

Threats to the Critically Endangered yellow-headed tortoise *Indotestudo elongata* in Jalthal Forest, eastern lowland Nepal

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Abstract Jalthal Forest (62.6 km²) is a remnant forest patch of a once continuous, lush and dense area of sal *Shorea robusta* and mixed deciduous vegetation in eastern lowland Nepal that is now surrounded by a dense human population. The forest is one of the last remnants of suitable habitat for the Critically Endangered yellow-headed tortoise *Indotestudo elongata*. This study explored the distribution of and conservation threats facing the yellow-headed tortoise in Jalthal Forest through field surveys in 20 community forests and structured interviews with 80 members of 22 community forest user groups and local people during September–November 2021. We surveyed 11.3 km² of the forest and observed only four individuals of *I. elongata*, indicating a population density of 0.35/km². Local people perceived that the species is decreasing mainly because of hunting (42%) and habitat deterioration from incursion of invasive species (30%). Based on the interviews with local people involved in hunting, an annual mean of 6.8 tortoises were killed during 2017–2021. The purposes of hunting were consumption (70%) and ethnomedicinal uses (30%) by the Meche and Sathar communities. Awareness campaigns and networks of communication amongst all stakeholders are required to conserve this species in Jalthal Forest.

Keywords Ethnomedicine, illegal hunting, *Indotestudo elongata*, invasive species, Jalthal Forest, Nepal, Sathar community, yellow-headed tortoise

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The yellow-headed tortoise *Indotestudo elongata* is widely distributed throughout South and Southeast Asia, ranging across northern India, Nepal, Bhutan, Bangladesh, Thailand, Viet Nam, Cambodia, Laos and Malaysia (Rahman et al., 2019). It lives at low to mid elevations, primarily in evergreen and deciduous forests, grasslands and secondary forests (Schleich & Kästle, 2002; Ihlow et al.,

2016). In Nepal its distribution has been recorded in the lowland Terai from Jhapa District in the far east to Shuklaphanta National Park in the far west (Aryal et al., 2010; Rawat et al., 2020). Human-induced forest fires, habitat loss, excessive collection for food, traditional medicinal uses and as pets in temples and houses, and targeted hunting with dogs, for trade, are the major threats facing the species (Kästle et al., 2013; Ihlow et al., 2016). It is categorized as Critically Endangered on the IUCN Red List (Rahman et al., 2019), and is also listed in Appendix II of CITES (Ihlow et al., 2016).

Jalthal Forest in the eastern lowland of Nepal is a remnant of a once continuous, dense and lush forest called Charkoshe Jhadi (Fig. 1). It spans 62.6 km² and comprises floristic elements from the Indo-Malayan Floristic Region, consisting of dominant sal *Shorea robusta* forest and mixed deciduous forest (Thapa et al., 2003). The climate is mostly tropical monsoon with a dry and warm summer (March–mid May), a humid and warm period (mid May–October) and a dry and cold winter (November–February; Bhattarai, 2017). Mean annual minimum and maximum temperatures are 10 and 33 °C, respectively. The forest is home to a high diversity of plant and animal species, including threatened vertebrates such as the Chinese pangolin *Manis pentadactyla*, Asian elephant *Elephas maximus* and leopard *Panthera pardus*. Isolated populations, invasive plant species (e.g. *Mikania micrantha* and *Chromolaena odorata*), wildlife hunting, biomass collection, road development in the forest and forest fires are the direct threats to Jalthal Forest (Sharma et al., 2021).

Jalthal Forest is one of the last remnants of suitable habitat for the Critically Endangered *I. elongata* in eastern lowland Nepal but there is limited information on the distribution of and threats facing this species there. During 25–31 August 2021, we conducted 55 structured interviews with members of community forest user groups to identify the probable locations and habitats of *I. elongata*. From the interviews we identified 45 potential locations, and we then conducted surveys within an area of c. 0.25 km² at each location. We conducted three field surveys during September–November 2021, on foot. We conducted the initial survey on 3–16 September, followed by surveys on 5–12 October and 4–11 November. We surveyed 22 community forests for a total of 240 h. Because of the elusive nature of *I. elongata*, we surveyed open and dense vegetation, fallen leaves and tree trunks and porcupine and pangolin

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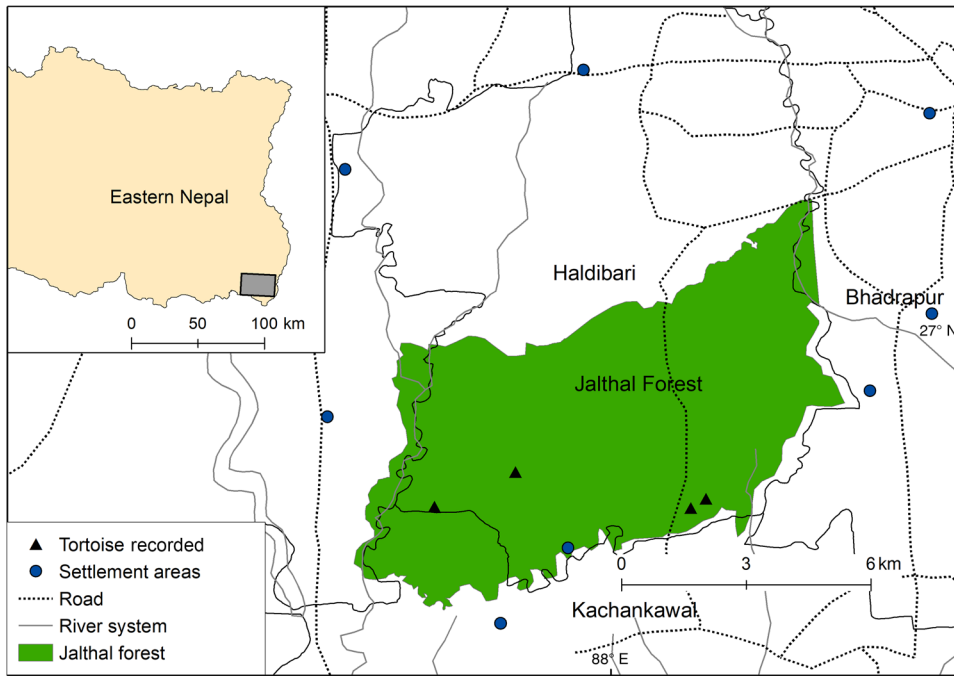


FIG. 1 Jalthal Forest in eastern lowland Nepal, showing the four locations in which we recorded the yellow-headed tortoise *Indotestudo elongata*.

burrows (van Dijk, 1998), and searched for indirect signs of footprints and triangular bite marks on vegetation characteristic of the species (Sriprateep et al., 2013; Deepak & Vasudevan, 2015). In total we surveyed 25.4% (11.25 km²) of Jalthal Forest and recorded only four mature individuals of *I. elongata*, giving a naïve population density of 0.35/km. We did not observe any indirect signs of the species.

From 25 August to 11 November 2021 we also interviewed 80 people (including 10 local hunters) who were dependent on the forest for their livelihood. Each interview lasted c. 20 min and included open-ended questions about socio-demographic characteristics, background, motivation, local knowledge and trends and perceptions regarding the species (Supplementary Material 1). We found that 90% of the respondents knew *I. elongata* inhabited Jalthal Forest, and 33% of the respondents admitted they had killed *I. elongata* in their lifetime; 42% believed the species is decreasing because of hunting and/or incursion of invasive species (30%), and the remaining 28% were unsure of the cause of this decrease. Nine of the hunters were from the eastern ($n = 6$) and southern ($n = 3$) parts of the forest, were aged 35–55 and belonged to the Meche and Sathar communities. These are Indigenous local tribes that hunt traditionally. Based on the interviews we determined that 34 *I. elongata* individuals had been hunted during 2017–2021, an annual mean of 6.8, and that the numbers hunted were decreasing. The purpose of hunting was for consumption (70% of respondents) and ethnomedicinal purposes (30% of respondents).

During June–August 2022, through information gained from local people, one *I. elongata* was handed to the Turtle Rescue and Conservation Center, Nepal, through coordination with Forest Action Nepal (Plate 1), two

individuals were successfully released by the community forest user groups in Jalthal Forest, but two other individuals (Plate 2) were killed.

Information from the interviews, and our surveys, suggest this isolated population of *I. elongata* is small and severely threatened. Compared to north-east Thailand, where a density of 243 per km² has been recorded (Sriprateep et al., 2013), the density of *I. elongata* in Jalthal Forest is low. That we recorded only a few *I. elongata* could, however, be in part a result of surveying during the drier,

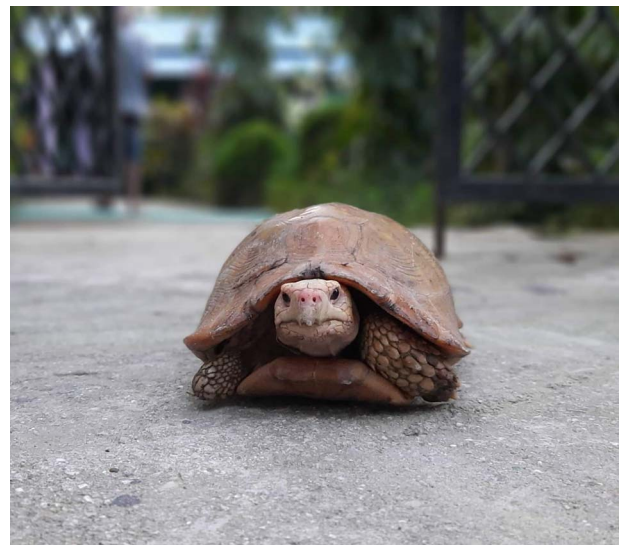


PLATE 1 A rescued yellow-headed tortoise *Indotestudo elongata* handed to the Turtle Rescue and Conservation Center, Nepal, on 4 June 2022 through coordination with Forest Action Nepal. Photo: Asmit Subba.



PLATE 2 A yellow-headed tortoise from Jalthal Forest killed on 10 July 2022. Photo: Keshav Kausik.

cooler time of year, when *I. elongata* is less active (van Dijk, 1998), and the disturbance at this time of year from people entering the forest to collect edible mushrooms and ferns (authors, pers. obs.). On the other hand, of the 45 potential survey locations, 25 had a dense ground cover (mean $74 \pm \text{SD } 12\%$) comprised principally of the invasive alien *M. micrantha*. An area of 29.4 km² of Jalthal Forest has been invaded by alien plant species, of which 8.8 km² has been heavily invaded (Tamang & Sharma, 2021). A dense cover of *M. micrantha* could negatively affect the foraging and basking of *I. elongata*.

The distribution range of a species influences its risk of extinction, as smaller-ranging species have lower genetic variation and lower genetic plasticity compared to wider-ranging congeners (Brown, 1984; Gaston, 2003; Meiri et al., 2017; Novosolov et al., 2017). In this context, climate change, introduced species, pathogens, cataclysms and habitat change can drive isolated, small-ranging species to extinction (Caughley, 2013; Meiri et al., 2017). These threats already exist in Jalthal Forest and, combined with a slow reproductive cycle (males and females reach sexual maturity at 6 and 8 years, respectively; Sriprateep et al., 2013), local hunter-gatherer practices could drive the small population of *I. elongata* in Jalthal Forest to extinction.

Considering the threats to *I. elongata* we recommend strong conservation interventions by local government

and conservation organizations. Additionally, awareness campaigns focused on local hunters, promoting allopathic medicine rather than the use of animal body parts, further research to assess the impacts of invasive species on *I. elongata*, and establishment of communication networks amongst community forest user groups and other stakeholders are required to conserve this species in Jalthal Forest.

Author contributions Study design: both authors; fieldwork, data analysis, writing: AS; revision: both authors.

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Conflicts of interest None.

Ethical standards Interviews were conducted in accordance with the standards of the Association of Social Anthropologists of the UK and Commonwealth, and this research otherwise abided by the Oryx guidelines on ethical standards. The study did not involve specimen collection or animal experimentation.

Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

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