

Identification of the best sites around the gulf of Iskenderun, Turkey, for monitoring the autumn migration of Egyptian Vultures *Neophron percnopterus* and other diurnal raptors

STEFFEN OPPEL, PETAR IANKOV, SANIYE MUMUN, GEORGI GERDZHIKOV, MIHAIL ILIEV, SÜREYYA ISFENDIYAROĞLU, ÇAN YENIYURT & EVRIM TABUR

Monitoring raptors along migration corridors can be used to assess changes in population size. The Balkan population of the endangered Egyptian Vulture *Neophron percnopterus* is declining rapidly, but no trend information exists of the larger adjacent population in western Turkey. In September 2013, we explored 13 localities around the gulf of Iskenderun, southern Turkey, to establish whether long-term migration monitoring would be possible in the area. We found that the small hills north of the gulf of Iskenderun were consistently better for observing migration than locations at the Belen pass, southeast of the gulf. Long-term raptor monitoring should be established at three points north of the gulf of Iskenderun near the villages of Sarimazi and Selimiye. If attended by 2–3 observers mid August–mid October, these observation points would likely allow monitoring of the majority of Egyptian Vultures migrating around the eastern coast of the Mediterranean sea. Summing observations at the 13 localities, we counted 552 Egyptian Vultures with a peak between 10 and 24 September. In addition, we observed >50 000 individuals of 24 other raptor species, with Lesser Spotted Eagle, Levant Sparrowhawk, European Honey Buzzard, and Short-toed Snake Eagle being the most common.

INTRODUCTION

Many raptor species around the world are declining (Chaudhary *et al* 2012, Thiollay 2006, Virani *et al* 2011), but monitoring population changes of raptors can be logistically difficult because most have large home ranges and breed at very low densities in sometimes remote localities. For migratory species, counts at migratory bottlenecks can provide useful indices of population size for a given region, and require much lower effort than breeding season surveys covering large areas (Bednarz *et al* 1990, Farmer *et al* 2007, Lewis & Gould 2000).

The fall migration of diurnal raptors from western Palaearctic breeding grounds to wintering regions in Africa or Arabia follows several migration corridors to cross or bypass the Mediterranean sea (Cameron *et al* 1967, Corso 2001, Evans & Lathbury 1973, Lucia *et al* 2011, Porter & Willis 1968). Many raptors breeding in eastern Europe and western Turkey use the migratory corridor that passes around the western edge of the Black sea and the eastern extent of the Mediterranean. Along this flyway, well-known migratory bottlenecks exist at Burgas bay (eastern Bulgaria), the Bosphorus (Turkey), Eilat (Israel), Suez (Egypt) and in southern Turkey (Frumkin *et al* 1995, Michev *et al* 2011, Porter & Beaman 1985, Safriel 1968, Sutherland & Brooks 1981). Monitoring raptors along this flyway can thus provide useful indices of the size of eastern European and western Turkish populations for several species (Leshem & Yom-Tov 1996).

One species for which information about population size and trend is urgently needed is the Egyptian Vulture *Neophron percnopterus*. This species breeds in the Balkans and in Turkey, and strong population declines have been reported from the Balkan countries (Andevski 2012, BirdLife International 2008, Nisbet & Smout 1957). While the size of the breeding population is relatively well known for Bulgaria, Greece and FYR Macedonia, very little information exists about the size of the breeding population in Turkey (Andevski 2012). Because Egyptian Vultures from eastern Europe and western Turkey

migrate to Africa via the migration route around the eastern Mediterranean sea (Meyburg *et al* 2004), a raptor migration monitoring station along this corridor could potentially provide useful indices of Egyptian Vulture population size for the Balkan and western Turkish populations.

In September 2013 we conducted exploratory work in northern Hatay province, southern Turkey, with the aim of identifying a suitable location for a census station where Egyptian Vulture migration could be monitored consistently over many years. We used historic information about raptor migration at Belen pass in the Amanos mountain range, Hatay province (Cameron *et al* 1967, Can 2001, Sutherland & Brooks 1981), combined with information on satellite-tracked Egyptian Vultures migrating from Bulgaria and Greece (<http://lifeneophron.eu/en/map.html>, accessed 5 April 2014) to identify potentially suitable locations, and conducted raptor migration counts to assess the relative suitability of several sites. This work provides guidance on where and how raptor monitoring could be implemented that would allow trend estimation for Egyptian Vultures breeding in the Balkans and western Turkey.

METHODS

Selection of potential raptor migration monitoring sites

Sutherland & Brooks (1981) and Cameron *et al* (1967) described several locations where they had observed concentrated raptor migration: Belen pass (locations 8 and 9 in Figure 1), Sariseki (locations 6 and 7 in Figure 1), and the mountain slopes above Dörtyol (location 12 in Figure 1), and we spent at least two days at each of these locations. In addition, we used the information from eight satellite-tracked Egyptian Vultures (<http://lifeneophron>.

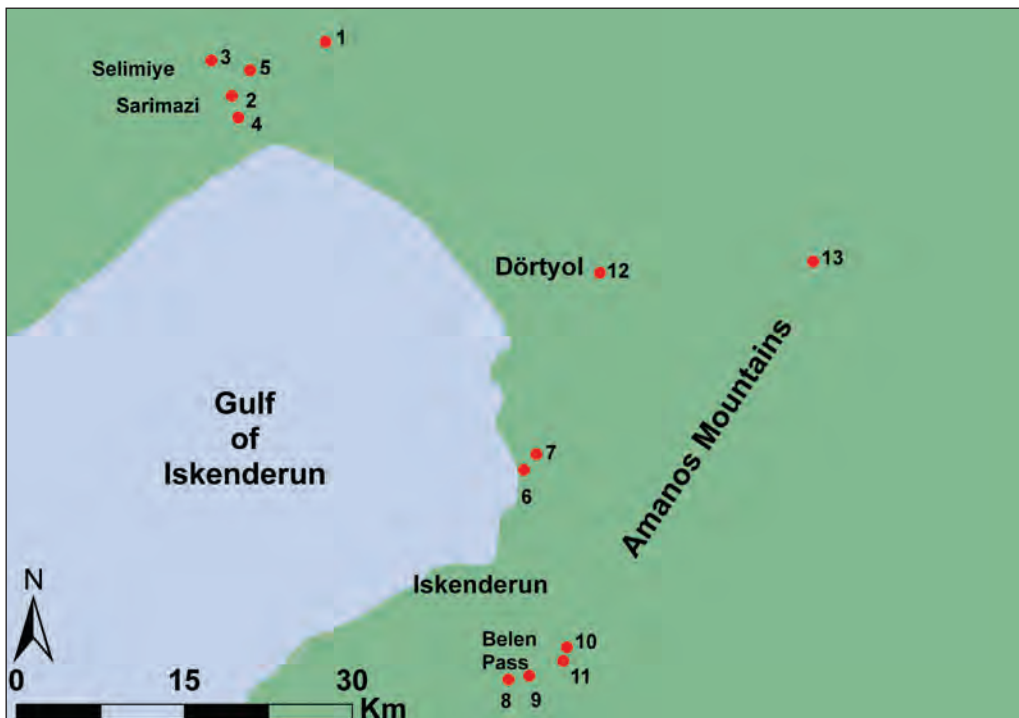


Figure 1. Locations of observation points explored near the gulf of Iskenderun during September 2013. Coordinates for locations are presented in Table 1. Locations 2, 3, and 4 are the observation points that we recommend for long-term monitoring.

eu/en/map.html, accessed 5 April 2014) to identify likely good observation locations. The spatial separation between individual tracks was minimal at the northwestern tip of the gulf of Iskenderun, but birds appeared to cross the Amanos mountain range at various places (Figure 1). Although locations provided by satellite telemetry may contain location error of several hundred metres, and the precise flight path of birds is unknown when a location is only obtained every 2–4 hours, the satellite tracks provided useful guidance that supported previous observations in the area. Additional monitoring locations were identified based on our field observations, local topography and ease of access (Table 1).

Field data collection

After identifying potential monitoring stations, we used standard raptor migration monitoring guidelines (Bildstein *et al* 2007, Bildstein *et al* 2008, Farmer *et al* 2007) to record migratory raptors passing these locations. We monitored raptor migration 30 August–26 September 2013 between 09.00 and 17.00 h local time by scanning the sky and the horizon with the naked eye and 8 or 10× binoculars. We recorded all passing raptors with the exception of Common Kestrel *Falco tinnunculus*, because we observed mostly local breeders of this species. Local residents of other species that did not appear to migrate were also excluded. We recorded different age classes only for Egyptian Vulture, which was the focal species of this field study. Passing raptors were recorded continuously, and entered as hourly totals into a database.

We recorded cloud cover, temperature, wind speed and direction and barometric pressure for every 1 hour monitoring period using a handheld weather station (Kestrel 2500). In addition, we recorded the number of observers and the actual observation effort for every 1 hour monitoring period (excluding periods where weather or other conditions rendered observations impossible). Observer effort was allocated in accordance with an *a priori* expectation of migration volume, with 1–5 observers present at different monitoring stations. Birds that could not be identified with binoculars were identified using 30–60× spotting scopes, or were recorded as ‘unidentified raptors’ (Hull *et al* 2010). On days when multiple locations were monitored simultaneously, care was taken to avoid double-counting of Egyptian Vultures by matching time and location of flight paths from detailed observer records. It was not possible to record detailed flight trajectories for more abundant species, so we attempted to prevent double-counting large flocks by direct radio communication between adjacent observation points.

Data analysis and presentation

The goal of our exploratory work was to identify the most suitable monitoring locality for Egyptian Vulture migration. Therefore, much effort was spent locating potential monitoring sites, and counting passing raptors at different locations on different days. Because of the irregular monitoring schedule, all data collected must be seen as minimum numbers of birds migrating through the region. Due to the variable nature of migration, with very strong migration occurring during favourable weather (Mandel *et al* 2011, Shamoun-Baranes *et al* 2006), comparisons between sites that were surveyed on different days are potentially confounded because some sites may have appeared ‘poor’ because they were surveyed during ‘poor’ conditions. We attempted to monitor migration for several days at each site to avoid misjudging sites based on low sampling effort.

RESULTS

We explored 13 different potential monitoring locations that provided good observation opportunities (Figure 1). They ranged in elevation from 123–1696 m (Table 1). The best observation sites for Egyptian Vultures (Plate 1) were north of the gulf of Iskenderun,

Table 1. Coordinates (decimal degrees, WGS84 datum), elevation, observation effort (duration of observations) and total number of migrating raptors observed in autumn 2013 at 13 different locations near the gulf of Iskenderun, Turkey (Figure 1).

location	latitude °N	longitude °E	elevation (m asl)	effort (h)	no. raptors
1	37.02	36.06	464	30.4	5527
2	36.97	35.99	218	123.0	18 934
3	37.00	35.97	265	77.1	2516
4	36.96	35.99	207	94.7	30 642
5	36.99	36.00	174	8.3	1065
6	36.67	36.22	123	3.0	7
7	36.68	36.23	350	3.2	15
8	36.50	36.21	904	24.7	3533
9	36.51	36.23	1125	6.0	154
10	36.53	36.26	1451	3.0	3
11	36.52	36.26	1696	1.3	35
12	36.83	36.28	855	7.0	239
13	36.84	36.46	1477	1.5	35

where we also observed the highest migration volume of all raptors combined (locations 2 and 4, Table 1). Birds appeared to approach from the west or southwest, and clearly avoided the water crossing over the gulf. Because the landscape north of the gulf is fairly flat with a few rolling hills, birds flew at low to intermediate altitudes (<1000 m) and were generally easy to detect as they utilised updrafts or thermals over dark surfaces like volcanic rock or dark agricultural fields.

A total of 552 Egyptian Vultures were observed (366 adults, 149 juveniles, 37 immatures) over the one month of our observations. The most commonly recorded raptor species were Lesser Spotted Eagle *Clanga pomarina*, Levant Sparrowhawk *Accipiter brevipes* and European Honey Buzzard *Pernis apivorus* (Table 2). For most species our count exceeded the numbers recorded by Sutherland & Brooks (1981) at Belen pass in 1976, despite considerably lower monitoring effort (Table 2).

The rate at which Egyptian Vultures passed observation points situated along or in the Amanos mountain range was generally lower than north of the gulf. We observed Egyptian Vultures crossing the mountain range at four different places (locations 8, 11–13, Table 1, Figure 1), including passes and ridges exceeding 1500 m in elevation. The observation point with the highest number of Egyptian Vultures per unit time was along the road between Hassa and Dörtyol (location 13, Table 1, Figure 1), where we observed 16 Egyptian Vultures in a single afternoon on 8 September. The pass was situated at 1477 m, and birds approached from the WNW, flying 200–400 m above ground. Unfortunately,



Plate 1. Juvenile Egyptian Vulture *Neophron percnopterus* above Sarimazi, Hatay, Turkey, September 2013. © Georgi Gerdzhikov

Table 2. Summary of observed raptors at Belen pass in 1976 (Sutherland & Brooks 1981) and 2000 (Can 2001) and at our observation sites around the gulf of Iskenderun in 2013 (this study). Note that due to different locations and observation effort (given in hours) differences in numbers between years cannot be interpreted as changes in population size.

Species	Scientific name	2013 (383 h)	2000 (440 h)	1976 (689 h)
Lesser Spotted Eagle	<i>Clanga pomarina</i>	22 197	14 041	3875
Levant Sparrowhawk	<i>Accipiter brevipes</i>	15 701	2739	2951
European Honey Buzzard (Plate 2)	<i>Pernis apivorus</i>	11 354	9627	15 971
Short-toed Snake Eagle (Plate 3)	<i>Circaetus gallicus</i>	6257	1648	727
Common Buzzard	<i>Buteo buteo</i>	4010	1434	207
Booted Eagle	<i>Hieraetus pennatus</i>	1028	89	588
Black Kite	<i>Milvus migrans</i>	556	56	506
Egyptian Vulture	<i>Neophron percnopterus</i>	552	45	874
Red-footed Falcon	<i>Falco vespertinus</i>	243	0	2
Western Marsh Harrier	<i>Circus aeruginosus</i>	143	26	31
Eurasian Sparrowhawk (Plate 4)	<i>Accipiter nisus</i>	73	41	11
Eurasian Hobby	<i>Falco subbuteo</i>	71	6	11
Long-legged Buzzard	<i>Buteo rufinus</i>	37	0	2
Peregrine Falcon	<i>Falco peregrinus</i>	32	9	0
Montagu's Harrier	<i>Circus pygargus</i>	16	6	27
Eastern Imperial Eagle	<i>Aquila heliaca</i>	5	0	0
Bonelli's Eagle	<i>Aquila fasciata</i>	4	0	3
Great Spotted Eagle	<i>Clanga clanga</i>	4	2	0
Eurasian Griffon Vulture	<i>Gyps fulvus</i>	2	5	15
Pallid Harrier	<i>Circus macrourus</i>	2	0	4
Saker Falcon	<i>Falco cherrug</i>	2	0	1
Lesser Kestrel	<i>Falco naumanni</i>	1	4	0
Red Kite	<i>Milvus milvus</i>	1	0	0
Western Osprey	<i>Pandion haliaetus</i>	1	2	6
Steppe Eagle	<i>Aquila nipalensis</i>	1	0	0
Hen Harrier	<i>Circus cyaneus</i>	0	11	1

the road leading to that pass from the gulf was in extremely poor condition and we were unable to visit this site again. It is therefore unclear whether this pass is a regularly used migration flyway through the mountain range.

Weather played an important role in determining the location of raptor concentrations. On sunny days with no cloud cover very few birds flew through the Belen pass, but when clouds obscured the top of the mountain range to the north, many more birds migrated through the pass. The influence of weather was also apparent on the northern side of the gulf of Iskenderun, where migration usually followed the coastline, but on days with heavy clouds occurring over the sea, migration volume was much higher at the site 8 km inland (location 3, Figure 1) than at the site near the coast (location 4, Figure 1).

Phenology of the most common species

The apparent peaks in migration of the two most numerous species were separated by about three weeks. European Honey Buzzards were most abundant at the end of August and early September (Figure 2), but our monitoring may have missed the actual peak of this species. In late August most European Honey Buzzards migrated towards the southeast, but there was a notable second peak at the end of September, with many European Honey Buzzards migrating southwest. This second peak coincided with the peak migration of Lesser

Spotted Eagles, which reached a maximum on 25 September with 6854 birds passing (Figure 2). Levant Sparrowhawks showed a phenology similar to Lesser Spotted Eagles, with most birds migrating at the end of September. The species was recorded in tight, whirling flocks of up to 770 individuals. Egyptian Vultures were recorded throughout our 4-week monitoring period, with a fairly broad migration peak spanning from 10–24 September, and a maximum of 81 birds on 12 September (Figure 2).

DISCUSSION

Potential for long-term raptor monitoring

We found raptor migration at the gulf of Iskenderun to be most concentrated around the northern extent of the gulf, rather than at Belen pass. Cameron *et al* (1967) and Sutherland & Brooks (1981) were aware that an unknown proportion of birds traversed the mountain range either via other mountain passes or at very high altitudes above Belen pass, and they noted that during clear and cloudless conditions the visible migration was substantially lower. Can (2001) reported a similar pattern with some days of very heavy migration at Belen pass followed by days without any visible migration and highly variable migration volume. The sites where we made our observations at the northern end of the gulf exhibited much lower daily fluctuations in migration volume, and therefore appeared to be much less susceptible to stochastic weather influences than observation sites located in the mountains.

In addition, our observations at other mountain passes (locations 10, 12, 13, Figure 1) indicate that Egyptian Vultures cross the Amanos mountain range at several places, and counts at a single pass will therefore only capture a proportion of the migration. Because the proportion that is monitored may vary annually with weather conditions, long-term trends would be obscured by weather differences and highly variable migration volume recorded between years. The locations on the northern side of the gulf are therefore more suitable for long-term monitoring, as the horizontal displacement of migratory raptors

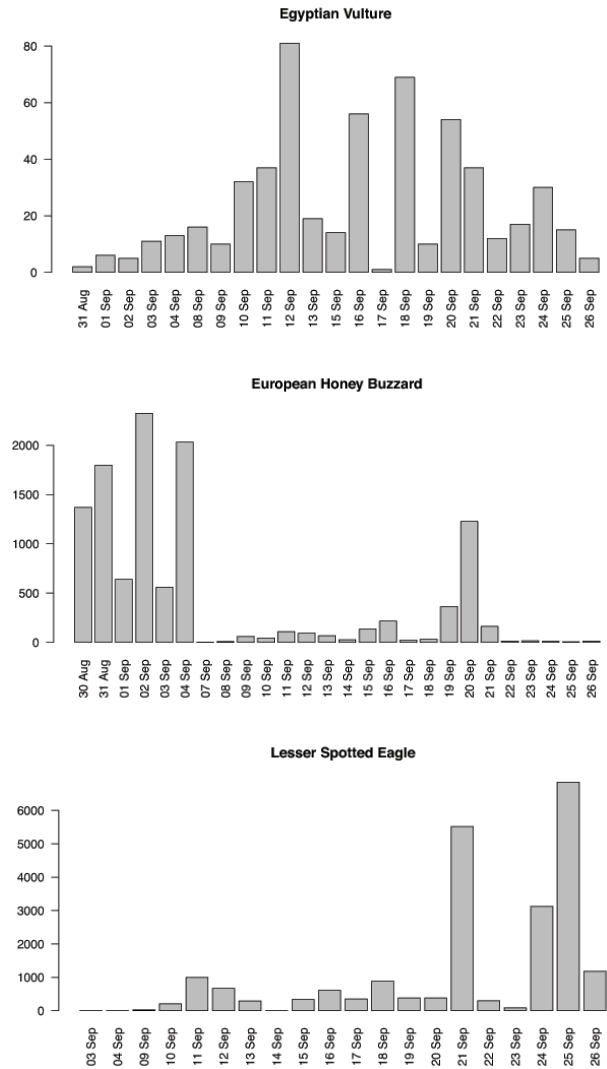


Figure 2. Migration phenology of Egyptian Vulture, European Honey Buzzard, and Lesser Spotted Eagle around the gulf of Iskenderun in September 2013. Numbers indicate daily totals for each species. Note that observation effort and location varied between days.



Plate 2. Flock of European Honey Buzzards *Pernis apivorus* above Sarimazi, Hatay, Turkey, September 2013. © Georgi Gerdzhikov

under varying weather conditions is small (<15 km) and fewer observation points (3) could likely cover the vast majority of the migratory flyway under a range of different weather conditions. Our choice of observation locations may explain why we observed 5–10 times as many Lesser Spotted Eagles, Short-toed Snake Eagles *Circaetus gallicus* and Levant Sparrowhawks as Sutherland and Brooks in 1976 at Belen pass (Table 2).

Raptor monitoring to detect changes in population size must be consistent over a period of at least 10 years (Lewis & Gould 2000). Based on our pilot work in 2013 it is unlikely that observations from a single location can adequately capture the raptor migration passing around the gulf of Iskenderun. Because raptors can cross the Amanos mountain range at different places, and weather will cause variation in migration travel routes, the most practical approach that will facilitate long-term comparisons would be to monitor the relatively narrow corridor on the northern side of the gulf of Iskenderun. We therefore recommend that future raptor monitoring efforts occur at three points around the villages of Sarimazi and Selimiye north of the gulf of Iskenderun (locations 2–4, Figure 1). These three points are separated by 2.0 km and 3.5 km, and permanent simultaneous monitoring of all three locations would facilitate the observation of a very large proportion of the migration volume under various weather conditions, similar to other migration monitoring stations (see Vansteelant *et al* 2014).

The length of the fall migration monitoring period will be determined by the focal species for which the monitoring is designed. Our pilot work did not cover the entire migration period for the Egyptian Vulture and several other species. We recommend that the time window to monitor the majority of the Egyptian Vulture migration would



Plate 3. Short-toed Snake Eagle *Circaetus gallicus* at Belen pass, Hatay, Turkey, September 2013. © Georgi Gerdzhikov



Plate 4. Juvenile Eurasian Sparrowhawk *Accipiter nisus* above Sarimazi, Hatay, Turkey, September 2013. © Georgi Gerdzhikov

span about two months, starting around mid August and extending into mid-late October (Sutherland & Brooks 1981), but future work may provide information to refine this period.

Recording the migration of all raptor species during this migration period is feasible if there are sufficient observers at each of the three observation points. To add other soaring birds, such as storks, pelicans, spoonbills *etc* to the species inventory may either distract observers or may require additional observers. During peak times, when migration is intense (European Honey Buzzard early September, Lesser Spotted Eagle late September) it may be useful to exclude from the monitoring low priority species that pass in large numbers (European Honey Buzzard, Levant Sparrowhawk, Lesser Spotted Eagle), if the key goal of the monitoring is to obtain an accurate count of Egyptian Vultures. We recommend that staffing levels at observation sites reflect the species selected for long-term monitoring, but that during peak migration periods each site is staffed by at least three observers. Thus, the long-term monitoring we recommend for estimating population trends of Egyptian Vultures and a number of other raptors will require 10 observers for a period of two months annually.

Comparison of migration patterns recorded in 1976 and 2013

Because observation locations, methods and survey effort differed between our study and previous work, direct comparisons of total numbers cannot be interpreted as changes in population sizes of individual species. Nonetheless, we can draw some general conclusions from comparing the numbers of raptors observed at Belen pass in 1976 (Sutherland & Brooks 1981) and in the wider region in 2013 (this study). For most species, our survey recorded a larger number of birds despite lower observation effort (Table 1), which may be mostly due to many birds not migrating through Belen pass under certain

weather conditions. However, for two species, European Honey Buzzard and Egyptian Vulture, we recorded substantially fewer birds.

The lower number of European Honey Buzzards observed in our study is most likely the result of our observations commencing rather late (29 August), and our focus on exploration for good observation sites during the first part of September. European Honey Buzzards are known to migrate relatively early and the migration peak around the Black sea as well as at the Bosphorus is in late August and early September (Michev *et al* 2011, Nisbet & Smout 1957, Porter & Willis 1968, Vansteelant *et al* 2014) and in the first half of September in Israel (Leshem & Yom-Tov 1996) and Egypt (Hilgerloh *et al* 2011). Our survey may have missed a substantial proportion of the migration of European Honey Buzzards due to our late start date.

For the Egyptian Vulture, our numbers allow two broad conclusions. First, the much lower number of Egyptian Vultures recorded during this study compared with the number recorded at Belen pass in 1976 is in line with studies in the Balkans that have documented a strong population decline of the species over the past decades (Andevski 2012, Nisbet & Smout 1957). Second, despite this population decline in the Balkans, the number of observed Egyptian Vultures in 2013 vastly exceeded the number of known territorial pairs in FYR Macedonia (22), Bulgaria (26) and Greece (12) (LIFE+ Project 'The Return of the Neophron' unpubl data). Thus, we conclude that the Egyptian Vulture population in western Turkey is substantially larger than that occurring in the Balkans, and this is consistent with the findings of Cameron *et al* (1967) in the mid 1960s. We highly recommend that more intensive studies such as migration, breeding territory and nest monitoring are undertaken to elucidate the size and demographic parameters of the Egyptian Vulture population in western Turkey.

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Steffen Oppel, RSPB Centre for Conservation Science, Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK. steffen.oppel@rspb.org.uk

Petar Iankov, Saniye Mumun, Georgi Gerdzhikov, Mihail Iliev, Bulgarian Society for the Protection of Birds, Compl. Yavorov, bl.71, BG-1111 Sofia, Bulgaria

Süreyya İsfendiyaroğlu, Çan Yeniyurt, Evrim Tabur, Doğa Derneği, Mebusan Yokuşu, Alçakdam Yokuşu 24/3 Fındıklı. Beyoğlu / İstanbul, Turkey