

## Short Communication

# Trends in extinction and persistence of diurnal primates in the fragmented lowland rainforests of the Upper Brahmaputra Valley, north-eastern India

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**Abstract** The historical deforestation of the Upper Brahmaputra Valley in the Indian state of Assam has resulted in the transformation of its once-contiguous lowland rainforests into many isolated forest fragments that are still rich in species, including primates. We report the recent history and current status of six diurnal primates in one large (2,098 ha) and three small (< 500 ha) fragments of the Upper Brahmaputra Valley. We censused primates in the small fragments during 2002, 2005, 2009, in the large fragment in 2008, and used other published census data to derive population trends. We also used key informant surveys to obtain historical occurrence data for these populations. Our analyses reveal the recent extinction of some populations and the simultaneous long-term persistence of others in these fragments over 16 years. Most populations appeared to have declined in the small fragments but primate abundance has increased significantly in the largest fragment over the last decade. Addressing the biomass needs of the local human populations, which appears to drive habitat degradation, and better protection of these forests, will be crucial in ensuring the future survival of this diverse and unique primate assemblage in the last rainforest fragments of the human-dominated Upper Brahmaputra Valley.

**Keywords** Capped langur, fragmentation, habitat degradation, hoolock gibbon, local extinction, population decline, primate assemblage, stump-tailed macaque

The biologically diverse and unique Upper Brahmaputra Valley of north-eastern India has experienced deforestation of its tropical lowland forests over the previous 2 centuries. Extensive changes in land use, mainly from the expansion of tea plantations and agriculture, has resulted in the dramatic transformation of the once-contiguous forests into many small, isolated fragments that today extend over < 25% of the valley (Forest Survey of India, 2009). This deforestation and fragmentation pose a threat to the flora and fauna of these lowland rainforests and particularly to the unique primate assemblage.

The forests of the Upper Brahmaputra Valley originally supported a high diversity of primate species, including four cercopithecines (the rhesus macaque *Macaca mulatta*, stump-tailed macaque *Macaca arctoides*, northern pig-tailed macaque *Macaca leonina* and Assamese macaque *Macaca assamensis*), one species of colobine (the capped langur *Trachypithecus pileatus*) and the western hoolock gibbon *Hoolock hoolock* (all threatened or Near Threatened on the IUCN Red List, 2011, except for the rhesus macaque; Table 1), and a strepsirrhine (the Vulnerable Bengal slow loris *Nycticebus bengalensis*). Fragmentation of the forests divided the original populations of these primates into several subpopulations. The decrease in habitat area, increase in isolation, particularly from source populations, and greater exposure to direct and indirect threats are likely to have seriously affected the demography of the remaining primate populations in these fragments (N. Sharma et al., unpubl. data). There are documented declines of primates, because of habitat loss, in at least one forest fragment (Srivastava et al., 2001a), raising concerns about the future of primates in the c. 30 forest fragments in the valley.

Here we report the status of six diurnal primate species using data from four forest fragments in the Upper Brahmaputra Valley (Fig. 1, Table 1; for details of the study areas see Choudhury, 1996; Das et al., 2009): Bherjan (104 ha), Podumoni (176 ha) and Borajan (439 ha) in the Bherjan–Borajan–Podumoni Wildlife Sanctuary, and the Hollongapar–Gibbon Wildlife Sanctuary (2,098 ha).

We conducted three censuses (21 April to 2 May 2002, 22 June to 19 July 2005, and 7–11 December 2009) in Bherjan, Podumoni and Borajan, and a single 10-day census (20–29 July 2008) in Hollongapar–Gibbon Wildlife Sanctuary. We

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TABLE 1 Characteristics of the four rainforest fragments (Bherjan, Podumoni and Borajan in the Bherjan–Borajan–Podumoni Wildlife Sanctuary, and the Hollongapar–Gibbon Wildlife Sanctuary) of the Upper Brahmaputra Valley (Fig. 1) and the historical and current occurrence of the six diurnal primate species, with their Red List status (IUCN, 2011) in parentheses.

	Bherjan	Podumoni	Borajan	Hollongapar
<b>Fragment characteristics</b>				
Administrative area (ha)	104	176	439	2,098
Area of suitable habitat (ha)	104	176	439	1,771
Distance to contiguous forest (km)	10.7	15.6	8.09	5
Distance to nearest forest (km)	4.63	4.63	8.09	5
Time since isolation (years)	75–100 <sup>1</sup>	75–100 <sup>1</sup>	75–100 <sup>1</sup>	90–120 <sup>2</sup>
Year of notification (as Reserve Forest/Wildlife Sanctuary)	1916/1999	1916/1999	1916/1999	1881/1997
<b>Species present<sup>3</sup> (H, historically<sup>4</sup>; C, currently)</b>				
Hoolock gibbon <i>Hoolock hoolock</i> (EN)	H	H	H/C	H/C
Capped langur <i>Trachypithecus pileatus</i> (VU)	H/C	H/C	H/C	H/C
Assamese macaque <i>Macaca assamensis</i> (NT)	H/C	H	H/C	H
Pig-tailed macaque <i>Macaca leonina</i> (VU)	H/C	H	H/C	H/C
Stump-tailed macaque <i>Macaca arctoides</i> (VU)			H	H/C
Rhesus macaque <i>Macaca mulatta</i> (LC)	H/C	H/C	H/C	H/C

<sup>1</sup>Purkayastha (1936) <sup>2</sup>Duarah & Saikia (2003)

<sup>3</sup>EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern

<sup>4</sup>30–50 years ago

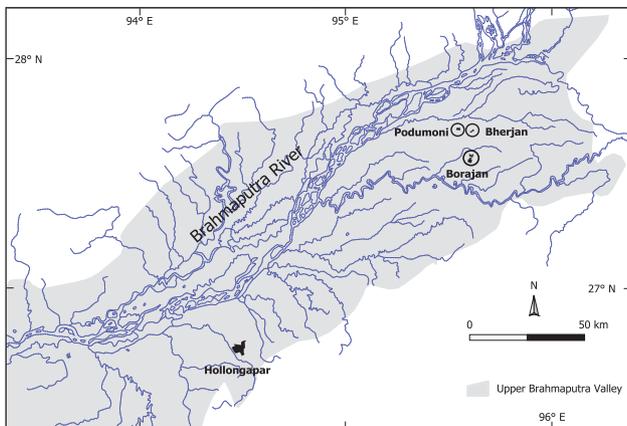


FIG. 1 The location of the four lowland rainforest fragments (Bherjan, Podumoni and Borajan in the Bherjan–Borajan–Podumoni Wildlife Sanctuary, and the Hollongapar–Gibbon Wildlife Sanctuary) in the Upper Brahmaputra Valley, Assam, north-eastern India.

used a complete census (Struhsaker, 1981) for estimating abundance, which is best suited for small fragments. We used repeated trail walks to ensure that all groups and individuals were enumerated. We followed the troop from first encounter until all individuals were recorded. We report here the abundance of primate groups seen inside the fragments only. Groups detected in the surrounding matrix of agricultural lands and plantations were recorded but not included in the analysis of abundance. We considered a species extinct in a fragment when it was not sighted in that fragment even after repeated surveys and local interviews independently corroborated its absence. In addition, we used data from earlier censuses (Choudhury, 1996; Srivastava et al., 2001a,b) as baselines to evaluate the possible

loss or persistence of these populations. We conducted unstructured interviews with two or three local key informants (45–70 years of age), chosen on the basis of their knowledge of the local fauna and past ecological changes, about each fragment to determine the presence of primate species and their occurrence c. 30 years ago.

Primates appear to have persisted in the forest fragments of the Upper Brahmaputra Valley for > 100 years. Thirty years ago all six diurnal species (the Bengal slow loris is nocturnal) were present in the largest fragment although the stump-tailed macaque was already absent in the three smaller fragments. Choudhury (1996), however, reports that the stump-tailed macaque was present in the Borajan fragment c. 40 years ago. Our results (Fig. 2) show that during the last 16 years overall primate abundance declined by 56 and 89% in Bherjan and Borajan, respectively, whilst in Podumoni the Assamese and pig-tailed macaques went extinct. In the larger Hollongapar–Gibbon Wildlife Sanctuary overall primate abundance increased by 251% over the last decade; populations of all the species except the Assamese macaque significantly increased.

In a landscape where the hunting of primates is negligible, the dramatic decline of all six species in the three small fragments appears to be linked to the size of these fragments and their status (Fig. 2). In the small fragments not only is the proportion of the area under intact canopy significantly lower than in Hollongapar–Gibbon Wildlife Sanctuary but forest loss has been more rapid over the last 16 years (Kakati, 2004; N. Sharma, pers. obs.). As a result, a larger proportion of food and roosting trees have been lost in these fragments in addition to a greater disruption of canopy contiguity. In Podumoni the remaining closed canopy forest is mostly provided by a plantation of *Lagerstroemia flos-reginae*.

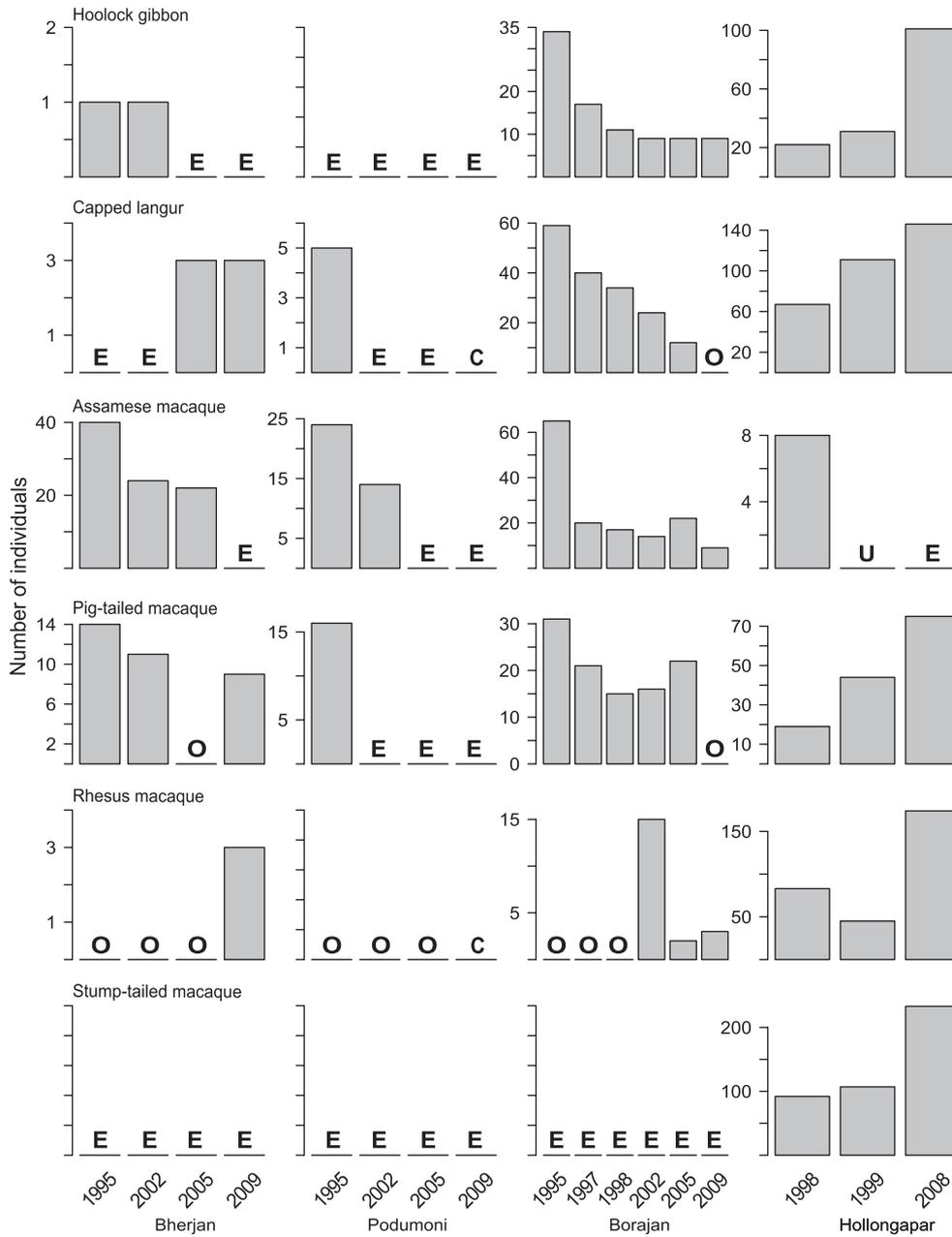


FIG. 2 Temporal trends in the abundance of six primate species in the four lowland rainforest fragments in the Upper Brahmaputra Valley, Assam, north-eastern India (Fig. 1). Note the difference in scales. E, extinct; C, colonized; O, present only in areas surrounding the fragment; U, undetected.

The six primate species appear to exhibit variable responses to fragmentation over time. The hoolock gibbon, a highly arboreal species, was lost > 40 years ago in Podumoni (Choudhury, 1996) and since 2005 in Bherjan. Capped langurs, which were present in all the fragments 30 years ago (Table 1), went extinct in all small fragments but subsequent recolonization has been recorded in both Bherjan (three males) and Podumoni (a troop of eight).

Of the four macaque species the stump-tailed macaque seems the most vulnerable, having gone extinct in all three smaller fragments. Given that the home range sizes of the two troops in Hollongapar–Gibbon Wildlife Sanctuary are 400 and 900 ha (Srivastava 1999; Sharma et al., 2010), it is likely that small fragments are unable to support populations of this species. Schwarzkopf & Rylands (1989) also

reported the absence of large-ranging primates in smaller forest fragments. The increase of the stump-tailed macaque in the Sanctuary (with an adult female–immature ratio of 1 : 2) is perhaps a consequence of the abundance and diversity of forage resources available in this large fragment.

The Assamese macaque appears to be declining in all four fragments. Habitat loss in the three smaller fragments appears to have affected the viability of this species and its extinction in the Sanctuary may have been due to its broad habitat niche, bringing it into competition with increasing populations of the three other macaque species (N. Sharma, pers. obs.). The ability of the pig-tailed and rhesus macaques to adapt to a wide range of habitats, including crop-fields and orchards, may enable them to persist even in the smaller fragments.

Our analysis highlights the fact that although the forest fragments studied have been isolated for > 1 century the extinction of primates in them has been relatively recent, with most losses occurring in the last 30–40 years. A factor that appears to have contributed to the persistence of some primate populations in some of these fragments is the system of logging. Historically, tree species such as *Mesua ferrea* and *Dipterocarpus macrocarpus* were heavily logged in these fragments (Purkayastha, 1936; Duarah & Saikia, 2003) whereas the key food and sleeping trees of primates, including *Artocarpus chama* and *Ficus* species (Kakati, 2004; N. Sharma, pers. obs.) were mostly left untouched. It is likely that the continued availability of these key resources have helped primates persist even under high logging pressures (Johns, 1986). Timber extraction, however, has been more indiscriminate over the last 30 years, with even the high-density *Artocarpus* being lost from the smaller fragments.

Given the importance of small forest fragments for biodiversity conservation (Turner & Corlett, 1996), the fragments of the Brahmaputra Valley need to be protected and managed proactively. As it is not feasible to establish corridors between these fragments, given their high degree of isolation, better protection of the existing fragments by the local forest department is the only realistic conservation option. The local communities in the Valley, which depend on these fragments for their daily needs, are generally tolerant of primates. To secure the future of this diverse primate assemblage of the last remaining forest fragments in this human-dominated valley, conservation initiatives by the forest department, in collaboration with local NGOs, are required to balance habitat protection with the provision of alternative resources for local communities.

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NARAYAN SHARMA studies community and behavioural ecology and the conservation biology of the primates of north-east India. He is also interested in human ecology and the ecological history and landscape ecology of India. M. D. MADHUSUDAN is working to identify limits and opportunities to reconcile human resource use with the goals of conservation in India. He studies large mammal ecology in south India. PRABAL SARKAR is interested in the ecology and behaviour of large mammals, particularly non-primates, elephants and Himalayan ungulates. He has also worked for the rehabilitation of wildlife, particularly ungulates, in north-east India. MAYUR BAWRI studies behavioural ecology of Asiatic wild buffalo in north-east India and is interested in the ecology of other large mammals of the Indian subcontinent. ANINDYA SINHA studies behavioural ecology and cognitive psychology of primates, animal genetics, evolutionary biology, conservation science and the philosophy of biology.