Is the population of the Critically Endangered white-bellied heron declining in Namdapha Tiger Reserve, India?

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Abstract The Critically Endangered white-bellied heron *Ardea insignis* is a large-bodied, range-restricted, piscivorous bird of the Himalayan mountains. With fewer than 60 individuals remaining globally, regular monitoring is required for this rare species. We present the results of surveys during 2017 and 2023–2024 in Namdapha Tiger Reserve, Arunachal Pradesh, India. The encounter rate of white-bellied herons in 2017 was 0.55 individuals per km of river, but we did not detect the bird during intensive surveys in the same location during 2023–2024. The surveyed area within the Reserve was once a stronghold for the species, but its population appears to be declining. Monitoring the population has helped reveal this decline, but identifying and conserving stretches of river still utilized by the remaining individuals is now critical.

Keywords *Ardea insignis*, Arunachal Pradesh, conservation status, Eastern Himalaya, India, Namdapha Tiger Reserve, population trends, white-bellied heron

Herons (family Ardeidae) occur in freshwater and coastal habitats and, because of their longevity and site-specificity, are considered potential indicators of environmental conditions (Kushlan, 2018). Threats to herons include habitat degradation, hunting and pesticide use, and although they are generally adaptable, nine species and 12% of heron populations are considered threatened (Kushlan, 2007, 2018). A key challenge in heron conservation is protecting foraging sites from habitat alteration (Kushlan, 2018, and references therein), and identifying sites occupied annually can be particularly useful for conservation of threatened heron species (Kushlan, 2007). The white-bellied heron *Ardea insignis* is categorized as Critically Endangered on the IUCN Red List, with c. 60 individuals estimated to remain globally (Stanley Price & Goodman, 2015; BirdLife International, 2018). The species is regionally extinct in Nepal and possibly extinct in Bangladesh, and its global population is declining (BirdLife International, 2018). Its distribution is patchy across Bhutan, Myanmar and a few locations in north-east India (Stanley Price & Goodman, 2015). Previous studies of the heron have focused on foraging (Mondal & Maheswaran, 2021), breeding (Mondal & Maheswaran, 2014; Acharja, 2020) and anecdotal natural history observations (Maheswaran, 2008). Information on encounter rates or densities of the species that can aid population monitoring is relatively limited (but see Menzies et al., 2021). Since 2016, white-bellied herons in Bhutan appear to no longer re-use nests each year, instead showing a single-use nesting pattern and abandoning older nesting areas, leading to unsuccessful nests in many locations (Acharja, 2020). There are now as few as five breeding pairs in Bhutan (Acharja, 2020). Given its rarity and critical conservation status, it is imperative to monitor populations of this river bird.

There are two known populations of the species: the western population in Bhutan and the eastern population in the Indo–Myanmar region. The eastern part of Arunachal Pradesh in India, at the junction of the Eastern Himalayas and the Indo–Myanmar region, is an important area for the eastern population. Because of political instability in Myanmar, it is difficult to monitor the population or ensure its protection in the country (Hanson et al., 2009; Goswami & Ganesh, 2014), and thus eastern Arunachal is potentially the last refuge for the eastern population of the white-bellied heron. In this region, the 1,985 km² Namdapha Tiger Reserve, which has harboured low but stable heron populations (Maheswaran, 2008; Menzies et al., 2021), is the largest and most important protected area for the species. Recently, the bird has been reported in areas adjoining Namdapha (Patgiri et al., 2023). During a systematic survey in the central and western parts of Namdapha in 2017 (Menzies et al., 2021) we determined its presence in the Reserve. Here, we report a significant decline in white-bellied heron encounter rates from the central and western parts of Namdapha based on surveys during 2023–2024.

We surveyed the Deban, Namdapha and Noa-Dihing Rivers in Namdapha Tiger Reserve in the Changlang District of Arunachal Pradesh (Fig. 1). In November 2017, as part of the Eastern Himalayan-wide survey of the

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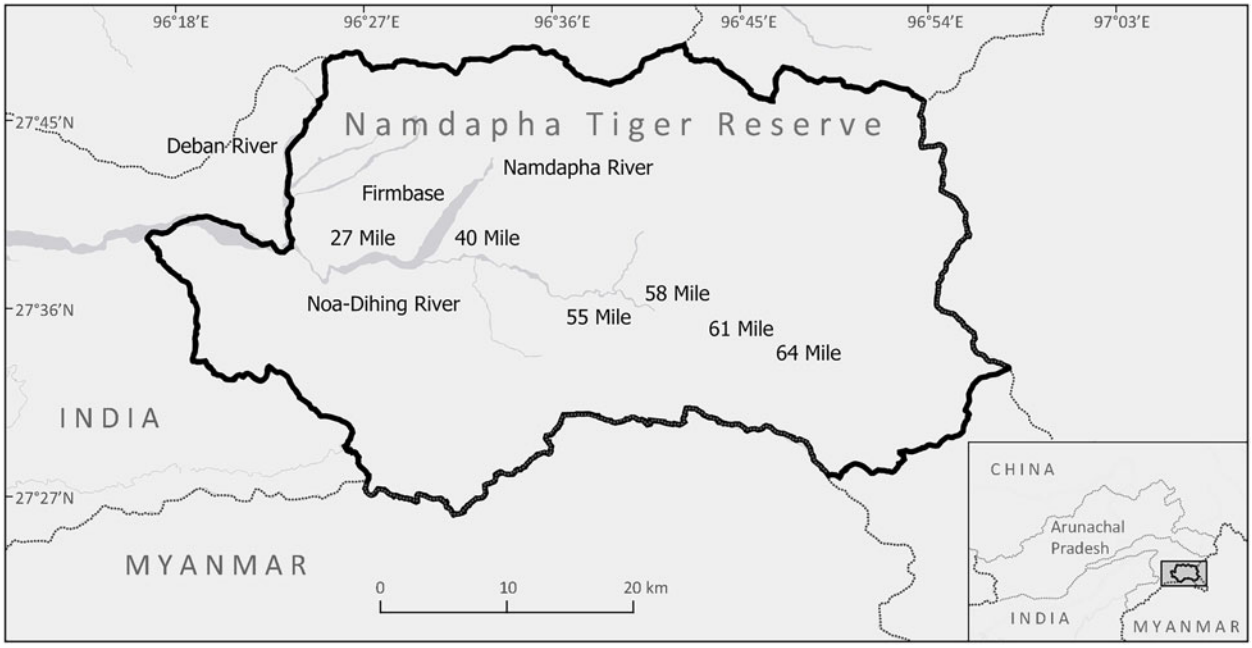

FIG. 1 Namdapha Tiger Reserve, Arunachal Pradesh, India, where we surveyed the Deban, Namdapha and Noa-Dihing Rivers during November 2017 (Menzies et al., 2021) and November 2023–March 2024 (this study) to record sightings of the white-bellied heron *Ardea insignis*.

TABLE 1 White-bellied heron *Ardea insignis* detections and encounter rates from line transect surveys in Namdapha Tiger Reserve during 2014–2024.

Survey	Duration	No. of transects	Mean length (km)	Total effort (km)	Total detections	Total individuals	Encounter rate (per km)
Mondal (2018)	Nov. 2014–Jan. 2017	65	0.62	40.0	7	8	0.20*
Menzies et al. (2021)	Nov. 2017	7	1.80	12.6	6	7	0.55
This study	Feb. 2023	5	5.93	29.7	0	0	0.00
This study	Nov. 2023–Mar. 2024	90	0.50	45.0	0	0	0.00

*The author used total detections divided by effort to calculate an encounter rate of 0.175, meaning multiple individuals encountered on a single occasion were recorded as a single detection. Here we use total individuals sighted divided by effort, adjusting this encounter rate to 0.20.

white-bellied heron (Menzies et al., 2021), we surveyed seven 0.6–2 km long transects, with a total survey effort of 12.6 km. In February 2023, we surveyed five 3.8–7.7 km long transects, with a total effort of 29.7 km, and during November 2023–March 2024 we surveyed 18 0.5 km transects five times each, with a total effort of 45 km (Table 1). We recorded all sightings (perched or flying) of the white-bellied heron during and outside the transect walks (Plate 1).

During our surveys in 2017 we recorded seven herons, with a mean encounter rate of 0.55 ± SE 0.24 individuals per km. We detected no herons during our 2023 and 2024 field surveys but opportunistically recorded one individual in February 2023, between 38 Mile and Firmbase, and two near Bor Nala between November 2023 and March 2024 (Fig. 2g,h).

The earliest surveys of the white-bellied heron (in 2005 and 2006) along the entire stretch of the Noa-Dihing River reported all five sightings west of 40 Mile (Maheswaran,

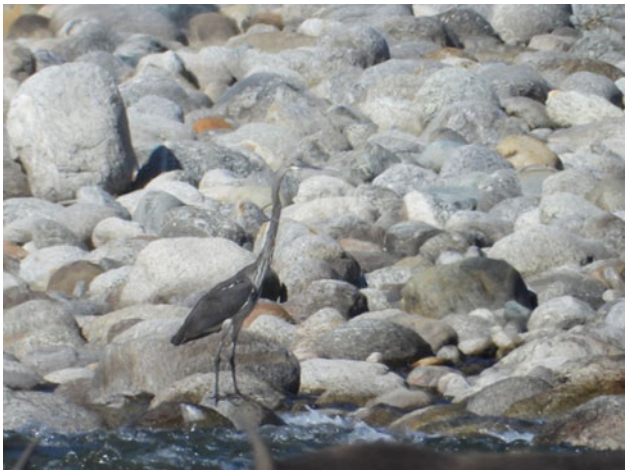

PLATE 1 A white-bellied heron *Ardea insignis* photographed in November 2023 along the Noa-Dihing River in Namdapha Tiger Reserve, outside of our fixed line transects. Photo: Rohan K. Menzies.

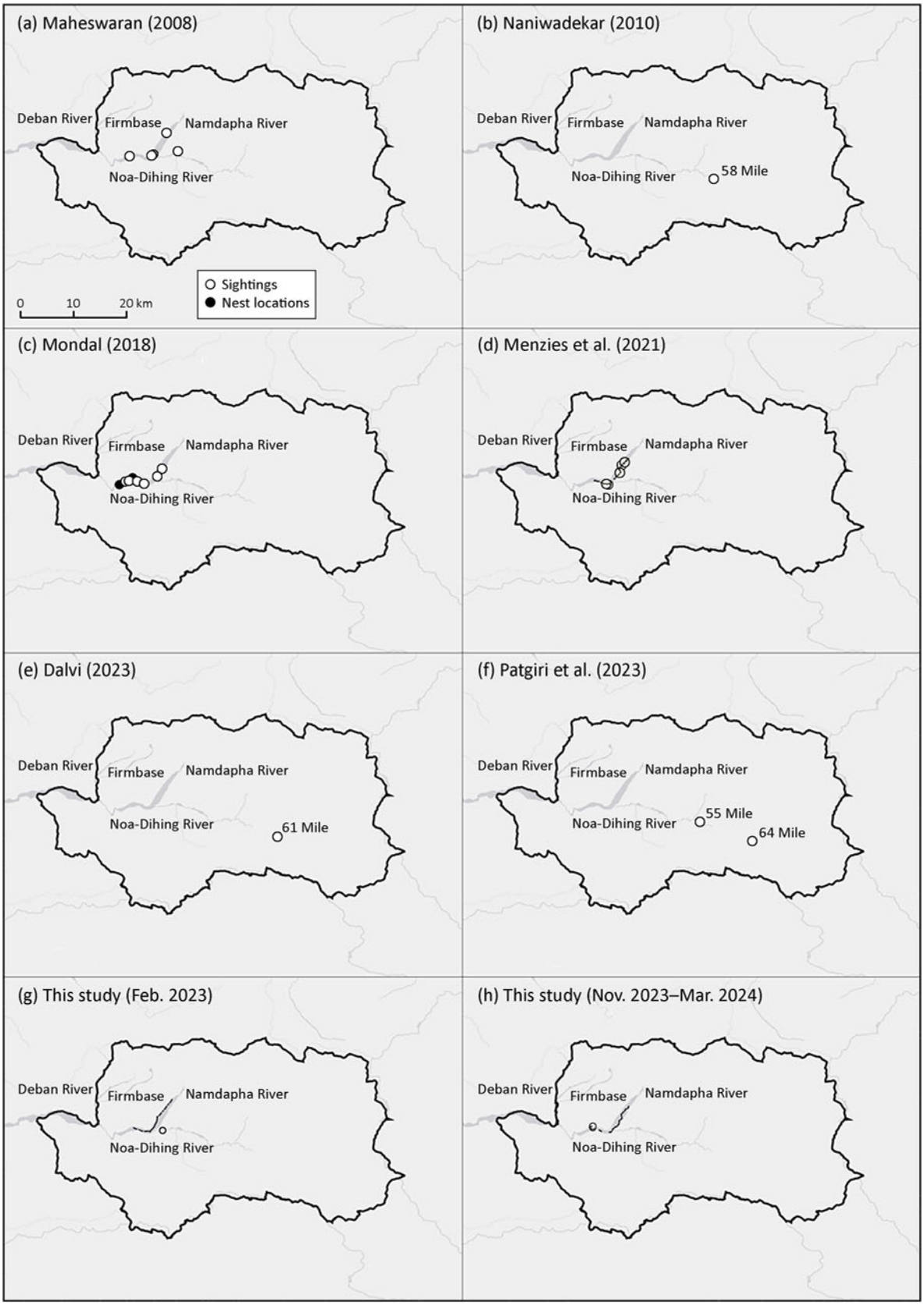

FIG. 2 Sighting locations of white-bellied heron in Namdapha Tiger Reserve during 2008–2024. The black lines indicate the surveyed river stretches where this information was available. Additional sightings were reported by Patgiri et al. (2023), but because these records did not include exact location information, they are not shown in part (f).

2008; Fig. 2a). From 2007 onwards there have been incidental reports of the heron from sites east of 40 Mile, up to 65 Mile: in the 52 Mile area in 2007 (Umesh Srinivasan and Shashank Dalvi, pers. comm., 2024), at 58 Mile in February 2010 (photographed by RN; eBird, 2021; Fig. 2b), and at 55 Mile and 64 Mile in 2022 (Patgiri et al., 2023; Fig. 2f). Firmbase was previously the preferred location for sighting the heron (Japang Pansa, pers. comm., 2024), but because of improved accessibility following construction of the Miao-Vijaynagar road and fewer sightings in the Firmbase area, bird enthusiasts now favour 65 Mile as a viewing location (Shashank Dalvi, pers. comm., 2024). Some local people have suggested the species has moved away from Firmbase to the higher reaches of the Noa-Dihing River in the eastern part of the Park, but there are only incidental observations of the heron in eastern Namdapha. We therefore cannot ascertain whether the bird has moved from the central and western reaches to the east or whether the population in central and western Namdapha has declined.

Our repeated surveys in Namdapha Tiger Reserve, a significant site for heron conservation, demonstrate declines in the white-bellied heron population. Patgiri et al. (2023) also failed to detect the heron around Firmbase, however, they reported a sighting at the confluence of Namdapha and Noa-Dihing. We do not know the reasons for the declines in the western and central parts of Namdapha; previous studies have suggested anthropogenic disturbances as a possible driver (Stanley Price & Goodman, 2015; Patgiri et al., 2023), but we noted a reduction in human activities in the protected area between our 2017 and 2023–2024 surveys. When comparing the number of 100 m river segments within a site with signs of fishing, we found evidence of fishing in 5.6% of segments in 2017 (Menzies et al., 2021) but in only 1.8% of segments during 2023–2024, despite nearly four times the survey effort. Similarly, we recorded human presence in 9.5% of segments in 2017 (Menzies et al., 2021) and 7.6% during 2023–2024. The surveyed riverine habitat inside the protected area has remained mostly unaltered, and human activity (except by villagers staying around Firmbase) along the river has probably declined following the recent road connectivity between Miao and Vijaynagar that enables direct transportation between the various settlements, reducing the need for people to walk and camp along the river. Annual rainfall in the Changlang District is 3,800–4,866 mm (Government of Arunachal Pradesh, 2024) and there have been no adverse weather events that could have significantly impacted the rivers in recent years (Japang Pansa, pers. comm., 2024). In February 2023, we observed a school of dead fish at Firmbase, probably killed by dynamiting, but in our surveys during November 2023–March 2024 we did not detect any evidence of destructive fishing methods inside Namdapha Tiger Reserve, although fishing continues inside the Reserve. Knowledge of temporal changes in fish abundance, a potentially important driver of white-bellied heron abundance, is poor; the abundance of fish species known to be eaten by the white-bellied heron (Khandu et al., 2021; Mondal & Maheswaran, 2021) needs to be compared between the eastern and western parts of the Reserve.

Our findings suggest there has been a decline in the number of white-bellied herons in central and western Namdapha, either because of local extirpations or the movement of birds to other areas (e.g. further east). There is a need for systematic surveys of the white-bellied heron in the eastern part of Namdapha. Moreover, systematic efforts to locate and monitor heron nests away from the core area of the Reserve are crucial to determine breeding success and potential influencing factors. As part of the river bird study during November 2023–March 2024, we also surveyed areas outside Namdapha and Kamlang Tiger Reserves (Menzies et al., unpubl. data), but we did not detect the species. Systematic surveys and long-term monitoring in more remote parts of Kamlang and the higher reaches of Anjaw District, in addition to monitoring the known individuals (Reddy et al., 2021), are critical to determine nesting sites in the region as this species appears to be on the verge of extinction. An improved understanding of the reasons for the species' decline would benefit the conservation management of the eastern population.

Author contributions Study design: all authors; fieldwork: RKM, RN; writing: all authors.

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Conflicts of interest None.

Ethical standards This research abided by the *Oryx* guidelines on ethical standards.

Data availability All data generated during the study are presented in the paper. The locations of white-bellied heron records can be requested from the corresponding author.

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