Hunting strategies, wild meat preferences and perceptions of wildlife conservation in Nagaland, India

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Abstract Wild meat hunting is one of the primary threats to biodiversity, and it is important to understand the drivers of hunting by communities residing within biodiverse areas, the methods they employ and their preferences for particular wild meat types. We investigated these aspects of wild meat hunting amongst the Indigenous Naga tribes of the Indo–Myanmar biodiversity hotspot in Nagaland, north-east India. Local people consumed all 31 species of wild mammals detected on camera traps, but the hunters we surveyed mostly preferred large-bodied wild mammals, particularly barking deer *Muntiacus muntjak* and bears (Asiatic black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*). Hunting is subsistence driven following the predictions of optimal foraging theory. The traditional hunting weapons, techniques and strategies used varied according to prey, forest habitat type, community and season. The use of guns, however, is widespread and has replaced most traditional methods of hunting. Additionally, subsistence hunting is evolving into an economically driven activity because of the influence of wildlife trafficking. Discussions with local people regarding their perceptions of conservation provided insights into the dependency of these communities on biodiversity and their recognition of biodiversity losses from overhunting. Nevertheless, communities appear not to be motivated to participate in biodiversity conservation. An interdisciplinary approach to conservation, addressing education coupled with integrated policies that could sustain economic and cultural values is needed in communities such as Nagaland, where hunting remains culturally driven and primarily subsistence orientated.

Keywords Biodiversity threats, conservation perceptions, India, Indigenous Naga tribe, Indo–Myanmar biodiversity hotspot, optimal foraging, traditional hunting, wild meat hunting

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Introduction

Agricultural expansion, timber extraction and infrastructure development have long been recognized as primary causes of forest loss and degradation (Geist & Lambin, 2002). However, overhunting is also emerging as a leading cause of loss of wilderness, particularly in tropical biomes and developing countries (Hayward, 2009; Gosler, 2012; Maxwell et al., 2021). Overhunting is driven by increasing demand for protein and expanding rural and urban populations, infrastructure development that has improved accessibility to forests, weak or ineffective forest management and increased use of modern hunting methods (Alvard, 1995; Corlett, 2007; Aiyadurai, 2011). Unsustainable hunting practices have reduced wildlife populations to near extinction in many tropical areas (Redford, 1992).

Traditionally, wild meat hunting has provided food security and subsistence income to many Indigenous communities (Lee et al., 2014). Hunting methods vary across biomes and ethnic groups, as do the hunters' preferences regarding prey species and body mass (Tana et al., 2014). These variations in hunting practices are influenced by differing motivations, from subsistence to economic (Bugir et al., 2021). Following the principle of optimal foraging, hunters aim to maximize their net energy gain whilst minimizing associated hunting costs (Kraft et al., 2021; Griffiths et al., 2022). Therefore, gathering data on hunting patterns and techniques, traditional methods and hunter profiles could improve management to prevent overharvesting of species (Aiyadurai et al., 2010; Gubbi & Linkie, 2012).

North-east India is predominantly a tribal region, home to > 200 Indigenous groups (Maikhuri & Gangwar, 1993). The region falls within the Indo–Myanmar biodiversity hotspot, supporting high species diversity. Hunting is widespread and traditionally rooted (Datta et al., 2008; Velho et al., 2012), with Indigenous communities hunting for subsistence, cultural and medicinal purposes, as well as for economic reasons (Aiyadurai et al., 2010; Velho & Laurance, 2013).

Rural communities in north-east India are highly dependent on wild meat (Hilaluddin & Ghose, 2005). In such communities hunting is widely accepted and practiced, so targeted species, especially large-bodied mammals, are particularly vulnerable to overhunting because of their low population densities and low reproductive rates (Madhusudan &

Karanth, 2002). As the human population increases, this can lead to severe wildlife population declines, causing irreversible impacts especially on the genetic diversity and viability of wildlife populations, which in turn has adverse effects not only on biodiversity but also on the communities dependent on these resources (Ripple et al., 2015).

The Naga ethnic group of north-east India primarily resides in the state of Nagaland and parts of the neighbouring states of Manipur, Assam and Arunachal Pradesh, and comprises several Indigenous communities for whom forests and wildlife are integral to their identity. The communities of Nagaland have a special provision under Article 371A of the Constitution of India, recognizing the rights of the Naga tribes to retain their unique languages, customs, traditions and control of the land and forest. Nagaland is one of the few states in India with extensive community participation in conservation areas, with 88% of the forest being community owned and managed (Kothari & Pathak, 2006). Although the Indian Wild Life (Protection) Act 1972 protects wildlife from hunting, these laws are mostly ineffective in Nagaland because of weak enforcement, long-standing customary hunting traditions and the many community-owned forests (Bhupathy et al., 2013). Traditionally, Indigenous hunting preferences have been rooted in cultural traditions and beliefs, but these have evolved under the influence of economic pressures and environmental changes. Furthermore, the availability of modern weapons has increased the accessibility and efficiency of hunting, resulting in increased hunting impacts and more opportunistic hunting (Yi & Mohd-Azlan, 2020). Conflicts arise when conservation efforts impose restrictions on hunting or encroach upon traditional hunting territories, leading to tension between conservationists and local people (Nijhawan & Mihu, 2020).

Therefore, there is a need to understand the drivers of hunting and identify potential measures for wildlife protection through local participation. We addressed this need through a questionnaire-based interview survey and by deploying camera traps to obtain ancillary information. Our key objectives were to determine the wildlife preferences of local hunters, document their hunting methods and motives, and determine their perceptions regarding wildlife conservation.

Study area

We conducted this study in Nagaland, a north-east Indian state known for its tribal heritage, with 16 officially recognized tribes. The forests of Nagaland are a unique landscape, and the management of these forests is notable for its distinctive community-focused approach, with large areas of community-owned forests. Geographically, Nagaland falls within the transition zone of the Indian, Indo–Malayan and Indo–Chinese biogeographical regions at the junction of the Himalayas and Southeast Asia (Changkija, 2012). Nagaland has conserved 75% of its original forest cover (Forest Survey of India, 2021), which includes tropical semi-evergreen, tropical moist deciduous, subtropical broad-leaved hill, subtropical pine and montane wet temperate forests (Champion & Seth, 1968). Altitudes are 100–3,000 m, with the majority of rainfall occuring during the south-west monsoon season (May–September), with a total annual rainfall of 1,800–2,500 mm. We selected two forest habitats: Khelia Community Forest and Intangki National Park (Fig. 1), representing highland and lowland forest habitats, respectively, with different forest management regimes practiced by different Naga tribal communities.

Khelia Community Forest

Khelia Community Forest lies at 1,200–3,000 m altitude in easternmost Nagaland and covers an area of 244 km^2. The forest is classified as Naga hill wet temperate broad-leaved forest, with a small portion of subtropical wet hill forest and subtropical pine forest (Forest Survey of India, 2021). This community forest is owned by the villages of Choklangan and Wui (Fig. 1), with a small extension of this community forest into Myanmar. One of the major Naga tribes, the Khiamniugan Naga, lives in these villages. The village council and elders manage the forest for the well-being of the community. Although extraction of natural resources from the forest is permitted, there are specific restrictions in place to protect wildlife.

Intangki National Park

Intangki National Park, the only national park in Nagaland, lies at 200–700 m altitude and covers an area of 202 km^2 (Fig. 1). It is managed by the government of Nagaland. Intangki has two major rivers delineating its boundary: the Intangki and Dhansiri Rivers. The Park is contiguous with Dhansiri Reserve Forest in Assam state, and is an important wildlife corridor between the two states. Intangki comprises east Himalayan moist mixed deciduous, secondary moist bamboo brakes, east Himalayan sal and hill forests with mixed vegetation (Champion & Seth, 1968). Diverse tribal communities (both Naga and non-Naga tribes) surround the National Park: the Kachari-Dimasa, Chakesang Naga, Zeliang Naga and Kuki tribes to the north and the Kuki and Zeliang Naga tribes to the south.

Methods

Data collection

We conducted questionnaire surveys during June 2020–June 2022 in the villages around Intangki and Khelia. However, Covid-19 restrictions imposed by village councils meant that

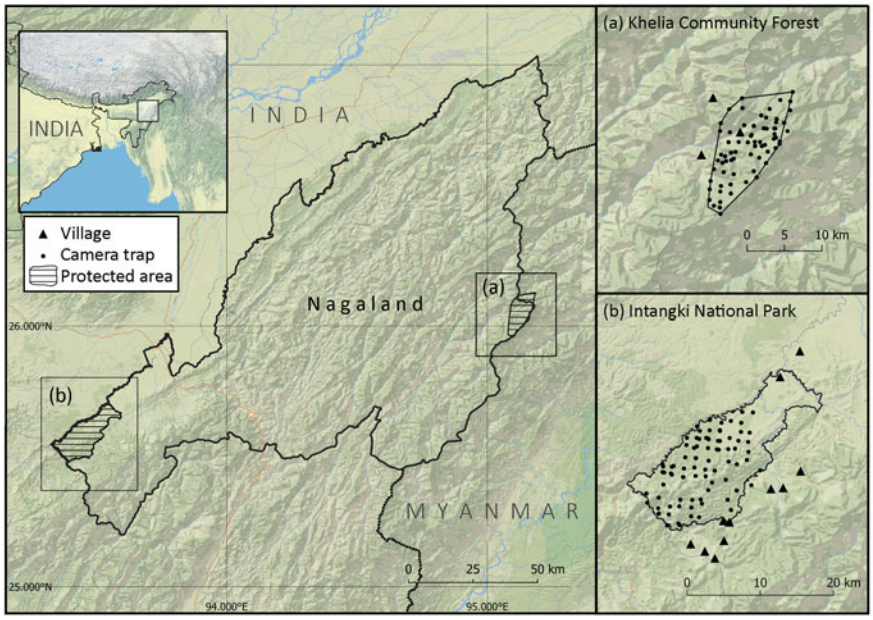

FIG. 1 Nagaland, India, showing (a) Intangki National Park and (b) Khelia community forest, with surveyed villages and camera-trap locations.

some villages were inaccessible to visitors. Consequently, the study was limited to 10 villages: seven in Intangki and three in Khelia (Supplementary Table 1). We obtained permission and permits to visit the villages from the government district administration office before starting fieldwork. We then communicated these permissions to the respective village headman. Following this, we sought verbal consent from interview participants before proceeding with our questionnaire survey. The participants included village elders who had a history of previous hunting, active hunters and village residents who had never hunted. We also collected information on ancestral hunting practices and beliefs from the literature and from Nagaland State Museum records. We used a mammal field guidebook to assist interviewees in identifying hunted animals (Menon, 2014).

We collected information regarding previously and currently active hunters via snowball sampling (Goodman, 1961). We consulted 10 village elders (one from each village) for information on traditional methods of hunting and for suggestions regarding potential participants who currently hunted. We gathered information on cultural factors relevant to hunting through open-ended follow-up questions and informal discussions. We cross-checked information from hunters with fellow hunters in the village and with the village elders. We interviewed 45 active hunters (27 from Intangki, 18 from Khelia), asking about their preferences and the local market demand for particular species, and their hunting activities, motives and hunting weapons (Supplementary Material 1). Additionally, we collected evidence of the types of hunting traps used by the local tribes, through observations during our field surveys.

We collected information on perceptions regarding wildlife conservation from 80 village residents aged ≥ 15 years (81% male, n = 65; 19% female, n = 15) in the 10 villages. We randomly selected respondents, and asked about the biodiversity values of the forest, the main causes of biodiversity loss, the challenges facing biodiversity conservation in the area and personal contributions to biodiversity preservation. We conducted the interviews using semi-structured questions in a casual environment on Saturdays or Sundays when most of the villagers were available. Interviews lasted 30–40 min and were conducted in Nagamese and recorded on paper (Supplementary Materials 1 & 2). Our survey field team comprised author SL and individuals recruited from the surveyed villages who were fluent in both Nagamese and English. Details of the tribes, villages and households, and hunters interviewed are in Supplementary Tables 1 and 2. We anonymized all data to protect the privacy of participants and to ensure compliance with ethical research standards.

To estimate the relative abundance of hunted species (O'Brien, 2011), we deployed 156 camera traps (73 camera-trap stations in Khelia and 83 in Intangki). Our camera trapping followed the All India Tiger Estimation 2018 protocol (Jhala et al., 2019). Our sampling periods included two dry seasons (October–March) and one pre-monsoon season (April–June) during 2018–2021. The cameras operated continuously for 30 days in each session. We employed a systematic approach, alternating monthly between Intangki and Khelia and installing cameras at strategic locations such as crossings, water holes, salt licks and animal trails. We used Cuddeback cameras (Cuddeback, USA) set to capture five images per trigger, with a 1–2 s delay in 'Fast as Possible' mode. We defined photo captures of the same species as independent if they were separated by an interval of at least 30 min.

Data analysis

We examined differences between the two study areas in frequency of use of traditional weapons and firearms, using χ^2 tests, in the distances that hunters travelled to hunting sites from their villages, using *t*-tests in *OriginPro 2017* (OriginLab Corporation, USA), and in selectivity by hunters for particular species, using Jacobs' index (Jacobs, 1974). Jacobs' index assesses how prey selection is influenced by prey abundance, and addresses limitations associated with other indices, such as limited data, non-linearity, bias towards rare species and increasing confidence intervals with increasing heterogeneity (Hayward et al., 2011; Clements et al., 2014). We calculated this selectivity index using the relative abundance of prey (i.e. the number of independent photo capture events of each preferred species over 100 trap-nights) and the per cent frequency of occurrence of prey categories in the list provided by each hunter. The index ranges from −1 to +1, where +1 indicates a taxon is hunted proportionately more than its availability in the environment, −1 indicates hunting proportionately less than availability, and 0 indicates hunting in proportion to availability (Gras & Saint Jean, 1982; Cupples et al., 2011).

Results

Hunting activities

Of the 45 hunters interviewed, five were aged 15–25 years, 14 aged 25–35 years, 16 aged 35–45 years, eight aged 45–69 years, and two aged > 70 years. Over half (56%, n = 25) of the respondents started hunting at 16–25 years of age, although many reported catching frogs and snaring small animals and birds at younger ages. Forty per cent (n = 18) of hunters hunted once or twice per month, with 62% (n = 28) preferring the winter season with its thinner forest vegetation for hunting. Thirty-eight per cent (n = 17) of hunters favoured hunting on moonless nights using flashlights, in pairs or alone. Hunting involved considerable travel times, particularly for hunters in Khelia (5.4 ± SE 3.8 h, range 2–13 h), who travelled significantly farther than those from Intangki (2.8 ± SE 1.1 h, range 1–4 h; $t = 2.68$, df = 20, P = 0.014, $\alpha < 0.05$). Seventy-eight per cent (n = 35) of the hunters owned firearms that they used for hunting. The majority of respondents (87%, n = 39) reported a decline in wild fauna over the period during which they had been hunting.

Hunting methods

In traditional hunting practices a variety of weapons were used, including machetes, spears, bows and arrows, slings and catapults, depending on the target species (Supplementary Table 3). Museum records support the villagers' reports (Supplementary Table 3). During our survey we documented evidence of traditional hunting techniques such as traps and snares, pitfall traps, box traps, triangular snares, gun traps, group chase hunting and hunting with dogs. We also recorded frog trapping and poisoning using plant toxins (from monkshood *Aconitum* spp. and the creeper *Millettia pachycarpa*). These practices were used in both Khelia and Intangki (Supplementary Table 4). However, all of the hunters we interviewed also used firearms for hunting, with most respondents owning firearms (73%, n = 33), many of which were handmade (Supplementary Table 4). There were no significant differences in either the preferred methods of hunting ($\chi^2 = 8.67$, df = 4, P = 0.07) or in the preferred traditional hunting weapons between the Intangki and Khelia communities ($\chi^2 = 5.3$, df = 3, P = 0.14; Supplementary Table 4).

Species targeted by hunters

Over 6,634 camera trap-nights (3,923 in Intangki and 2,711 in Khelia) we recorded 31 mammalian species as well as people. The community members hunted all wild mammal species detected by our camera traps, for multiple purposes. We excluded pheasants and other birds from our analysis, as hunters in the region tend to prioritize larger animals. In total, 2,591 independent photo capture events were recorded (Intangki, 1,594; Khelia, 997), with 29 mammal species photographed in Intangki and 19 in Khelia. The most frequently captured species were the mithun *Bos frontalis* (feral domesticated cattle) and barking deer *Muntiacus muntjak* (Table 1). Hunters' stated species preferences were barking deer (27 hunters), wild boar *Sus scrofa* (8), bears *Ursus* spp. (4), primates (3), red serow *Capricornis rubidus* (2) gaur *Bos gaurus* (2) and small mammals (2; Table 1). Based on Jacobs' index, barking deer (0.59) were disproportionally preferred by hunters, whereas red serow (−0.16), primates (−0.36), small mammals (−0.58), wild boar (−0.32) and gaur (−0.28) were hunted proportionally less than their availability (Table 1). Sixty per cent (n = 27) of respondents preferred hunting barking deer (17 in Intangki and 10 in Khelia).

Perceptions of wildlife conservation

The majority of the 80 village residents interviewed were engaged in agricultural activities (38 respondents from Intangki and 14 from Khelia; Supplementary Table 5). Almost half (48%) of the respondents expressed a high level of concern regarding biodiversity loss, stating that forest clearing for agriculture and hunting contributed significantly to this problem. In their occupation as farmers, the respondents encountered challenges that impeded their active participation in biodiversity conservation: 36% (n = 29) stated they had little time for involvement in biodiversity

TABLE 1 Species photographed by camera traps, with their local names, uses by the major tribes residing near Intangki National Park and Khelia Community Forest in Nagaland, India (Fig. 1), levels of local market demand (derived from interviews with hunters), number and per cent of interviewed hunters preferring the species, and Jacobs' index for hunter prey species preferences.

Species	Local names[1]			Use	Local market demand	Number of photo captures	Number of hunters preferring species (%)	Jacobs' index
	Zeliang tribe (Intangki)	Kuki tribe (Intangki)	Khiamniungan tribe (Khelia)					
Herbivores								
Gaur *Bos gaurus*	*Mangpui*	*Sah-le*	*Ion/Jang*	Meat consumption, horn	Low	14	2 (0.5)	−0.28
Red serow *Capricornis rubidus*	*Helung*	*Sah-arja*	*Shou*	Meat consumption, horn for use as buckles in traditional attire	High	20	2 (0.7)	−0.16
Barking deer *Muntiacus muntjak*	*Heti*	*Sah-khi*	*Chingchai*	Meat consumption	High	360	27 (60.0)	0.59
Wild boar *Sus scrofa*	*Tahao* (female), *tingkia* (male)	*Sah-ruol*	*Duo*	Meat consumption, canine teeth for use in traditional attire (teeth have market value)	High	296	8 (11.4)	−0.32
Sambar *Rusa unicolor*	*Rehie*	*Sah-juk*	*Juk*	Meat consumption, stag antlers (antlers have high market value)	High	33		
Elephant *Elephas maximus*	*Hepua*	*Sah-ipui*	*Changpoknyiu/ Chapaknyiu*	Ivory & bone poaching, meat consumption	Medium	28		
Mithun *Bos frontalis*	*Buichang*		*Jang/Nguo*	Meat consumption	High	472		
Bears								
Asiatic black bear *Ursus thibetanus*, sun bear *Helarctos malayanus*	*Hegum*	*Ivom*	*Shap*	Bile for medicine (high market value), meat consumption, skin & claws for traditional attire	High	11	4 (0.4)	0.00
Primates[2]						8	3 (0.2)	−0.36
Rhesus macaque *Macaca mulatta*, pig-tailed macaque *Macaca leonine*	*Hezuagiebe*	*Jongsang*	*Meshou*	Meat consumption, illegal pet trade	High			
Capped langur *Trachypithecus pileatus*	*He-nga*	*Sah-ha*		Meat consumption	Medium			
Hoolock gibbon *Hoolock hoolock*	*Kepie*	*Indor*	*Sheo*	Meat consumption, medicinal purposes (raw blood consumed by Zeliang tribes)	High			
Slow loris *Nycticebus bengalensis*	*Hingnguipau*	*Jongkurma*		Meat consumption, medicinal purposes	Low			

Table 1 (*Cont.*)

Species	Local names[1]			Use	Local market demand	Number of photo captures	Number of hunters preferring species (%)	Jacobs' index
	Zeliang tribe (Intangki)	Kuki tribe (Intangki)	Khiamniungan tribe (Khelia)					
Small mammals								
Yellow-throated marten *Martes flavigula*	*Keteine*	*Tumpui*	*Velie*	Meat consumption	Low	60	2 (8.4)	−0.58
Common palm civet *Paradoxurus hermaphroditus*	*Guizing*	*Sah-jo*	*Shim khao*	Meat consumption	High	57		
Himalayan masked palm civet *Paguma larvata*			*Pai khao*	Meat consumption	High	8		
Spotted linsang *Prionodon pardicolor*			*Ngo thso*	Meat consumption, pelt use for commercial purposes	Medium	5		
Large Indian civet *Viverra zibetha*	*Reh-hei*			Meat consumption	Low	39		
Small Indian civet *Viverricula indica*				Meat consumption	Low	6		
Carnivores								
Leopard cat *Prionailurus bengalensis*	*Heng-ie*	*Sah-kngar*	*Khapholou*	Meat consumption	Medium	57		
Clouded leopard *Neofelis nebulosa*			*Tsong*	Pelt, claws, canine teeth	Low	15		
Marbled cat *Pardofelis marmorata*			*Paikhapholou*	Meat consumption	Low	7		
Common leopard *Panthera pardus*	*Lairik*	*Bongkurui*	*Khaohyang*	Pelt, claws, canine teeth	Low	15		
Asiatic golden cat *Catopuma temminckii*			*Chingchai he khao*	Opportunistic hunting	Low	17		
Dhole *Cuon alpinus*	*Henei*	*Sial*	*Chiuh*	Opportunistic hunting & retaliation killing but not hunted preferably by veteran hunters because of distasteful flavour of meat	Medium	54		
Indian jackal *Canis aureus indicus*	*Misrung*	*Melang*	*Chiuh*	Opportunistic hunting & retaliation killing but not hunted preferably by veteran hunters because of distasteful flavour of meat	Medium	0		

Table 1 (*Cont.*)

Species	Local names[1]			Use	Local market demand	Number of photo captures	Number of hunters preferring species (%)	Jacobs' index
	Zeliang tribe (Intangki)	Kuki tribe (Intangki)	Khiamniungan tribe (Khelia)					
Porcupines, mongooses & pangolins								
Asiatic brush-tailed porcupine *Atherurus macrourus*	*Raunten*	*Sah-rket*	*Shipthso*	Meat consumption	Medium	316		
Malayan porcupine *Hystrix brachyura*	*Tingn-gua*	*Sah-rko*	*Khiaptsou*	Meat consumption, spines for making traditional hair accessories	Medium	81		
Crab-eating mongoose *Urva urva*	*Zurongpuang*			Meat consumption	Low	89		
Chinese pangolin *Manis pentadactyla*	*Tepah*	*Sa-phu*	*Khiapthsu*	Poaching for commercial market for traditional Chinese medicine	High	2		
Pheasants								
Blyths tragopan *Tragopan blythii*			*Angaweo*	Meat consumption	Medium	4		
Kalij pheasant *Lophura leucomelanos*	*Kerik*	*Varid*	*Ouwangniu*	Meat consumption	High	75		
Red junglefowl *Gallus gallus*	*Chakperui*	*Archa*	*Nokweo*	Meat consumption	High	129		
Partridge *Arborophila* spp.	*Hekoi*	*Varung*	*Lupoi*	Meat consumption	High	34		
Grey peacock-pheasant *Polyplectron bicalcaratum*	*Reheu*	*Varho*		Meat consumption	High	67		

[1]Pronunciation and spelling could vary slightly because of the differences in dialect amongst villages.
[2]All primate species were considered as a single category for the number of photo captures and for hunter preference.

protection. A minority (11%, n = 9) cited the absence of economic benefits as a reason for their lack of participation in biodiversity conservation. A minority (11%, n = 9) also reported an increase in hunting following the onset of the Covid-19 pandemic (Supplementary Table 2). Over half of the respondents (53%) recognized the significant economic and aesthetic values of the biodiversity in their respective regions. Responses varied by gender in this perspective, with female respondents demonstrating a stronger inclination towards aesthetics over economics (73%, n = 11), compared to male respondents (60%, n = 39; Supplementary Table 2). In terms of sustainable biodiversity conservation, half of the respondents (54%) advocated tree planting.

Discussion

In many Indigenous communities hunting is influenced by traditional laws, history, geography, biodiversity and most notably, economic value (Peterle, 1977; Madhusudan, 2018). Our study provides insights into the hunting culture of the Indigenous communities of Nagaland, where people hunt mainly for consumption and local trade. The hunting preferences and practices of Naga hunters were similar to those of hunters elsewhere, with hunting tools and strategies depending on prey, habitats, communities and seasonality (Supplementary Tables 3 & 5; Bartholomew et al., 2021; Teutloff et al., 2021; Fatem et al., 2023). Use of pitfall traps, deadfall traps and snares by the Naga tribes was similar to that observed amongst other Indigenous communities in Arunachal Pradesh, India (Aiyadurai et al., 2010), Southeast Asia (Pangau-Adam et al., 2012; Loke et al., 2020), South America (Alves et al., 2009) and Africa (Gandiwa, 2011). In Khelia we documented a unique traditional hunting technique for trapping small prey such as frogs for consumption, involving placing conical-shaped bamboo baskets tucked between several vertical posts along stream edges during summer. Strong currents washed the frogs downstream, where they were collected in the baskets (Supplementary Table 5). During a successful season the villagers could collect as many as 500 frogs per week for personal consumption and for sale at the local market. Another traditional hunting method in the area involved the use of plant toxins, and this varied according to the hunted species and community. For example, the creeper *M. pachycarpa* was used to release poison into the river for fishing purposes. This practice was prevalent amongst the Kachari and Dimasa tribes, non-Naga Indigenous tribes living near Intangki National Park, but has also been recorded in other parts of Nagaland (Imchen & Joglekar, 2017; Ovung et al., 2022). The use of plant poisons in streams obviates the need to use artificial chemical pollutants, resulting in a lower impact on the overall aquatic ecosystem, as plant-based toxins break down more quickly than synthetic chemicals and have a shorter lasting effect on the environment. In the higher altitudes of our study area, the Khiamniungan Naga tribe hunted for wild meat using bow and arrows, for which arrow tips were steeped in an extract made from monkshood. This technique has been observed in other Southeast Asian countries (Heizer, 1938; Bisset, 1981) and amongst Indigenous North Americans and tribal communities in Africa and South America (Jones, 2021). Barking deer were particularly sought-after for their taste in Nagaland, as they were one of the most abundant species, were easy to hunt and had a high commercial value (6,000–10,000 INR; GBP 50–90 for a whole animal; SL, pers. obs., 2021). From our open-ended questions and informal discussions we determined that bears were also preferred in Khelia because of their high economic and cultural values (Longchar & Hayward, 2022). However, people generally consumed all animals caught, irrespective of the species.

Hunters in Nagaland followed optimal foraging theory in their decision-making and prey selection (Pyke et al., 1977), aiming to maximize net energy gain whilst minimizing hunting costs (Kraft et al., 2021) by preferring large-bodied wildlife, a pattern consistent with findings from other studies (Velho et al., 2012). However, in the absence of larger fauna, hunters shifted to smaller-bodied prey and opportunistic hunting practices. This shift reflects the adaptability of local hunting strategies but raises ecological concerns (Griffiths et al., 2022). The widespread use of cheap, homemade firearms has replaced most traditional methods of hunting in Nagaland, as elsewhere in India, with gun ownership now being common and culturally embedded (Aiyadurai et al., 2010; Gubbi & Linkie, 2012). Homemade firearms are often acquired without an official gun license, making them convenient for hunters; although less reliable than commercial firearms, their affordability and accessibility make them a popular choice (SL, pers. obs., 2021). Guns reduce both the energy and time required for hunting compared to traditional methods, and also enable hunters to target larger mammals that provide a higher yield of meat. In addition, hunting motives in Nagaland extended beyond optimizing energy gain, as taste preferences for specific wild meat played a significant role in hunting (Schenck et al., 2006). This led to an increased focus on hunting during the winter, particularly for animals with winter body fat storage, such as common palm civets *Paradoxurus hermaphroditus* and bears. Moreover, the forest becomes more accessible in winter, which is drier than other seasons, thereby facilitating hunting. Additionally, preferences for hunting during nights without moonlight and in dense forests indicated that hunters could easily locate animals using flashlights.

The preference for selective hunting of large-bodied mammals, especially using firearms, raises concerns for

these species. This preference also indirectly affects large carnivores such as tigers *Panthera tigris* that predate on large-bodied mammals and are limited by the availability of their preferred prey (Hayward et al., 2007). Although hunters now seldom use bow and arrows or spears, traps and snares remain popular amongst children, facilitating capture of smaller mammals and birds for both sport and consumption. Additionally, based on our discussions with local elders and hunters, it became evident that a decline in experienced older hunters has reduced adherence to traditional hunting ethics, such as respecting seasonal hunting restrictions during breeding periods and refraining from hunting certain protected species (SL, pers. obs., 2021). Lastly, the practice of offering hunted wildlife products to influential community members is growing, further fostering unsustainable hunting (SL, pers. obs., 2021). Unsustainable hunting and habitat loss have led to local perceptions of wildlife declines, especially in areas where conservation is not considered a priority.

Transboundary trade routes have existed in north-east India for centuries, with Nagaland emerging as a hub for illegal wildlife trade in the region. This trafficking of wildlife parts from north-east India to Southeast Asian countries poses a significant conservation concern (Savage, 2022). Our observations during the study revealed instances of this illicit activity, particularly in areas bordering Myanmar, where hunters targeted bears, for their bile (Longchar & Hayward, 2022). Wildlife hunting for trade is driven by the poor economy of the state, especially in rural areas where agriculture is the primary livelihood. Hence, the dual benefits of hunting (sustenance and income) can have repercussions for the targeted species and for ecosystem functioning (Peres & Lake, 2003; Loke et al., 2020). Addressing socio-economic disparities within these rural communities can minimize the impacts of overhunting.

Perceptions of wildlife hunting and conservation in Naga society are rooted in ancestral beliefs and traditional practices, which encompass customary land ownership, socio-economic structures and governance systems. However, conservation interventions often involve restrictions on the utilization of community-forested areas, and are not always accepted by community members, reflecting a diversity of perspectives on conservation strategies. Furthermore, gender also plays a significant role in shaping perceptions of wildlife conservation in Naga society. Women exhibited greater appreciation of the aesthetics of nature, and their use of forest resources focused less on hunting and more on gathering wild plants and herbs, which were utilized both commercially and for personal consumption. Despite varying views, the majority of community members appeared not to be motivated to participate in biodiversity conservation, primarily because of reliance on agriculture and subsistence activities, leaving little time or resources for conservation. The absence of incentives associated with conservation initiatives further contributed to their limited motivation.

This study relied on voluntary participation and recall data, which can have limitations if participants are uncomfortable exposing certain activities for fear of incriminating themselves. Nevertheless, we were able to broach sensitive topics with the villagers from Khelia, such as hunting locations and the commercial value of wildlife, as hunting remains a part of their traditions and the community retains management and ownership of the local forest. However, some participants in Intangki were hesitant to talk about hunting as they were aware of the restrictions imposed by the forest department on hunting and extracting natural resources from the national park.

There is a need for an interdisciplinary approach to conservation in which communities that rely on nature for their identity and economic sustenance are actively involved in decision-making and management. Comprehensive policies are needed to sustain the economic and cultural values of communities such as those of Nagaland. In this case, we recommend incentivized monitoring and control of illegal wildlife trade by the relevant stakeholders (communities, government and NGOs) in the border areas with Myanmar, to protect this vital biodiversity area.

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Conflicts of interest None.

Ethical standards This study received ethical approval from the Animal and Human Ethics Committee, University of Newcastle, Australia, under permits L1 184-2018 and H-2021-0360. All funding sources supporting the work contained in the article and all institutional, corporate and village affiliations of the authors are acknowledged in the article. All respondents gave their informed consent prior to participation, and this research otherwise abided by the *Oryx* guidelines

on ethical standards. All incidental camera-trap photographs of people were deleted.

Data availability The data that support the findings of this study are available upon reasonable request from the corresponding author, SL. The data are not publicly available due to privacy considerations.

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