

been documented (K. S. G. Sundar *in litt.* 2006). The case I observed was probably facilitated by the destruction of the second clutch early in incubation, and the heavier than normal rains in September 2005 that gave the pair sufficient time to nest for a third time. In captivity, cranes can be induced to lay up to eleven clutches in a row by removing eggs from the nest (Ellis *et al.* 1996). Cranes have been documented to re-nest only if the eggs or nest are lost, but there have been no records of successful re-nesting once the eggs have hatched.

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## Greater Spotted Eagles *Aquila clanga* in central Thailand

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Greater Spotted Eagle *Aquila clanga* breeds from eastern Europe to China, and winters from Europe, central and east Africa, across the Middle East to Japan and south to Malaysia and Sumatra in Indonesia. It typically breeds in lowland forests near wetlands. On migration and in winter it occurs in a wide variety of lowland open habitats, particularly wetlands. The global population has been estimated at no more than 10,000 birds and is thought to be declining mainly as a result of habitat destruction, disturbance and hunting, so that the species is classified as Vulnerable (BirdLife International 2001, Meyburg *et al.* 2001). Within Thailand it is an annual winter visitor and passage migrant between October and April.

The wintering population in Thailand has been estimated at 10–100 birds, occurring primarily in the lower central plains (BirdLife International 2001), although the actual numbers observed in recent years prior to 2003 have been in single figures (e.g. Round and Jukmongkol 2001–2002). Since 2003, there has been a significant rise in numbers recorded in central Thailand as a result of fieldwork that has led to greater awareness of habitat preferences and roosting behaviour. I present here information on Greater Spotted Eagle in Thailand based mainly on observations I made in 2003–2004.

### METHODS

I made field observations of Greater Spotted Eagles in central Thailand during November 2003–March 2004,

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spending 26 days looking for the species in the lower and upper central plains and in the northern part of the peninsula (Fig. 1), covering the provinces of Phetchaburi, Chachoengsao, Prachinburi, Nakhon Sawan, Ayutthaya, Chainat, Lopburi, Saraburi and Prachuap Khiri Khan. A vehicle was used to cover large areas and locate potentially suitable sites, which were then searched using minor roads and tracks, with frequent stops to scan the sky, trees and ground. At the most-visited location (Khao Yoi), photographs of individuals helped to estimate the minimum number of birds using the site. Elsewhere, notes on plumage differences between individual birds also helped to estimate the minimum number of birds using a single site. When possible, individuals were aged using criteria in Forsman (1999). Notes were taken of any crops being grown at the time of each visit, including in areas not holding Greater Spotted Eagles. A one-day follow-up visit to Phanom Sarakham–Sri Mahosot was made in December 2005.

### RESULTS

During November 2003–March 2004, Greater Spotted Eagles were found at six sites (Table 1). There were 117 sightings, but the actual number of individuals was likely much lower than this figure.

#### Habitat preferences

Greater Spotted Eagles wintered in large expanses of rice fields, which they occupied from harvest time to the

beginning of the next cultivation phase. These areas had scattered trees and occasional small copses, minor irrigation canals, a few small human settlements confined to the edges of widely separated sealed roads, and dirt tracks to allow access by machinery for ploughing and harvesting. Almost all were cultivated under an irrigated one- or two-crop regime, which leaves stubbles for about three months in the dry season between December and March (with local variations in the timing of cultivation phases). All sites were within 10 km of areas of fishponds or other wetlands.

### Movements and seasonality

During November 2003–March 2004, the first Greater Spotted Eagles were seen on 8 November. At Khao Yoi, an influx at the end of November or early December, coincided with the rice harvest, as at least nine birds were seen on 6 December 2003, where none had been present on 21 November. Evidence of movements was provided by a sequence of counts around a roost site in Sri Mahosot. Here counts of 8–11 birds during visits between 8 February

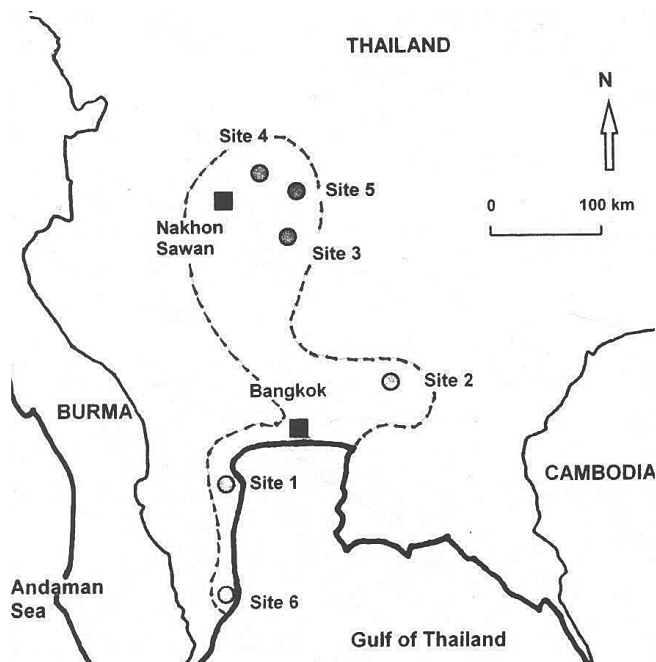
and 3 March declined to 2–4 birds on 13 and 17 March, and only one on 27 March, the final day of observations at this site. Two Greater Spotted Eagles remained at single sites for more than three weeks: at Khao Yoi, the same adult (identified by wing moult pattern) was observed on 7 and 31 January 2004, while near Sri Mahosot, a distinctive *fulvescens* form of Greater Spotted Eagle was seen on 8 and 18 February, and 3 March 2004.

### Roosting behaviour

At one site, Ban Thung Sawang, at least 11 birds gathered in an area of about 1 km<sup>2</sup>, roosting in trees growing along the edges of fallow rice fields within 3 km of a small village. Near Sri Mahosot, up to ten birds roosted close to (possibly among) Black Kites *Milvus migrans* in woodland among extensive cassava plantations c.4 km from the nearest suitable hunting areas. This site held 253 Black Kites on 17 March 2004 and 520 on 30 December 2005. At Khao Yoi, there was a more dispersed pattern, with the eagles typically roosting singly in isolated trees in fallow rice fields, not usually in close proximity (though two Greater Spotted Eagles were seen roosting together on one occasion, along with an Imperial Eagle *Aquila heliaca* or Steppe Eagle *A. nipalensis*).

### Age profile

Using criteria in Forsman (1999) c.36% of aged birds were thought to be adults or near-adults (fourth calendar year or older), 30–36% were immatures (>1 year old), and 28–34% were juveniles (some non-adult birds were too distant to distinguish between juvenile and immature). Two *fulvescens*-type birds were seen.



**Figure 1.** Map of central Thailand showing sites where Greater Spotted Eagles were found during November 2003–March 2004. Broken line shows boundary of survey area. Site numbers correspond to those in Table 1.

## DISCUSSION

My observations were made over an extended period of nearly five months, which overlapped both migration periods and therefore cannot be used to estimate accurately the number of Greater Spotted Eagles overwintering in central Thailand. However, I counted a total of 24 birds during a five-day period between 28 February 2004 and 3 March 2004 at five sites (rows 2–6 in Table 1). Based on the estimated total area of these sites, this would suggest a density of about 4.4 birds per 100 km<sup>2</sup>. My fieldwork and study of maps suggests that only a few areas still suitable for Greater Spotted Eagles in the lower central plains could have been missed. Subsequent to my observations, there have been numerous further records

**Table 1.** Counts of Greater Spotted Eagles in central Thailand, November 2003–March 2004. Site numbers correspond to those in Fig. 1.

Site (and province)	Coordinates	Number of day visits	Maximum count	Date of maximum count	Minimum number of individuals using site during period
1. Khao Yoi (Phetchaburi)	13°12'N 99°50'E	11	9	6 Dec 2003	14
2. Phanom Sarakham–Sri Mahosot (Chachoengsao and Prachinburi)	13°49'N 101°20'E	6	11	8 Feb 2004	12
3. Ban Thung Thale Sai (Nakhon Sawan)	15°08'N 100°23'E	1	3	1 Mar 2004	3
4. Ban Thung Sawang (Nakhon Sawan)	15°46'N 100°25'E	4	11	28 & 29 Feb 2004	12
5. Tha Tako (Nakhon Sawan)	15°38'N 100°28'E	2	3	21 Feb 2004	3
6. Khao Sam Roi Yot (Prachuap Khiri Khan)	12°09'N 99°53'E	1	1	2 Mar 2004	1
Total		25			45

of wintering Greater Spotted Eagles in central Thailand, which confirm the importance of sites 1, 2 and 4 in Table 1 (Round and Jukmongkol 2005, Round and Jukmongkol 2006a,b, C. Kaesorndorkbua *in litt.* 2006).

Other sites holding Greater Spotted Eagles may exist in the upper central plains (Northern region). The North-eastern region, where there are large areas of seasonally dry rice fields and a small number of major wetlands (Wolstencroft *et al.* 1993), may also hold some birds. There are a number of previous records from this region including two birds in Chaiyaphum province in February 2005 (BirdLife International 2001, Round and Jukmongkol 2005), but large tracts are probably too arid to provide suitable over-wintering habitat (personal observations). The Lake Songkhla basin, in the south of the country, and perhaps some low-lying parts of Eastern region might also hold some birds. There are no known regular over-wintering sites anywhere in Thailand not covered by my fieldwork (from recent reports in *Bird Conserv. Soc. Thai. Bull.* since 1998, plus BirdLife International 2001). Migrant Greater Spotted Eagles are regularly reported in very small numbers from the Chumphon raptor migration watch site in the Thai peninsula (e.g. DeCandido *et al.* 2004).

I obtained very limited information on prey. Rodents may well be important, given their abundance in rice fields. At fish ponds near Khao Yoi, five Greater Spotted Eagles were seen scavenging dead fish on a newly drained pond in January 2003 (Round and Jukmongkol 2003). I saw birds in the same area on several occasions in February and March 2003, sometimes flying up from inaccessible (to me) locations in the company of Black Kites, almost certainly having scavenged dead or dying fish from drained ponds. I observed attempted kleptoparasitism by Greater Spotted Eagles on three occasions, once on an Osprey *Pandion haliaetus* and twice on an Eastern Marsh Harrier *Circus spilonotus*. At most sites, flocks of several hundred flightless domestic ducks were present in stubble fields. Although these flocks were tended by farm workers and were never harassed by the eagles, some ducks became separated and were then vulnerable: a Greater Spotted Eagle was seen feeding on a domestic duck at one site. In March 2005, two Greater Spotted Eagles in Phetchaburi province fed on the carcasses of Lesser Whistling-ducks *Dendrocygna javanica* apparently killed by poison intended to destroy snails (Round and Jukmongkol 2005). I found no evidence of direct persecution of Greater Spotted Eagles (or other birds of prey) by people, although persecution of eagles has been noted in Thailand in the past (BirdLife International 2001).

In recent years, rapid changes in the pattern of dry season cropping of rice, together with creeping urbanisation, have dramatically reduced the areas of habitat suitable for Greater Spotted Eagles in the central plains. These changes in cultivation patterns involve planting of a third annual crop and/or earlier planting of dry season crops (Molle *et al.* 2001). There are very short fallow periods, which may temporarily attract some eagles. However, the uniform expanses of growing crops during much of the over-wintering period do not hold Greater Spotted Eagles, although birds may be present where there is a patchwork of growing crops, stubbles and fishponds or other wetlands. The main short to medium-term threats to Greater Spotted Eagles in central Thailand are probably further expansion in these cropping patterns

and urbanisation. For example, in December 2005, there were large expanses of irrigated young rice growing in the Phanom Sarakham–Sri Mahosot area (site 2 in Table 1) where there had been only dry stubbles in early 2004.

Rodenticides and other poisons may be a cause of mortality in Greater Spotted Eagles and other birds of prey in Thailand. Although this survey did not attempt to assess the extent of use of rodenticides, these are used and are known to have poisoned birds of prey in oil palm plantations in Thailand (Anon. 1998). In Malaysia, *Aquila* spp. eagles have been observed feeding on poisoned rats (Wells 1999). In Shanxi province, China, studies of Greater Spotted Eagles over-wintering in Shanxi Lishan National Nature Reserve during 1991–1995 found that predation on poisoned Common Pheasants *Phasianus colchicus* was a major cause of mortality (Qingxia 1996).

Although the species is nominally protected under Thai law, there are no significant numbers of Greater Spotted Eagles in any existing national park or wildlife sanctuary. No extensive wetland or other suitable lowland area is fully protected as a nature reserve, and therefore the outlook is not good if the present trend towards increased dry-season cropping continues. Other birds of prey may also be affected, including the Vulnerable Imperial Eagle, nine of which were seen during my fieldwork.

Future studies of Greater Spotted Eagles in Thailand should aim to locate roosting sites to reduce the risk of underestimating the numbers of over-wintering birds. Pellet analysis would provide useful information on prey species.

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## Infanticide-cannibalism in the Oriental Pied Hornbill *Anthracoceros albirostris*

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We report here infanticide followed by cannibalism in Oriental Pied Hornbill *Anthracoceros albirostris*, which to our knowledge has not been previously been reported in hornbills.

In December 2005–January 2006, video cameras were placed in four Oriental Pied Hornbill nest cavities (before they were occupied), in the forests of Pulau Ubin, an island off Singapore, as part of the Singapore Hornbill Project. Pulau Ubin (1°24'N 103°58'E) lies in the Straits of Johor, north-east of the main island of Singapore; it is 8 km in length and 1.3–1.7 km in breadth and has an area of 10.2 km<sup>2</sup>. The habitat is mainly mixed secondary forest with old fruit plantations, primarily durian *Durio zibethinus*. The nest trees were 0.6–2.7 km apart, at an altitude of 1–5 m. The cavity openings were 7–12.1 m above the ground.

### METHODS

Three CCTV cameras with infra-red capabilities were positioned at each nest: one inside the nest cavity, one at the nest entrance and one 5–10 m away. A DVD recorder, portable 12V 120AH batteries, inverter and monitor powered by 12V 80AH batteries were connected to the cameras. Images from all cameras were recorded 24 hours daily by a digital video recorder running the Telexper programme (Telexper International Inc, California, U.S.A.). Data were transferred fortnightly to external hard disks for storage. Data were reviewed and analysed daily, with the timing of events noted directly from the recordings.

Dimensions (e.g. egg size and beak length) were obtained by measuring the images and multiplying by the relevant magnification factor. Magnification factors were derived from an image of a reference object (a ruler placed inside the nest cavity). Parallax effects were minimised by taking the measurements at the bottom of the nest.

### OBSERVATIONS

Three of the nests were subsequently occupied by females. The female in the first nest first entered the nest cavity on

27 December 2005, and she was sealed in by both her mate and herself on 4 January 2006. She laid four eggs, with the first on 10 January and the others at 3–4 day intervals. The nestlings hatched on 6–16 February, 28–29 days after the eggs were laid. The male brought food to the nest up to 31 times a day during the nesting period. During the 15 days from the hatching of the first chick to the death of the fourth chick, the items brought by the male comprised 50% fruits, 40% insects and 10% lizards. The duration of visits by the male ranged from 30 seconds to three minutes, depending on the size and amount of food.

All the chicks positioned themselves just under the opening through which the male brought the food, which was distributed whole by the female to the chicks. Visual estimations of the food intake by the individual chicks over these 15 days indicated that the food mass received by each of the eldest three chicks was similar. During individual feeding visits, chicks that were satiated did not fight for food as much as the hungrier chicks, and the female appeared to distribute food to the chicks that begged most vigorously.

The fourth (youngest) chick appeared to receive much less food than the other three chicks (Fig. 1a) and it looked much smaller and weaker. Whereas the mean feeding frequency of the three larger chicks during their first four days was 17.4 times a day, the fourth chick received just eight feeds on its second day after hatching and three on its fourth day. The three older chicks grew steadily and at similar rates (Fig. 1b), but the fourth appeared to stop growing after its second day.

On the fourth day after hatching, the fourth chick ceased giving begging calls (although it continued gaping). At 15h59, the female picked up the fourth chick and killed it by repeatedly crushing it with her beak. Then she tried to feed it to the remaining chicks. All three chicks attempted to swallow it, and after 30 minutes the second oldest chick succeeded (Plate 1).

We recorded the disappearance of a fourth-hatched chick in another nest, but unfortunately the battery failed at the critical time and we were unable to obtain a video recording. In this nest the female sealed herself into the nest on 5 February 2006. The first egg was laid on 12