Continued survival of the Asiatic black bear *Ursus thibetanus* in Hainan, China

Jialing Li[1,2], Yilin Cui[1], Hui Liu[1]*, Youqiang Wang[2], Heidi Ma[3] and Samuel T. Turvey[3]

Abstract Determining whether cryptic remnant animal populations survive within specific landscapes is a conservation challenge and may require multiple types of information. Hainan Island, China, has lost most of its large mammal fauna, with no recent evidence for persistence of large carnivores. We conducted a survey of local ecological knowledge in communities around seven protected areas in 2015, collecting sighting reports of the Asiatic black bear *Ursus thibetanus*. Respondents living near Wuzhishan National Nature Reserve reported the highest number of dated sightings as well as the most recent sightings. In follow-up interviews, wildlife rangers at Wuzhishan reported recent signs of bears and local hunting, and a possible bear photograph was taken inside the Reserve in 2017. Characteristic bear signs, including fresh diagnostic claw marks on trees, were detected at Wuzhishan in 2021, confirming bear presence. Wuzhishan is the last area in Hainan where large herbivores and carnivores survive, and where local conservation efforts still have the potential to maintain functional forest ecosystems that support megafaunal assemblages.

Keywords Asiatic black bear, interviews, last-sighting dates, local ecological knowledge, science-based monitoring, small population, survey, *Ursus thibetanus*

Determining whether threatened species continue to survive within specific landscapes is essential for evidence-based conservation planning. However, small populations can persist undetected for decades, especially if survey effort is limited or uneven, and survival of depleted populations can be uncertain even for large mammals (Fusco-Costa et al., 2023; Wirdateti et al., 2024). Clarifying the status of so-called 'lost species' is a global concern (Long & Rodríguez, 2022), and various approaches have been employed in efforts to ascertain the potential survival of many populations, including reviewing sighting records and investigating ecological correlates of species rediscovery (Fisher, 2011). In practice, assessment of cryptic populations often requires using multiple types of information, including ecological data collected by conservation practitioners and local ecological knowledge held by non-scientists with personal experience of key landscapes, but such data require critical and context-specific consideration (McKelvey et al., 2008).

Hainan Island, China's southernmost province, has lost most of its large mammals, with wild boar *Sus scrofa* and northern red muntjac *Muntiacus vaginalis* now the largest widely occurring species (Turvey et al., 2019). Other native deer are restricted to a few sites (Wong et al., 2021) and the only large carnivore documented within recent decades is the Asiatic black bear *Ursus thibetanus*. Relatively fresh bear signs were reported from four national nature reserves (Bawangling, Jianfengling, Wuzhishan, Yinggeling) during rapid biodiversity surveys in 1998–2005 (Lau et al., 2010). However, although suitable habitat exists in Hainan, poaching pressure remains high (Gong et al., 2017; Wang et al., 2021) and there are no recent confirmed reports of bears.

We conducted a large-scale survey of local ecological knowledge to investigate the status of Hainan's mammals during January–April 2015, interviewing 709 respondents in villages near seven national or provincial nature reserves (Bawangling, Diaoluoshan, Jianfengling, Jiaxi, Limushan, Wuzhishan, Yinggeling; Fig. 1), with 99–107 respondents interviewed per reserve. These reserves contain most of Hainan's remaining forests and are now managed within Hainan Tropical Rainforest National Park, which was established in 2021. Local communities are dependent upon natural resources from adjacent forests and are thus potentially familiar with locally occurring fauna (Turvey et al., 2017). We conducted anonymous face-to-face interviews following informed verbal consent (for full details of the questionnaire, respondent selection criteria and interview protocols, see Turvey et al., 2017). Mean respondent age was 50 years (range: 20–94), 83% were male and 17% were female, and 84% were farmers. We showed respondents a colour photograph of an Asiatic black bear, asked them to identify the animal and enquired whether they had encountered bears (direct sightings or diagnostic signs), and if so, where and when. Overall, 193 respondents reported dated sightings of bears or bear signs, including 25 from the previous decade. Respondents near Wuzhishan reported the highest number of dated local sightings (41% of respondents, n = 100; versus 14–38% from other reserves), the most recent mean and median last-sighting dates (mean last-sighting, 24 years previously; other

*Corresponding author, liuhui@hainanu.edu.cn
[1]School of Tropical Agriculture and Forestry, Hainan University, Haikou, China
[2]Wuzhishan Branch, Hainan Tropical Rainforest National Park Administration, Wuzhishan, China
[3]Institute of Zoology, Zoological Society of London, London, UK

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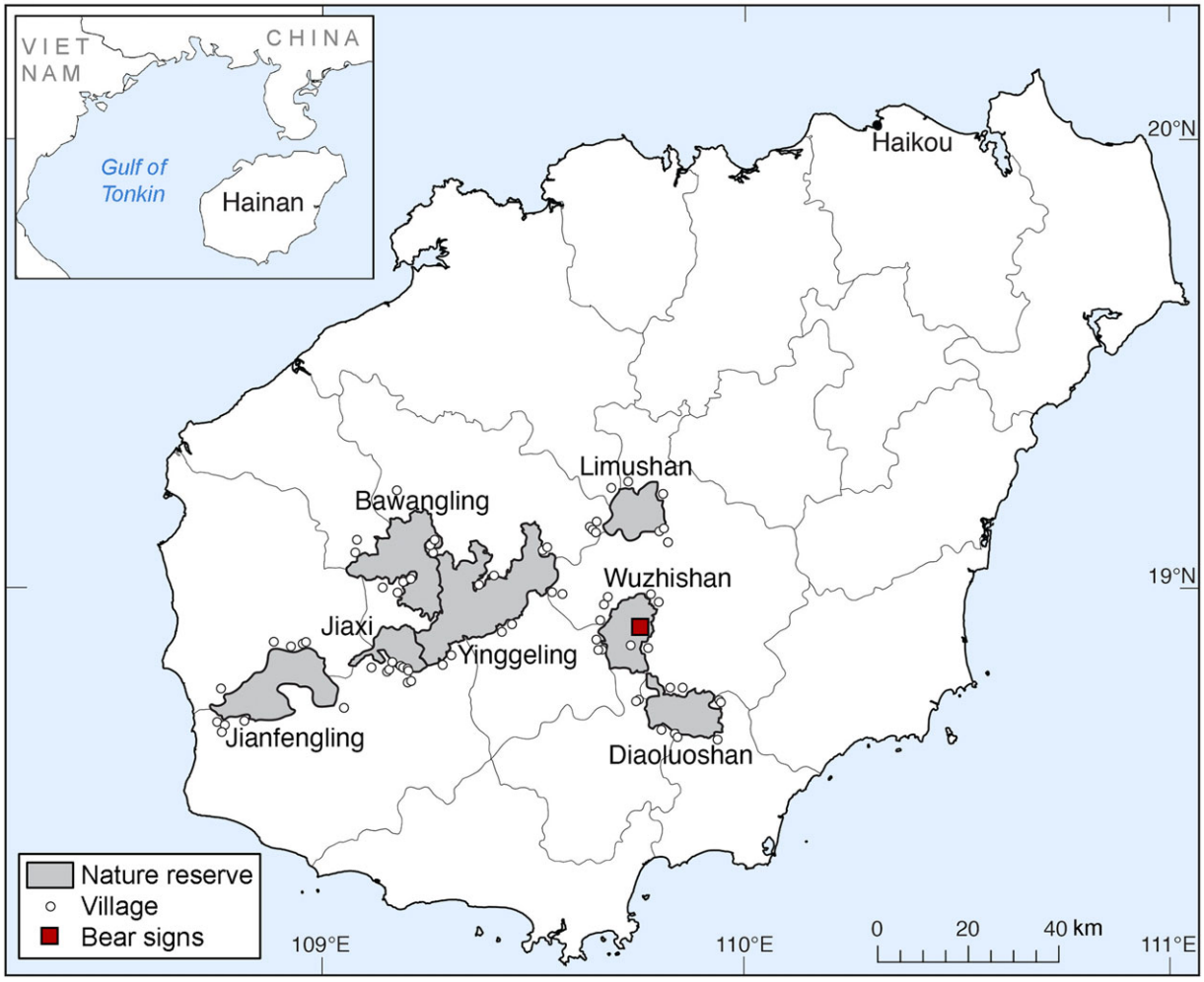

FIG. 1 Hainan Island, China, showing the location of seven nature reserves and neighbouring villages where we interviewed local communities to gather reports of sightings or signs of Asiatic black bears *Ursus thibetanus*, and the location of diagnostic bear signs observed in Wuzhishan National Nature Reserve in December 2021.

reserves, 26–32 years previously; median last-sighting, 21 years previously; other reserves, 27–33 years previously), and the most sightings from the previous decade (eight reports from 1–8 years previously; Fig. 2).

We conducted additional informal interviews with four forest rangers at Wuzhishan (Shuiman and Zapo management stations) in December 2023, which revealed that bears had declined locally since the 1970s but were still relatively common during the 1980s and 1990s, when they were hunted using guns and leg-hold traps. Five bears were killed by hunters from one village during 1997–1998, and bears were hunted into the mid-2010s until anti-poaching enforcement increased. Rangers stated that bear signs could still be found within the Reserve, with recent sightings reported from 2020 and 2022 by villagers entering the Reserve to collect honey or locate free-roaming cattle.

In April 2017, a villager from Shuimanxiang reported a bear sighting within the Shuiman management area core zone and provided a photograph of an animal in a tree (Plate 1a). The image is indistinct but appears to show a black animal larger than other arboreal mammals in Hainan (civets, Hainan gibbon *Nomascus hainanus*, rhesus macaque *Macaca mulatta*, black giant squirrel *Ratufa bicolor*), which suggests it is a bear.

On 13 December 2021, rangers from Zapo management station found a c. 20 m² area of flattened and broken shrubs and damaged trees several hundred metres off the trail, within a small clearing in montane tropical forest at an altitude of 1,145 m and 2.75 km inside the Reserve (Fig. 1). This disturbed area contained large footprints and holes dug into the ground, and 10 sets of claw marks on the trunks of seven large trees (*Glochidion puberum*, *Lithocarpus polystachyus*), with a mean five-claw hindfoot width of 7.9 cm (matching the hindfoot width of a young adult Asiatic black bear; Steinmetz & Garshelis, 2008) at a mean height of 1.6 m above the ground (Plate 1b-f). Experienced rangers recognized these as bear signs. Although bear claw marks can persist for long periods,

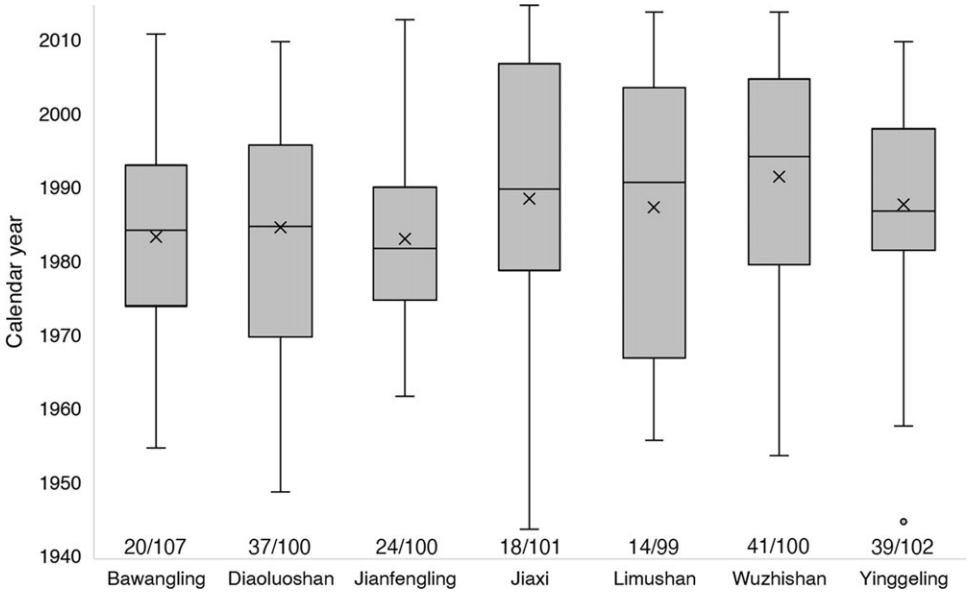

FIG. 2 Boxplots of the last-sighting year for reported Asiatic black bear sightings in seven nature reserves on Hainan Island, China. Crosses show the mean, horizontal lines the median, boxes the interquartile ranges, and whiskers the upper and lower extremes of the last-sighting year, and an outlier is also shown at Yinggeling. The number of respondents who reported dated bear sightings or signs are given as a proportion of the total respondent sample from each nature reserve.

PLATE 1 Evidence of Asiatic black bear *Ursus thibetanus* survival in Wuzhishan National Nature Reserve, Hainan Island, China. (a) Photograph from April 2017 showing indistinct large black animal (arrow indicates probable head), (b–f) bear signs found by wildlife rangers in December 2021: (b) hole dug by large animal, (c, d, f) hindfoot claw marks (scale bar = 2 cm), (e) flattened vegetation.

Table 1 Summary of evidence for Asiatic black bear *Ursus thibetanus* survival in Wuzhishan National Nature Reserve, Hainan Island, China.

Date	Data type	Evidence	Source
8–12 June 1999	Rapid biodiversity surveys	Fairly fresh claw marks and feeding signs	Lau et al. (2010)
2–4 Aug. 2001	Rapid biodiversity surveys	Fairly fresh claw marks and feeding signs	Lau et al. (2010)
Jan.–Apr. 2015	Local ecological knowledge survey of nearby villages	41 of 100 respondents reported dated local bear sightings, including eight reports from 1–8 years previously (Fig. 2)	This study
Apr. 2017	Opportunistic encounter	Photograph of possible Asiatic black bear in tree taken by local villager (Plate 1a)	This study
2017–2025	Camera trapping	1 × 1 km & 2 × 2 km camera-trap grids have not detected bears	This study
13 Dec. 2021	Ranger patrol	Large footprints, excavated holes, 10 sets of fresh claw marks on trees (Plate 1b–f)	This study
Dec. 2023	Informal interviews with four forest rangers	Reports that bears were hunted locally until the mid 2010s; reported sightings of bears in 2020 and 2022; bear signs reportedly still observed regularly	This study

these showed the sharp edges and fine woody grit consistent with fresh marks (< 2.5 months old; Steinmetz & Garshelis, 2010).

These findings represent evidence for the continued survival of bears in Hainan (Table 1). Wuzhishan has lost the Hainan gibbon, which now only survives at Bawangling (Turvey et al., 2017). However, it contains one of Hainan's few surviving populations of sambar deer *Rusa unicolor*. Wuzhishan is thus the last ecosystem in Hainan to support large mammalian herbivores and carnivores.

Systematic monitoring is needed to determine bear population size, population viability and landscape use at Wuzhishan. Low-density camera trapping, conducted by the Wuzhishan Branch of Hainan Tropical Rainforest National Park Administration and Hainan University since 2019, has not detected bears. Cameras were initially deployed across 132 km² (1 × 1 km grid, n = 132 cameras), with coverage expanded and 100 more cameras added on a 2 × 2 km grid in 2023 following the expansion of the Reserve to 534 km². We recommend more intensive camera trapping, potentially incorporating methods that increase the likelihood of bear detection (e.g. baits, lures; Buyaskas et al., 2020).

Wuzhishan does not have a specific management plan, and specialized strategies are needed to conserve the surviving bear population and reduce anthropogenic pressures. Research is needed to understand the dynamics and drivers of hunting and resource extraction by local people, and management actions should be implemented to reduce habitat degradation by free-roaming cattle. We also encourage research into the genetics of the bear population in Hainan using DNA from museum specimens, to establish whether it is distinct from mainland populations.

Our findings highlight the importance of multidisciplinary approaches that integrate ecological, observational and Indigenous knowledge to detect remnant wildlife populations. Such efforts should also investigate unsubstantiated local reports of clouded leopards *Neofelis nebulosa* (Lau et al., 2010). The rediscovery of Asiatic black bears in Wuzhishan provides new hope that local conservation management can maintain populations of keystone species and thus support functional forest ecosystems.

Author contributions Study design: JL, HL, STT; data collection: JL, YC, HL, YW, STT; data analysis: JL, HL, STT; writing: STT, HM, HL.

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Conflicts of interest None.

Ethical standards This study abided by *Oryx* guidelines on ethical standards. Ethical approval was granted by the Zoological Society of London Ethics Committee.

Data availability All data generated during the study are available from the corresponding author upon request.

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