

# Abundance and timing of migratory raptors passing through Khao Dinsor, southern Thailand, in autumn 2015–2016

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Khao Dinsor, Chumphon Province, on the Thai-Malay Peninsula, is a globally important monitoring site for southbound migratory raptors using the East Asian Continental Flyway. We report the progress of our observations, in which 35 species of resident and migratory raptors were recorded during successive autumns in 2010–2016. During two years of systematised coverage, totals of 397,285 individuals of at least 24 migratory raptor species were counted during late August to mid November 2015 and 791,229 individuals of 22 species in 2016. The first records of Bonelli's Eagle *Aquila fasciata* and Rufous-winged Buzzard *Butastur liventer* for the Thai-Malay Peninsula and previously unreported significant migratory passages of Jerdon's Baza *Aviceda jerdoni*, Crested Serpent Eagle *Spilornis cheela*, Shikra *Accipiter badius* and Besra *A. virgatus* are documented.

## INTRODUCTION

Raptor migration has long been a subject of study worldwide. Because diurnal raptors rely much on thermal soaring and gliding above landmasses, bottlenecks such as narrow land bridges or straits where they are concentrated during migration attract study (Steinfatt 1932, Nisbet & Smout 1957, Collman & Croxall 1967, Porter & Willis 1968, Safriel 1968, Kerlinger 1989, Kasperek 1997, Verhelst *et al.* 2011, Zalles & Bildstein 2000, Bildstein 2006, Newton 2008).

Within the East Asian Flyway, extensive monitoring of migrating raptors has been undertaken in Japan since 1974 (Irago Migration Count Club 2000, Sinsyu Raptors Migration Research Group 2000, Takeda 1989) and in Taiwan since the 1980s (Liu 1991). Different raptor populations utilise both continental/coastal and trans-oceanic routes from breeding grounds to South-East Asian wintering grounds (Bildstein 2006, Germe *et al.* 2009). The East Asian Continental Flyway describes the inland route from north-east Asia to the Indochinese peninsula, the Thai-Malay Peninsula, Sumatra, Borneo and the Lesser Sundas. The East Asian Oceanic Flyway extends from north-eastern Siberia via the Kuril Islands and Sakhalin Island, the Korean peninsula and Japan to Taiwan, Philippines and eastern Indonesia (Bildstein 2006, Newton 2008). The respective flyways were earlier referred to as the 'Coastal Pacific Corridor' and 'Oceanic Pacific Corridor' by Zalles & Bildstein (2000).

The importance of the Thai-Malay Peninsula has been long recognised (Melville & Fletcher 1982, Lekagul *et al.* 1985, Bijlsma 1996, Zalles & Bildstein 2000). The peninsular landmass is narrowest near the Isthmus of Kra, c. 10.500°N, connecting continental Thailand and adjacent south Tanintharyi Province, Myanmar, to the Thai-Malay Peninsula (Figure 1). The peninsular mountain spine here divides the narrower, more mountainous Thai provinces of Ranong, in the west, from the broader (now largely deforested) coastal plain of Chumphon province in the east. The most

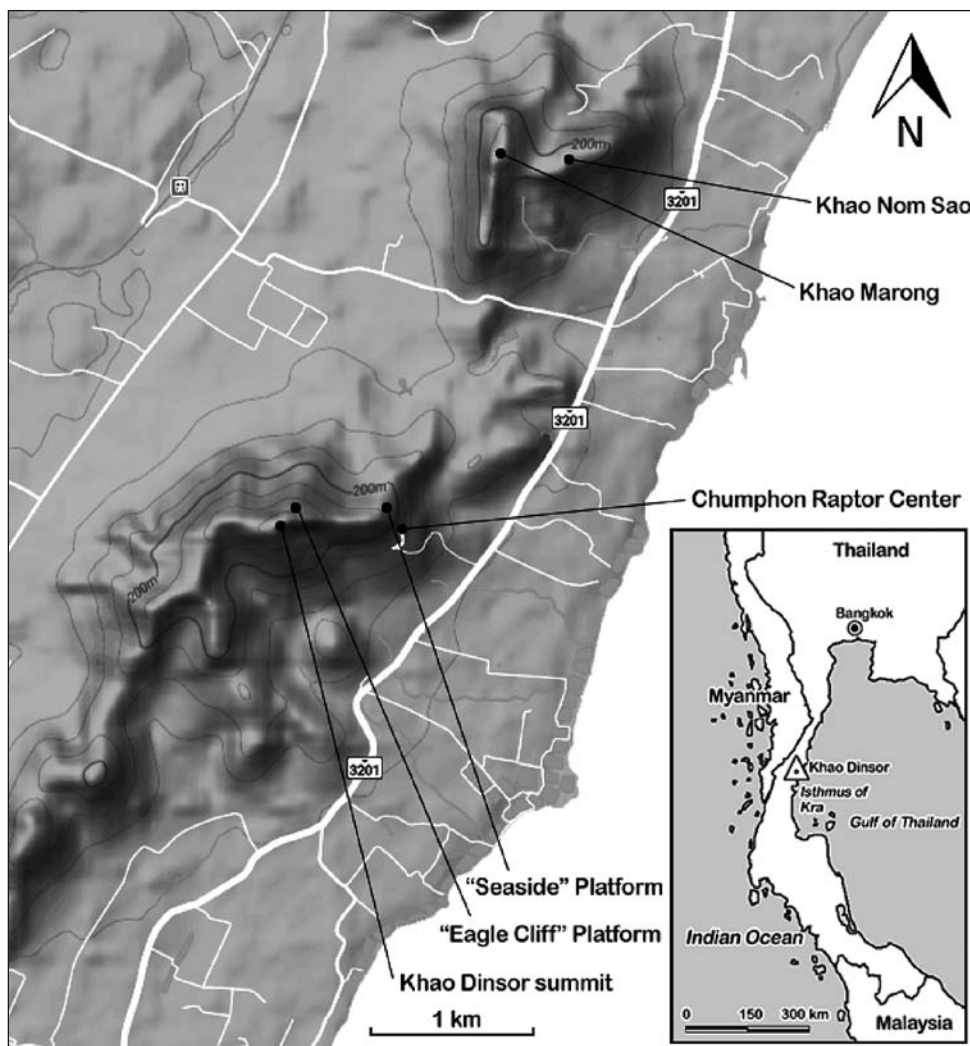


Figure 1. Location of Khao Dinsor, Chumphon province, Thailand.

recent (post-2000) observations of the migration of raptors and other diurnal migrants were initiated by CN in Chumphon, and by other observers in Prachuap Khiri Khan province further north (DeCandido *et al.* 2004a, 2004b, 2008, Lorsunyaluck *et al.* 2008).

Khao Dinsor<sup>1</sup>, Pathiu district, 20 km north of Chumphon provincial town, was identified in September 2008 as an ideal site for monitoring diurnal migration in autumn (Nualsri & DeCandido 2010). Viewing platforms and shelters were subsequently constructed with the cooperation of local bodies in order to facilitate systematic bird counts and promote eco-tourism, and in 2012 the Chumphon Raptor Centre was constructed. Khao Dinsor was recently featured among the best birdwatching sites in South-East Asia (Yong & Low 2016).

The objective of this paper is to examine the abundance and timing of the migration of diurnal raptors at Khao Dinsor during two successive autumns, 2015–2016, and document the patterns of occurrence of all species with reference to earlier, less systematised, counts during 2010–2014.

## STUDY SITE AND METHODS

Khao Dinsor (alternative spelling, 1:50,000 Royal Thai Survey Department Maps, Khao Dinso), 10.63°N 99.28°E, rising to c. 356 m above sea level and lying 1.5 km inland, is the tallest hill within a radius of approximately 5 km. Lower hills (> 200 m) located < 2 km north, Khao Marong and Khao Nom Sao (Figure 1), provide a source of thermals that funnel southbound raptors and other diurnal migrants towards Khao Dinsor. The Chumphon Raptor Centre, situated at 140 m elevation on the eastern flank of the mountain, is accessible by a blacktop road. From here a concrete path leads upslope to raptor watch sites which lie along an east–west ridge between 220 m and 300 m.

Counts of diurnal migrants passing through the site have been conducted since 2010 but coverage in the first few years was not consistent, with frequently only one or two observers present, and only fully systematised in 2015–2016 under the auspices of the newly established Flyway Foundation.

During 2015–2016, counts were made concurrently from two observation platforms, located c. 100 m different in elevation and c. 500 m distant, rigorously for 10 hours per day, from 07h00–17h00 during 1 September–15 November. The two stations combined to offer clear views of both the coastline towards the north-east and east, and the hills to the north and north-west. Birds migrating over the sea were best counted from the ‘Seaside’ platform. Birds utilising further inland routes, judged not visible from ‘Seaside’, were counted from ‘Eagle Cliff’. Counters at each station only recorded birds flying closer to their respective station, remaining in constant contact through use of CB radios so as to avoid double-counting. At least two and occasionally up to seven counters were present per station at any one time, with one of two experienced count coordinators (WL or AJ) present throughout on every day of the count in both years. All migratory bird species (diurnal raptors and non-raptors) were identified and recorded, using DSLR cameras and long lenses (200–600 mm) to record those whose identification required further study.

Presumed resident raptors seen at the site (Black-winged Kite *Elanus caeruleus*, Changeable Hawk-eagle *Nisaetus limnaetus*, Mountain Hawk-eagle *N. nipalensis*, Blyth’s Hawk-eagle *N. alboniger*, Rufous-bellied Eagle *Lophotriorchis kienerii*, Black Eagle *Ictinaetus*

*malaiensis*, Crested Goshawk *Accipiter trivirgatus*, Brahminy Kite *Haliastur indus*, White-bellied Sea-eagle *Haliaeetus leucogaster* and Oriental Hobby *Falco severus*) were omitted from results.

Weather conditions (wind direction, wind speed, barometric pressure, cloud cover and temperature) were measured *in situ* and recorded hourly at both stations. The impact of weather conditions on migration is discussed in a companion paper (Dumandan *et al.*, in prep.).

Supplementary data on abundance and timing from 2010–2012 were retrieved from annual reports (Nualsri *et al.* 2010, Pajunen *et al.* 2012, Siponen *et al.* 2013). Data from 2013 are lacking. For the most frequently recorded species we give peak numbers, extreme passage dates and median dates. The latter were calculated based on the cessation of counting on 15 November. It is recognised, however, that in a few species migration likely continued beyond this date.

## RESULTS

At least 25 species of migratory raptors were recorded at Khao Dinsor during 2010–2016. In five of the six years since observations commenced in 2010, annual totals exceeded 200,000 raptors. During two years of systematised coverage, totals of 397,285 individuals of at least 24 migratory raptor species were counted in 2015, compared with 791,229 individuals of 22 species in 2016 (Table 1, Figure 2). Species accounts follow.

### Western Osprey *Pandion haliaetus*

Annual passage from 25 September onwards, with counts of 76 and 81 individuals in 2015 and 2016 respectively. Migrates solitarily. Peak daily count was six individuals in both 2015 (7 October) and 2016 (10 October), well before the median passage dates (21 and 19 October; Table 2). Small numbers (1–10 individuals) also winter in the immediate area. It is a widespread visitor to waterbodies and coastal areas throughout the country. Oversummering birds (presumed subadults) are also regular.

### Oriental Honey-buzzard *Pernis ptilorhynchus*

Consistently the third most numerous raptor, with the 2016 total of 136,683 more than twice that recorded in 2015. Median passage dates and peak daily counts consistently occurred during the first week of October. Usually gregarious, in loose flocks of a few to several hundred birds. Adult males predominated early in the season, followed later by adult females, with juveniles predominating from around 21 October onwards. A few definite *P. p. torquatus*, the distinctive race resident in south-west Thailand and the Thai-Malay Peninsula (henceforth TMP), were recognised apparently moving south alongside long-distance migrant *orientalis* in some years. The occurrence of *ruficollis* of the Himalaya and continental South-East Asia has not been confirmed in TMP (Wells & Medway 1976, Wells 1999), but would likely be overlooked given its morphological similarity to *orientalis*.

### Jerdon’s Baza *Aviceda jerdoni*

Recorded annually since 2010, with a well-defined passage taking place from 10 October onwards to at least mid-November (average eight individuals per day for both 2015 and 2016: the largest single day count was 54 on 25 October 2016). The numbers recorded during the 2015 and 2016 seasons were remarkably similar, 286 and 288 respectively, though the median passage date in 2015 (27 October) was one week earlier (Table 1). It is a comparatively slow flyer, migrating either solitarily or in a loose group (one, exceptionally, numbering c. 20 individuals), and heavily reliant on thermal-soaring. Although assumed to be largely resident, Lekagul & Round (1991) recognised that passage migrants or winter visitors appeared within its Thai range.

<sup>1</sup> The name ‘Pencil Hill’, a direct translation of the Thai word *dinsor* (pencil) as given by Nualsri & DeCandido (2010) and oft-quoted subsequently, is mistaken. ‘Dinsor’ in Khao Dinsor is, in fact, derived from *dinsor pong*, which refers to the ‘white clay filler’ that local people collected there in the past.

**Table 1.** Totals of migratory raptor species in annual autumn counts at Khao Dinsor, Thailand.

Species	2016	2015	2014	2012	2011	2010
	31 August– 15 November (77 days)	29 August– 15 November (79 days)	1 September– 31 October (59 days)	15 August– 9 November (89 days)	24 August– 5 November (74 days)	6 September– 5 November (56 days)
Western Osprey <i>Pandion haliaetus</i>	81	76	47	51	50	57
Oriental Honey-buzzard <i>Pernis ptilorhynchus</i>	136,683	65,899	42,358	33,835	15,541	32,870
Jerdon's Baza <i>Aviceda jerdoni</i>	288	286	111	192	78	20
Black Baza <i>Aviceda leuphotes</i>	177,169	100,500	154,716	119,324	39,113	74,033
Crested Serpent-eagle <i>Spilornis cheela</i>	890	357	286	393	127	126
Short-toed Snake-eagle <i>Circaetus gallicus</i>	1	8	—	3	1	<10
Greater Spotted Eagle <i>Clanga clanga</i>	12	16	11	20	20	21
Steppe Eagle <i>Aquila nipalensis</i>	—	2	—	—	—	—
Bonelli's Eagle <i>Aquila fasciata</i>	—	—	2	1	—	—
Booted Eagle <i>Hieraetus pennatus</i>	97	121	129	74	70	71
Eastern Marsh Harrier <i>Circus spilonotus</i>	197	155	119	107	171	173
Pied Harrier <i>Circus melanoleucos</i>	31	53	18	39	53	65
Shikra <i>Accipiter badius</i>	13,768	10,962	2,179	6,086	1,970	2,772
Chinese Sparrowhawk <i>Accipiter soloensis</i>	410,721	170,925	61,845	83,168	93,406	83,308
Japanese Sparrowhawk <i>Accipiter gularis</i>	28,254	17,855	10,405	11,907	12,047	5,452
Besra <i>Accipiter virgatus</i>	123	50	9	9	3	uncertain (<15)
Eurasian Sparrowhawk <i>Accipiter nisus</i>	14	13	7	3	—	<10
Black Kite <i>Milvus migrans</i>	266	185	154	172	173	168
Rufous-winged Buzzard <i>Butastur liventer</i>	2	40	2	9	4	1
Grey-faced Buzzard <i>Butastur indicus</i>	20,773	24,007	12,016	10,159	5,589	14,434
<i>Circus</i> spp.	8	—	N/A	N/A	N/A	N/A
<i>Accipiter</i> spp.	1,343	5,645	2,845	N/A	N/A	N/A
<i>Buteo</i> spp.	54	46	24	36	47	83
Eurasian Kestrel <i>Falco tinnunculus</i>	26	24	6	26	11	12
Amur Falcon <i>Falco amurensis</i>	—	6	—	4	4	1
Eurasian Hobby <i>Falco subbuteo</i>	7	5	1	3	4	7
Peregrine Falcon <i>Falco peregrinus</i>	32	43	36	30	42	30
other unidentified raptor	389	6	60	4,193	N/A	N/A
<b>Total</b>	<b>791,229</b>	<b>397,285</b>	<b>287,386</b>	<b>269,844</b>	<b>168,524</b>	<b>213,704</b>

Small numbers (1–7 birds) were recorded per year in Singapore during 2002–2011, although the first record was in 1996 (Chia 2011). Some may cross the sea to winter in Sumatra or elsewhere in the Sundas (Ferguson-Lees & Christie 2001, Tan 2016), although there are no records from Tanjung Tuan, Malaysia (Chia 2011; C. A. Yeap pers. comm.), where sea-crossings to and from Sumatra by many species take place.

### Black Baza *Aviceda leuphotes*

The migration of Black Bazas, usually the second most abundant hawk, is arguably the most spectacular, and synchronised around the last week of October, when 68% (2016) to 78% (2015) of all sightings were recorded. Additionally, Black Bazas usually migrate in tight flocks of up to 2,000 individuals, adding to the spectacle. Depending on conditions, they either utilise flapping flight or soar on thermals.

The 2016 count (177,169 individuals) represented an increase of 76% over the number recorded during the preceding year. Median dates and peak daily counts fell within the three days 23 to 25 October in both years. The largest day's count was 68,848 on 24 October 2016. The only record outside the typical passage period was a single highly worn individual flying south on 19 September 2016.

Migrants were thought to be of the Chinese breeding populations *A. l. syama* or *A. l. wolfei* rather than Himalayan to Indochinese resident breeders *A. l. leuphotes* (although Rasmussen & Anderton (2012) have questioned the validity of these races). Wintering flocks and individuals are recorded regularly in central and peninsular Thailand (Lekagul & Round 1991) and in Malaysia (Wells 1999).

### Crested Serpent-eagle *Spilornis cheela*

A well-defined passage of Crested Serpent-eagles has been evident since the earliest watching at Khao Dinsor, with increasing numbers recorded as coverage has improved. The 890 counted in 2016 was more than double that in the previous year, nearly half of them passing on a single day (17 October), coinciding with the median passage date. Migrates mainly solitarily, but sporadically in small loose flocks or with Oriental Honey-buzzards. Glides for a long distance without flapping. Potentially, South-East Asian and Chinese breeding races, respectively *burmanicus* and *ricketti*, could both occur on migration: their morphological differences are not fully clarified. With its larger range and more northerly distribution, *ricketti* should be the more numerous. However, the nominate race *S. c. cheela*, breeding in the northern Indian Subcontinent, is the

only subspecies explicitly described as migrating south in winter (Clark *et al.* 2016). Resident *S. c. malayanus* occurs in the vicinity and may account for a single individual observed flying north on 6 September 2016—long before the arrival of the first genuine migrants in October (Table 2). Crested Serpent-eagles in non-adult plumage predominated among observed birds.

### Short-toed Snake-eagle *Circaetus gallicus*

A scarce migrant, one to eight recorded per year, from 21 October onwards in five of the past six years (Table 1). The Short-toed Snake-eagle is a widespread, albeit scarce, winter visitor to lowlands in continental Thailand (Kasorndorkbua *et al.* 2008, Lekagul & Round 1991) and to peninsular Malaysia and Singapore (Wells 1999).

### Greater Spotted Eagle *Clanga clanga*

Small numbers (11–21 per year) recorded in all years during the second week of October onwards into early November, with median dates 25 October 2015 and 23 October 2016. Largest single day count four. Most were aged as first-winters. It is the only species showing an apparent decline throughout the observation period despite increased coverage (Table 1), with 20–21 in the first three years and 11–16 in the last three years. This globally threatened raptor is a regular winter visitor to lowland open areas, especially paddy basins, in the vicinity of wetlands throughout Thailand and in peninsular Malaysia (BirdLife International 2017).

### Steppe Eagle *Aquila nipalensis*

Very scarce; only three identified (two in 2015 and one in 2013, all first-winters). The earliest record was 23 October 2015. Although its large size makes it unlikely to be overlooked, there are fewer records during passage at Khao Dinsor than from wintering grounds in TMP, where it is local and sparse to uncommon, records spanning November to March (Wells 1999). It may be a very late migrant, most occurring later than our observation period. Bijlsma's (1996) three from Satun Province and one from Phuket were on migration during late November. These, and a first-winter bird photographed at Bedong, Kedah, Malaysia, on 30 October 2016 by Tan Choo Eng (D. Bakewell pers. comm.), may suggest that Steppe Eagles use a more westerly route, bypassing Khao Dinsor. Steppe Eagle was uplisted from Least Concern to globally Endangered in 2015 (BirdLife International 2016a).

### Bonelli's Eagle *Aquila fasciata*

Vagrant. Two juveniles; one in 2012 (4 November) and one in 2014 (17 and 19 October) are the only records for TMP (Sa-ar *et al.* 2018). Comparison of photographs suggests that both 2014 sightings were probably the same individual. The few Thai records are otherwise chiefly from the north (Round 1983, Lekagul & Round 1991, Treesucon & Limparungpatthanakij 2018).

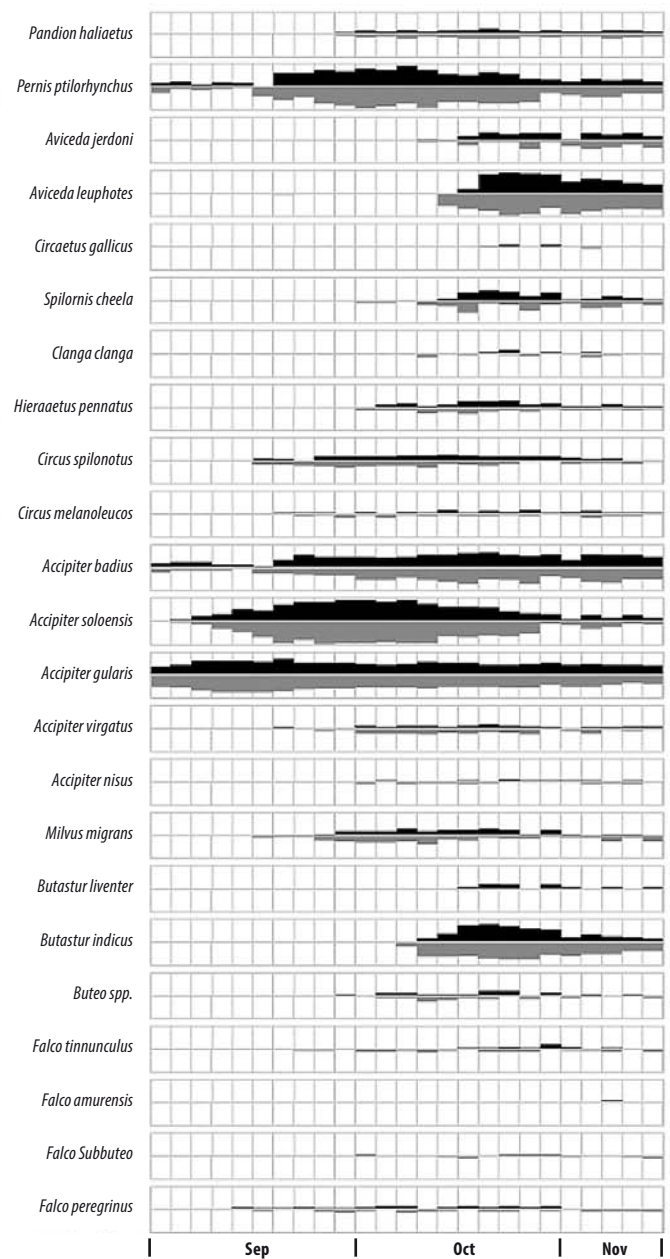
### Booted Eagle *Hieraaetus pennatus*

Recorded annually since 2010, with 70–129 individuals per year. In contrast to most other raptors, the 2015 count (121) was higher than the 2016 total of 97. Median dates and highest daily counts occurred shortly after mid-October, with the earliest recorded on 1 October and some likely still passing after the cessation of coverage. Small numbers may winter in the area and widely in open country elsewhere throughout Thailand. Migrates solitarily, but often travels with flocks of Oriental Honey-buzzard. In contrast to the European part of its range (Ferguson-Lees & Christie 2001), pale morph individuals were greatly outnumbered by dark birds (six compared with 115 in 2015).

### Eastern Marsh Harrier *Circus spilonotus*

Counts per year of 107 to 197 individuals. Not all harriers were identified and Eastern Marsh Harrier may possibly be slightly

**Figure 2.** Totals of migratory raptors counted at Khao Dinsor in autumn 2015 & 2016 by three-day intervals. Black and grey bars represent 2015 and 2016 data respectively. The block height is equivalent to 100,000 individuals.



under-recorded due to confusion with the less common Pied Harrier *C. melanoleucos*. Usually keeps low, occurring either solitarily or in small, loose flocks. Passage occurred from mid-September onwards, with some still passing irregularly beyond mid-November. Median dates and highest daily counts varied from year to year and were later in 2015 (14 October and 12 October, 11 birds) than 2016 (3 October and 13 birds on 28 September).

### Pied Harrier *Circus melanoleucos*

Pied Harriers were outnumbered roughly 3:1 by Eastern Marsh Harriers. It is a slightly later migrant on average than Eastern Marsh Harrier (median occurrence dates 19 October and 18 October in 2015 and 2016 respectively). The highest daily total was three birds (4 October 2016).

### Shikra *Accipiter badius*

Consistently the sixth most numerous raptor at the site, with

**Table 2.** Peak daily counts and passage periods of migratory raptor species at Khao Dinsor in autumn 2015 and 2016. Note that both years' counts terminated on 15 November.

Species	Passage period (2016)	Median date	Peak daily count (date)	Passage period (2015)	Median date	Peak daily count (date)
Western Osprey <i>Pandion haliaetus</i>	25 September–14 November	19 October	6 (10 October)	28 September–15 November	21 October	6 (7 October)
Oriental Honey-buzzard <i>Pernis ptilorhynchus</i>	31 August–15 November	4 October	27,439 (10 October)	29 August–15 November	8 October	15,943 (8 October)
Jerdon's Baza <i>Aviceda jerdoni</i>	12 October–15 November	4 November	54 (25 October)	11 October–15 November	27 October	45 (21 October)
Black Baza <i>Aviceda leuphotes</i>	19 September, 15 October–15 November	25 October	68,848 (24 October)	17 October–15 November	24 October	17,669 (23 October)
Crested Serpent-eagle <i>Spilornis cheela</i>	1 October–15 November	17 October	402 (17 October)	15 October–14 November	21 October	51 (20 October)
Short-toed Snake-eagle <i>Circaetus gallicus</i>	6 November	—	1	21 October–5 November	28 October	2 (22, 28 October)
Greater Spotted Eagle <i>Clanga clanga</i>	11 October–7 November	25 October	2 (11, 12 October)	20 October–7 November	23 October	4 (22, 23 October)
Steppe Eagle <i>Aquila nipalensis</i>	—	—	—	23 October, 7 November	—	1
Booted Eagle <i>Hieraetus pennatus</i>	1 October–14 November	17 October	10 (16, 18 October)	5 October–13 November	22 October	18 (22 October)
Eastern Marsh Harrier <i>Circus spilonotus</i>	17 September–15 November	3 October	13 (28 September)	16 September–9 November	14 October	11 (12 October)
Pied Harrier <i>Circus melanoleucos</i>	22 September–12 November	18 October	3 (4 October)	19 September–14 November	19 October	7 (15 October)
Shikra <i>Accipiter badius</i>	1 September–15 November	25 October	2,385 (25 October)	30 August–15 November	20 October	838 (19 October)
Chinese Sparrowhawk <i>Accipiter soloensis</i>	6 September–15 November	30 September	45,800 (25 September)	6 September–15 November	2 October	18,279 (8 October)
Japanese Sparrowhawk <i>Accipiter gularis</i>	31 August–15 November	17 September	2,927 (12 September)	29 August–15 November	20 September	1,936 (20 September)
Besra <i>Accipiter virgatus</i>	26 September–15 November	14 October	10 (11 October)	19 September–15 November	19 October	5 (12, 21 October)
Eurasian Sparrowhawk <i>Accipiter nisus</i>	1 October–14 November	18 October	2 (multiple dates)	5 October–11 November	25 October	2 (multiple dates)
Black Kite <i>Milvus migrans</i>	16 September–15 November	10 October	29 (11 October)	25 September–11 November	18 October	19 (21 October)
Rufous-winged Buzzard <i>Butastur liventer</i>	17 October–8 November	—	1	18 October–15 November	23 October	10 (23 October)
Grey-faced Buzzard <i>Butastur indicus</i>	8 October–15 November	23 October	3,167 (24 October)	10 October–15 November	20 October	5,488 (20 October)
<i>Buteo</i> spp.	4 October–15 November	12 October	12 (12 October)	30 September–12 November	21 October	11 (21 October)
Eurasian Kestrel <i>Falco tinnunculus</i>	23 September–15 November	19 October	2 (multiple dates)	16 October–8 November	30 October	6 (31 October)
Amur Falcon <i>Falco amurensis</i>	—	—	—	25 October–8 November	7 November	2 (7 November)
Eurasian Hobby <i>Falco subbuteo</i>	15 October–15 November	2 November	2 (15 November)	1–31 October	25 October	1
Peregrine Falcon <i>Falco peregrinus</i>	16 September–14 November	12 October	2 (multiple dates)	14 September–1 November	7 October	5 (6, 7 October)
<b>Combined</b>		<b>6 October</b>	<b>77,073 (24 October)</b>		<b>8 October</b>	<b>34,433 (8 October)</b>

totals exceeding 10,000 individuals in both 2015 and 2016 (Table 1). Although a few were already passing in early September, the number counted daily did not normally reach three figures until late September, during the monsoon transition period of variable direction, mainly light, winds. This species is unusual in that juveniles appeared earlier in the season than adults, and outnumbered them throughout the entire season. Median dates 20 October 2015 and 25 October 2016; highest daily counts 838 individuals on 19 October 2015 and 2,385 on 25 October 2016 (Table 2). Shikras were still coming through on the last day of counting with, respectively, 203 and 61 individuals on 15 November 2015 and 2016.

Although long regarded primarily as a non-breeding visitor in northern parts of TMP (Lekagul & Round 1991, Wells 1999), Shikra evidently breeds near Khao Dinsor (DeCandido *et al.* 2014), the present southernmost known extent of its breeding range. Passage migrants may have been previously overlooked among other sparrowhawks.

Employing more soaring and gliding than other sparrowhawks, Shikras may rely more strongly on tail-winds. An individual photographed by AJ at Khao Dinsor on 2 November 2016 showed the distinctive buffy rufous semi-collar shared by the Indian Subcontinent races *cenchröides* (stated to winter in South-East Asia) and *dussumieri* (Ferguson-Lees & Christie 2001).

### Chinese Sparrowhawk *Accipiter soloensis*

Usually the most abundant raptor species; outnumbered by Black Baza only in 2012 and 2014 (Table 1). The counts of 170,925 individuals in 2015 and an unprecedented 410,721 individuals in 2016 accounted for 43% and 51.9% of migratory raptors in those years.

Median passage dates fell in late September–early October (2 October 2015 and 30 September 2016). Peak dates 8 October 2015 (18,279 individuals) and 25 September 2016 (45,800; Table 2). Among individuals identified to age-classes (only 2% of individuals overall), the ratio of adults to juveniles was about 2:1. Chinese Sparrowhawks tended to migrate in fast-moving, tight flocks of several hundred and occasionally over 1,000 individuals, visible from afar, with a few individuals of other sparrowhawks mixed in. Records spanned the first week of September (6 September in both years; Table 2) to late October, when numbers dropped drastically. A very few were recorded up to mid-November. May not winter in numbers anywhere in TMP (Wells 1999): most are assumed to cross the straits to the Sundas.

### Japanese Sparrowhawk *Accipiter gularis*

Counts of 17,855 individuals in 2015 and 28,254 in 2016 were markedly higher than in preceding years (Table 1). Japanese Sparrowhawks migrated either solitarily or in small loose flocks, often with Chinese Sparrowhawks, causing them to be sometimes overlooked and under-recorded. A few were already passing the site before mid-August and the migration continued past mid-November, when approaching 100 per day (89 birds on 15 November 2015) were still recorded. Migration is believed to continue to mid-December (Wells 1999). Our median dates fell in the third week of September (20 September 2015 and 17 September 2016; Table 2), with highest daily counts of 1,936 individuals on 20 September 2015 and 2,927 on 12 September 2016. The differential timing among age/sex classes recalled that in Oriental Honey-buzzard: adult males peaked first, were outnumbered by females in mid-September, with adults of both sexes outnumbered by juveniles during the second week of October. Even so, our sex ratio data may be skewed toward adult males as their distinct grey upperparts and dark irises make them easier to distinguish.

### Besra *Accipiter virgatus*

Although first recorded in 2010 (Nualsri *et al.* 2010, Sa-ar *et al.* 2018), the many more recorded subsequently (50 birds in 2015 and 123 in 2016) reflect the fact that Besras were previously much overlooked. Although considered an uncommon late migrant, appearing after 10 October (DeCandido *et al.* 2014), passage commenced earlier than previously recognised (earliest 19 September 2015). Recorded more or less daily from 2 October and 26 September onwards respectively in 2015 and 2016, with median dates around mid-October (19 October 2015 and 14 October 2016; Table 2). Juveniles are easily dismissed as either Shikra or Japanese Sparrowhawk, and perhaps not all can be safely identified. Improved counting and recognition of key identification features (the combination of prominent mesial stripe, broad barring on tail- and flight-feathers, variably spotted underwing-coverts, bright yellow orbital rings, light yellow irises and darker brown head than juveniles of similar species: DeCandido *et al.* 2014) followed scrutiny of images of questionable individuals captured by DSLR cameras and telephoto lenses. Juveniles and adult females significantly outnumbered adult males. Of seven accepted records from Singapore and Peninsular Malaysia, five were adult females and two were juveniles (Kennerley 1995; G. C. Tan pers. comm.). Besras were still passing on the last day of the count in both 2015 and 2016.

### Eurasian Sparrowhawk *Accipiter nisus*

Recorded annually in very small numbers on passage in Chumphon and adjacent Prachuap Khiri Khan since c. 2001 (Kasorndorkbua

2009), and at Khao Dinsor since observations commenced in 2010. A total of 13 individuals in 2015 and 14 in 2016 (Table 1), with records from 1 October onwards. Likely under-recorded: distant individuals appearing concurrently with numbers of (e.g.) Shikras (similar in size and likewise long-tailed) or female Japanese Sparrowhawks may be overlooked. Individuals identified with certainty were mostly juveniles, with a few adult females; presumably subspecies *nisosimilis* of north-east and central Asia. It is an uncommon annual winter visitor to hilly wooded areas, mostly in northern Thailand (Lekagul & Round 1991).

### Black Kite *Milvus migrans*

Annual counts of 154 to 266 individuals, all apparently migrant *M. m. lineatus* (Table 1), with records from mid-September (earliest 16 September 2016) onwards until at least mid-November. Median dates 18 October 2015 and 10 October 2016. Highest daily counts were on 21 October 2015 (19 individuals) and 11 October 2016 (29 individuals). Migrates solitarily or in small loose flocks, often traveling with flocks of Oriental Honey-buzzards. A widespread though declining winter visitor to open country throughout Thailand, principally in paddy basins and major wetlands.

### Rufous-winged Buzzard *Butastur liventer*

A scarce annual migrant, one to (exceptionally) 40 individuals per year, recorded from mid-October onwards (Table 1, Table 2). The highest daily total (10 individuals on 23 October 2015) coincided with the median passage date and exceeded the annual total for every other year. The first birds appear after the onset of the passage of its much more abundant migratory congener, Grey-faced Buzzard *B. indicus*—both presumably funnelled by the early north-east monsoon winds and fine weather. Not previously known as a migrant, it has also been recorded heading south at more northerly raptor watch sites in adjacent Prachuap Khiri Khan province (Kasorndorkbua 2009). Small numbers may winter overlooked in TMP. It is a widespread though uncommon resident in deciduous woodland and dry, open country of lowlands and lower hills in continental Thailand (Lekagul & Round 1991). The unprecedented count of 40 individuals in 2015 was possibly driven by the strong El Niño which caused a major drought, perhaps resulting in prey scarcity in its core range.

### Grey-faced Buzzard *Butastur indicus*

Counts of 24,007 in 2015 and 20,773 in 2016 were made during a well-defined passage period from the second week of October: earliest records 10 October 2015 and 8 October 2016; median dates 20 October 2015 and 23 October 2016, with highest daily counts of 5,488 individuals on 20 October 2015 and 3,167 on 24 October 2016 (Table 2). Numbers had dwindled to less than 100 per day by early November. It is a widespread winter visitor to well-wooded open habitats throughout the country, from the far north southwards throughout the peninsula.

### 'Common Buzzard' *Buteo* spp.

Annual totals of fewer than 100 individuals (average 48 per year) were recorded (Table 1). Records cover the period from 30 September onwards (Table 2). Juveniles greatly outnumbered other age-classes. Identification to specific taxon is problematical. At least two taxa, widely treated as different species (Robson 2011, del Hoyo *et al.* 2014), were identified from photographs. 'Steppe' Eurasian Buzzard *B. buteo vulpinus*, characterised by its combination of distinct dark subterminal band on reddish tail, no well-defined carpal patches and dark underwing-coverts, and 'Himalayan Buzzards' *B. (b.) burmanicus* and/or *B. (b.) japonicus* (*cf.* Robson 2011, Rasmussen & Anderson 2012), characterised by well-defined contrasting dark carpal patches and typically paler head (Lindholm & Forsten 2013), were represented in similar numbers. Specimens from TMP

comprised both *vulpinus* and *japonicus* and apparent intergrades (Wells 1999). Collectively a widespread winter visitor throughout the country, but much commoner in the north. Migrates solitarily but was often associated with flocks of Oriental Honey-buzzards.

#### Common Kestrel *Falco tinnunculus*

The second most numerous falcon, after Peregrine Falcon *F. peregrinus*, with totals not exceeding 26 individuals per year. Earliest records 16 October 2015 and 19 September 2016, and median passage dates 30 October and 19 October respectively for the two years (Table 2). Commoner in northern Thailand, though a widespread winter visitor to open country throughout. Only subspecies *interstinctus* has been recorded in TMP (Wells 1999). Other wintering South-East Asian subspecies, *tinnunculus* and *perpallidus* (often subsumed within the nominate race), may possibly occur (Orta *et al.* 2017).

#### Amur Falcon *Falco amurensis*

Scarce: the highest annual total was six birds in 2015. Earliest records, in the last week of October, were roughly three weeks later than the earliest migrants through northern Thailand, where hundreds per day may sometimes be seen (Limparungpatthanakij *et al.* 2015). Passage may continue after the end of the observation period in mid-November (Round *et al.* 2016). All but one of those photographed were thought to be juveniles, likely wanderers away from the usual migration route.

#### Eurasian Hobby *Falco subbuteo*

Annual but scarce migrant, totaling 1–7 individuals per year from 1 October onwards. The median dates were 25 October 2015 and 2 November 2016, with two individuals recorded on 15 November that year (Table 2) indicating that Eurasian Hobbies may still pass after our period of coverage. Most were juveniles. The occurrence of the highly migratory nominate race *subbuteo* is seemingly supported by wintering specimens from Timor and Java (Wells 1999), while the slightly paler and shorter-winged shorter-distance migrant *streichi*, which breeds in south China and Laos (Wells 1999, Ferguson-Lees & Christie 2001), might also occur.

#### Peregrine Falcon *Falco peregrinus*

Consistently the most numerous falcon, with at least 30 individuals of non-breeding races recorded per year. The highest count was 43 individuals in 2015 (Table 1). Records spanned from 14 September to mid-November, with highest daily counts of five birds on two consecutive days, 6 and 7 October 2015, and median dates of 7 October 2015 and 12 October 2016. Those reaching South-East Asia and Thailand have been assigned to races *calidus* and the more common *japonensis* (Ferguson-Lees & Christie 2001, Kasorndorkbua *et al.* 2008). Resident birds showing the characteristics of *F. p. ernesti* also occur in the area and were excluded from the totals.

## DISCUSSION

With several hundred thousand raptors recorded annually, Khao Dinsor is a globally important monitoring site for southbound migratory raptors using the East Asian Continental Flyway. Less sustained observations in spring have shown that northbound raptors pass over 10 km west of Khao Dinsor, when alternative watchpoints must be sought (DeCandido *et al.* 2008, DeCandido & Nualsri 2009).

#### Scarcer species

Regular monitoring of raptors and other diurnal migrants at Khao Dinsor and neighbouring sites has changed our understanding of the

status of many species. Booted Eagle, for example, was regarded as an uncommon winter visitor in small numbers (Lekagul & Round 1991), whereas 70–129 were recorded annually during our six years' coverage. The major passage of Shikras was previously undocumented and it was regarded as only a vagrant to south TMP and Singapore (Robson 2011). Other species in which migratory movements had scarcely been previously suspected or documented were Crested Serpent-eagle, the seventh most numerous migratory species in both 2015 and 2016, Jerdon's Baza, Rufous-winged Buzzard and Besra.

Black Eagle, regarded as resident in the area and not listed above, was noted among migrants moving south in most years (1–4 per season), with records spanning from 25 September to 6 November. These data are still inadequate to reach a conclusion concerning its status, but it has apparently been recorded on passage further north, in east Tonkin, Vietnam (Robson 2011).

#### Relative abundance

The proportions of the most numerous species were relatively consistent over the years, Chinese Sparrowhawk accounting for at least 43% and 52% of total migratory raptors counted in 2015 and 2016 respectively, Black Baza 25.3% and 22.4%, and Oriental Honey-buzzard 16.6% and 17.3% (Table 1). The count of 410,721 Chinese Sparrowhawks at Khao Dinsor in autumn 2016 (Table 1) was close to the highest ever East Asian Oceanic Flyway total (439,276 in Uchiyama-toge, Nagasaki, Japan, in 1999: Chong 2000). This suggests that even the upper limit of previous estimates of the global population, 100,000–499,999 individuals (BirdLife International 2016b), may underestimate the global population significantly. The previous highest count for Oriental Honey-buzzard (121,000 individuals in the Selangor Plain, Malaysia, in 1963: Wells 1999, DeCandido *et al.* 2004) was also exceeded by Khao Dinsor's 136,683 individuals in autumn 2016 (Table 1), while the numbers of both Black Baza and Japanese Sparrowhawk at Khao Dinsor were higher than for any other watch site (Table 1).

Other than Black Baza, Chinese Sparrowhawk and Oriental Honey-buzzard, only four species accounted for c. 0.1% or more of the annual total in either 2015 or 2016. These were Japanese Sparrowhawk (4.5% and 3.6%), Grey-faced Buzzard (6.0% and 2.6%), Shikra (2.8% and 1.7%) and Crested Serpent-eagle (0.1% in both years).

The 2016 total was more than twice that in 2015. A large part of this difference was accounted for by the many more Chinese Sparrowhawks recorded that year, an increase of 52% over that attained in 2015. A similar twofold increase was recorded in 2016 along the East Asian Oceanic Flyway, where 127,495 Chinese Sparrowhawks were counted at Taiwan's most renowned watch site, Kenting National Park (Raptor Research Group of Taiwan 2016), compared with 59,290 in the preceding year (Raptor Research Group of Taiwan 2015). The underlying cause of the apparent rise in numbers on both flyways remains unknown. It may be coincidental: without accurate counts of juvenile:adult age ratios it cannot necessarily be attributed to recruitment during a good breeding season, although this might be a contributory cause. However, it was notable that the numbers of five of the six most abundant raptor species, each of which contributed > 0.1% of the total recorded, were larger in 2016 than 2015. The sole exception was Grey-faced Buzzard, in which the 2016 total was 13.5% lower than that in 2015. In both years, the numbers of Grey-faced Buzzards at Khao Dinsor were less than those recorded on the oceanic route at Kenting National Park—34,525 individuals in autumn 2015 (Raptor Research Group of Taiwan 2015) and 37,242 in 2016 (Raptor Research Group of Taiwan 2016). Considerable annual variation may be due to vicariance: how variable weather conditions and local geography affect flightlines and therefore appreciation of numbers.

Reduced visibility during 2015, an El Niño year, almost certainly depressed the numbers of raptors detected that year. The annual

haze, occurring as a result of man-made forest fires in Sundaland, particularly Sumatra and Kalimantan, was, in autumn 2015, the worst on record (National News Bureau of Thailand 2015, Reuters/AFP 2015). Certainly, from mid-October onwards, the northern part of TMP was affected, with the sun blotted out for days on end. Flocks utilising thermals in the hill ranges due west (Figure 1) were less visible to counters. On some days raptors at Khao Dinsor could be seen only at less than 1 km range and many undoubtedly went unrecorded.

Weather is only one of many confounding factors that may combine to produce differential biases in the totals of raptors recorded year to year at regular watch sites (Bildstein 2006). This underscores the importance of long-term monitoring.

### Seasonal timing

The autumn migration, from mid-August into November, straddles the transition between the end of the south-west monsoon and the onset of the north-east monsoon (Khedari *et al.* 2002, DeCandido *et al.* 2008). Some rain could be expected almost daily throughout, with heavy showers on at least 20 days per season, becoming more frequent or prolonged towards the end of our period of coverage. During the south-west monsoon, from May until usually the first week of October, raptors are chiefly flying into a headwind. Japanese Sparrowhawk, the migration of which peaked earliest, around mid-September, flew with a combination of frequent flapping and short glides, often 'hedge-hopping' at little more than tree-top height, which probably helped it cope with the headwind. As the north-east monsoon wind strengthened during October, the tailwind aided raptors on migration, especially the gliding and soaring bazas, eagles and buzzards that appeared later in the season (Table 2).

All species declined in numbers towards mid-November. While a few species continued migrating south after mid-November, it is safe to assume that our count period covered the peak passage dates for most populations (Table 2). Black Baza and Shikra were the only two species still passing through in hundreds on the last day of the count—93 and 264 Black Bazas and 203 and 61 Shikras in 2015 and 2016 respectively.

No comparably intensive monitoring has yet been implemented during the spring (northwards) migration, for which alternative sites must be sought (though see DeCandido & Nualsri 2009). Further efforts aimed at the northbound passage are needed so as to improve our understanding of the annual migration cycle.

Many migrant bird species are declining due to a variety of factors, including habitat change and direct persecution (Bildstein 2006, Ferguson-Lees & Christie 2011). Additionally, the impacts of climate change are predicted to adversely impact populations of many migrants (Wichmann *et al.* 2005, Sullivan *et al.* 2016). Over 200,000 other diurnal migrants besides raptors were counted at Khao Dinsor in 2016, making a total of over one million birds recorded, and a paper summarising non-raptor migrants is in preparation. Ongoing annual counts could potentially help track population levels, annual recruitment and timing of migration among all diurnal migrants, not just raptors. In future it would be worthwhile to integrate other aspects in our data collection and analysis, examining factors shaping population-specific migratory patterns and temporal trends in greater detail. Public awareness, nature education, site management and conservation also remain to be emphasised effectively alongside data-gathering in future.

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