Tracking movements of Indian Spotted Eagles *Clanga hastata* in lowland Nepal using GPS transmitters

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INTRODUCTION

The Indian Spotted Eagle *Clanga hastata* is one of the least known raptors of the Indian Subcontinent. This species was previously treated as a subspecies of Lesser Spotted Eagle *C. pomarina*. Subsequently, a molecular study indicated it to be a distinct species of *Clanga* eagle (Parry et al. 2002). It is an endemic and scarce resident of the Indian subcontinent occurring in Nepal, India, Pakistan, Cambodia and Bangladesh. In Nepal, this species is the only breeding *Clanga* eagle, with a very small population size (30 to 70 individuals) and as such is of special conservation concern (Inskipp et al. 2016). A recent assessment in the IUCN Red Data Book lists this eagle as globally Vulnerable because of continued declines in population (BirdLife 2019). Almost no information exists about movements of Indian Spotted Eagles, knowledge of which is important to help identify threats and to propose conservation strategies. In this vein, we conducted a project to study movements of this species through the deployment of GPS transmitter tracking devices, which in turn would generate valuable further information regarding its ecology and main threats within Nepal, thus assisting in making informed decisions regarding future conservation.

METHODS

Study area: The study was conducted in the Farmlands of Lumbini IBA (27.5009ºN, 83.2788ºE), Rupandehi district, in the south-central lowlands of Nepal (Fig. 1). This area supports a mosaic of habitats, predominantly comprising farmland with remnant patches of trees, also patches of grassland/wasteland and some perennial sources of water (e.g. small rivers and ponds), this mix providing very good habitat for some raptor species, waterbirds and other farmland/open-country birds (Baral 2018). Summer months have hot 'tropical' weather (daytime temperature ranging between 27 to 40º C) and winter months are mild (temperatures ranging 9 to 27º C). Totals of 421 bird species (residents plus migrants), 69 species of herpetofauna and 39 species of mammal have been recorded (Baral 2018). In the original project proposal it was mentioned that the work was intended to be carried out in Dhanusha and Koshi. However, due to absence of any Indian Spotted Eagle (ISE) nesting territories in 2019 at these sites, the project activities focused on Farmlands of Lumbini IBA.

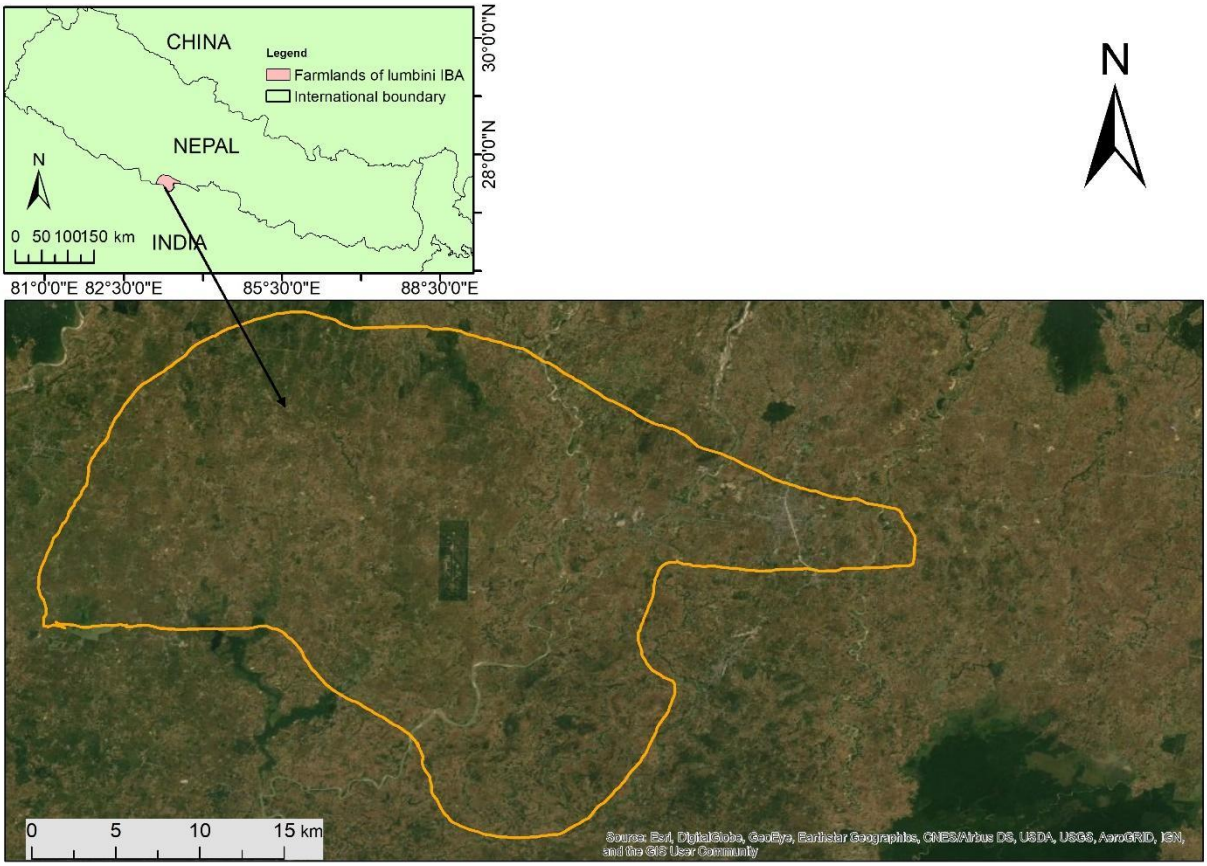

Figure 1. Location of study area, yellow line is the boundary of Farmlands of Lumbini IBA (Data: BirdLife International).

Capture, deployment of transmitters and monitoring: In 2018, one of our team members, Sandesh Gurung (Himalayan Nature), conducted a breeding study of ISE in the Farmlands of Lumbini IBA, and Dhanusha and Koshi Tappu Wildlife Reserve area, locating five active nests. These territories were then followed in 2019 with the intention of later, trapping these eagles and fitting transmitters. However, no nesting territories were observed in Dhanusha and Koshi, therefore we focused on the Lumbini IBA. From March 2019 to August 2019, we conducted three field trips to capture eagles and deploy transmitters. Tulsi Subedi, Sandesh Guring and Simon Thomsett of the Kenya Birds of Prey Trust (KBPT), undertook this fieldwork.

To capture adult ISEs we used a 'Bal-Chetri' cage (Plate 1) fitted with braided monofilament nooses/snares over the surface (Plate 1), and a live chicken or rat as a bait placed inside. On 17 and

18 May, we trapped two adult male ISEs from two breeding territories. Additionally, a newly fledged juvenile (Plate 2) was trapped on 25 August, using a harness with snares on a dead chicken bait that was placed over a branch near the nest. We fitted each (using a Teflon ribbon backpack harness with a leather 'weak-link', attached to the transmitter using aluminum crimps) with a 42 g WT-300 (Gull model) GPS-GSM transmitter with solar panel charger (Plate 3); these units were developed by the Korea Institute of Environment Ecology. They were programmed to take a GPS location once every 2 hours, plus, when a bird's flight speed is greater than 20 km/h and the battery charge is higher than 4 volts, the units record a location every 10 minutes. Data were programmed to download twice daily. After transmitter deployment and recording of morphometric data (Plate 4), birds were released unharmed. Subsequently we monitored their movement data via downloads onto computers, these were linked with 'Movebank' (an online database of animal tracking: www.movebank.org) to make a live feed.

Data analysis: We ran an adehabitatHR package in R to compute the home range of individual birds. Home ranges was estimated as minimum convex polygon (MCP) and kernel utilization density (KUD) in 50% (K50) and 95% (K95), where MCP represent the overall foraging area, K50 indicates core area and K95 indicates home range. For visualization of the space use, we processed home range isopleths in ArcGIS. To identify habitat use, we overlapped home range isopleths with the land use data developed by the International Centre for Integrated Mountain Development (ICIMOD) and different habitat types/land use types within the home range isopleths were computed using the spatial analyst tool in ArcGIS.

RESULTS and DISCUSSION

We tracked three birds (two adult males, which we named 'Buddha' and 'Rahul', and a newly fledged juvenile) for a total 341 bird days and received 7,166 GPS fixes (results summarised in Table 1). MCP area (see Fig. 2) of the two adults was 46.50 (Buddha) and 53.37 (Rahul) km^2, whilst that of the juvenile was much less (0.36 km^2). The adults home range sizes (K95) were 11.64 and 21.20 km^2 while their core areas were 3.06 and 4.43 km^2, respectively (Fig. 2; Table 2). On average, > 69% of the home ranges (K95) of the adults overlapped with the agriculture land. Additionally they used other areas including around settlements and a small proportion of wetland areas (Fig. 2, Table 3).

Table 1. Summary of Indian Spotted Eagles tracked with GPS units.

Bird	Age/sex	Start date	End date	No. of days tracked	Total fixes	Remarks
Buddha	adult male	5/18/2019	1/11/2020	238	4,664	unit still on & functioning
Rahul	adult male	5/17/2019	7/29/2019	73	2,126	dead (poisoned?); corpse & transmitter retrieved
unnamed	juvenile	8/25/2019	9/24/2019	30	376	dead (cause of death unknown); corpse & transmitter retrieved

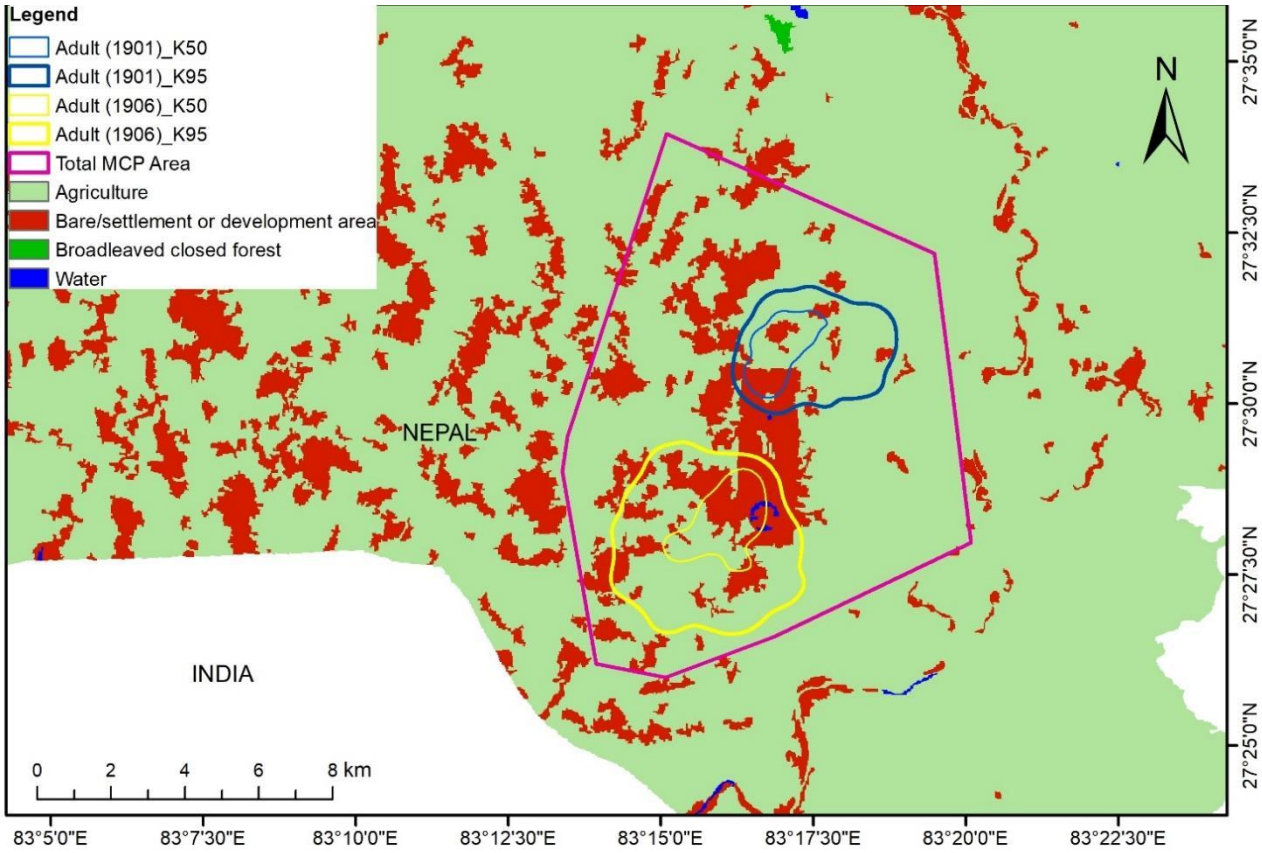

Figure 2. Geographical range and habitat use of the tracked adult (*n* = 2) Indian Spotted Eagles (Data source: ICIMOD 2010).

Table 2. Home range area of the three birds tracked with the GPS transmitters.

Bird	Transmitter used code	Age	K50	K75	K90	K95	MCP
Buddha	cemacs1901	adult	3.06	6.17	9.39	11.64	46.50
Rahul	cemacs1906	adult	4.43	9.82	16.34	21.20	53.37
Juvenile	cemacs1902	juvenile	0.01	0.02	0.03	0.04	0.36

Table 3. Habitat use of the tracked adult birds (*n* = 2) as a percentage of each habitat type.
Ag = Agriculture; B/S = Bare land/Settlement; W = Water.

Bird	Age	K50			K95		
		% Ag	%B/S	%W	% Ag	%B/S	%W
Buddha	adult	61.50	38.57	0.00	75.00	25.00	0.00
Rahul	adult	47.65	50.12	2.21	63.39	35.71	0.89

Our observation showed that the two adult ISEs had similar home range sizes to the closely related Lesser Spotted Eagle *C. pomarina* in Europe (Meyburg et al. 2004). Most of the home range areas were within a farmland landscape with scattered trees, which thus suggests that they are highly dependent on this open country habitat. Within cultivated areas of lowland Nepal, farmers tend to use large amounts of herbicides, insecticides and rodenticides (BCN & DNPWC 2011, Inskipp et al. 2016, pers. obs.; Plate 5) that impact numerous species of farmland-dependent fauna (both target and non-target species). ISE (being an apex predator) are probably often affected (i.e. as they accumulate toxins derived from their prey). Our field observations also revealed that several scattered settlements exist within the Farmlands of Lumbini IBA, with a network of several powerlines supplying electricity to these being another major threat to eagles and larger birds generally (i.e. collision and electrocution risk). In our recent period of work, we observed several carcasses of birds (including Himalayan Vulture *Gyps himalayensis* (Plate 7), Sarus Crane *Grus antigone* (Plate 8) and Black-winged Kite *Elanus caeruleus* etc.) under poles/pylons and transmission cables/lines, suggesting that such powerlines pose a serious problem for several species of birds.

Our research within the same area also identified some ISE prey items during their breeding season (overlaps with monsoonal rain in Nepal). It was found to consist of a high proportion (>70%) of

frogs, that are found readily over the paddy fields (Gurung et al. 2019). Anurans are a vertebrate group that are detrimentally highly impacted by organophosphate pesticides (Nataraj & Krishnamurthy, 2019). Consuming contaminated anurans may cause high mortality (through accumulation of toxins) of ISEs and other bird species that prey upon them; further research investigating this is required. Within the tracking period, we lost two (the juvenile and an adult) out of the three eagles tracked but recovered their corpses and GPS units. On 29 July 08:00 UTC (13:45 local time), the male ISE (see home range polygon in yellow, Fig. 2) was using a paddy field area to the southwest of its nest location. At 14:45 (local time) it was using its usual perch location inside the Lumbini Development Trust (LDT) area (a garden around the birth place of Lord Buddha, managed by the LDT), after that the bird was not recorded moving again. We found the carcass of this eagle under the roosting tree; based on the nature of the carcass (i.e. intact with no broken bones/feathers but decayed), we suspect it might have succumbed to secondary poisoning by eating prey items contaminated with pesticides. On 23 September, the GPS tracked juvenile took its first long flight from the natal area and visited farmland to the northwest of the nest location (Fig. 3). From 24 September there was a week-long fall of persistent rain and we suspect that the eagle might have been died during this period of adverse weather due to starvation, or perhaps was poisoned after feeding on prey contaminated with pesticides, but this is not clear.

Due to the rarity of ISEs, it will be very hard to get a sufficient sample size (for robust analyses) during a short period of study. Thus we require more time to conduct further work to increase the sample size in order to for example, estimate more accurately home range sizes of all age groups and sexes, and to gain further habitat use information. It is hoped that this will be achieved, in part, through future GPS tagging studies. However, the information obtained from this study represents the firsts pioneering attempts to understand the space use and identify potential threats (using GPS transmitter technology) facing this species in human dominated farmed landscapes of Nepal.

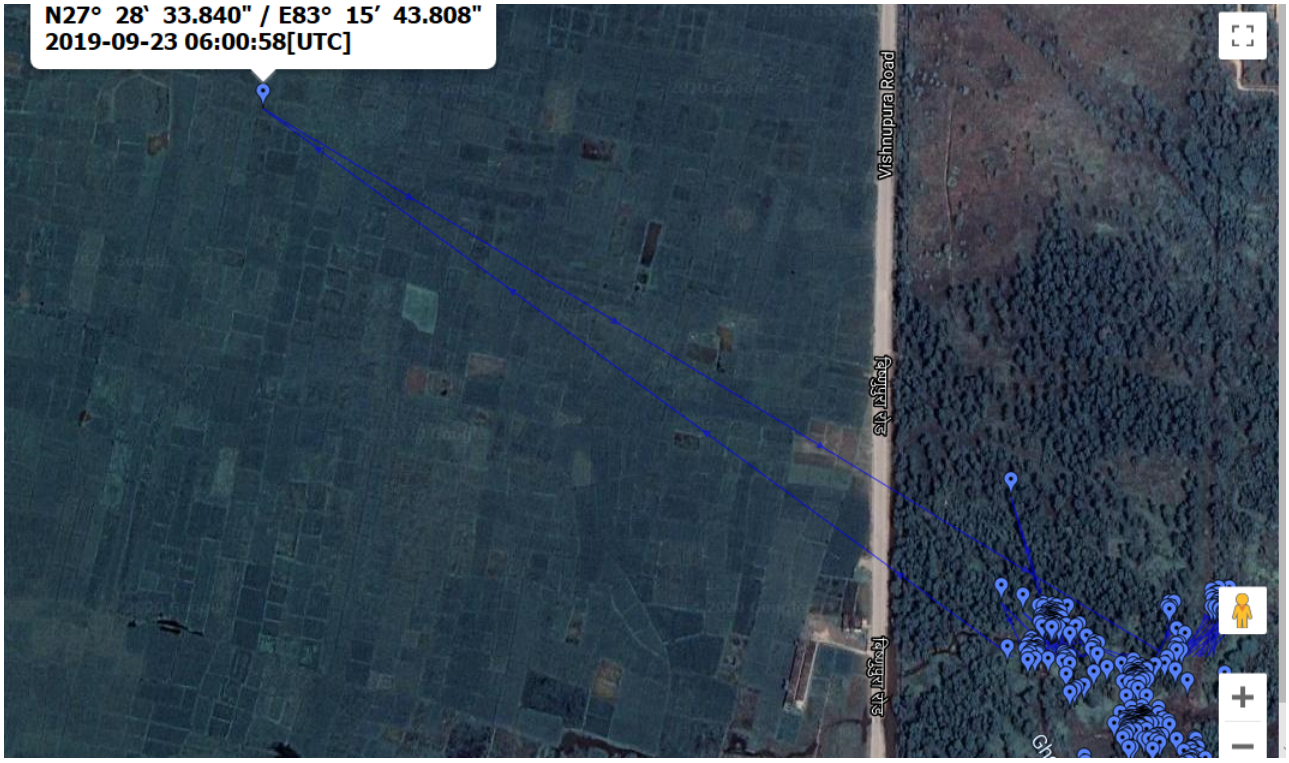

Figure 3. Figure showing the juvenile visiting farmland just before it died. The cluster of locations (lower right corner) show the natal area and a point location to the northwest indicates the end-point of its first long flight from the natal area.

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Appendix: Some photographs of the Indian Spotted Eagle project.

Plate 1. Bal-Chetri trap.

Plate 2. Fully grown juvenile ISE in nest.

Plate 3. Principal research (Tulsi) holding an adult male ISE.

Plate 4. Morphometric measurement of a captured ISE.

Plate 5. Adult male ISE after attachment of GPS transmitter.

Plate 5. Local farmer spreading pesticide in a rice paddy field within the Farmlands of Lumbini IBA.

Plate 6. Dead ISE with the GPS transmitter visible (22 August 2019).

Plate 7. Himalayan Vulture, dead after collision with a powerline in the Farmlands of Lumbini IBA.

Plate 8. A pair of dead Sarus Cranes due to collision with powerlines within the home range area of an ISE in the Farmlands of Lumbini IBA.