The timing of spring passage of soaring birds at Zait bay, Egypt

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The timing of spring passage of soaring and gliding birds was studied on the western side of the narrowest strait in the southern gulf of Suez, at Zait bay. The study was based on systematic observations performed in spring 2007. The passage of the following species was recorded: Black Stork *Ciconia nigra*, White Stork *Ciconia ciconia*, White Pelican *Pelecanus onocrotalus*, Lesser Kestrel *Falco naumanni*, European Honey Buzzard *Pernis apivorus*, Black Kite *Milvus migrans*, Egyptian Vulture *Neophron percnopterus*, Short-toed Eagle *Circaetus gallicus*, Western Marsh Harrier *Circus aeruginosus*, Levant Sparrowhawk *Accipiter brevipes*, Eurasian Sparrowhawk *Accipiter nisus*, Steppe Buzzard *Buteo b. vulpinus*, Long-legged Buzzard *Buteo rufinus*, Lesser Spotted Eagle *Aquila pomarina*, Steppe Eagle *Aquila nipalensis*, Booted Eagle *Hieraaetus pennatus* and Common Crane *Grus grus*. Measured migration density varied considerably from species to species, as a result of differences in density of migration and as some bird species are easier to detect than others.

On peak passage days, the percentage of passing individuals compared to the number recorded for the entire period was highest in Levant Sparrowhawk and Honey Buzzard, with 50% and more. The highest absolute numbers per season and largest flock sizes occurred in White Stork (average of 1000 individuals per flock). The duration of passage per species varied between 10 and 65 days for the central 90% of migrants. Species with immature birds passing later migrated in a wider time window (Steppe Eagle) than species with adults and immature birds migrating together (Common Crane). The extremely short passage period of Common Crane can also be explained by the fact that these birds congregate into huge flocks before migration. The dates of mean and peak migration correlated significantly with corresponding dates in Israel, but not duration of migration.

INTRODUCTION

Soaring and gliding birds depend to a large extent on updrafts during migration because of the high energetic costs of active flight (Alerstam 1990). Thus they avoid sea-crossings altogether or cross water at the narrowest point. One of these migration concentration points is situated at Zait bay (Figure 1), where soaring birds migrating along the East African flyway cross from mainland Egypt to Sinai (Grieve 1996, Baha El Din 1999, Christensen & Jensen 2002) or continue via Suez. The first systematic counts, performed in spring 2007 (Hilgerloh in press), provided an opportunity to analyse the timing of passage in soaring and gliding birds at this site.

The timing of soaring birds migrating along the East African flyway has been studied in Israel (Safriel 1968, Leshem & Yom-Tov 1996, Shirihai 1996, Shirihai *et al* 2000), but not that part of the flyway on the western side of the southernmost gulf of Suez. The aim of this study is to report details of timing of passage of soaring and gliding species passing through the Zait bay area and to compare them with results reported from Israel.

Figure 1. The Sinai region. Zait bay to Eilat is c240 km and to Suez town c260 km, straight-line distance.

METHODS

The data were collected to assess the risks to migratory soaring birds from a potential large onshore windfarm development. The study area was the coastal desert near Zait bay. In order to characterize the passage of

soaring birds through an area of *c*700 km², a double row of observation points was established parallel to the NW–SE directed coast 5 km apart (28.17° N, 33.15° E to 27.73° N, 33.49° E), on the assumption that soaring birds can be detected up to at least 2.5 km away. Each row contained 13 sites at 5 km intervals. The observation points were situated between the foothills of the Red Sea mountains to the west and the gulf of Suez, the coastal Gebel El Zait range and Zait bay to the east (Plates 1–4). The main road from Hurghada to Suez was immediately to the east of the eastern row of observation points. The observation points were closest to the sea (*c*2 km) in the far north and at Zait bay. The observation points were not manned continuously. Two teams of field workers performed the observations in shifts, using 10 x 40 binoculars and 20–60 magnification telescopes. A rotation schedule was set up, in order to get a data set representative of the entire study area. Observation periods lasted principally for 60 minutes during which time all birds sighted in any direction within the radius of 2.5 km from the observation site were logged (for details see Hilgerloh in press). Observations were performed 20 February–6 May 2007 for a total period of 604.4 hours. As migration in some species continued for a time after systematic observations had ceased, some median dates might be later than indicated.

Plate 1. The coastal Gebel El Zait range and, just visible further behind on the horizon across the gulf of Suez, the mountains of Sinai, to the east of the study area. © *Ingo Weiss*

Migratory soaring species where fewer than 20 birds were sighted, and local birds, are not included in this study. The Levant Sparrowhawk *Accipiter brevipes* is known to migrate to a small extent (*c*10%) at night (Stark & Liechti 1993, Spaar *et al* 1998). For methodological reasons, individuals migrating at night were not recorded.

The timing of soaring bird spring migration at Zait bay was compared with spring observations in Eilat, Israel (Christensen *et al* 1981, Leshem & Yom-Tov 1996). Christensen *et al*'s (1981) observations were performed 20 February–17 May 1977 (phenological data were calculated by us on the basis of their published raw data). Leshem & Yom-Tov's (1996) study lasted several years, with observations mainly 14 February–31 May. As White Storks in spring mostly migrate west of Eilat, observations made on that route were used for comparison (Leshem & Yom-Tov 1996).

Correlations between dates of peak migration, median and mean migration and of duration of passage at Zait bay and Eilat were performed using the Spearman rank correlation test.

RESULTS

Passage dates

In spring, most migrants crossed Zait bay in March and April. Of the 17 species studied, 12 first appeared in February: Black Stork *Ciconia nigra*, White Stork *Ciconia ciconia*, White Pelican *Pelecanus onocrotalus*, Black Kite *Milvus migrans*, Egyptian Vulture *Neophron percnopterus*, Short-toed Eagle *Circaetus gallicus*, Steppe Buzzard *Buteo b. vulpinus*, Long-legged Buzzard *Buteo rufinus*, Lesser Spotted Eagle *Aquila pomarina*, Steppe Eagle *Aquila nipalensis*, Booted Eagle *Hieraaetus pennatus* and Common Crane *Grus grus* (Figure 2, Table 1). In two

Plate 2. The foothills of the Red Sea mountains, west of the study area. © *Gudrun Hilgerloh*

Plate 3. Some of the few acacias in the study area. © *Ingo Weiss*

Plate 4. Undulating landscape in the northern part of the study area. © *Ingo Weiss*

species, Steppe Eagle and Common Crane, 50% of the migrants (to median date of passage) passed Zait bay before mid March. The species with the latest start (first sightings end March–mid-April) were Levant Sparrowhawk and European Honey Buzzard *Pernis apivorus*. In these species, the median date of passage was reached between mid-April and 2 May. Honey Buzzard was the only species with a median in May.

The median date correlated significantly with that of Christensen *et al* (1981) at Eilat (Spearman correlation test n = 10, R = 0.88, t = 5.24, p = 0.0008) and also the mean date (n = 10, R = 0.908, t = 6.15, p = 0.0003). In the Leshem & Yom-Tov (1996) longer term study from Eilat no median dates of passage were presented. However, comparing the mean passage dates at Zait bay with those of Leshem & Yom-Tov (1996) (Table 2) revealed a significant correlation (Spearman test n = 9, R = 0.864, t = 4.551, p = 0.002).

Of globally endangered species, Pallid Harrier *Circus macrourus* and Spotted Eagle *Aquila clanga* were noted migrating through the study area. Pallid Harriers were observed 23 February–26 April with the median on 31 March (n = 13) and Spotted Eagles 14 March–16 April with the median on 11 April (n = 9).

Peak migration

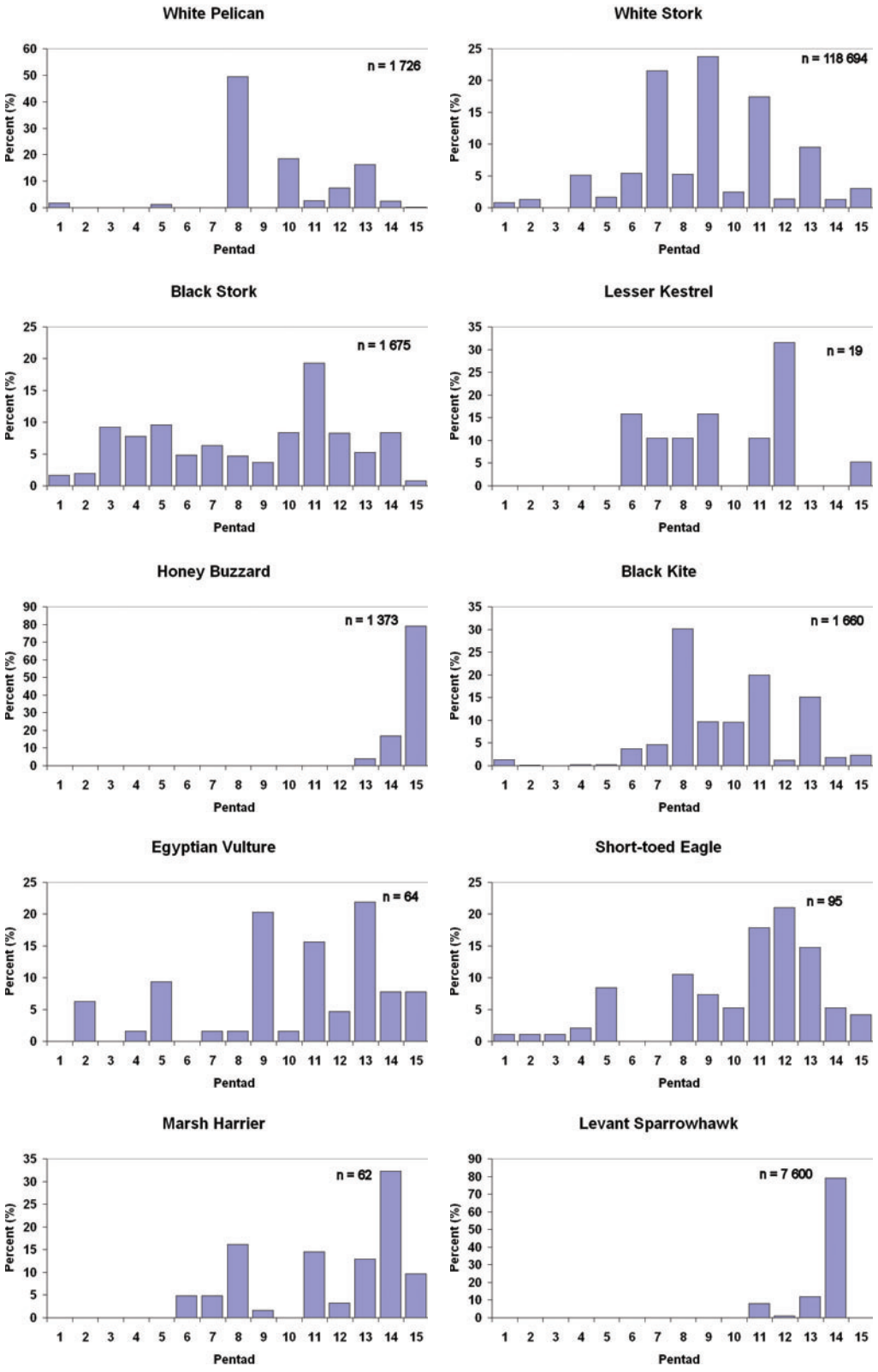
Observed migration density differed considerably between species, not only as a result of differences in migration density but also as some bird species are easier to detect than others. The 17 species studied can be grouped into 4 classes according to the number of birds recorded on the peak passage day:

- Over 10 000: White Stork.
- Between 1000 and 10 000: Levant Sparrowhawk, Steppe Buzzard, Common Crane.
- From 100 to 999: White Pelican, Black Stork, Black Kite, Honey Buzzard, Steppe Eagle.
- Under 100, thus of less relevance at this site: Egyptian Vulture, Marsh Harrier, Eurasian Sparrowhawk, Long-legged Buzzard, Lesser Spotted Eagle, Booted Eagle, Short-toed Eagle.

The proportion of migrants of one species passing on the peak passage day varied between 11 and 79%. The highest percentages were registered in Levant Sparrowhawk and Honey Buzzard with 50% and more passing through in one day (Table 1, Figure 2).

Table 1. Dates of first and last sightings (and duration of this period), dates of first and last sightings of the central 90% (and duration of this period), dates of the median and peak migration days, number of birds on peak migration day, percentage of total observed birds on peak migration day and total number of birds observed, Zait bay, Egypt, 2007.

	All sightings			Central 90%			Median	Peak	Numbers	Peak as	Total
	from	to	days	from	to	days	date	date	on peak day	% of all	
Black Stork *Ciconia nigra*	23 Feb	6 May	73	5 Mar	26 Apr	53	5 Apr	15 Apr	290	17.00	1709
White Stork *Ciconia ciconia*	23 Feb	6 May	73	11 Mar	26 Apr	47	3 Apr	22 Mar	25 561	21.20	120 745
White Pelican *Pelecanus onocrotalus*	21 Feb	6 May	75	27 Mar	28 Apr	33	31 Mar	27 Mar	335	18.60	1801
Lesser Kestrel *Falco naumanni*	17 Mar	6 May	51	19 Mar	2 May	45	2 Apr	20 Apr	5	25.00	20
European Honey Buzzard *Pernis apivorus*	17 Apr	6 May	20	26 Apr	5 May	10	2 May	2 May	687	49.70	1381
Black Kite *Milvus migrans*	23 Feb	6 May	73	20 Mar	25 Apr	37	5 Apr	31 Mar	344	20.70	1660
Egyptian Vulture *Neophron percnopterus*	26 Feb	2 May	68	27 Feb	2 May	65	11 Apr	5 Apr	11	17.20	64
Short-toed Eagle *Circaetus gallicus*	23 Feb	2 May	71	10 Mar	28 Apr	50	14 Apr	16 Apr	18	18.90	95
Western Marsh Harrier *Circus aeruginosus*	19 Mar	5 May	48	22 Mar	2 May	42	21 Apr	26 Apr	16	25.80	62
Levant Sparrowhawk *Accipiter brevipes*	30 Mar	2 May	34	15 Apr	26 Apr	12	26Apr	26 Apr	6014	79.10	7600
Eurasian Sparrowhawk *Accipiter nisus*	1 Apr	4 May	34	4 Apr	2 May	29	21Apr	26 Apr	15	19.70	76
Steppe Buzzard *Buteo b. vulpinus*	20 Feb	6 May	76	12 Mar	28 Apr	48	3Apr	29 Mar	2983	12.70	23 539
Long-legged Buzzard *Buteo rufinus*	23 Feb	4 May	71	23 Feb	11 Apr	48	16 Mar	6 Apr	17	17.30	98
Lesser Spotted Eagle *Aquila pomarina*	20 Feb	6 May	76	25 Feb	28 Apr	63	1 Apr	11 Apr	46	23.60	195
Steppe Eagle *Aquila nipalensis*	20 Feb	2 May	72	22 Feb	17 Apr	55	6 Mar	25 Feb	186	10.60	1747
Booted Eagle *Hieraaetus pennatus*	28 Feb	6 May	68	28 Mar	2 May	36	21 Apr	26 Apr	20	16.90	118
Common Crane *Grus grus*	22 Feb	12 Apr	50	27 Feb	10 Mar	12	10 Mar	8 Mar	3923	24.70	15 906


White Pelican
n = 1 726
White Stork
n = 118 694
Black Stork
n = 1 675
Lesser Kestrel
n = 19
Honey Buzzard
n = 1 373
Black Kite
n = 1 660
Egyptian Vulture
n = 64
Short-toed Eagle
n = 95
Marsh Harrier
n = 62
Levant Sparrowhawk
n = 7 600
Percent (%)
Pentad

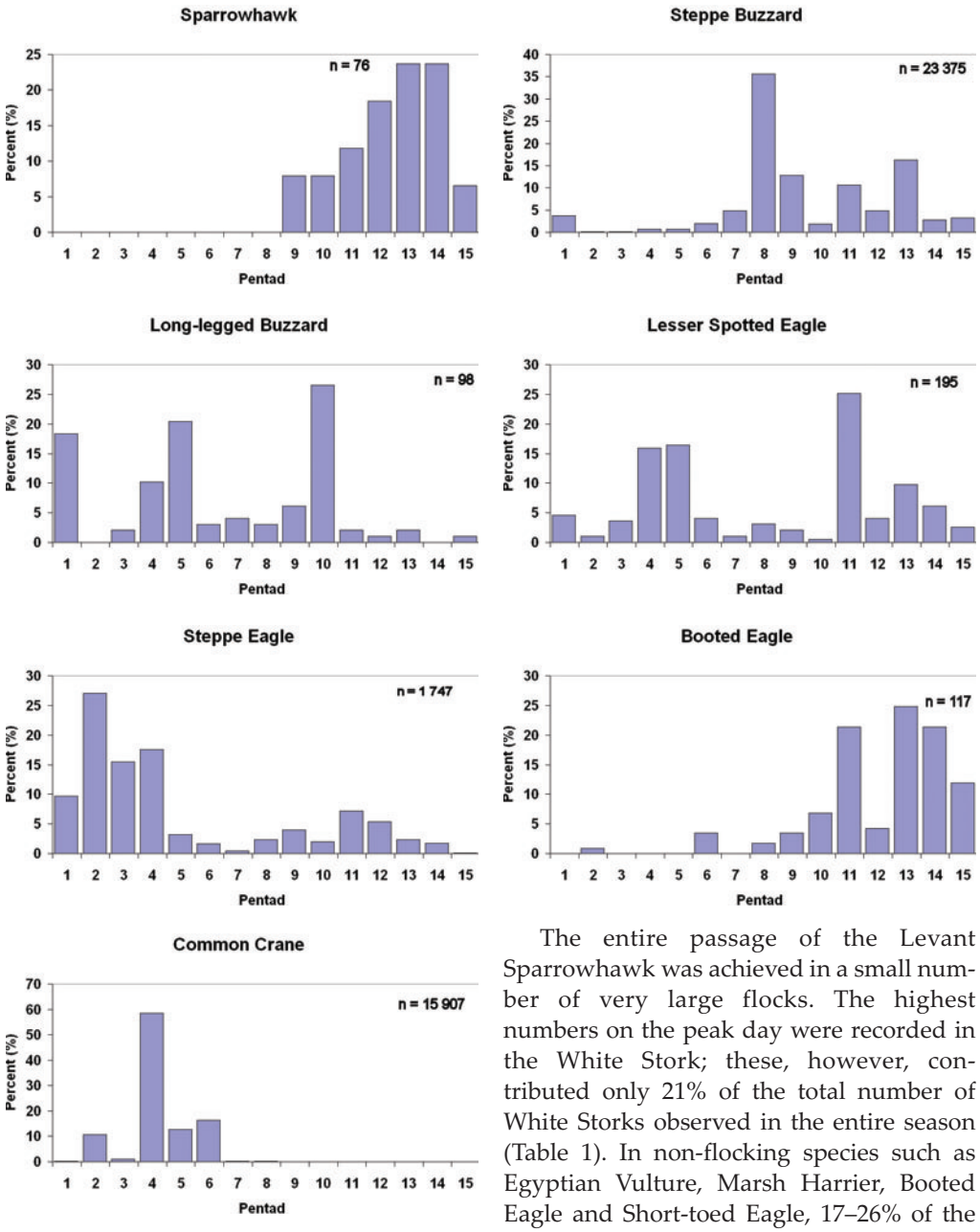


Figure 2. Timing of soaring and gliding bird migration at Zait bay, Egypt, as percentage of all birds of the species, 20 February–5 May 2007.

Pentads: 1, 20 Feb–24 Feb; 2, 25 Feb–1 Mar; 3; 2 Mar–6 Mar; 4, 7 Mar–11 Mar; 5, 12 Mar–16 Mar; 6, 17 Mar–21 Mar; 7, 22 Mar–26 Mar; 8, 27 Mar–31 Mar; 9, 1 Apr–5 Apr; 10, 6 Apr–10 Apr; 11, 11 Apr–15 Apr; 12, 16 Apr–20 Apr; 13, 21 Apr–25 Apr; 14, 26 Apr–30 Apr; 15, 1 May–5 May.

The entire passage of the Levant Sparrowhawk was achieved in a small number of very large flocks. The highest numbers on the peak day were recorded in the White Stork; these, however, contributed only 21% of the total number of White Storks observed in the entire season (Table 1). In non-flocking species such as Egyptian Vulture, Marsh Harrier, Booted Eagle and Short-toed Eagle, 17–26% of the birds migrated through the area on the peak day.

The day with peak numbers of migrants correlated significantly with the corresponding peak day of Christensen *et al* (1981) (Spearman n = 10, R = 0.83, t = 4.17, p = 0.003) and of Leshem & Yom-Tov (1996) (Spearman n = 9, R = 0.89, t = 5.03, p = 0.002) (Table 2).

Table 2. Date of median, mean and peak passage day and duration of the passage of the central 90% of migrants at Zait bay, Egypt, 2007, and in Israel (Christensen *et al* 1981, Leshem & Yom-Tov 1996). In Israel, raptor counts were performed at Eilat and White Stork counts further west.

	Median date		Mean date			peak date			duration of 90% of passage (days)		
	Zait bay	Israel (Chr 81)	Zait bay	Israel (L & Y-T 96)	Israel (Chr 81)	Zait bay	Israel (L&Y-T 96)	Israel (Chr 81)	Zait bay	Israel (L&Y-T 96)	Israel (Chr 81)
White Stork	3 Apr		31 Mar	30 Mar		22 Mar	28 Mar		47	43	
Honey Buzzard	2 May	9 May	26 Apr.	5 May	9 May	2 May	9 May	16 May	10	11	15
Black Kite	5 Apr	31 Mar	31 Mar	30 Mar	5 Apr	31 Mar	29 Mar	26 Mar	37	21	33
Egyptian Vulture	11 Apr	1 Apr	31 Mar	1 Apr	2 Apr	5 Apr	5 May	30 Mar	65	57	65
Short-toed Eagle	14 Apr	28 Mar	29 Mar		20 Mar	16 Apr		21 Mar	50		56
Western Marsh Harrier	21 Apr	9 Apr	11 Apr	11 Apr	12 Apr	26 Apr	12 Apr	9 Apr	42	62	62
Levant Sparrowhawk	26 Apr	20 Apr	15 Apr	24 Apr	23 Apr	26 Apr	24 Apr	20 Apr	12	9	9
Eurasian Sparrowhawk	21 Apr	11 Apr	28 Apr		13 Apr	26 Apr		10 Apr	29		29
Steppe Buzzard	3 Apr	8 Apr	29 Mar	3 Apr	6 Apr	29 Mar	31 Mar	9 Apr	48	25	30
Steppe Eagle	6 Mar	26 Feb	27 Mar	10 Mar	15 Mar	25 Feb	10 Mar	26 Feb	55	33	45
Booted Eagle	21 Apr	9 Apr	7 Apr	10 Apr	9 Apr	26 Apr	9 Apr	20 Apr	36	39	39

Flock size

Among raptors the greatest mean flock size was recorded in Levant Sparrowhawk (253 birds). All other raptor species migrated in small or very small flocks or singly (Table 3). However, birds often migrated in mixed-species flocks. Among the non-raptors, the White Stork, with an average of *c*1000 birds/flock, showed the largest mean flock size, followed by the Common Crane, with 150 birds/flock (Table 3).

Duration of passage

In general, the passage of the first and last 5% of the migrants was spread over relatively long periods. Sightings of the Common Crane, for example, were recorded over 50 days with the central 90% passing within 12 days. White Pelicans were observed over a period of 75 days, but the passage of the central 90% lasted 33 days (Table 1).

Time between first and last sighting of a species varied between 20 and 76 days (Table 1) with the central 90% of the migrants recorded in periods of 10–65 days. In the following, figures refer only to the central 90% of the migrants. The shortest passage period (10–12 days) was in Levant Sparrowhawk, Honey Buzzard and Common Crane, all flocking species. Non-flocking species such as Egyptian Vulture, Marsh Harrier, Booted Eagle and Short-toed Eagle had passage periods of 36–65 days (Table 1). Another passage pattern was displayed by White Stork and White Pelican, both species that form large flocks. The central 90% of both had a fairly long passage period, 33 and 47 days respectively.

A significant correlation between the duration of passage through the Zait bay area and Israel in 1977 (Christensen *et al* 1981) (Spearman $n = 10$, $R = 0.83$, $t = 4.21$, $p = 0.003$) was found but not with

Table 3. Mean flock size per species and confidence interval (*eg* European Honey Buzzards migrated through the area with an average flock size of 13.95 birds and 95% of their flocks varied in size between 9.24 and 18.66 birds), Zait bay, Egypt, 2007.

	N (flocks)	Mean number per flock	Confidence interval (-0.95%)	Confidence interval (+ 0.95%)
Raptors				
Lesser Kestrel	18	1.06	0.94	1.17
European Honey Buzzard	99	13.95	9.24	18.66
Black Kite	319	5.20	4.07	6.34
Egyptian Vulture	38	1.61	1.29	1.93
Short-toed Eagle	82	1.15	1.03	1.27
Western Marsh Harrier	51	1.22	1.07	1.36
Levant Sparrowhawk	30	253.33	85.33	421.34
Eurasian Sparrowhawk	66	1.15	1.04	1.27
Steppe Buzzard	1555	15.46	13.19	17.73
Long-legged Buzzard	52	1.88	1.11	2.66
Lesser Spotted Eagle	103	1.89	1.50	2.29
Steppe Eagle	410	4.26	3.41	5.11
Booted Eagle	84	1.40	1.19	1.62
Non-raptors				
Black Stork	74	23.18	16.38	29.97
White Stork	143	998.22	572.65	1423.78
White Pelican	25	75.04	38.13	111.95
Common Crane	106	150.07	110.68	189.46

that of the Leshem & Yom-Tov (1996) study (Spearman n = 9 R = 0.60, t = 1.98, p = 0.09) (Table 2).

DISCUSSION

In this study, the phenology of the passage of soaring and gliding birds close to the straits in the southern part of the gulf of Suez was investigated. The dates of peak and mean migration were similar to those in Israel (Christensen *et al* 1981, Leshem & Yom-Tov 1996). Timing of migration is related to various factors *eg* availability of food at the breeding grounds. A species feeding mainly on mammals in the breeding area (Steppe Eagle) was the one that expectedly passed first and the species passing last (Honey Buzzard) is insectivorous (Mebs & Schmidt 2006). However, the timing of other species (Table 1) is not so easy to explain.

The raptor observed migrating in the largest flocks (Levant Sparrowhawk) had one of the shortest passage periods. Similar findings are reported for the Broad-winged Hawk *Buteo platypterus* in America (Bildstein 2006, Newton 2008). Young birds are less inclined to migrate in large flocks than adults (Bildstein 2006). This pattern was seen in the Steppe Eagle, where adults formed mostly large flocks whereas immature birds migrated singly or in small groups (Hilgerloh *et al* unpublished data). Storks and other non-raptors displayed a different behaviour. Although the White Stork formed the largest flocks, its passage period was very protracted (Figure 2, Table 2), which reflects findings from Israel (Leshem & Yom-Tov 1996).

The duration of passage often depends on the timing of migration of immatures. Raptor species with a late migration of immatures were observed migrating through the study area for a longer period than those where immatures remain in the wintering quarters, con-

firming the results of Myers (1981) and Kjellén (1990). In spring, adults set off at first within a few days and the immatures of various ages follow later over a longer period, as shown for the Steppe Buzzard by Gorney & Yom-Tov (1994). In our data, this was best recognized in the phenology of the Steppe Eagle (Figure 2). Apparently, the wintering area of adult Steppe Eagles is separate from that of immatures, there being no overlap (Curry-Lindahl 1982). If most immature birds of a species remain on the wintering grounds (Honey Buzzard), its passage period may be expected to be as condensed as birds with short sexual maturation (Levant Sparrowhawk).

Common Cranes synchronise their migration by forming huge congregations before setting off, which goes far to explaining the short passage period we observed (Figure 2). As cranes are not averse to occasional stints of active flying rather than gliding and soaring (Pennycuick *et al* 1979), they are less dependent on thermals and are therefore in a position to cross the sea almost anywhere. It would appear, however, that cranes prefer to migrate from Zait bay directly across the gulf of Suez, presumably to conserve energy. At this migration bottleneck, we observed the highest concentration of Common Cranes ever recorded in Egypt (pers obs, Goodman & Meininger 1996).

The White Stork, migrating through one of its most important bottlenecks along the East African flyway, at Zait bay (Berthold *et al* 2001), also congregated in huge flocks. Unlike the Common Crane, the White Stork's passage period was long at Zait bay, which may to some extent be an effect of the extensive range of their wintering area (Elphick 2008).

A further consideration is the impact of energy strategies on migration timing. A species feeding extensively en route will migrate over a longer period than a species travelling on energy from fuel supplies accumulated before the journey. Contradicting earlier hypotheses, it appears that most soaring birds do, in fact, feed during migration. They hunt and feed either on a daily basis or opportunistically in times of poor migration weather (Nile *et al* 1996, Gorney & Yom-Tov 1994, Yosef 1996). And they pause to build up sufficient fat reserves whenever they are faced with crossing inhospitable areas (Yosef 1996). Towards the end of their journey, on approaching their breeding grounds, soaring birds often seek to replenish their energy reserves as capital for the breeding season, reflected in unequal migration speeds in Europe and Africa (Alerstam 2006, Hedenström 2006, Shamoun-Baranes *et al* 2006, Klaassen *et al* 2008). The nature of these strategies employed may vary both between and within species (Gorney & Yom-Tov 1994).

Among non-raptors, the White Stork was the species that rested in highest numbers around the coastal bays of Zait bay and nearby Ras Gemsa, where thousands of them spent the night before crossing the gulf of Suez (pers obs). Cranes and pelicans were also observed resting in the middle of the desert plain at the study area. In general, storks migrate lean (with low body mass and minimal fat deposits) and fly nearly every day for 8–10 hours, with a higher migration speed in Africa than in the Middle East and Europe (Berthold *et al* 2001, Shamoun-Baranes *et al* 2006). Consequently they need to refuel frequently.

Does the phenological data of this study reflect the usual pattern of spring passage at Zait bay? A comparison of our results with those of a study conducted over several years in Israel (Leshem & Yom-Tov 1996) revealed a strong correlation of passage dates. Further studies at Zait bay would be of interest.

ACKNOWLEDGEMENTS

We wish to thank the following ornithologists who carried out field work with us: G Pegram, J Rauhut, A Schreiber, D Sturm and K Wilson. F Ziesemer, K Wilson and F Liechti made critical comments. A Abdelmageed provided support in Egypt, E Niemann provided support during the entire study. Deutsche Entwicklungsbank (KfW) financed the field work and NREA (New and Renewable Energy Authority of Egypt) gave permission to publish these data.

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