

Demographic Profile and Population Status of Endangered Western Hoolock Gibbon in Yangoupokpi Lokchao Wildlife Sanctuary of Manipur, India

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ABSTRACT

The western hoolock gibbon (*Hoolock hoolock*), the only ape of India, is listed as Endangered and faces severe threats from habitat loss, fragmentation, and anthropogenic disturbances within its home ranges. Therefore, there is an urgent need for conservation measures for the ape, although baseline data on population status remain limited in many protected areas of Northeast India. This study revealed the population status, group composition, and encounter rate of western hoolock gibbons in the Yangoupokpi Lokchao Wildlife Sanctuary of Manipur, India, which is considered part of their natural range. A total of 43.18 km of survey walks covering 13.77 km² were conducted during November 2022 and March 2023. Six isolated gibbon groups comprising 18 individuals were recorded. The observed population consisted of six adult males, six adult females, two sub-adult males, one sub-adult female, one juvenile female, and two infants. Group size ranged from 2 to 4 individuals, with a mean of 3.0 ± 0.89 individuals per group. The group density and population density were estimated at 0.43 groups km⁻² and 1.30 individuals km⁻², respectively. The presence of sub-adults, juveniles, and infants revealed a viable breeding population within the sanctuary. These findings provided a systematic census-based population assessment of western hoolock gibbons in the Yangoupokpi Lokchao Wildlife Sanctuary of Manipur, India.

Key words: Indo-Burma, Kwatha village, Home range, Group composition, Habitat loss, Conservation

INTRODUCTION

Gibbons are the smallest among all apes and are referred to as the lesser apes, which represent 16 of 350 primate species (Chetry et al. 2007). Before the discovery of the eastern hoolock gibbon (*Hoolock leuconedys*) from Arunachal Pradesh in 2006 (Das et al. 2006), the western hoolock gibbon (*H. hoolock*) was the only reported ape species in India. Both species are characterized by distinctive black fur colouration in males and light brown in females, and share other similar characteristics (Groves 1972). Unless otherwise specified, the term "Hoolock gibbon" refers collectively to both eastern hoolock gibbon and western hoolock gibbon.

The distribution of the western hoolock gibbon is restricted to the westernmost limit of the global distribution of gibbons, which includes countries, viz. India, Myanmar and Bangladesh, where its distributional range in India is isolated to the Eastern Himalaya and the Indo-Burma biodiversity hotspot, bound by the Brahmaputra River on the west and the Chindwin River on the east (Das 2002, Harlan and Burrough 1834, Islam and Feeroz 1992, Kumar et al. 2013). On the other hand, the distribution of the eastern hoolock gibbon (*H. leuconedys*) has been reported from Myanmar, between the eastern part of the Chindwin River and the Salween River in southwestern Yunnan Province, China, at elevations ranging from 1066.8 to 1219.2 m amsl

(Groves 1970). In India, the distribution of the western hoolock gibbon is restricted to the hilly regions of the Northeast, viz., Arunachal Pradesh, Assam, Manipur, Mizoram, Tripura, Meghalaya, and Nagaland (Choudhury 2006). On the contrary, the eastern hoolock gibbon was reported from a few specific habitats in Assam and Arunachal Pradesh (Chetry et al. 2010).

In addition to the rapid loss and fragmentation of natural habitats resulting from encroachment and land-use and land-cover changes, hunting continues to pose a serious threat to these two gibbon species in the hill regions of Northeast India, further increasing the risk of population decline. Because of the evidence of widespread and rapid decline in population, *H. hoolock* has been listed in the IUCN Red List of Threatened taxa under the endangered category (Brockelman et al. 2019). In India, the species is listed in Schedule I of the Indian Wildlife (Protection) Act, 1972 and in Appendix I of CITES. Detailed studies on the population and habitat of western hoolock gibbon were conducted in a few states of Northeast India, particularly in Arunachal Pradesh and Assam (Biswas et al. 2013, Choudhury 2009, Kakati et al. 2009, Kumar et al. 2009, Sarma 2015, Sarma et al. 2021, Sarma and Kumar 2016). However, no systematic study has been carried out in the state of Manipur. Despite its importance as a potential stronghold for *H. hoolock* distribution and its location within the Indo-Burma Biodiversity

hotspot, this region remained poorly explored (Lwin et al. 2021). Due to porous, open borders, the forest forms a contiguous landscape with Myanmar. It is a hotspot for illegal timber trade (Sharma and Thoudam 2025), leading to the rapid decline of forest cover in Manipur (Guria et al. 2024). Considering the trend of forest degradation and species' vulnerability to microenvironmental changes, there is an urgent need to generate baseline data on their current population status. Therefore, in this study, we aim to estimate the population size of the western hoolock gibbon in the Yangoupokpi Lokchao Wildlife Sanctuary at the Indo-Burma biodiversity hotspot of Manipur, India.

MATERIALS AND METHODS

Study area

The study was conducted in the Yangoupokpi-Lokchao Wildlife Sanctuary, which covers an area of 184.8 km². The sanctuary is located in the extreme southern part of Tengnoupal district of Manipur, India, bordering Myanmar, at an elevation ranging from 276 to 888 m amsl. Considering its significance as a suitable habitat for many wild animals, it was declared a wildlife sanctuary on 21st March 1989, having previously been a reserve forest. A detailed study was carried out in the buffer and transition zones of the sanctuary, as shown in Figure 1. These zones

represent 57% of the sanctuary's total geographical area. The core zone was excluded from this study due to security reasons at the Indo-Myanmar international border and the ongoing political instability in Myanmar, which has heightened the sensitivity of the border region. The sanctuary has a tropical monsoon climate, characterised by a hot, humid summer and a mild, cold, dry winter. Air temperature ranges from 4°C during winter to 40°C in summer, with humidity ranging from 35% in winter to 80% during the monsoon. Annual rainfall is around 2263 mm (Bunnamei and Saikia 2020).

Fauna: As per a recent report, Yangoupokpi Lokchao Wildlife Sanctuary has ca. 42 species of mammals, 74 species of birds, 29 species of reptiles, 6 species of amphibians, and 86 species of fish (Meitei 2024). Western hoolock gibbon (*Hoolock hoolock*), Malayan sun bear (*Helarctos malayanus*), Barking deer (*Muntiacus muntjak*), Sambar (*Cervus unicolor*), Leopard (*Panthera pardus*), Golden cat (*Catopuma temminckii*), Jackal (*Canis aureus*), Pangolin (*Manis crassicaudata*), Wild boar (*Sus scrofa*), Bear (*Ursus* sp.), Jungle cat (*Felis chaus*), Flying Squirrel (*Petaurista petaurista*), Slow loris (*Nycticebus bengalensis*), Stump-tailed macaque (*Macaca arctoides*), Serow (*Capricornis sumatraensis*) etc. are some of the important mammals harboring in the sanctuary. Birds such

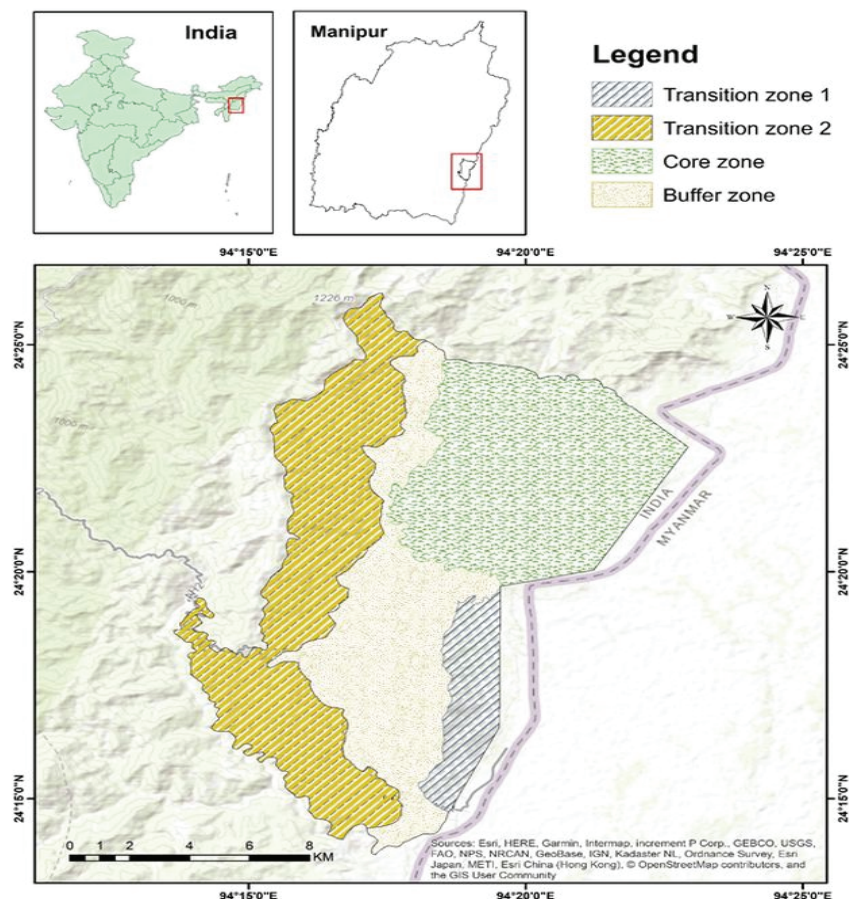


Figure 1. Location of study site - Yangoupokpi Lokchao Wildlife Sanctuary and its zonation

as Jungle fowl (*Gallus gallus*), Hawk (*Accipiter badius*), Parakeet (*Psittacula krameri*), Mrs Hume's pheasant (*Syrnaticus humiae*), Blyth's tragopan (*Tragopan blythii*), Owl (*Bubo bengalensis*), Green peafowl (*Pavo muticus*), Wild pigeon (*Columba* sp.), Hornbills, Cuckoo (*Cuculus canorus*), Drongo (*Dicrurus macrocercus*), Myna (*Acridotheres tristis*), etc., are also among the common avifauna reported from the locality (Devi et al. 2025).

Flora: As per Meitei (2024), the forest vegetation of the sanctuary was broadly divided into four types, such as:

Teak forests: *Tectona grandis*, *Duabanga grandiflora*, *Macaranga denticulata*, *Mallotus paniculatus*, *Oroxylum indicum*, etc., are common trees found along the foothills and in village settlements.

Dipterocarpus forest: *Dipterocarpus* spp. dominates the forest, which lies at a higher altitude. *Dipterocarpus turbinatus* generally occupies the banks of streams, and *Dipterocarpus tuberculatus* flourishes in the open areas.

Mixed broadleaf forests: The dominant plant species in this vegetation type are *Artocarpus heterophyllus*, *Artocarpus lakoocha*, *Bauhinia variegata*, *Dipterocarpus turbinatus*, *Dipterocarpus tuberculatus*, *Duabanga grandiflora*, *Phyllanthus emblica*, *Ficus auriculata*, *Ficus hispida*, *Ficus racemosa*, *Ficus religiosa*, *Ficus semicordata*, etc.

Riverine bamboo forest: Bamboo brakes are commonly distributed along the banks of rivers and streams. The most common species are *Bambusa nutans*, *Bambusa tulda*, *Dendrocalamus hookeri*, and *Melocanna baccifera*.

The Yangoupokpi-Lokchao Wildlife Sanctuary had many settlements within its boundary before it was officially designated as a wildlife sanctuary. Villages within the sanctuary are Satang, H. Monjang, B. Bonjang, Govajang, Saikul, Nungkam, S Khudengthabi, Langkhongching, Laigi Khunjao, Kwatha, and Yangoupokpi, inhabited by various communities, viz. Maring, Naga, and Kuki Tribes, where Kwatha is the only Meitei settlement among

the villages (Bunnamei and Saikia 2020). The residents of these villages depend solely on forest resources to earn their livelihoods and fulfil daily needs, extracting fuelwood, pole wood, charcoal, and timber for household consumption and, in part, for commercial purposes. In addition, shifting cultivation, locally referred to as jhum cultivation, remains the primary agricultural practice mainly for subsistence rice farming.

Study design

To ensure a systematic sampling design, the entire study area was divided into 1×1 km (100 ha) grid cells using the Grid Index Feature tool in ArcGIS 10.3. Recent studies have reported considerable variation in gibbon home range size, with estimates ranging from approximately 20 to 100 ha depending on habitat condition and season (Hasan et al. 2025, Sarma and Kumar 2016, Zhang et al. 2014, 2024). Given the rugged and difficult terrain of Yangoupokpi Lokchao Wildlife Sanctuary, a smaller grid size, such as 20 ha, would increase the number of sampling units, which would require repeated movement and increase travel time. Moreover, gibbons are highly vocal primates and can be detected over a large area. So, a larger 100 ha (1 km²) grid was selected as a practical sampling unit. This resulted in 169 grid cells covering the study area (Fig. 2a). Each grid cell was assigned a number from 1 to 169. To minimize sampling bias and provide each grid cell with an equal probability of selection, 10 random grids were selected by using Microsoft Excel's random number generator. Information on sightings and regular vocalisations of *H. hoolock* was also collected from local villagers settled in the adjoining areas of the study site. Based on the information, we added 7 more grids where gibbon sightings were expected, bringing the total number of grids selected for the survey to 17. This information was used solely to guide the placement of survey effort within the selected grids and to improve the efficiency of field sampling in the rugged forest landscape. Figure 2a

Table 1. Characteristic features considered to classify *Hoolock hoolock* in the field as per Kakati et al. (2009)

Age category	Sex	Characteristics
Adult (> 8 years)	Male	Black fur, White eyebrow, Prominent scrotum, scowling expression
	Female	Light brown/blonde fur colour
Sub-adult (6-8 years)	Male	Black fur, slightly smaller than adult male, gentle facial expression
	Female	Slightly black to brown fur colour, smaller than adult female
Juvenile (2-6 years)	Male	Black fur, size smaller, no distinct scrotum
	Female	Black fur, smaller size, no scrotum at all
Infant (0-2 years)	Male and female	Carried by adult female, light grey to dark grey fur. Hard to determine sex in the field

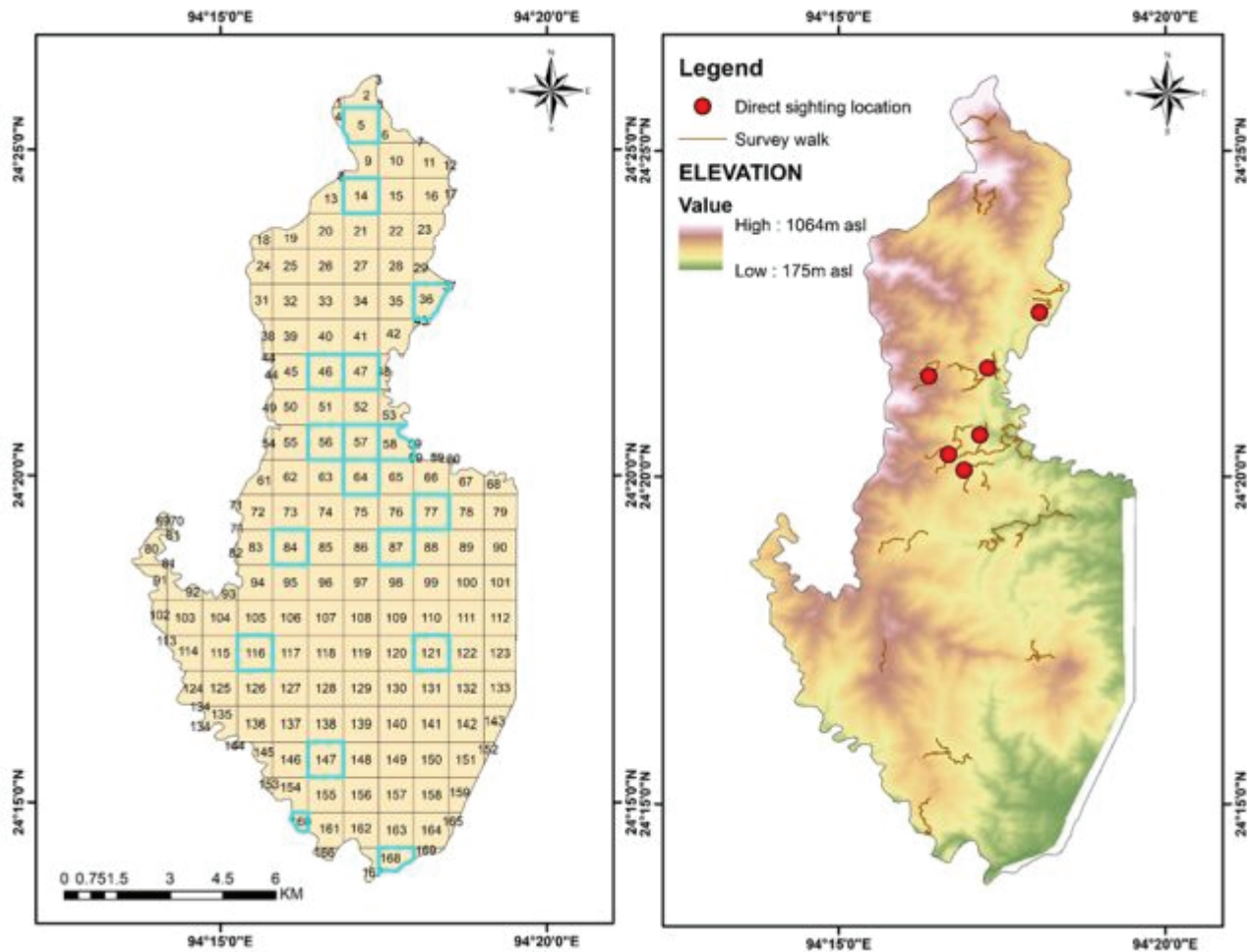


Figure 2. a. Grid overlaid map of the study site with highlighted grids considered for population study of *Hoolock hoolock*, b. Sighting locations of *Hoolock hoolock* and survey walks at the study area

shows the highlighted grids selected for the field survey.

Before the field survey began, all team members were trained to observe and identify gibbons using audio and visual aids. The age structure of gibbons was classified based on Kakati et al. (2009), as shown in Table 1. A survey for population status was conducted between November 2022 and March 2023. Within each selected grid, population census walks were carried out following the methods of Kakati et al. (2009) and Kashyap and Bose (2025). A total of 29-foot surveys were conducted across forest interiors, edges, and adjacent human-modified landscapes to maximise encounter rates with the focal species. A four-member team was assigned to a survey trail accompanied by a local guide familiar with the terrain and forest trails. Surveys were commenced at 06:00 h till 12:00 h during the peak period of gibbon vocal activity as per the survey trails shown in Figure 2b.

The census walk was initially designed to cover the entire grid as outlined. Still, there were a few deviations due to difficult site characteristics such as steep slopes, dense vegetation, cliffs, and

other physical barriers in the study area. In such circumstances, existing forest trails were followed while maintaining the transect's general direction to ensure safe access without compromising survey coverage. Subsequently, the survey teams covered an average of 1.4 km per grid. Owing to the sensitive location of the study area along the Indo-Myanmar border, all field teams were allowed to be in the field only for a limited hour at a maximum of six hours a day, with due reporting about the entry and exit from the forest to the nearest security post in accordance with local security protocols. Therefore, chances for establishing concrete listening posts within the study area were limited.

During the survey, the presence of the hoolock gibbon was recorded by direct and indirect cues. Gibbon vocalizations and songs, branch movements associated with brachiation, and sounds produced during feeding and movement through the forest canopy were considered indirect evidence of detection. Whenever a hoolock gibbon group was detected, observers recorded the geographical coordinates using a handheld Global Positioning System (GPS) receiver. Group size, group

km^{-1} .

Population status

All hoolock gibbon sightings were recorded between the elevation ranges of 300-600 m above mean sea level within the sanctuary. A total of 18 individuals were recorded during direct encounters and distributed among five social groups. In all records, vocal detections were followed by visual confirmation, so all encounters are hereby direct encounters. The visual encounters were along trail no. 36a, 46a, 47b, 56a, 57a, and 64a (Table 2), where perpendicular sighting distances varied from 25.4 m to 102.3 m. Most of the observations were recorded during the morning hours between 07:40 am and 10:50 am. In addition, call-count surveys confirmed the presence of two additional groups outside the selected sampling grids.

$$\text{Sex ratio (SR)} = (\text{Total number of male})/(\text{Total number of female})$$

Group size and age composition

Group structure and composition of the western hoolock gibbon (*H. hoolock*) observed during the survey are presented in Table 2. A total of 6 groups were recorded, with group sizes ranging from 2 to 4 individuals and a mean of 3. Of these, the first two groups comprised two individuals each, the second two groups comprised three individuals each, and the third two groups comprised four individuals each. The adult sex ratio was 1:1, with equal numbers of adult males and females. Adults constituted the majority of the population (66.6%), followed by sub-adults (16.6%), infants (11.1%), and juveniles (5.5%). Based on the surveyed area, the observed group density was 0.43 groups km⁻², and the observed population density was 1.30 individuals km⁻².

DISCUSSION

This study presents the demographic profile, a first of its kind, for the populations of the western hoolock gibbon (*Hoolock hoolock*) in Yangoupokpi Lokchao Wildlife Sanctuary, a fringe locality

[illegible]

in Manipur, India. The occurrence of hoolock gibbons in the sanctuary was first reported by Choudhury (2006), primarily based on opportunistic observations conducted from 1988 to 2001, which estimated an average population of 50-100 western hoolock gibbons. However, the estimate lacked a standardised sampling design and did not report demographic parameters such as group composition, age structure, or sex ratio.

Using a systematic transect walk across randomly selected grids, we recorded 6 gibbon groups totalling 18 individuals. Since the present survey was confined to the sanctuary's transition and buffer zones and did not encompass the entire protected area, our findings may be interpreted as evidence of either population decline or recovery compared with earlier reports (Choudhury 2006). The findings also establish the first baseline estimate for the portion of the sanctuary experiencing relatively high levels of anthropogenic disturbance. This baseline provides an essential reference against which future monitoring programmes can evaluate population trends, demographic changes, and the effectiveness of conservation interventions.

Using a similar transect method but with varying transect lengths, Chetry et al. (2021) reported an estimate of seven groups of eastern hoolock gibbon in three reserve forests of Sadiya sub-division of Assam, India, through direct sightings covering approximately 789.95 km². A study conducted at Semongkat Nature Park, Indonesia, reported 61 lion-tailed macaques across 17 to 25 groups, with an overall population density of 1.52 individuals per ha, using a methodology similar to that outlined by Hidayati et al. (2025). Due to differences in terrain, landscape, and study species, direct numerical comparisons are not suitable for such studies.

Our observations are consistent with recent findings on hoolock gibbon taxa reported by Yang et al. (2020), in which a total of 15-18 Gaoligong hoolock gibbons were distributed among five to six groups, with one solitary individual at Houqiao Town, Yunnan, China. Their study estimated a mean group size of 2.8 individuals and a population density of 0.32-0.39 groups km⁻² over a relatively small survey area of ca. 21.4 km². The present study revealed stable pair-bonded family groups, suggesting a stable breeding population across the landscape despite low population density.

Acquaintance with local ecological knowledge before the field study was an important component of the present study, where discussions with forest-dependent communities regarding recent sightings and vocalisation sites helped identify areas of occurrence of the western hoolock gibbon with high probability, thereby improving the efficiency of systematic field surveys. The addition of 7 grids may introduce a degree of bias. However, these additional grids were specifically to increase encounter and

detection opportunities rather than to replace the random sampling design. Local ecological knowledge can be particularly valuable in surveys of arboreal primates in difficult terrain, where low detectability and logistic constraints may limit encounters under purely random sampling. Nevertheless, the potential influence of this selection should be acknowledged while interpreting the results. Similar local-field knowledge has increasingly been recognised as a valuable component of conventional wildlife monitoring, particularly for elusive and low-density species inhabiting tropical forests. It may improve species detectability and guide survey design (Braga-Pereira et al. 2022).

Conservation issues

A land-use and land-cover change study demonstrated substantial alterations in land use and forest cover within and around the study area of the sanctuary, where built-up areas in the transition and buffer zones expanded by nearly fourfold between the years 2000 and 2016, accompanied by the loss of approximately 5,802.4 ha of dense forest (Bunnamei and Saikia 2020). Such landscape modifications are crucial for arboreal primates as the hoolock gibbon depends on continuous closed-canopy forests for their movement, foraging, and territorial defence. Habitat fragmentation may reduce canopy connectivity, isolate social groups, restrict dispersal, result in lower reproductive success and long-term population viability.

The conservation effectiveness of such protected areas has been under pressure from development activities across Southeast Asia, where protected areas experience the highest levels of anthropogenic pressure, including infrastructure expansion, resource extraction, and increasing human settlement (Graham et al. 2021). Human dependence on forest resources is another conservation challenge in the sanctuary's current study areas, where local inhabitants practice shifting cultivation (jhum), a traditional cultivation system involving cyclic clearing, cultivation, and fallow regeneration of forest (Baite and Baite 2021). Quantifying the spatial extent and intensity of shifting cultivation remains difficult because cultivation plots are continuously relocated across the landscape (Padoch et al. 2007), making long-term assessment of habitat dynamics particularly challenging. In addition to shifting cultivation, selective logging and extraction of forest products continue to influence forest structure within this sanctuary (Baite and Baite 2021). Previous studies also showed that selective logging modifies the abundance, distribution, and behaviour of medium- and large-bodied vertebrates through changes in habitat structure and resource availability (Fredericksen and Fredericksen 2002, Heydon and Bulloh 1997, Singh et al. 2025). For hoolock gibbons, which rely on continuous canopy for

locomotion, even localised canopy gaps may reduce habitat quality. Reliable quantitative information on logging intensity and other anthropogenic disturbances remains scarce for many protected areas in northeastern India. Data on actual timber extraction, encroachment, and small-scale resource harvesting are often very meagre or unavailable, resulting in cumulative ecological impacts (Lele and Joshi 2009, Reddy et al. 2017). Field observations during the present study revealed illegal extraction of fuelwood, bamboo, poles, and timber, where such incidents were reported from other protected areas in Mizoram (Saikia et al. 2013). Such low-intensity but chronic disturbances may collectively contribute to gradual habitat degradation, declining canopy integrity, and reduced habitat suitability for canopy-dependent primates, including the western hoolock gibbon.

CONCLUSION

The population density of the hoolock gibbon recorded during this study is far lower than that reported from Assam and Arunachal Pradesh of North East India. Nonetheless, a more extensive survey is required to cover the entire sanctuary area and estimate its population size and distribution. Habitat fragmentation due to jhum cultivation, hunting, and poaching could be the main threats to the gibbon population in the current study site. Jhum activities drastically reduce the forest canopy and create open gaps within its home ranges. Overexploitation and large-scale logging for timber and charcoal production disrupted the forest's continuity and reduced the availability of food resources for the western hoolock gibbon. As most villagers depend on forest resources due to limited livelihood options, timber and non-timber forest products are collected year-round. These activities led to overexploitation of the critical gibbon microhabitat, including their preferred nesting trees. Therefore, attention is invited to the immediate implementation of integrated conservation measures for this miniature population of the western hoolock gibbon, a flagship species, to ensure its long-term survival within its unique home ranges in the Indo-Burma Biodiversity hotspot of Manipur, India. A few among the conservation measures may include effective implementations of the Wildlife Protection Act and restrictions for illegal hunting and poaching activities of wildlife, conducting community-level awareness camps, sustainable alternative livelihood options for the associated community that are dependent on timber and timber products and regular monitoring of the micro habitats and the activities of the western hoolock gibbon.

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Conflict of interest: The authors declare no conflicts of interest regarding the publication of this paper.

Data availability statement: All census walks (in kml format) and supporting photographs taken during the survey are also available from the corresponding author upon reasonable request.

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