

Population status, ecology and threats of one of the least known primate species: Bengal slow loris (*N. bengalensis*) in the Protected Areas of Assam, India

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Introduction

The infra-order lorisiformes of order primate is the ‘least known of all primate’ (Nekaris & Bearder, 2007) having 34 recognized nocturnal species under three subfamilies Galaginae (galagos), Perodicticinae (pottos and angwantibos) and Lorisidae (lorises). The Lorisidae represented by two species in India - *Loris lydekkerianus* (Slender loris) and *Nycticebus bengalensis* (Bengal slow loris) which is endemic to south and Southeast Asia. The genus *Nycticebus* of infraorder lorisiformes, native to South and Southeast Asia is one of the least studied Asian primates, owing to its nocturnal lifestyle, cryptic and its small body size (Groves 1998, 2006; Srivastava & Mohnot 2001). Five species of genus *Nycticebus* (*N. bengalensis*, *N. coucang*, *N. javanicus*, *N. menagensis* and *N. pygmaeus*) are recognized based on genetic analysis (Roos 2003, Brandon- Jones *et al.*, 2004; Chen *et al.*, 2006; Nekaris *et al.*, 2007). As studies of this previously unknown genus became available, so does the dramatic conservation crisis that they face. For example, in 2007, *Nycticebus* became the first primate genus to be up listed to CITES I in over 15 years and Javan slow loris (*N. javanicus*) was placed on the list of top 25 most endangered primate species of the World (IUCN 2008).

The five species of genus *Nycticebus* are endemic to South and Southeast Asia, each having its own significantly smaller range from Assam, Northeast India to Mindanao and islands of the Sunda Shelf (Mackinnon and Mackinnon, 1987) as follows:

- a) Pygmy slow loris (*N. pygmaeus*) - found in Cambodia, South China, Laos and Vietnam;
- b) Bengal or Northern slow loris (*N. bengalensis*) - found in Burma, Cambodia, South China, Bhutan, North-east India, Laos, Thailand north of the Isthmus of Kra and Vietnam;
- c) Greater slow loris (*N. coucang*) - found in Indonesia on Natuna Island and Sumatra, peninsular Malaysia and Thailand south of the Isthmus of Kra;
- d) Bornean slow loris (*N. menagensis*) - found in Brunei, Kalimantan in Indonesia and the Malaysian states of Sabah and Sarawak;
- e) Javan slow loris (*Nycticebus javanicus*) - found in Indonesia on the island of Java.

Bengal slow loris *Nycticebus bengalensis* has the largest geographic range among the slow lorises and this species remains very poorly researched, both in the wild and in captivity. In many Asian countries slow lorises are in high demand for traditional medicine and pet trade. With their low reproduction rate, wild populations of *Nycticebus* cannot withstand these large-scale off-takes and many authors report regional population declines (Nekaris et al 2008). In India, the distribution of Bengal slow lorises is confined only to the 7 northeastern states of India (Brandon-Jones *et al.*, 2004; Choudhury, 1992; Srivastava, 1999). In Assam, Northeast India slow loris are seriously suffering from escalating habitat destruction, hunting, medicinal and pet trades despite being included in Schedule I Species list as per Wildlife Protection Act of India, 1972. Recently IUCN listed the species as 'Vulnerable' throughout its distribution range (IUCN 2008) with limited conservation attention. No long term ecological studies have been conducted so far on Bengal slow loris in India except a handful of distribution records (Choudhury, 1992; Radhakrishna *et al.*, 2004). Lack of information about the current population, habitat status, and general ecology of slow loris demand specific studies to formulate a comprehensive as well as a site specific conservation action plan for the species and its habitats as it is an important seed disperser, pollinator (Nekaris and Bearder, 2007). It also prefers dense forests, indicating the health of forest ecosystem (Gupta, 2001). Being ecologically unexplored and unattended, the survival threat of Bengal slow loris becomes more real in Assam due to present deforestation crisis and the hunting. The primary threat to this species in Assam is from habitat destruction (illegal logging, slash & burn cultivation and encroachment) hunting for food, medicinal use and pet trade.

Scientific synonyms of Bengal slow loris

Nycticebus coucang bengalensis

Nycticebus c. tenasserimensis (Elliot, 1967)

Nycticebus cinereus (Milne-Edwards, 1867)

Nycticebus incanus (Thomas 1921)

Nycticebus tardigradus (Blanford 1888)

Local Names of Bengal slow loris in India

In India it is commonly known as following in different languages:

Assamese: Lajuki-bandar; **Hindi:** Sharimindii-billi; **Bengali:** Lajjawati-bandar; **Garo:** Galwee, Durok; **Mizo:** Sahuai; **Manipuri:** Samrok gamkok; **Rukni:** Mukhra ochai; **Khasi:** Yapnang; **Bodo:** Nilaji makhra; **Rankhol:** Zong ochai; **Hmar Kuki:** Mitungki.

Identification

Slow lorises are robust, compact animals with short and dense woolly fur. Lorises have very large eyes, which are directed forward. A prominent stripe down their back and lack of a visible tail make it easy to distinguish slow lorises from other small mammals. With creamy or white colored neck with a prominent stripe, ear encased by white or creamy fur, eye fork are light colored or sometimes not present, having dark rim around eyes are the distinctive identification characters of a Bengal slow loris separating it from other four species of slow lorises. With a length of 26-38 cm and a weight of up to 2 kg, is the largest *Nycticebus* species. Their tightly clinging hands and feet have human-like nails. The nail on the second digit of the foot is elongated and rolled up to form a grooming claw. They can maintain a grip while remaining completely immobile for long periods due to a specialized network of blood vessels in the limbs.



Fig 1: Bengal slow loris (*Nycticebus bengalensis*) in Assam, NE India.

Finding slow loris in night

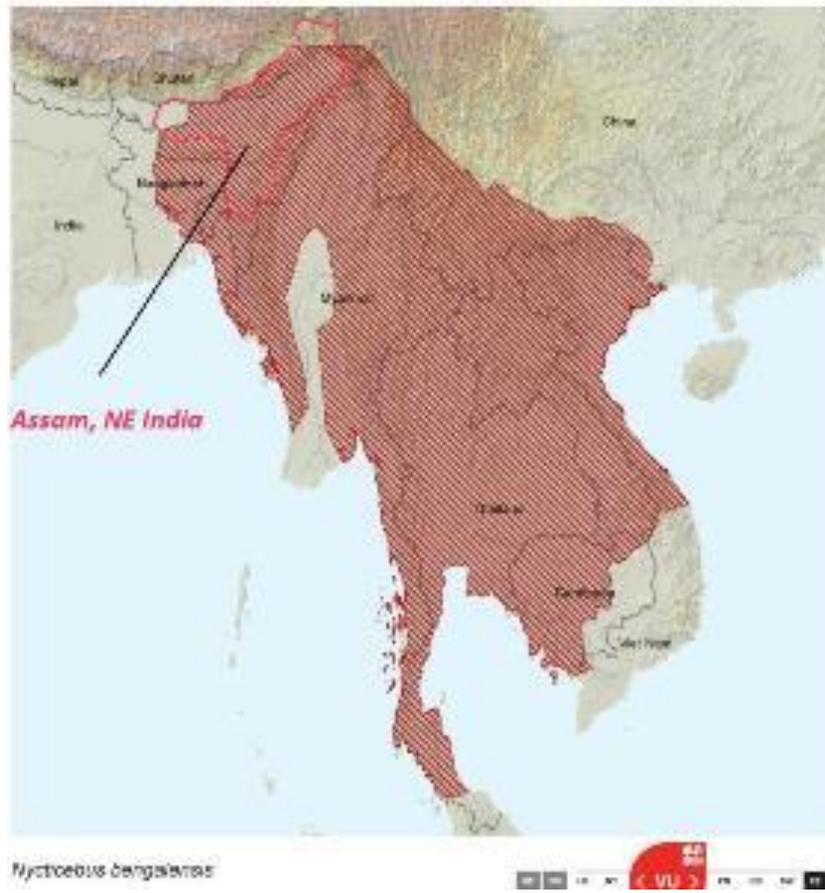
In darkness with torchlight, head lamp or other light, the *tapetum lucidum* in the eyes of the animals (reflecting layer of cells behind the retina) causes a reflection well visible as long as the animal is looking towards the light (Pariante,1979). In *Nycticebus caucang*, strong orange or orange-red reflection (Barrett 1984) occurs and similar pattern of eye shine in night found in *Nycticebus bengalensis* also.

Distribution range

N.bengalensis is endemic to south and Southeast Asia, found in the following countries: Bangladesh, Northeast India, Bhutan, Southern China, Lao People's Democratic Republic, Myanmar, Thailand, Philippines and Vietnam (Brandon-Jones *et al.* 2004; Gursky 2002; Groves 2001) (Tab: 1). This species is found in tropical evergreen, semi-evergreen, tropical mixed deciduous, and sub-tropical broadleaf type forests in Northeast India (Choudhury, 1992).

Tab 1: Distribution range of Bengal slow loris *Nycticebus bengalensis*

Country	Region
Bangladesh	Recorded e.g. from Chittagong Hill Tracts and from Garo Hills (WTB undated).
Bhutan	Southern Bhutan, area bordering Assam of Northeast India(Choudhury 2008).
India	Northeast India (States of Assam, Arunachal Pradesh, Mizoram, Nagaland, Meghalaya, Manipur and Tripura (Srivastava & Mohnot 2001; Choudhury 1992).
China	In Yunnan and in southwest Guangxi (CSIS 2006; Bangjie 1985).
Lao People's Democratic Republic	Have been recorded in the north, central, and southern part of the country (Duckworth <i>et al.</i> 1999).
Thailand	Distributed over most of the country areas (Schulze & Groves 2004).
Viet Nam	It is known from 12 24 protected areas (Long <i>et al.</i> 2000; SFNC 2000, Dang 1998).
Philippines	In the islands of Simunul, Bongao, Sanga Sanga, and Tawitawi, where Tawitawi represents this species most eastern most limit (Fooden, 1991).
Myanmar	Recorded from Bhamo, Sumprabum, Kindat, Chin Hills, Pathein, Thauंगाung and Pegu (Groves 1971).



Map courtesy: IUCN website

Fig 2: IUCN Bengal slow loris distribution range

Project Goal and Objectives

Project goal:

- To collect data on the present population and habitat status and demography as well as feeding ecology and habitat utilization pattern of Bengal slow loris in Assam to support long-term conservation of the species in Assam.
- To generate reliable information on, and create a database for Bengal slow loris, population status, habitat use, general ecology and conservation issues, to be used as a base for the IUCN Species Survival Commission Primate Specialist Group classification.
- Determination of the major threats to the species in Assam as it is the part of NE India where Bengal slow loris found.

Specific Objectives:

Survey: -

- To know the present distribution and population status as well as demography of Bengal slow loris in the protected areas (PAs) of Assam.

Habitat assessment: -

- To identify and compare the habitat of the Bengal slow loris in term of quantitative vegetation structure, density, and species composition.

Study general ecology & home range:

- To find out food plants used by Bengal slow loris in different habitat type.
- To obtain comparative account of feeding ecology including their diet, quantity of forage, frequency of consumption in different habitat conditions.
- To obtain home range and habitat utilization pattern of Bengal slow loris.

Conservation & Threat analysis: -

- To evaluate the threats from various angle viz., (a) population, (b) demography, (c) quality of habitat.

Study area

The immense variety of the climatic, edaphic and altitudinal variations in India have resulted in a great range of ecological habitats for which Northeast India takes the pride of place. Lying between 22--30⁰ N latitude and 89--97⁰ E longitude, and sprawling over 2,62,379 sq.km., it was the part of the northward migrating 'Deccan Peninsula' that first touched the Asian landmass after the breakup of 'Gondwanaland' in the early Tertiary period (Molnar 1986). Northeast India is thus the geographical 'gateway' for much of India's flora and fauna, and as a consequence, the region is one of the richest in biological values (Myers 1999, 2000). It is in this lowland-highland transition zone that the highest diversity of biomes or ecological communities can be found, and species diversities within these communities are also extremely high.

Northeast India comprised with seven states viz. Assam, Arunachal Pradesh, Mizoram, Meghalaya, Nagaland, Tripura and Manipur, blessed with a wide range of physiography and eco-climatic conditions. The forests in the region are extremely diverse in structure and composition and combine tropical and temperate forest types, alpine meadows and savanna. The state of Assam represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese biogeographical regions and a meeting place of the Himalayan Mountains and Peninsular India. The State situated within 24°07' to 28°00' North Latitude and 89°42' to 96°02' East longitude. It is the area in the whole of the South Asia with extremely rich forests serving as a habitat of a variety of primate, carnivore, herbivore and birds. The recorded forest area is 26,832 km², which is 34.21% of the total geographic area of the state. According to the legal classification, Reserved Forests constitute 66.58% and Un-classed Forests, 33.42%.

Owing to the location in the sub-tropical zone and the prevalence of the Monsoon climate, the landmass of Assam possesses mainly evergreen, semi-evergreen and deciduous trees. However, depending upon the intensity of precipitation, humidity and temperature, the forests are classified as wet or dry. Variation occurs in growth of different species of trees in different parts of the state due to different soil and ground water regimes and other geographical factors. The

vegetation cover found in Assam can be classified into six major forest types viz. Tropical Wet Evergreen, Tropical Semi-Evergreen, Tropical Moist Deciduous, Subtropical Broad Leaved Hill, Sub Tropical pine and Littoral Swamp forests (Champion & Seth 1968).

In Assam, there are 5 National Parks (NP) and 18 Wildlife Sanctuaries (WLS) covering an area of about 0.4 million ha constituting 4.98% of the total geographic area of the state. In this project work on Bengal slow loris, we have selected the following 13 Protected Areas (PAs) of Assam (Table: 2) on the basis of different habitat structure and to cover distant geographic location within the state of Assam. Survey covered 3 National Parks and 10 Wildlife Sanctuaries of Assam. In addition to this we also surveyed one National Park in Arunachal Pradesh and 2 other Reserve Forests (RF) in Assam.

Tab 2: Bengal slow loris surveyed PAs of Assam.

SI No	Surveyed Areas	Total area in sq.km	District
1	Manas NP	500	Baska
2	Nameri NP	200	Sonitpur
3	Dibru Saikhowa NP	340	Tinsukia
4	Chakrasilla WLS	45.50	Kokrajhar
5	Barnadi WLS	26.22	Kamrup
6	Amsang WLS	78.64	Kamrup
7	Laokhowa WLS	70.13	Nagaon
8	Burachapori WLS	44.06	Sonitpur
9	Bherjan -Borajan WLS	7.22	Tinsukia
10	Dehing Patkai WLS	111.19	Dibrugarh
11	Gibbon WLS	20.98	Jorhat
12	Garampani WLS	6.05	Golaghat
13	Nambor-Doigurung WLS	97.15	Golaghat

Bengal slow loris survey:

The survey of Bengal slow loris was begun in February 2008 and ended in May 2009. As survey covered a large area within a stipulated time period, we adopt the ‘recce’ (reconnaissance) survey (Walsh and White, 1999) in conjunction with line transects (Burnham et al., 1980) method; the ‘Recce-Survey Transects’ (MIKE, 2006) to estimate loris encounter rate. Survey carried out at night (1800 – 0200 h) on foot and by vehicle (where night walking is prohibited). Two /three transects were selected randomly to avoid bias (White and Edwards 2000) for each night; one is during early part of night (1800 – 2130 h) and another is middle of night (2230—0200 h). All types of vegetation searched by headlamp (Ptezl headlamp) for detection of loris that produces an orange red refraction from its eye. This anatomical feature enhances their nocturnal vision in that it increases the amount of light reflected back through the receptors (Wolin, 1974). The index used for estimating relative abundance is the loris encounter rate, or ‘sightings’ per km (Anonymous, 1981; Sutherland, 2002).

Habitat assessment:

Habitat assessment studies were done by strip sampling method (Strushsaker, 1975 and Williamson, 1993) in daytime to characterize the different habitats, where slow loris is encountered in nights in the surveyed areas. In the case of smaller mammals it has been shown that their distribution is often associated with the availability of suitable habitats (Entwistle and Stephenson, 2000). All the forest types of loris encountered area, containing different microhabitats was considered for this study. Initially plants were identified by local name with the help of local field assistants and later on plant species were identified with the help of standard field guide following Hajra and Jain, (1978) and Kanjilal *et al.* (1934-1940). Data related to density of the understory vegetation, the percentage canopy cover and the height of the canopy at each observation were recorded. Understory density was estimated on a scale from 1 to 5, canopy cover was estimated as percentage cover to the nearest 5% and the height of the canopy was estimated to the nearest 5 m. The species of tree, shrub, or liana on which animal was found

was recorded as well as its diameter at breast height (DBH) measured with a tape measure. The DBH of the entire tree species was done in a 50 X 10 meter strip where loris was encountered in night.

General ecology & Home range:

Ad labium sampling and focal animal sampling are adopted as per Altmann (1974). For behavioral data recording, we found out one slow loris then follow the animal in a specific study site (Gibbon WLS). We used head-lamp (Petzl headlamp) and binoculars for observing the targeted loris individual. We concentrated our effort to follow a loris continuously from its sleeping site at dusk to its sleeping site at dawn, whenever possible. Data relating to feeding, quantity of forage and frequency of consumption was recorded during *focal animal sampling*. When food was consumed, identification of foodstuff was made; if this could not be ascertained from observation, food materials dropped by the animal were collected for later identification. Feeding trees are identified to species level on site or are tagged for later identification if unknown. Besides focal animal sampling, opportunistic observation of occasional, but important behaviors is also done in *Ad labium* sampling (Altmann 1974).

Feeding behavior was carried out from March 2008 to May 2009 in Gibbon Wildlife Sanctuary (26°40'-- 26°45' N and 94°20'--- 94°25' E), situated on south bank of river Bhramaputra in Assam. The forest type in the Gibbon Wildlife Sanctuary is Assam plains alluvial semi evergreen forests, sparsely interspersed with wet evergreen forest patches (Champion & Seth 1968). The vegetation is composed of several canopy layers; most of the components are evergreen in character. The study area of 2098.62 h, distinctly divided into five compartments having thick under storey and a canopy at a height of about 10–19 m.

1. Slow loris survey

We surveyed 13 different protected areas of Assam covering almost all representative areas except southern Assam. A total of 20 slow lorises were recorded from 7 different protected areas and confirmed the presence of slow loris from 4 different protected areas from secondary information and past record of captured animals (Table: 3)

We started our survey activities from February 2008 to May 2009. During this period we surveyed the protected areas (Table: 2), which falls under the probable distribution area of Bengal slow loris (*Nycticebus bengalensis*) in Assam. We were forced to temporarily withdraw the survey activities due to heavy monsoon rain during June and July 2008. It was not an easy task especially at night, since the access to the fragments was often difficult due to bad rainy conditions or even to the absence of existing forest trails to get to specific parts of the forests. We partially surveyed some parts of Manas NP and Chakrasilla WLS in that time, which were completed after monsoon season later on. In addition to protected areas, we also surveyed tea estates (in Gibbon WLS, Padumani-Bherjan-Borajan WLS, Dehing Patkai WLS), and areas bordering forests and villages (In Manas NP, Nameri NP, Dibru Saikhowa NP, Barnadi WLS and Chakrasilla WLS). The forest types in the surveyed areas included tropical wet evergreen, tropical semi-evergreen, tropical moist deciduous and subtropical broad leaved hill forests. Instead of our stipulated survey sites, in addition we also surveyed two other Reserved Forests (Chirrang Ripu RF and Joypur RF) of Assam and one National Park of Arunachal Pradesh (Namdapha NP).

Abundance estimate of Bengal slow loris in different protected areas

During the survey we spent 99 full survey nights and 28 partial survey nights covering 370 km long transect within PAs & RF of Assam and Arunachal Pradesh. All the lorises encountered were lone animals. Since the density or actual abundance of the species could not be calculated due to its cryptic nocturnal habits and shyness, eye shine detection is the only method

of animal sighting at night - which is also very intermittent, reduces the chances of any density estimates. During our survey efforts, only in 22.0% (n = 25) survey nights we were successful in encountering lorises. Because of these difficulties workers are estimating the average encounter rate per kilometer and considered it as abundance estimate instead of true abundance.



Fig 3: Slow loris in Manas National Park



Fig 4: Slow loris in Nameri National Park

In this study, the average encounter rate or abundance of the species in all the PAs of Assam was calculated to be 0.11 loris / km. This estimates varies in different protected areas as we observed and highest abundance observed in Gibbon WLS (0.18 loris /km) followed by Borajan-Bherjan-Podumani WLS (0.17 loris / km) and Garampani WLS and Nameri NP (0.10 loris / km).



Fig 5: Slow loris in Bherjan-Borajan WLS



Fig 6: Slow loris in Garampani WLS

It is most remarkable that in the upper Bhramaputra valley of Assam where Padumani - Bherjan -Borajan WLS, Gibbon WLS, Dehing Patkai WLS are located, 13 lorises were encountered among the total of twenty loris sighting during this survey in 13 PAs areas of Assam. The average sighting encounter distance from transect was 14.7 m depending on the

vegetation pattern and degree of disturbance of the forests. The nearest loris encountered distance observed in bushes and bamboo thickets (3 m & 4 m), where slow lorises were concealed with the local environment and immediately disappeared if disturbed.

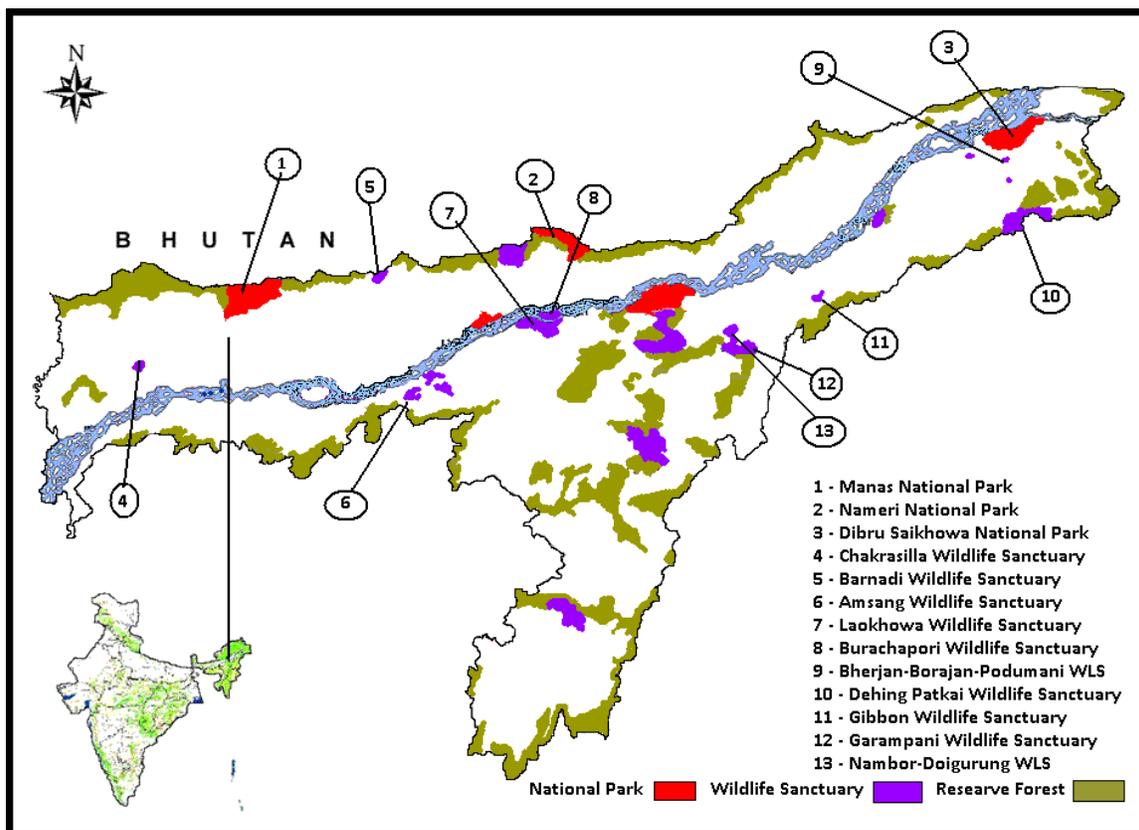


Fig 7: Map showing Bengal slow loris surveyed PAs in Assam

No lorises were seen on the transect line. On every occasion all lorises were found in solitary conditions. All lorises were seen at average heights of 12.1 m with respect to the ground. The heights, at which the animals were sighted, however made it difficult to identify their sex and age. Feeding behavior was recorded when the lorises were first detected in three incidences (viz. one in Nameri NP and two in Gibbon WLS). Local villagers and forest staff concurred that sightings of slow lorises had become very rare in recent years or that the species was no longer in areas that they had previously inhabited.



Fig 8: Slow loris in Nambor Doigurung WLS



Fig 9: Slow loris in Dehing Patkai WLS

Apart from these protected areas, we also surveyed two Reserved Forest of Assam viz. Chirrang Ripu RF and Joypur RF which constitute the buffer area of protected areas. In these two reserved forests, we encountered two animals spending another 8 full survey nights and one partial survey night. The estimated abundance of the two reserved forests was calculated to be 0.06 loris/km and 0.09 loris/km respectively.



Fig 10: Slow loris in Bamboo thickets



Fig 11: Characteristic eye shine of Slow loris



Fig 12: Slow loris in Chirang Reserved Forest



Fig 13: Slow loris in Gibbon WLS



Fig 14: Slow loris in Gibbon WLS

Fig 15: Slow loris in Gibbon WLS

Fig 16: Slow loris in Gibbon WLS

Table 3: Slow loris encounter rate per km in some protected areas of Assam and Arunachal Pradesh

<i>Surveyed Areas</i>	<i>Night survey</i>	<i>Sighting rate per km</i>	<i>Remarks</i>
Manas NP	8 full night & 3 partial night	0.08 loris/km	Western most distribution recorded
Nameri NP	7 full night	0.10 loris/km	
Dibru Saikhowa NP	6 full nights.	--	One animal caught two year back and one animal released on 2006.
Chakrasilla WLS	6 full night & 4 partial nights	----	
Laokhowa WLS	7 full & 4 partial nights.	----	Loris sighting occur way back in 5 years ago, as per forest official.
Burachapori WLS	6 full & 3 partial nights.	---	
Padumani -Bherjan - Borajan WLS	6 full night.	0.17 loris/km	
Gibbon WLS	12 full night & 3 partial nights.	0.18 loris/km	
Dehing Patkai WLS	10 full night & 3 partial nights	0.09 loris/km	
Garampani WLS	3 full nights & 1 partial nights	0.10 loris/km	
Nambor-Doigurung WLS	4 full nights & 2 partial nights	0.06 loris/km	
Amsang WLS	6 full nights & 1 partial night	-----	Three animals were caught and handed over to State Zoo, Assam.
Barnadi WLS	5 full nights & 3 partial nights	-----	Loris dry body parts were confiscated from poacher.

13 PAs of Assam	86 full & 27 partial nights.	0.11 loris/km	
Namdapha NP, Arunachal Pradesh	5 full nights	0.2 loris/km	Good habitat for slow loris.
Joypur RF, Assam	3 full nights & 1 partial night	0.09 loris/km	Good habitat for slow loris.
Chirrang RF, Assam	5 full nights	0.06 loris/km	Western most distribution recorded
Total	99 full nights & 28 partial nights	0.11 loris /km	----

Similarly we spent 5 full survey nights in Namdapha NP cum Tiger Reserve in Arunachal Pradesh, which is a contiguous landscape with Dehing Patkai Wild Life Sanctuary. From this observation the abundance of loris was calculated to be 0.2 loris / km which are quite high compared to the observation in protected areas of neighboring Assam. Thus the total animal sighted during this study was 25 animals in 8 PAs and two RFs.

Indirect evidences of slow loris presence

Although sighting probability was low in some of the protected areas but we confirmed the presence of slow loris in 7 PAs. In our interaction with the local fringe villagers and forest officials in some of protected areas the presence of loris in those areas was clearly confirmed. In Barnadi WLS, forest officials already confiscated some dry body parts (hand and legs) of slow loris from a poacher (Fig: 17). In Laokhowa WLS, slow loris sightings occurred way back in 5 years ago, we also visited that area, where loris was sighted by a forest official in day time and found a suitable habitat for slow lorises. We did not find any lorises during our survey nights in



Fig 17: Bengal slow loris body parts confiscated from Barnadi WLS, Assam.

Dibru Saikhowa NP, but one animal was caught two year back nearby tea garden and one is released on 2006, which was also caught from another nearby villages. Similarly three animals were caught in nearby villages of Amsang WLS and were handed over to State Zoo in Guwahati. Three slow lorises were rescued from ‘Jokaikuwnargaon’ of Dibrugarh District, ‘Barhola’ of Golaghat District and ‘Sakomatha tea estate’ of Sonitpur District on 6th, 18th June 2008 and 11th May 2009 respectively as reported by local news paper. Later all these rescued lorises were handed over to forest officials. We did not find any sign of slow loris presence in Chakrasilla WLS during our survey activities.

2. Habitat characteristics

After survey throughout loris encountered site within the surveyed PAs in Assam, Bengal slow loris was found to be distributed in only 4 major types of forest viz., tropical wet evergreen forest, tropical semi-evergreen forest, tropical moist deciduous forest, and subtropical broad-leaved hill forest. According to Champion and Seth (1968), the typical evergreen tree species in these forests are *Syzygium*, *Cinnamomum*, *Artocarpus*, and *Magnoliaceae*, and the common deciduous species include *Terminalia myriocarpa*, *Terminalia citrina*, *Terminalia tomentosa*, *Tetrameles* spp., and *Stereospermum* spp. *Shorea robusta* is present in disturbed habitats, especially in areas that have been subjected to fire, and represents a sub-climax community. Other *Dipterocarpus* species are considered to be indicative of a forest in retrogression from the tropical evergreen or as a preclimax stage. Typically, the canopy trees are 20-30 m high. Patches of forests, scattered along the Indo-Bhutan and along the northern border between Assam-Arunachal are semi-evergreen forests. Many of these forest patches are confined to protected areas. One slow loris was also sighted in deciduous forests (Chirang Ripu RF), this confirming the presence of its Western most distribution instead of IUCN (2008) distribution map. Deciduous forests lay mainly in the ‘Sal’ (*Shorea robusta*) tracts areas of Western Assam. Associates of ‘Sal’ are *Lagerstroemia perviflora*, *Kydia calycina*, *Schima wallichii*, *Careya arborea*, *Gmelina arborea*, *Cassia fistula*, *Albizzia lucida*, *A.odoratissima*, *Millusa velutina*, *Stereospermum chelonoides* etc.

Habitat sampling was done daytime where Bengal slow loris was encountered in previous night. A total of 60 habitat sampling (50 m x 10 m plot each) was conducted in the surveyed areas. A total of 920 tree the same as or greater than 1cm DBH was measured in the total sample area. Trees of a DBH of between 1 cm and 5 cm make up 78% and between 4 cm to above make up 22% of the trees in the study area. It should be noted that identification of plant specimens was still going at the time of completing this project and, therefore, the analysis is based on approximately only half the number of species recorded and finally identified from plots. Thus, re-examination of the dataset once finalized is imperative.

The total number of plant species encountered in these plots was 18 (excluding the unidentified species). The number of plant species in these plots ranged from 3 to 9. In most plots (27, 45 %), the number of species was only 3 and only in 2 plots, a total of 9 species were noted. In 31 plots (51.7%), the number of species varied from 4 to 8 only.

The canopy cover in 32 plots (53.4%) was between medium (25-50%) to very dense (75-100%). The canopy continuity in 29 plots (48.4%) was also between medium (25- 50%) to very dense (75-100%). The plots were very poor in herb concentration as only 16% plots were with medium to very dense herb growth and majority (84%) were either with no herb growth or very poor herb growth (less than 25%). Shrubs were even poorer in their growth as only about 9% of the plots were supporting medium to very dense shrub growth, while almost 91% of the plots either had no shrub growth or very poor (below 25%).

There was a significant difference in tree density per study plot and mean canopy cover between all the loris encountered sites. The tree density was highest in Gibbon WLS, followed by Dehing Patkai WLS. Similarly Gibbon WLS had the highest mean canopy cover of 82.11%, followed by Nambor Doigurung WLS with 64.45% and Manas National Park with 57.37%.

During the survey within the state of Assam and Arunachal Pradesh sighting of slow lorises occur in 15 different trees.

3. Feeding behaviour:

We have selected Gibbon Wildlife Sanctuary for the studies of feeding ecology as well as loris general ecology. The study has conducted 12 continuous nights with every two months interval right from the months of March 2008. But it is almost impossible to find and follow a

slow loris in wild to gather their eco-behavioral data without having radio collared animal. In other Southeast Asian countries like Thailand, Vietnam, Cambodia, slow loris eco-behavioral observation has been made using Radio telemetry technique as such it is the prerequisite for any nocturnal solitary species.

Without using any radio collared Bengal slow loris for feeding and general ecological study in this area, we have achieved a little bit success to follow the slow loris in night continuously up to maximum 5 hours. In most instances we are able to follow the subject for 5 min to 1 hr.

The diets were assessed by direct feeding observations made during nocturnal tracking (396 h). When lorises were seen feeding, kind of food (gum, exudates, flower, plants bark, arthropod) as well as the vernacular name of the forage plant were recorded. The forage plant were marked and visited during the day to collect leaves, fruits or flowers for identification. The heights of the point where the animals fed estimated to the nearest meter.

During the behavior study it was observed that Bengal slow lorises used 18 different tree species of 12 families for feeding. We recorded five food types – plant exudates (gum and sap), floral parts, fruits, bark and insects. It was found that as high as 83.70 % of feeding bouts were of plant exudates (gum and sap). This was followed by bark, floral parts, insects and fruits. Out of total exudates eating, Bengal slow loris preferred 5 tree species, which have high medicinal value and commonly used by the local communities of the region for medicinal purpose. Most exudates eating plants were between 5 and 18 m in height (58%). The comparison of eaten and not eaten fruits revealed that they prefer smaller fruits and seeds for feeding. The eaten fruits had a length of 13.8mm and a width of 10.4mm.

These observations suggest that the food preference and dietary composition of Bengal slow loris is highly enriched with medicinal plants which might have some implication on its physiology and socio-sexual behaviour. An emphasis on the dietary affinity of the species towards the medicinal plants is offering a strong vista for successful conservation in the region.



Fig 18: Bridge formation by Slow loris in Gibbon WLS Fig 19: Climbing down by a Slow loris in Gibbon WLS

4. Threats to lorises

Habitat destruction is the most significant threat to the survival of Bengal slow loris. It is evident, however, that there are certain instances of this species visiting human habitation areas, that's may be shortage of their food items due to illegal extraction of large quantity of non timber forest product (tree gums, resins and latex) from the forest by people, but the long-term consequences on reproduction and survival are unknown. Habitat destruction/degradation through irresponsible economic activities creates another problem along with the affects of population explosion in Assam. This may trigger the decreasing trends of slow loris population.

Hunting is another alarming threat for Bengal slow loris population in Assam and other wildlife in NE India. All parts of slow loris body are too much popular in some of local tribes of NE India, believed that it can heal many diseases. People also believed that the meat of slow loris increase male power and acts as an aphrodisiac. An evidence was sighted by us during the survey in Barnadi WLS, Assam from where loris dry body parts were confiscated from a local poacher. This established that loris body parts are used in some parts of Assam for treatment of some diseases. Similarly slow loris meat is very popular among some of hilly areas of NE India and Assam.

Trapping also pose, to some extent, threats to its survival in Assam. It is a popular choice as pet perhaps due to their docile nature, large eyes, colorful pelage and teddy bear-like appearance. *Nycticebus* are easily captured because they are nocturnal and do not flee in daytime.

When trees are cut, or when forests are cleared, the lorises can be easily gathered and captured. But this threat till date is not so serious in the state of Assam, as it poses a very serious alarming threat for the other species of *Nycticebus* in other Southeast Asian countries.



Fig 20: P.I recording data with researchers in field



Fig 21: Co investigator crossing a river during survey



Fig 22: Principal investigator crossing a river



Fig 23: Principal investigator and co investigator in Namdapha National Park



Fig 24: In search of two glowing eyes of slow lorises



Fig 25: Recording GPS location of the sighted slow loris in Gibbon WLS



Fig 26: Recording habitat data in Gibbon WLS



Fig 27: Unexpected problem in jungle at night

Conclusions

Although the average encounter rate or speculative relative abundance of sighting for all the protected areas is low but in some PAs it is as high as 0.18 individual / km (Table-3), which means that the population of Bengal slow loris in some specific PAs are substantial. This study reveals an abundance rate of Bengal slow loris population allowing comparison with the only other available estimate reported for Assam. Radhakrishna *et al.* in 2004 conducted surveys in some parts of Assam, and found 0.33 – 0.03 loris /km (Radhakrishna *et al.* 2006), that also, survey was mainly concentrated in reserve forests in Assam and Meghalaya. Our survey estimated an abundance rate of 0.18 --- 0.06 loris/km, in all the surveyed protected areas (NP and WLS) in Assam. This low encounter rate is in accordance with the suggested IUCN Red List status of ‘Vulnerable’.

During our surveys, we confirm by the direct sighting of slow loris outside the IUCN Bengal slow loris distribution range, i.e. sighting occur in westernmost part of Chirang Ripu RF (part of Manas Biosphere Reserve) of Assam. Before this survey in Nameri National Park, Assam, there were indirect evidences about the presence of slow loris in that park. I and our survey team is the first ever to confirm the presence of slow loris in Nameri National Park with some good shots of slow loris photograph. Generally all loris species are sparsely distributed throughout much of their range (Nekaris *et al.* 2008). The present abundance estimate of Bengal slow loris in all the PAs and RFs falls within the ranges as reported by some authors in its distribution areas (Table-4) which portrays a substantial population of Bengal slow loris in few PAs of Assam are isolated from each other. Despite a serious danger of becoming extinct in many parts of Assam (Radhakrishna *et al.* 2006), conservation action for this species is still neglected in the western part of its distribution range. While Namdapha NP, Arunachal Pradesh may have a good population, but rampant hunting in the peripheral areas for medicinal use is a cause of concern.

Table 4: Bengal slow loris *Nycticebus bengalensis* abundance estimation via nocturnal field observations in Southeast Asia.

<i>Study site</i>	<i>abundance estimate</i>	<i>Surveyor</i>
Phou Xang He, Central Laos	0.30 – 0.65 loris /km	Duckworth, 1994
Nakay-Nam Theun, Central Laos	0.04 – 0.08 loris /km	Duckworth, 1998a
Xe Piang, Central Laos	0.13–0.27 loris /km	Duckworth, 1994
Muang Hom, Central Laos	0.10–0.21 loris /km	Evans et al. 2000
Nam Kading, Central Laos	0.10–0.22 loris /km	Do
Nam Ao, Central Laos	0.14–0.30 loris /km	Do
Bang Navang, Central Laos	0.09–0.20 loris /km	Do
Xe Namoy, South Laos	0.40–0.87 loris /km	Do
Assam, Northeastern India	0.33 – 0.03 loris /km	Radhakrishna <i>et al.</i> 2006
7 PAs of Assam*	0.06 – 0.18 loris/km	Present study
Namdapha NP, Arunachal Pradesh*	0.2 loris/km	Present study
2 RFs of Assam*	0.06 – 0.09 loris/km	Present study

Limitations of the study:

As it is totally a night survey, we are forced to use a 4 X 4 wheel vehicle for dropping the survey team in the interior most survey site due to the threats of Elephants in Manas NP, Dehing Patkai WLS, Barnadi WLS and Gibbon WLS. We have used country boat to cross the river for entering inside the Nameri NP and Dibru Saikhowa NP. At the beginning of the survey activities that started from February 2008, in some places we surveyed the area using vehicle. But later we realized that, sound produced by vehicle may disturb the activities of slow loris or may force to hide their face away from the sound source. This is vital because it is simply impossible to find out a loris in wild, if they do not look towards the source of the light (again the light, should not be a brighter one, it should be a moderate bright). We confirmed this, by encountering two lorises in Gibbon WLS through survey on foot later on in that area where previously surveyed by Vehicle. Moreover, inaccessibility to approach inside the dense woodland forest and elephant movement have reduced our encounter rate in some protected areas like Dibru-Saikhowa NP, Manas NP, Nameri NP, Dehing Patkai WLS etc.

Future studies on Bengal slow lorises in NE India

The high encounter rate during survey period in Gibbon Wildlife Sanctuary as well as frequent encounter of slow loris in this Sanctuary during feeding behavior studies indicated the possibility of conducting long-term population and behavioral studies in this site. In this study we have not followed any loris through radio tracking, so we are unable to obtain any data on loris home range. A detailed and quantifiable feeding observation and study through radio collaring, which would include examining fecal samples for diet as well as the availability of arthropods and fruits needs to be done. Studies using radio collaring of lorises may reveals some of its home range and ranging pattern in near future. Further efforts should be concentrated on the recording and analysis of slow loris calls because if individual identification is achievable then it could (1) generate information on life history parameters (2) produce input data for conservation models and (3) highlight certain behavioral traits, which could again help to shape future conservation and management decisions.

This study yielded original natural information on Bengal slow loris *Nycticebus bengalensis* and added to some extant of our knowledge of slow loris ecology in this part of its distribution range. To this end it is necessary to capture, radio collar and track this nocturnal primate of NE India over a long period of time for unveiling its night secrets.

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Table 5: Other mammals encountered during the survey

Sighted Mammals	Survey sites
Capped langur <i>Trachypithecus pileatus</i>	Manas National Park Nameri National Park Dibru-Saikhowa National Park Gibbon Wildlife Sanctuary Garampani Wildlife Sanctuary Amsang Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary Barnadi Wildlife Sanctuary Padumani Bherjan Wildlife Sanctuary
Hoolock gibbon <i>Hylobates hoolock</i>	Dibru-Saikhowa National Park Gibbon Wildlife Sanctuary Padumani Bherjan Wildlife Sanctuary Amsang Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary Garampani Wildlife Sanctuary
Golden langur <i>Trachypithecus gee</i>	Manas National Park Chakrasilla Wildlife Sanctuary
Rhesus macaque <i>Macaca mulatta</i>	Manas National Park Nameri National Park Chakrasilla Wildlife Sanctuary Gibbon Wildlife Sanctuary Padumani Bherjan Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary Garampani Wildlife Sanctuary Barnadi Wildlife Sanctuary Amasang Wildlife Sanctuary Laokhowa Wildlife Sanctuary Burachapori Wildlife Sanctuary
Pig tailed macaque <i>Macaca nemestrina</i>	Dibru-Saikhowa National Park Gibbon Wildlife Sanctuary Padumani Bherjan Wildlife Sanctuary
Assamese macaque <i>Macacca assamensis</i>	Nameri National Park Manas National Park Dibru-Saikhowa National Park Amsang Wildlife Sanctuary Barnadi Wildlife Sanctuary Padumani Bherjan Wildlife Sanctuary Garampani Wildlife Sanctuary Gibbon Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary

Stamp tailed macaque <i>Macaca arctoides</i>	Gibbon Wildlife Sanctuary
Flying Squirrel (Species not known)	Manas National Park Chakrasilla Wildlife Sanctuary Namdapha National Park Padumani Bherjan Wildlife Sanctuary
Small Indian Civet <i>Viverricula indica</i>	Gibbon Wildlife Sanctuary Laokhowa Wildlife Sanctuary Burachapori Wildlife Sanctuary Manas National Park
Large Indian Civet <i>Viverra zibetha</i>	Burachapori Wildlife Sanctuary Gibbon Wildlife Sanctuary
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	Manas National Park Gibbon Wildlife Sanctuary Laokhowa Wildlife Sanctuary Burachapori Wildlife Sanctuary
Elephant <i>Elephas maximus</i>	Manas National Park Nameri National Park Dibru Saikhowa National Park Barnadi Wildlife Sanctuary Amsang wildlife Sanctuary Gibbon Wildlife Sanctuary Garampani Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary
Barking Deer <i>Muntiacus muntjak</i>	Manas National Park Nameri National Park Dibru Saikhowa National Park Gibbon Wildlife Sanctuary Barnadi Wildlife Sanctuary Dehing Patkai Wildlife Sanctuary Amsang wildlife Sanctuary
Sambar <i>Cervus unicolor</i>	Manas National Park
Leopard <i>Panthera pardus</i>	Gibbon Wildlife Sanctuary Manas National Park
Leopard Cat <i>Prionailurus bengalensis</i>	Gibbon Wildlife Sanctuary Nameri National Park
Jungle Cat (unidentified species)	Burachapori Wildlife Sanctuary Nameri National Park
Gaur <i>Bos gaurus</i>	Manas National Park Nameri National Park Barnadi Wildlife Sanctuary
Wild water buffalo <i>Bulbalus bubalis</i>	Manas National Park Burachapori Wildlife Sanctuary
Wild pig <i>Sus scrofa</i>	Manas National Park Burachapori Wildlife Sanctuary Gibbon Wildlife Sanctuary Laokhowa Wildlife Sanctuary Barnadi Wildlife Sanctuary

Indian here <i>Lepus nigricollis</i>	Burachapori Wildlife Sanctuary Laokhowa Wildlife Sanctuary
Indian fox <i>Vulpes bengalensis</i>	Manas National Park Nameri National Park Gibbon Wildlife Sanctuary Laokhowa Wildlife Sanctuary Burachapori Wildlife Sanctuary Chakrasilla Wildlife Sanctuary

Fig 28: Some photos of other animals encountered during night survey



Flying Squirrel in Namdapha NP



Civet in Namdapha NP



Barking Deer in Manas NP



Wild boar in Barnadi WLS



Leopard cat in Gibbon WLS



Elephant in Nameri National Park



Peacock in Manas National Park



Civet in Gibbon WLS