Italian Journal of Zoology

ISSN: 1125-0003 (Print) 1748-5851 (Online) Journal homepage: http://www.tandfonline.com/loi/tizo20

Factors affecting the visible southbound migration of raptors approaching a water surface

N. Agostini, A. Scuderi, G. Chiatante, G. Bogliani & M. Panuccio

To cite this article: N. Agostini, A. Scuderi, G. Chiatante, G. Bogliani & M. Panuccio (2015) Factors affecting the visible southbound migration of raptors approaching a water surface, Italian Journal of Zoology, 82:2, 186-193, DOI: 10.1080/11250003.2015.1009404

To link to this article: http://dx.doi.org/10.1080/11250003.2015.1009404

Published online: 12 Feb 2015.

Italian Journal of Zoology, 2015, 186–193
Vol. 82, No. 2, http://dx.doi.org/10.1080/11250003.2015.1009404

Factors affecting the visible southbound migration of raptors approaching a water surface

N. AGOSTINI[1]*, A. SCUDERI[3], G. CHIATANTE[1,2], G. BOGLIANI[2], & M. PANUCCIO[1]

[1]*MEDRAPTORS (Mediterranean Raptor Migration Network), Rome, Italy,* [2]*Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Pavia, Italy, and* [3]*Via Giovanni XXIII 20, Moio Alcantara, ME, Italy*

(Received 29 March 2014; accepted 12 January 2015)

Abstract
We investigated the visible migration of raptors when approaching a water surface in relation to local wind conditions, time of the day and topography. Observations were made during autumn migration in 2011 and 2012 at a watchsite located in the southernmost part of the Calabrian Apennines (southern continental Italy). In this area, the Apennines show differential topographical features with a plateau west of the mountain ridge. West–southwest of the plateau lies the Straits of Messina, the narrowest water surface between southern continental Italy and eastern Sicily. The passage of migrants was recorded along the ridge of the mountain chain and over the plateau. As expected for a soaring raptor, European Honey Buzzards were detected mostly during midday and early afternoon, while significant numbers were seen toward sunset probably when flying at lower altitude to roost. In addition, they were detected during strong winds when exploiting deflection updrafts, avoiding wind drift and limiting the negative effect of head winds. Western Marsh Harriers were detected mostly during crosswinds blowing from W–NW, perhaps because of a partial drift effect on birds passing along the Tyrrhenian coast. Black Kites were seen concentrating the passage over the plateau, confirming the hypothesis that these raptors tend to move along the western slope of the Italian peninsula perhaps because of foraging behaviour. Finally, European Kestrels/Lesser Kestrels were seen toward the sunset. This result seems to confirm that these small falcons migrate at considerable altitudes resulting in them being hardly detectable by direct visual observation but becoming more visible toward sunset, when they were probably moving to roost.

Keywords: *Migration, raptor, topography, wind, Mediterranean*

Introduction

Most raptors depend on soaring/gliding flight during migratory movements. This flight strategy reduces energetic costs by exploiting thermals and deflection updrafts over land (Kerlinger 1989). Since thermals are very weak over water at Mediterranean latitudes, these species tend to avoid crossing large water surfaces and instead follow peninsulas and concentrate their passage through isthmuses and straits (Kerlinger 1989; Bildstein 2006). In addition, since stronger thermals form on terrains oriented perpendicular to solar radiation, they tend to concentrate along mountain ridges, especially when they are aligned along the axis of migration (Bildstein 2006). Several studies show that soaring migrants can fly at altitudes that make them impossible to detect by direct visual observation, especially at midday and during early afternoon when the rates of thermals increase. In addition, thermals are weaker during strong winds, when migrants can soar in deflection updrafts but at a lower altitude (Kerlinger 1989; Bildstein 2006; Panuccio et al. 2013a). Radar studies have shown that 80–90% of soaring birds are detected within 1000 m of the ground (Kerlinger et al. 1985; Kerlinger & Gautreaux 1985a, 1985b; Spaar 1995), but they are difficult to see at altitudes higher than 600 m (Kerlinger 1989). Some authors (Spaar 1995, 1997; Mateos-Rodriguez & Liechti 2012; Mellone et al. 2012) reported intraspecific and species differences concerning flight behaviour, reflecting size and morphology under different weather conditions, while recent research made by satellite tracking showed high flexibility in the routes used by each

*Correspondence: N. Agostini, MEDRAPTORS (Mediterranean Raptor Migration Network), Via Mario Fioretti 18, 00152 Rome, Italy. Email: nicolantonioagostini@gmail.com

individual (Vardanis et al. 2011; Mellone et al. 2012). Soaring raptors actively search for stronger thermals, use these thermals longer than weaker ones and can be attracted to geographical and topographical features that promote the formation of thermals (Kerlinger 1989). Each autumn, thousands of raptors migrate through southern continental Italy and Sicily en route to Africa (Agostini & Logozzo 1997) showing species-specific flyway patterns depending on their morphology and behaviour. However in the "toe" of the peninsula, routes of four species, the European Honey Buzzard (*Pernis apivorus*), Western Marsh Harrier (*Circus aeruginosus*), Black Kite (*Milvus migrans*) and European Kestrel/Lesser Kestrel (*Falco tinnunculus*/*Falco naumanni*) converge along the Calabrian Apennines, a mountain chain oriented along their direction of migration (NE–SW; Agostini & Logozzo 1997; Panuccio et al. 2005). In the southernmost portion in front of the Mediterranean Sea, the Apennines form a large area that has different topographical features with a plateau west of a mountain ridge. West–southwest of the plateau lies the Straits of Messina which is the narrowest water surface between southern continental Italy and eastern Sicily (Figures 1, 2). Since these features make this area suitable for a study of migration of raptors having a different dependence on soaring flight and showing a different tendency to cross water surfaces (Kerlinger 1989), we investigated the visible migration of these species in relation to topography, local wind conditions and time of day to verify eventual species-specific effects.

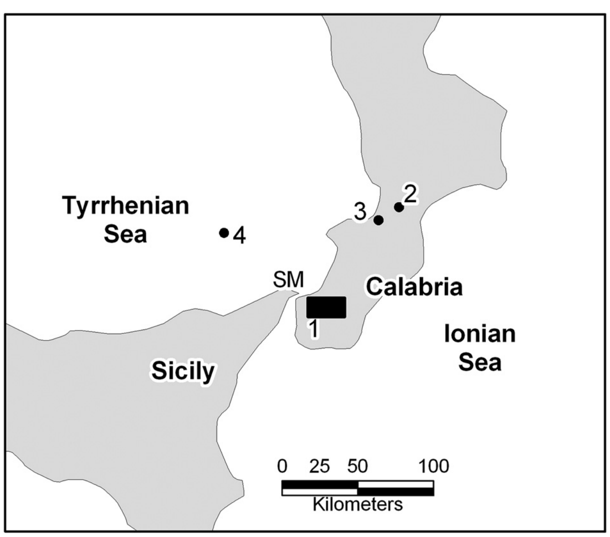

Figure 1. Location of the study area (1; the black rectangle) in southern continental Italy (SM = Strait of Messina; 2 = Mount Covello; 3: Lake Angitola; 4 = Panarea).

Study area and methods

Observations were made from 23 August to 10 October 2011 and from 12 August to 10 October 2012, with the aid of telescopes and binoculars. Three observation posts (P1, P2 and P3) were used during the fieldwork, with two located in the Aspromonte National Park (P1 at Contrada Nino Martino: 38°09′44.41″N, 15°52′36.64″E, altitude 1807 m above sea level (a.s.l.); P2 at Piano delle Casine: 38°12′57.77″N, 15°52′17.98″E, altitude 1052 m a.s.l.) and one about 5 km inland of the Tyrrhenian coast (P3 at Contrada Zagarella 38° 13′05.12″N, 15°46′50.90″E, altitude 987 m. a.s.l.; Figure 2). Two observers monitored the migration at each post. A flat zone (Gioia Tauro plain) lies north of the study area. P1 is located along the ridge of the mountain chain, while the other two posts are on the Aspromonte plateau, but the central one (P2) is closest to the western slope of the ridge (Figure 2). As a result, we divided the study area into two topographic zones. We defined passage along the mountain ridge as the raptors observed from P1 and the raptors passing east of P2, and passage over the plateau as the raptors seen overhead or passing west of P2 and the raptors reported from P3 (inland of the narrowest point of the Straits of Messina). Woodlands and agricultural fields dominate the mountain chain and the plateau, respectively. Each day, observations were made simultaneously at these three posts. The inability to recognize European Kestrels and Lesser Kestrels in the field, with rare exceptions, forced observers to create the category European Kestrel/Lesser Kestrel, as shown in Table I. Having similar flight characteristics (Bruderer & Boldt 2001), these species show the same dependence on soaring flight and the same tendency to cross water surfaces (Kerlinger 1989). Considering, however, that over 10,000 Lesser Kestrels, mainly nesting in southern continental Italy, are expected during the autumn migration through the study area (Palumbo 1997; BirdLife International 2004), it is conceivable that almost all raptors included in this category were Lesser Kestrels. Data recorded at each post were compared with data from the other posts according to the time and location of the birds' passage, to eliminate the possibility of double-counting the same birds (Dovrat 1991; Shirihai et al. 2000; Panuccio et al. 2010). To investigate the circadian pattern of migration, each observation day was divided into nine time slots; eight of which lasting 1-hour, between 08:00 and 15:59, and the final lasting from 16:00 to the end of observations, which were about 1 hour before sunset (solar time). In the statistical

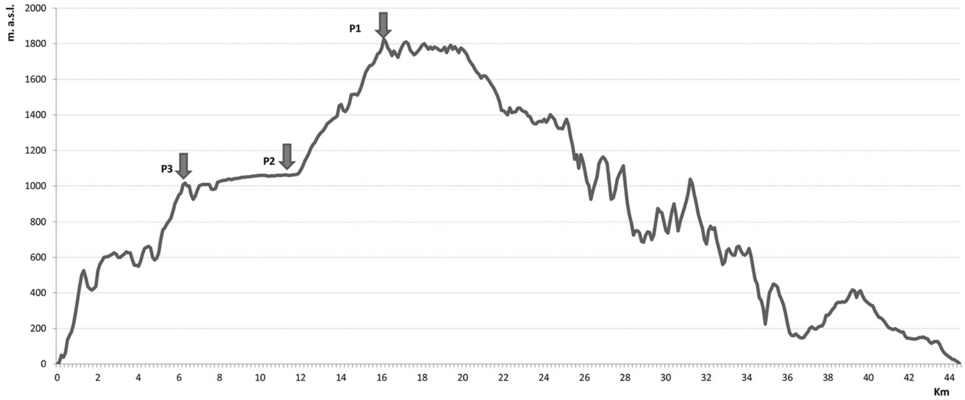

Figure 2. Topographical features of the study area in southern continental Italy; a.s.l. = above sea level.

Table I. Factors affecting (in boldface) the visible migration of raptors in the study area.

Explanatory term	F value	P	df
European Honey Buzzard			
Time of day	**2.124**	**0.032**	**8**
Topographic zone	0.035	0.851	1
Wind direction	2.324	0.074	3
Wind strength	**12.312**	**< 0.001**	**1**
Western Marsh Harrier			
Time of day	1.798	0.075	8
Topographic zone	0.519	0.472	1
Wind direction	**5.316**	**0.001**	**3**
Wind strenght	3.103	0.079	1
Black Kite			
Time of day	0.660	0.725	8
Topographic zone	**4.451**	**0.038**	**1**
Wind direction	0.990	0.401	3
Wind strength	0.274	0.602	1
European Kestrel/Lesser Kestrel			
Time of day	**2.143**	**0.034**	**8**
Topographic zone	0.037	0.848	1
Wind direction	2.332	0.076	3
Wind strength	1.000	0.319	1

analysis, we used generalized linear models (GLM) with negative binomial, quasi-Gaussian or Poisson distributions according to the data distribution, after logarithmic transformation of the original data when necessary. In order to keep our analysis as conservative as possible, we did not consider hours in which no raptors were reported, since this could have been related to factors occurring outside our study area (Panuccio et al. 2010). The observed number of raptors was explained by the time of day, wind direction and topographic zones, used as categorical variables, and by wind strength, used as a continuous variable. In particular, we considered four wind directions: a lateral component from W–NW, a lateral component from E–SE, a tail component (from N–NE), and a head component (from S–SW). We checked the statistical power of each model by verifying the normal distribution of the residuals of the models. Finally, we considered the passage of raptors during the peak periods (European Honey Buzzards: 23 August–12 September; Western Marsh Harrier: 6 September–4 October; Black Kites: 12–31 August; Kestrel/Lesser Kestrel 16 September–10 October (Agostini 2002). Wind data at 1500 m. a.s.l. during the observation period of each species were obtained from the NCEP/NCAR (National Centers of Environmental Prediction/National Center for Atmospheric Research) reanalysis project (NOAA/OAR/ESRL PSD, Boulder, CO, USA, http://www.esrl.noaa.gov/psd/; National Oceanic and Atmospheric Administration/Oceanic and Atmospheric Research/Earth System Research Laboratory, Physical Sciences Division).

Results and discussion

During the peak periods, we reported a total of 17.197 (8.094 in 2011, 9.103 in 2012) European Honey Buzzards passing through the study area. The visible migration was positively affected by wind strength (Estimate = 0.014143) and the time of day (Table I); in particular, higher numbers of migrants were detected at midday and early afternoon between the third and the sixth time slots (10:00–13:59; estimate = 0.290090, 0.257389, 0.332949, 0.385220) and during the last period of observation (between 16:00 and the end of observations; estimate = 0.371807; Figure 3). European Honey Buzzards mostly use soaring/gliding flight during migration to reduce energetic costs (Kerlinger 1989). For this reason, as mentioned above, we expected that they would concentrate

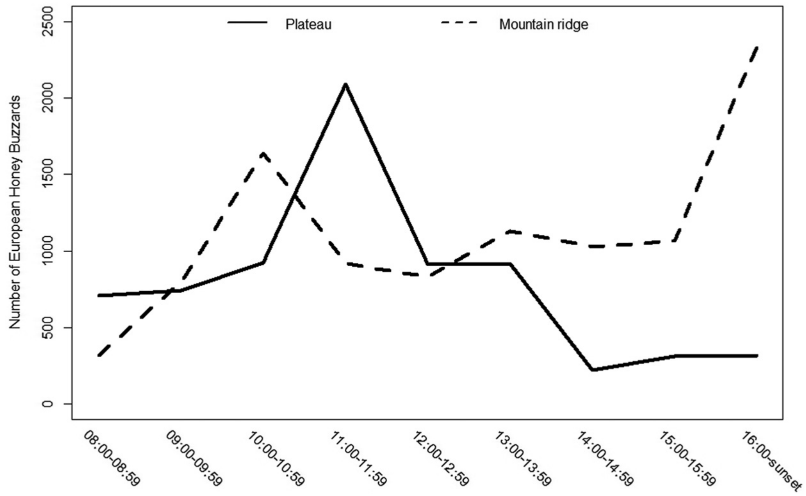

Figure 3. Number of European Honey Buzzards migrating throughout the day over the plateau (N = 7.139) and along the mountain ridge (N = 10.058).

their passage along the ridge of the mountain chain, where thermals are stronger. However, topography did not affect their visible passage. The age of migrants, with nearly all individuals being adults during the peak passage (Agostini & Logozzo 1997), could explain this result. As a matter of fact, adult European Honey Buzzards are expected to cross the sea between southern continental Italy and eastern Sicily at the Straits of Messina located W–SW of the plateau (Agostini 2004). After reaching eastern Sicily, they head towards western Sicily and cross the sea at the Channel of Sicily that is the narrowest crossing point of the central Mediterranean (approx. 150 km wide; Figure 4). This route largely retraces their spring movements (Agostini & Panuccio 2005) revealing their navigational ability, which allows buzzards to avoid longer water crossing between southern Sicily and North Africa (Agostini 2004). As a result, when passing through southern continental Italy, large numbers of buzzards probably tend to leave the mountain ridge heading towards the Straits when they are north of the study area by passing over the Aspromonte plateau. The visible passage of European Honey Buzzards was positively affected by wind strength. During strong wind conditions, thermals are weaker and migrants that soar in deflection updrafts are more visible to observers on the

Figure 4. Approximate flyways across the central Mediterranean used by adult European Honey Buzzards and Black Kites (solid arrows) and Western Marsh Harriers and European Kestrels/Lesser Kestrels (sketched arrow) passing through southern continental Italy.

ground, because they are flying at lower altitudes and at lower speeds (Bildstein 2006; Duerr et al. 2012). In addition, a study made in an isthmus area in southern continental Italy (Mount Covello; Figure 1) has shown that adults of this species tend to migrate at a lower altitude in strong crosswinds, which limits the use of soaring flight, probably in order to compensate for drift effects (Panuccio et al. 2010). It is interesting to note that, in our study, wind direction did not affect the visible migration of the European Honey Buzzard. In particular, crosswinds did not influence their visible migration, confirming the ability of this species to compensate for the wind drift. Moreover, it was expected that winds with a tail component, from N–NE, had a positive effect on migration counts and the opposite effect for head winds (from S–SW; Kerlinger 1989). Our results suggest that raptors migrated at higher altitudes to optimize the use of soaring/gliding flight to increase their travel speed during favourable (tail) winds and would often pass undetected. Conversely, during unfavourable (head) winds, they perhaps flew at lower altitude to limit the negative impact on the travel speed. Finally, as expected for a soaring bird, larger numbers of European Honey Buzzards were detected during midday and early afternoon (between 10:00 and 14:00 h) when optimal conditions for soaring flight occur, and during the last observation period of the day when birds were probably flying at lower altitudes and moving to roost in the forest on the mountain ridge (Figure 3).

The visible migration of Western Marsh Harriers (N = 5.031 during the peak periods; 2.708 in 2011 and 2.323 in 2012) was positively affected by wind direction, in particular by W–NW winds (Estimate = 0.207453; Figure 5), while wind strength, topography and time of day did not affect their visible passage (Table I). During migration, Western Marsh Harriers, like other harriers, are less dependent on soaring flight than most Accipitriformes (Spaar & Bruderer 1997). In particular, when using powered flight, energy consumption is less expensive for Western Marsh Harriers than other raptor species (Panuccio et al. 2013b), allowing them to undertake long sea crossings during both spring and autumn movements (Agostini & Panuccio 2010; Panuccio 2011; Figure 4). As a result, this species is less affected by thermal conditions and time of day when migrating over land (Panuccio et al. 2005). In particular, Spaar and Bruderer (1997) observed harriers increasing flight altitudes throughout the day culminating toward sunset, unlike typical soaring birds (e.g., the European Honey Buzzard). Simultaneous

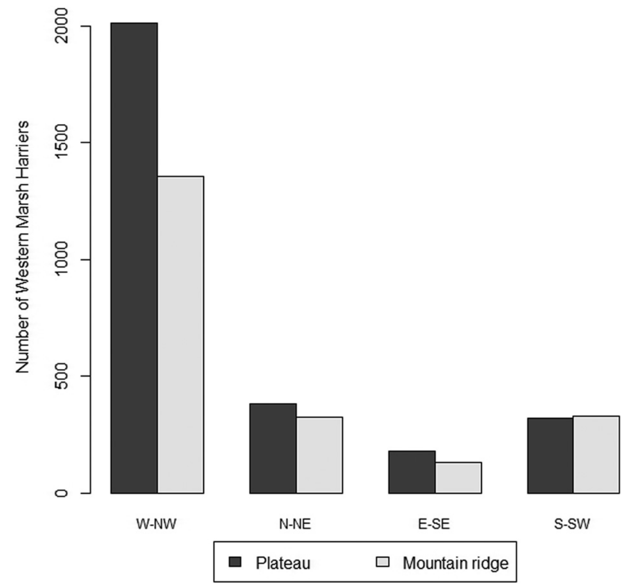

Figure 5. Western Marsh Harriers seen per hour during different wind conditions (W–NW: N = 448; N–NE: N = 158; E–SE: N = 92; S–SW: N = 238) over the plateau and along the mountain ridge.

observations made in autumn at P2 and over Panarea (a small volcanic island about 65 km NW off the Strait of Messina; Figure 1), in 2004, recorded the passage of comparable numbers of Western Marsh Harriers over land and over water moving parallel to NE–SW flyways, independently of the direction of crosswinds as reported in other Mediterranean areas (Panuccio et al. 2002, 2005, 2013b; Agostini et al. 2003). Using NE–SW flyways, harriers passing through southern continental Italy are expected to bypass the Straits of Messina, head towards southern Sicily and cross the Central Mediterranean at its widest point while concentrating over the island of Malta (Figure 4; Agostini et al. 2003; Sammut & Bonavia 2004). In this picture, their passage both over the plateau and along the mountain ridge could be related to their flight style since these raptors actively search less for thermal currents. In addition, the positive influence of crosswinds from W–NW on the number of birds detected in the study area could suggest at least a light drift effect on birds passing along the Tyrrhenian coast. Being a species that migrates on a broad front, both over land and over water, Western Marsh Harriers often leave the drift effect of crosswinds, as has already been observed in southern Greece (Panuccio et al. 2013b). A recent study realized by the means of satellite telemetry has shown that Western Marsh Harriers allow about a 47% drift (Klaassen et al. 2011).

A total of 1.702 Black Kites were reported during the peak periods (470 in 2011 and 1.232 in 2012). The topographic zone was the only factor affecting the visible passage of Black Kites through the study area. In particular, these raptors were seen mostly over the plateau (Table I; estimate (mountain ridge)- = −0.271556). This result confirms the hypothesis that large numbers of Black Kites migrate following the western coast of the Italian peninsula (Panuccio et al. 2005). In agreement with this conclusion, over 700 Black Kites have been reported in sporadic observations made in the area around Lake Angitola, located a few tens of kilometers north of the study area towards the Tyrrhenian coast, between 12 and 20 August 2011 (Condello 2013; Figure 1). Since Black Kites are regularly seen foraging at rubbish dumps (Blanco 1994, 1997) or hunting around burning fields during migration, Panuccio et al. (2005) suggested that most birds migrating along the Italian peninsula could perhaps choose to move onto flat areas close to the Tyrrhenian coast where they can find suitable feeding areas en route to Africa (Panuccio et al. 2014). As a matter of fact, many pairs of this species breed along the Tyrrhenian slope of central Italy (Brichetti et al. 1992). In addition to others, such as adult European Honey Buzzards, Black Kites are expected to cross the sea between southern continental Italy and eastern Sicily at the Strait of Messina en route to the Channel of Sicily (Agostini et al. 2000, 2004, 2005).

European Kestrel/Lesser Kestrels (N = 1.389 during the peak periods; 753 in 2011 and 639 in 2012) were seen mostly during the last observation period of the day (estimate = 1.13796; Figure 6). Little is known about the migratory habits of these species. A recent study made by satellite telemetry has shown that the Lesser Kestrel is not affected by tail wind during migration but is highly drifted by crosswinds (Limiñana et al. 2013). They both migrate on a broad front and undertake long water crossings flying also during the night, having morphological wing characteristics which are not linked to the exploitation of thermal currents (Kerlinger 1989; Limiñana et al. 2012). In particular, kestrels passing through southern continental Italy are expected to cross the Mediterranean Sea between southern Sicily and Libya (Agostini 2002; Figure 4). It has been speculated that these raptors migrate at considerable altitudes resulting in them being hardly detectable by direct visual observation during the crossing of large water surfaces (Beaman et al. 1974). Our results seem to confirm this conclusion, since European Kestrels/Lesser Kestrels were visible mostly toward sunset when they were probably moving to roost and were flying at a lower altitude.

In conclusion, local wind conditions, the time of the day, topographical features, and geography had species-specific effects on migration patterns and the detectability of raptors passing through the "toe" of the Italian peninsula. In particular, different flight styles, water crossing tendencies and foraging behaviour during migration (in the case of Black Kites) seem to play a role in shaping the pattern of movements of these species and probably affect migration counts.

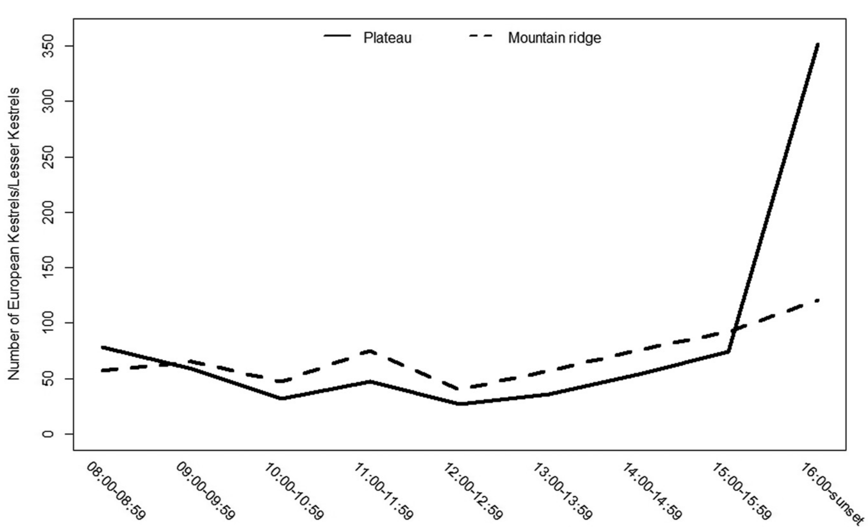

Figure 6. Number of European Kestrels/Lesser Kestrels migrating throughout the day over the plateau (N = 759) and along the mountain ridge (N = 630).

Acknowledgements

We wish to thank MEDRAPTORS (www.raptormigration.org), a network of ornithologists involved in the research and the protection of migrating birds of prey through specific projects and observation camps. We appreciate the improvements in English usage made by Peter Lowther through the Association of Field Ornithologists' program of editorial assistance, and by Kelsey Horvath. Finally, we wish to thank Eugenio Muscianese, Manuela Policastrese, Elena Grasso, Giuseppe Camelliti, Francesco Polimeni, Andrea Ciulla, Giuseppe Martino, Domenico Vitale, Ivan Zavettieri, Renzo Ientile and Giuseppe Signorino for their help during observations. Data collection as part of the monitoring activity of the post-reproductive migration of raptors in the Aspromonte National Park, seasons 2011–2012, was planned and financed by the *Ente Nazionale Parco dell'Aspromonte*.

References

Agostini N. 2002. La migrazione dei rapaci in Italia. In: Brichetti P, Gariboldi A, editors. Manuale di Ornitologia. Vol. 3. Bologna: Edagricole-Il Sole 24 Ore. pp. 157–182.

Agostini N. 2004. Additional observations of age-dependent migration behaviour in western honey buzzards *Pernis apivorus*. Journal of Avian Biology 35:469–470. doi:10.1111/j.0908-8857.2004.03450.x.

Agostini N, Coleiro C, Panuccio M. 2003. Autumn migration of Marsh Harriers (*Circus aeruginosus*) across the Central Mediterranean in 2002. Ring 25:47–52. doi:10.2478/v10050-008-0073-3.

Agostini N, Logozzo D. 1997. Autumn migration of Accipitriformes through Italy en route to Africa. Avocetta 21:174–179.

Agostini N, Logozzo D, Panuccio M. 2000. The island of Marettimo (Italy), important bird area for the autumn migration of raptors. Avocetta 24:95–99.

Agostini N, Panuccio M. 2005. Analysis of the spatial migration patterns of adult Honey Buzzards (*Pernis apivorus*) during spring and autumn in the Central Mediterranean. Ring 27:29–34. doi:10.2478/v10050-008-0018-x.

Agostini N, Panuccio M. 2010. Western Marsh Harrier (*Circus aeruginosus*) migration through the Mediterranean Sea: A review. Journal of Raptor Research 44:136–142. doi:10.3356/JRR-09-48.1.

Agostini N, Premuda G, Mellone U, Panuccio M, Logozzo D, Bassi E, Cocchi L. 2004. Crossing the sea en route to Africa: Autumn migration of some Accipitriformes over two central Mediterranean islands. Ring 26:71–78. doi:10.2478/v10050-008-0062-6.

Agostini N, Premuda G, Mellone U, Panuccio M, Logozzo D, Bassi E, Cocchi L. 2005. Influence of wind and geography on orientation behavior of adult Honey Buzzards *Pernis apivorus* during migration over water. Acta Ornithologica 40:71–74. doi:10.3161/068.040.0101.

Beaman M, Galea C. 1974. The visible migration of raptors over the Maltese Islands. Ibis 116:419–431. doi:10.1111/j.1474-919X.1974.tb07643.x.

Bildstein K. 2006. Migrating raptors of the world: Their ecology and conservation. New York, NY: Cornell University Press, Ithaca.

BirdLife International. 2004. Birds in Europe: Population estimates, trends and conservation status. BirdLife Conservation series No. 12. Cambridge, UK: BirdLife International.

Blanco G. 1994. Seasonal abundance of Black Kites associated with the rubbish dump of Madrid, Spain. Journal of Raptor Research 28:242–245.

Blanco G. 1997. Role of refuse as food for migrant, floater and breeding Black Kites (*Milvus migrans*). Journal of Raptor Research 31:71–76.

Brichetti P, De Franceschi P, Baccetti N. 1992. Fauna d'Italia. Aves I. Bologna: Edizioni Calderini.

Bruderer B, Boldt A. 2001. Flight characteristics of birds: I. radar measurements of speeds. Ibis 143:178–204. doi:10.1111/j.1474-919X.2001.tb04475.x.

Condello EG. 2013. La migrazione post-riproduttiva del Nibbio bruno *Milvus migrans* attraverso un'area collinare del versante tirrenico calabrese. Alula 20:126–130.

Dovrat E. 1991. The Kafr Quassem raptor migration survey, autumns 1977-1987: A brief summary. In: Yekutiel D, editor. Raptor in Israel: Passage and wintering populations. International Birdwatching Center Eilat. pp. 13–30.

Duerr AE, Miller TA, Lanzone M, Brandes D, Cooper J, O'Malley K, Maisonneuve C, Tremblay J, Katzner T. 2012. Testing an emerging paradigm in migration ecology shows surprising differences in efficiency between flight modes. PLoS ONE 7:e35548. doi:10.1371/journal.pone.0035548.

Kerlinger P. 1989. Flight strategies of migrating hawks. Chicago, IL: University of Chicago Press.

Kerlinger P, Bingman VP, Able KP. 1985. Comparative flight behaviour of migrating hawks studied with tracking radar during autumn in central New York. Canadian Journal of Zoology 63:755–761. doi:10.1139/z85-110.

Kerlinger P, Gautreaux SA. 1985a. Flight behavior of raptors during spring migration in south Texas studied with radar and visual observations. Journal of Field Ornithology 56:394–402.

Kerlinger P, Gautreaux SA. 1985b. Seasonal timing, geographic distribution, and flight behavior of Broad-winged Hawks during spring migration in south Texas: A radar and visual study. Auk 102:735–743.

Klaassen RHG, Hake M, Strandberg R, Alerstam T. 2011. Geographical and temporal flexibility in the response to crosswinds by migrating raptors. Proceedings of the Royal Society B: Biological Sciences 278:1339–1346. doi:10.1098/rspb.2010.2106.

Limiñana R, Romero M, Mellone U, Urios V. 2012. Mapping the migratory routes and wintering areas of Lesser Kestrels *Falco naumanni*: New insights from satellite telemetry. Ibis 154:389–399. doi:10.1111/j.1474-919X.2011.01210.x.

Limiñana R, Romero M, Mellone U, Urios V. 2013. Is there a different response to winds during migration between soaring and flapping raptors? An example with the Montagu's harrier and the lesser kestrel. Behavioral Ecology and Sociobiology 67:823–835. doi:10.1007/s00265-013-1506-9.

Mateos-Rodriguez M, Liechti F. 2012. How do diurnal long-distance migrants select flight altitude in relation to wind? Behavioral Ecology 23:403–409. doi:10.1093/beheco/arr204.

Mellone U, Klaassen RHG, García-Ripollés C, Limiñana R, López-López P, Pavón D, Strandberg R, Urios V, Vardakis M, Alerstam T. 2012. Interspecific comparison of the performance of soaring migrants in relation to morphology, meteorological conditions and migration strategies. PLoS ONE 7:e39833. doi:10.1371/journal.pone.0039833.

Palumbo G. 1997. Il Grillaio. Matera: Altrimedia Edizioni.
Panuccio M. 2011. Wind effects on visible raptor migration in spring at the Strait of Messina, Southern Italy. Journal of Raptor Research 45:88–92. doi:10.3356/JRR-10-16.1.
Panuccio M, Agostini N, Baghino L, Bogliani G. 2013a. Visible migration of Short-Toed Snake-Eagles: Interplay of weather and topographical features. Journal of Raptor Research 47:60–68. doi:10.3356/JRR-12-23.1.
Panuccio M, Agostini N, Lucia G, Mellone U, Wilson S, Ashton-Booth J, Chiatante G, Todisco S. 2010. Local weather conditions affect migration strategies of adult Western Honey Buzzards (*Pernis apivorus*) through an isthmus area. Zoological Studies 49:651–656.
Panuccio M, Agostini N, Massa B. 2002. Crossing the Tyrrhenian Sea: Spring migration of Marsh Harriers (*Circus aeruginosus)*, sex classes and relation to wind conditions. Vogelwarte 41:271–275.
Panuccio M, Agostini N, Mellone U. 2005. Autumn migration strategies of Honey Buzzards, Black Kites, Marsh and Montagu's harriers over land and over water in the Central Mediterranean. Avocetta 29:27–32.
Panuccio M, Agostini N, Mellone U, Bogliani G. 2014. Circannual variation in movement patterns of the Black Kite (*Milvus migrans migrans*): A review. Ethology, Ecology and Evolution 26:1–18. doi:10.1080/03949370.2013.812147.
Panuccio M, Chiatante G, Tarini D. 2013b. Two different migration strategies in response to an ecological barrier: Western Marsh Harriers and juvenile European Honey Buzzards crossing the central-eastern Mediterranean in autumn. Journal of Biological Research-Thessaloniki 19:10–18.
Sammut M, Bonavia E. 2004. Autumn raptor migration over Buskett, Malta. British Birds 97:318–322.
Shirihai H, Yosef R, Alon D, Kirwan G, Spaar R. 2000. Raptor migration in Israel and the Middle East. Eilat, Israel: International Birding & Research Centre.
Spaar R. 1995. Flight behavior of Steppe Buzzards (*Buteo buteo vulpinus*) during spring migration in southern Israel: A tracking radar study. Israel Journal of Zoology 41:489500.
Spaar R. 1997. Flight strategies of migrating raptors; a comparative study of interspecific variation in flight characteristics. Ibis 139:523–535. doi:10.1111/j.1474-919X.1997.tb04669.x.
Spaar R, Bruderer B. 1997. Migration by flapping or soaring: Flight strategies of Marsh, Montagu's and Pallid harriers in southern Israel. The Condor 99:458–469. doi:10.2307/1369952.
Vardanis Y, Klaassen RHG, Strandberg R, Alerstam T. 2011. Individuality in bird migration: Routes and timing. Biology Letters 7:502–505. doi:10.1098/rsbl.2010.1180.