of getting the dreaded rabies and are considered to harbor the stock of the virus. Rinderpest and foot-and-mouth disease have taken a huge toll of the Gaur *Bos gaurus* in India which had spread from domestic animals [86], and similar threats hover on the carnivores as well. The carnivores which have adapted to human modified habitats often search food in garbage in the household, hospitals, etc. and thereby are prone to diseases, toxic chemicals, etc.

3.5 Fishing and by-Catches

Use of ichthyo-toxic plants for large scale fishing is also practiced in the rivers of southern Assam, mainly during lean season. Fish poisoning is detrimental to the aquatic animals, including the dolphins, the fishes that otters feeds, and to them as well [87].

3.6 Road Kills

Through the Barail WLS as well as the other important RFs of southern Assam, national highways run with heavy traffic. As such, the carnivores are often crushed by speeding vehicles. Common victims are generally the common species such as small Indian civet, toddy cat, jungle cat, mongoose, etc. Floods are also common phenomenon in southern Assam, occurring in several waves every year and inundating the habitats of the carnivores living in plains. This causes them to seek refuge in habitations, road sides, etc. and making them vulnerable to road kills [3].

3.7 Lack of Research and Awareness, and Implementation of Laws

Despite its now-vanishing myriad wildlife diversity, southern Assam is largely unexplored, and the carnivores are among the least studied mammals here. No large scale information drive is conducted in the region, thus, the locals are not aware on the importance of the wildlife species. As such, they are unaware of the conservation status and ecological importance of the carnivores. Inadequate implementation of the laws, and lack of sufficient funding for research further adds to the treats of the species in southern Assam. Moreover, there are insurgency issues in all the RFs and the WLS, which interferes with researchers in conducting field studies.

Wild animals also often kill others, e.g. sloth bears are often killed by tigers, leopards and other bears [88], while leopards kill other carnivores.

4. CONCLUSION

The southern Assam, India, is imbued with enormous biological diversity. However, the wildlife wealth of the region remains largely untapped, and there are only a very few published articles on some selected species of the carnivores of the region. None of the published literature provides in-depth report of the order Carnivora in southern Assam, and thus the present article is of immense significance. The present study reports 33 species of carnivores from the region, of which Bengal fox and Red panda are already extinct, and Bengal tiger and Sloth bears are probably extinct and only stray individuals are expected at certain areas. Further confirmation on the species including *Mustela kathiah, M. strigidosa, Aonyx cinereus* and *Arctogalidia trivirgata* is wanting. All the carnivore species are under severe threat of varied types including habitat loss, changes in land-use pattern, poaching, conflicts and retaliation, etc. Further, lack of research and awareness, with insurgency issues, pose further threats to their continued existence. Thus, it is high time that the carnivores, as well as other wildlife, of the region be provided with conservation efforts. Since most of the carnivore species are nocturnal, camera-trapping should be carried out to identify the current distribution of the different species, their ecology and present status. Further, as habitat destruction is among the major threats, in addition to poaching and other forms of killings, enforcement of Forest Act, 1927 and Wildlife (Protection) Act, 1972 should be enforced in their true spirit. Above all, the local people should be made aware of the species, and any livestock depredation should be promptly and judiciously compensated by the Govt. to avoid any retaliatory killing and development of negative perception. Unless these and other targeted conservation efforts are taken up, the remaining wildlife of southern Assam shall also be extirpated soon.

5. RECOMMENDATIONS

A review of the fauna of southern Assam, specifically the carnivores, reveals that the region has high diversity, represented by 33 species. However, due to lack of adequate studies on the same, largely due to their elusive, and nocturnal nature, we still know very little about them. While distribution of the species have been recorded, their status is least known and the claim in the present article is tentative, largely based on peoples' perception and reports of forest officials. Unfortunately, the populations of all species are observed to be decreasing which could hamper the conduct of sufficient studies on their status, ecology, adaptations, specific threats, and species specific conservation tactics, and appreciate the ecosystem services they provide. Thus, it is very essential that the biodiversity of the southern Assam be provided with due conservation, including the following recommendations:

- **Conserving the Habitat:** This is the first and foremost step towards conservation of any species. Unfortunately, the Barail WLS is the only protected area of southern Assam with an area of mere 326 sq. km. Moreover, the National Highway runs along the sanctuary, which causes human disturbances, invites poaching and road kills. There is need to extend the existing area of the sanctuary. Moreover, some of the RFs may be upgraded to WLS, for which the Patharia RF and Innerline RF have ample potential. Encroachment and collection of forest produce and other human disturbances should be checked in the RFs as well as the WLS.
- **Checking Encroachment:** Unfortunately, encroachment into RFs as well as the Barail WLS is prominent. This includes clearing for forests, establishing human settlements, agricultural activities, monoculture plantations, and importantly the *Jhum* cultivation. These have led to significant reduction in the primary forests, with changes in land use pattern. Such encroachments should be strictly dealt with in accordance with the Forest Act, 1927.
- **Research and awareness:** As reiterated in the text, very limited numbers of studies are available on the wildlife of the region. It is essential that studies are initiated on the natural history and ecology of the species. Most species being elusive, camera trapping and radio-collaring should be performed in all the RFs and WLSs to elucidate the status, distribution and ecology of the species. A few camera-trapping studies from Northeast India have been useful in understanding the distribution and ecology of carnivores [89,90]. Large scale awareness programs need to be initiated, and the locals and forest dwellers should be motivated no to harm the wildlife. They should be provided with knowledge on the ecosystem services rendered by these species. It reveals from the study that the tea gardens are among

important habitats of the wildlife, including carnivores, in southern Assam now. Thus, mass awareness programs should also include tea garden workers and other stakeholders.

- **Enforcement of law:** All the species enlisted here are protected by law in India under the Wildlife (Protection) Act, 1972. However, this has not limited their poaching to the extent needed, largely due to lack of effective enforcement of the same. It is often the case that the forest dwellers are least bothered even if they are aware of the conservation status of the species. Thus, forest officials, in collaboration with other Govt. and non-Govt. organizations should initiate awareness programs targeting especially the forest villages.
- **Preventing spread of diseases:** As man, along with its livestock, lives in close proximity to the wildlife, there is always a possibility of spread of diseases from the domestic animals to the wild ones. In view of the same, first the cattle grazing in the RFs and the WLS should be checked, and the domestic animals should be immunized against the diseases like rabies, foot-and-mouth disease, rinderpest, and other parasites.
- **Checking collection of forest produce:** Collection of forest produce, including fruits, bamboo, wood, etc. has led to deforestation, and significant reduction in the food and shelter available to the carnivores and their prey species. Such practices should be checked in the RFs and the WLS, in accordance with the Forest Act, 1927.

SOURCE OF FUNDING

The present study has not been funded by any organization.

ACKNOWLEDGEMENT

We are thankful to the respondents, as named in text, for their cooperation during the surveys. We are also thankful to Dr. Nazimur Rahman Talukdar (Karimganj) and Mr. Saifur Rahman Laskar (Hailakandi), Hannan Uddin Laskar (Hailakandi) for providing us the photographs, as acknowledged in the caption.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Myers N, Mittermeier R, Mittermeier C, Da Fonseca G, Kent J. Biodiversity hotspots for conservation priorities. Nature. 2000; 403:853-858.
2. Choudhury A. The Mammals of North East India. 1st Ed. Gibbon Books (Guwahati, Assam) and the Rhino Foundation for Nature in North East India (Guwahati, Assam); 2013.
3. Mazumder MK. Diversity, habitat preferences, and conservation of the primates of Southern Assam, India: The story of a primate paradise. J. Asia-Pac. Biodivers. 2014;7:347-354.
4. Chatterjee SP. Gazateer of India (Physiography of India). Publication Division, Delhi. 1965;25-28.
5. Champion HG, Seth SK. A revised survey of the forest types of India. Forest Research Institutes and Colleges, Dehra Dun; 1964.
6. Talukdar NR, Singh B, Choudhury P. Conservation status of some endangered mammals in Barak Valley, Northeast India. J. Asia-Pac. Biodivers. 2018;11(2):167-172.
7. Choudhury A. The mammals of India: A systematic and cartographic review. 1st Ed. Gibbon Books and The Rhino Foundation for Nature in NE India (Guwahati, Assam, India), with support from Forest Bureau, COA. 2016:;140-141.
8. Singha U, Choudhury AS, Chakravarty H, Mazumder MK, Barbhuiya SA. Status, threats, and conservation of the mega-reptilian fauna of southern Assam, India. J. Bombay Nat. Hist. Soc. 2020;117:90-98.
9. Mazumder MK, Boro F, Barbhuiya B, Singha U. A study of the winter congregation sites of the gangetic river Dolphin in southern Assam, India, with reference to conservation. Glob. Ecol. Conserv. 2014;2:359–366.
10. Choudhury NB, Mazumder MK, Chakravarty H, Choudhury AS, Boro F, Choudhury IB. The endangered Ganges river dolphin heads towards local extinction in the Barak river system of Assam, India: A plea for conservation. Mamm. Biol. 2019;95:102–111.
11. Talukdar NR, Choudhury P. Conserving the wildlife wealth of Patharia Hills Reserve Forest, Assam, India: A critical analysis. Glob. Ecol. Conser. 2017;10:126-138.

12. Guha N. Ignored Barak Valley grappling with wildlife conservation issues. Mongabay. Accessed on July 03; 2023. Available:https://india.mongabay.com/2021/01/ignored-barak-valley-grappling-with-wildlife-conservation-issues/.
13. Finn F. Sterndale's mammalian of India. Revised edn. Thacker, Spink, Calcutta and Simla; 1929.
14. Pocock R.I. The black and brown bears of Europe and Asia. Part 2. J. Bombay Nat. Hist. Soc. 1932;30:101-138.
15. Pocock RI. The civet cats of Asia. J. Bombay Nat. Hist. Soc.1933;36:423-449; 629-656.
16. Pocock RI. The fauna of British India including Ceylon and Burma: Mammalia. Vol. I. Primates and Carnivora (in part). Taylor & Francis, London; 1939.
17. Pocock RI. The Fauna of British India, including Ceylon and Burma: Mammalia. Vol. II. Carnivora (in part). Taylor & Francis, London; 1941.
18. Ellerman JR, Morrison-Scott TCS. Checklist of Palaearctic and Indian Mammals, 1758 to 1946. British Museum (Natural History) 2nd Edition, 1966. London; 1951.
19. Prater SH. The Book of Indian Animals. 3rd Edition. Bombay Natural History Society, and Oxford University Press; 1971.
20. Corbet GB, Hill JE. The mammals of the Indo-Malayan region: a systematic review. Oxford University Press, Oxford, UK; 1992.
21. Wilson DE, Reeder DM (eds.). Mammalian species of the world: A taxonomic and geographic reference. 2nd Edition. Smithsonian Institution Press, Washington DC, USA; 1993.
22. Choudhury A. Tigers in India today. Tigerpaper 1989;16(3):1-6.
23. Choudhury A. Checklist of the Mammals of Assam. Revised 2nd Edition. Gibbon Books and Assam Science Technology & Environment Council, Guwahati, Assam, India. 1997;103.
24. Choudhury A. The status of the bears in Assam, India. Int. Bear News 1997: 6(2): 16.
25. Choudhury A. Red panda Ailurus fulgens F. Cuvier in the north-east with an important record from Garo Hills. J.Bombay Nat. Hist. Soc. 1997;94(1):145-147.
26. Choudhury A. The distribution and status of small carnivores (mustelids, viverrids and herpestids) in Assam, India. Small Carniv. Conserv. 1997;16:25-26.
27. Choudhury A. Mustelids, viverrids and herpesteds of Northeast India. ENVIS Bulletin: Wildlife and Protected Areas. 1999;2(2):43-47.
28. Choudhury A. Panther tigris in North East India. In: Royal Bengal tiger in the 21st century. Vision Publications Pvt. Ltd. (on behalf of Nature Environment and Wildlife Society), Calcutta. 2000; 61-77.
29. Choudhury A. A systematic review of the mammals of north-east India with special reference to the non-human primates. D.Sc. thesis. Gauhati University; 2001.
30. Choudhury A. An overview of the status and conservation of the red panda Ailurus fulgens in India, with reference to its global status. Oryx. 2001;35(3):250-259.
31. Choudhury A. The cats in NE India. Cat News 2003;39:15-19.
32. Choudhury A. Records of Sloth bear and Malayan Sun bear in North-East India. Final Report to International Association for Bear Research & Management (IBA). The Rhino Foundation for Nature in North-East India, Guwahati, Assam, India. 2011;53.
33. Choudhury A. Natural History of North East India Series, Vol. 1: Mammals. Rashmi Prakashan, Guwahati, India; 2018.
34. Menon V. A field guide to Indian mammals. Dorling Kindersley / Penguin, New Delhi, India; 2003.
35. Javanmard A., Mohammadabadi M.R., Zarrigabayi G.E., Gharahedaghi A.A. Polymorphism within the intron region of the bovine leptin gene in Iranian Sarabi cattle (Iranian Bos taurus). Russ. J. Genet. 2008;44(4):495-497.
36. Roudbar M.A., Abdollahi-Arpanahi R., Mehrgardi A.A., Mohammadabadi M. Estimation of the variance due to parent-of-origin effects for productive and reproductive traits in Lori-Bakhtiari sheep. Small Rumin. Res. 2018;160:95-102
37. Mohammadi A, Nassiry MR, Mosafer J, Mohammadabadi MR. Distribution of BoLA-DRB3 allelic frequencies and identification of a new allele in the Iranian cattle breed Sistani (Bos indicus). Russ. J. Genet. 2009;45(2):198-202.
38. Masoudzadeh SH, Mohammadabadi MR, Khezri A. Dlk1 gene expression in different Tissues of lamb. Iran. J. Appl. Anim. Sci. 2020;10(4):669-677.

39. Mohammadabadi MR, Soflaei M, Mostafavi H, Honarmand M. Using PCR for early diagnosis of bovine leukemia virus infection in some native cattle. Genet. Mol. Res. 2011;10(4):2658-2663.
40. Ahsani MR, Mohammadabadi MR, Shamsaddini MB. Clostridium perfringens isolate typing by multiplex PCR. J. Venom. Anim. Toxins Incl. Trop. Dis. 2010;16(4):573-578.
41. Nassiry MR, Shahroodi FE, Mosafer J, Mohammadi A, Manshad E, Ghazanfari S, Mohammad Abadi MR, Sulimova G.E. Analysis and frequency of bovine lymphocyte antigen (BoLA-DRB3) alleles in Iranian Holstein cattle. Russ. J. Genet. 2005;41(6):664-668.
42. Norouzy A, Nassiry MR, Shahrody FE, Javadmanesh A, Abadi MRM, Sulimova GE. Identification of bovine leucocyte adhesion deficiency (BLAD) carriers in Holstein and Brown Swiss AI bulls in Iran. Russ. J. Genet. 2005;1(12):1409-1413.
43. Sulimova GE, Azari MA, Rostamzadeh J, Mohammad Abadi M.R. κ-casein gene (CSN3) allelic polymorphism in Russian cattle breeds and its information value as a genetic marker. Russ. J. Genet. 2007;43(1):73-77.
44. Mousavizadeh A, Mohammadabadi MR, Torabi A, Nasiri MR, Ghiasi H. Genetic polymorphism at the growth hormone locus in Iranian Talli goats by polymerase chain reaction-single strand conformation polymorphism (PCR-SSCP). Iran. J. Biotechnol. 2009:7(1):51-53.
45. Jafari Ahmadabadi SAA, Askari-Hemmat H., Mohammadabadi M., Asadi Fozi M., Mansouri Babhootki M. The effect of Cannabis seed on DLK1 gene expression in heart tissue of Kermani lambs. Agric. Biotechnol. J. 2023;15(1):217-234.
46. Kock D, Posamentier H. Vulpes bengalensis in Bangladesh. Zeitschrift Säugetierk 1984;49:374-376.
47. Mazumdar K, Soud R, Gupta A. Mammalian diversity of degraded forest habitats around Assam University Campus, Cachar, Assam, India, with Notes on Conservation Status. Our Nature 2011;9:119-127.
48. Choudhury A. Photographic evidence of occurrence of Bengal fox Vulpes bengalensis (Shaw) in Northeast India. J. Bombay Nat. Hist. Soc. 2020;117.
49. Debnath D, Choudhury P. Population estimation of Golden Jackal (*Canis aureus*) using different methods in various habitats of Cachar district, Southern Assam. Indian Forester 2013;139(10): 888-894.
50. Steinmetz R, Garshelis D, Choudhury A. Adaptations and competitive interactions of tropical asian bear species define their biogeography: Past, present, and future. In: V. Penteriani & M. Melletti (Eds.), Bears of the World: Ecology, Conservation and Management. Cambridge: Cambridge University Press. 2020;45-52.
51. Choudhury A. Records of Asiatic black bear in North-East India. Final Report to International Association for Bear Research & Management (IBA). The Rhino Foundation for Nature in North-East India, Guwahati, Assam, India. 2013;96.
52. Sathyakumar S, Choudhury A. Distribution and status of the Asiatic black bear (*Ursus thibetanus*) in India. J. Bombay Nat. Hist. Soc. 2007;104:316-323.
53. Wrought RC. Bombay Natural History Society's Mammal survey of India, Burma and Ceylon. Report No. 26. Darjeeling district. J. Bombay Nat. Hist. Soc. 1916;24:773-782.
54. Steinmetz R. Ecology and distribution of sympatric Asiatic black bears and sun bears in the secondary dry forests of Southeast Asia. Smithsonian Institution Scholarly Press, Washington, DC; 2011.
55. Gee EP. A note on the occurrence of the Malayan sun bear Helarctos malayanus Raffles within Indian limits. J. Bombay Nat. Hist. Soc. 1967;64:352-354.
56. Higgins JC. The Malaya Bear. J. Bombay Nat. Hist. Soc. 1932;35:673-674.
57. Blanford W.T. Fauna of British India including Ceylon and Burma. Taylor and Francis, London. Mammalia, Part-1 (1888): 1-250; Part-2. 1891;251-617.
58. Choudhury A. Plea for a new wildlife refuge in eastern India. Tigerpaper. 1983;10(4):12-15.
59. Brown P., Davies B. Trading to Extinction. Dewi Lewis Publishing, UK; 2014.
60. Roberts MS, Gittelman JL. Ailurus fulgens. Mammalian Species. 1984;222:1-8.
61. Choudhury A. On some large-sized red pandas Ailurus fulgens F. Cuvier. J. Bombay Nat. Hist. Soc. 2002;99(2):285-286.
62. Duckworth JW. Records and reports of red pandas Ailurus fulgens from areas with warm climates. In: Glatston A. (Ed), Red Panda: Biology and Conservation of the first panda. Academic Press and Elsevier,

London and Burlington, USA. 2011;419-434.
63. Ando M, Corbet GB. The terrestrial mammals of Eastern Europe. G.T. Foulis & Co., London, UK; 1966.
64. Duckworth JW. Small carnivores in Laos: A status review with notes on ecology, behavior and conservation. Small Carniv. Conserv. 1997;16:1-21.
65. Datta A, Naniwadekar R, Anand MO. Occurrence and conservation status of small carnivores in two protected areas in Arunachal Pradesh, north-east India. Small Carniv. Conserv. 2008;39:1-10.
66. Mazumder MK. Small Indian civet. In: Anwaruddin Choudhury (Editor), Natural History of North East India Series, Mammals. Rashmi Prakashan, Guwahati, India. 2018;1:137-139.
67. Rabinowitz A. Behavior and movements of sympatric civet species in Huai Kha Khaeng Wildlife Sanctuary, Thailand. J. Zool. 1991;223:281-298.
68. Mazumder MK. Large Indian Civet. In: Anwaruddin Choudhury (Editor), Natural History of North East India Series, Vol. 1: Mammals. Rashmi Prakashan, Guwahati, India. 2018;133-136.
69. Choudhury A. Some recent records of the Spotted linsang Prionodon pardicolor from India. Small Carniv. Conserv. 2022; 27:12.
70. Menon V. Indian Mammals: a field guide. Hachette Book Publishing India Pvt. Ltd., Gurgaon, India; 2014.
71. Jothish PS. Diet of the common palm civet *Paradoxurus hermaphrodites* in a rural habitat in kerala, india, and its possible role in seed dispersal. Small Carniv. Conserv. 2011;45:14-17.
72. Joshi AR, Garshelis DL, Smith JLD. Home ranges of sloth bears in Nepal: implication for conservation. J. Wildl. Manage. 1995;59:204-214.
73. Corlett RT. Frugivory and seed dispersal by the vertebrates in the Oriental (Indomalayan) region. Biol. Rev. 1998;73:414-448.
74. Mills JP. Bombay Natural History Society's mammal survey of India, Burma and Ceylon. Report No. 36, Naga Hills. J. Bombay Nat. Hist. Soc. 1923;29(1):221-229.
75. Choudhury A. The marbled cat Felis marmorata Martin in Assam – some recent records. J. Bombay Nat. Hist. Soc. 1996;93:583-584.
76. Choudhury A. The clouded leopard in Assam. Oryx. 1993;27:51-53.
77. Choudhury A. The Clouded Leopard. Cheetal. 1996;35(1-2):13-18.
78. Choudhury A. A Naturalist in Karbi Anglong. Gibbon Books, Guwahati, India; 1993.
79. Census of India. Planning Commission, Government of India; 2001.
80. Census of India. Planning Commission, Government of India; 2011.
81. Osmani AR. Tipaimukh multipurpose hydroelectric project: A policy perspective – Indo- Bangla priorities, Indigenous Peoples' rights, and Environmental concerns. In: Rao P, Patil Y, Editors: Reconsidering the impact of climate change on Global water supply, use, and management. IGI Global, Hershey PA, USA. 2017;13:227-251.
82. Choudhury NB, Dey Choudhury SR. Implications for planning of hydroelectric projects in Northeast India: An analysis of the impacts of the Tipaimukh project. Geo Journal 2021;86:1999–2019.
83. Dutta H, Singha H, Dutta BK, Deb P, Das A. Human-wildlife conflict in the forest villages of Barak valley, Assam, India. Curr. World Environ. 2015;10(1):245-252.
84. Dutta H, Singha H. Dutta BK, Deb P, Das AK. Human-wildlife conflict in the forest fringe villages of Barak Valley, Assam, India. J. Human Ecol. 2016;55(1,2):104-110.
85. Gherman CM, Mihalea AD. A synoptic overview of Golden jackal parasite reveals high density of species. Parasit. Vectors. 2017;10:419.
86. Choudhury A. Distribution and conservation of the Gaur Bos gaurus in the Indian Subcontinent. Mamm. Rev. 2002;32(3):199-226.
87. Nawab A, Gautam P. Otters: can they be saved? Proceedings of Taal; The 12th World Lake Conference. 2007;591-596.
88. Gopal R. Ethological observations on the sloth bear (Melursus ursinus). Indian Forester. 1991; 117: 915-920.
89. Choudhury A. Camera trapping for wildlife with special reference to Small Mammals in parts of Arunachal Pradesh, Assam, Meghalaya, and Mizoram in North East India. Technical Report No. 17, The Rhino Foundation for nature in NE India, Guwahati, Assam, India. 2014;62.
90. Lahkar D, Ahmed MF, Begum RH, Das SK, Lahkar BP, Sarma HK, Harihar A.

Camera-trapping survey to assess diversity, distribution and photographic capture rate of terrestrial mammals in the aftermath of the ethnoolitical conflict in Manas National Park, Assam, India. J. Threat. Taxa. 2018;10(8):12008–12017.