

WESTERN MARSH HARRIER (*CIRCUS AERUGINOSUS*) MIGRATION THROUGH THE MEDITERRANEAN SEA: A REVIEW

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ABSTRACT.—The Western Marsh Harrier (*Circus aeruginosus*) is a summer visitor in northern, eastern, and central Europe. Some birds, mostly juveniles and adult females, winter in the Mediterranean region, while others cross the Sahara to winter in tropical Africa. Unlike other Accipitridae, which use primarily soaring flight over land during migration, Western Marsh Harriers tend to move on a broad front, with long, powered flights over water. In the last two decades, several researchers have investigated the migration of this species through the Mediterranean basin using direct observations, radar, band recovery data, and satellite telemetry. We here present a short review of these investigations and results.

KEY WORDS: *Western Marsh Harrier; Circus aeruginosus; Mediterranean; migration; orientation; water-crossing.*

MIGRACIÓN DE *CIRCUS AERUGINOSUS* SOBRE EL MAR MEDITERRÁNEO: UNA REVISIÓN

RESUMEN.—*Circus aeruginosus* visita el norte, este y centro de Europa durante el verano. Algunas aves, principalmente jóvenes y hembras adultas, pasan el invierno en la región mediterránea, mientras que otros cruzan el Sahara para pasar el invierno en África tropical. A diferencia de otros Accipitridae, que usan principalmente el vuelo elevado sobre áreas terrestres durante la migración, en *C. aeruginosus* los individuos tienden a moverse en un frente amplio y realizan vuelos largos e impulsados sobre el agua. En las últimas dos décadas, varios investigadores han estudiado la migración de esta especie en el Mediterráneo usando observaciones directas, datos de radar y de anillos recuperados, y telemetría satelital. Aquí presentamos una revisión corta de esas investigaciones y sus resultados.

[Traducción del equipo editorial]

The Western Marsh Harrier (*Circus aeruginosus*) is a partial migrant (Cramp and Simmons 1980). Unlike populations breeding in southern and western Europe, those breeding in northern, eastern, and central Europe are complete migrants. Some of these birds winter in the Mediterranean basin, while others cross the Sahara to winter in tropical Africa, with relatively few crossing the equator (Ferguson-Lees and Christie 2001). Marsh harriers have relatively long wings and, during migration, they frequently use powered flight (Spar and Bruderer 1997), undertaking the crossing of large bodies of water (Kerlinger 1989, Bildstein 2006). As a result, they tend to move on a broad front (Cramp and Simmons 1980, Gensbol 1992, Zalles and Bildstein 2000). In the last two decades, several researchers have investigated the migration of this species

through the Mediterranean basin using direct observations, radar, band recovery data, and, recently, satellite telemetry. In particular, Strandberg et al. (2008) reported satellite telemetry data of 33 migrations (20 autumn and 13 spring migrations) of 17 Western Marsh Harriers (eight adult females, six adult males and three juveniles) of the population breeding in southern Sweden. Here we provide a short review of these investigations.

AUTUMN MIGRATION

Peak Passage Date. The peak passage through the Mediterranean, as reported by systematic direct observations at several sites, occurs in September, mostly during the second and third ten-day period of the month (Finlayson 1992, Rebassa 1995, Agostini and Logozzo 1997, Jonzén and Pettersson 1999, Agostini et al. 2003, Sammut and Bonavia 2004, Roth and Corso 2007). Peak migration day varied notably among years, ranging from 9–23 September

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in southern continental Italy, 2002–2006 (E. Repaci and N. Morabito unpubl. data, Cutini et al. 2006).

Migration Route. Simultaneous direct observations in 2000, 2002, 2003, and 2004 (Agostini et al. 2001, 2003, 2004, Panuccio et al. 2005a), single-watchsite observations over various Mediterranean islands (Rebassa 1995, Jonzén and Pettersson 1999, Paesani and Politi 2002, Vanni and Paesani 2007, Roth and Corso 2007, Corso et al. in press, N. Agostini and D. Logozzo unpubl. data) and simultaneous radar and direct observation in southern Spain (Meyer et al. 2000, 2003; see Fig. 1) confirmed that this species crosses the sea on a broad front, undertaking long water crossings heading SSW-SW, as also suggested by band recovery data (Sultana and Gauci 1982, Bricchetti and Fracasso 2003, Reihmanis 2005, Spina and Volponi 2008). In particular, most band recoveries in Italy and Malta are of birds banded in central-eastern Europe, the Baltic, and Scandinavia. Germany and Czech Republic are the most important countries of origin, followed by Finland, Sweden, Latvia, and Poland (Sultana and Gauci 1982, Reihmanis 2005, Spina and Volponi 2008). This direction of migration (SSW-SW) might explain the scarce passage of this species at the Bosphorus along the SE flyway (Zalles and Bildstein 2000). Systematic surveys of Western Marsh Harrier migration through Greece are still lacking, although the species is observed throughout the country, and banding recovery data indicate that birds recovered in Greece were banded in Finland, Lithuania, Poland, and Slovakia (Handrinos and Akriotis 1997). Apparently, Western Marsh Harriers are little affected by the drift of lateral winds in choosing parallel flyways over land and over water (Panuccio et al. 2005a).

Migration of Different Sex and Age Classes. The migration periods of adults and juveniles largely overlap. Among adults, males tend to migrate earlier in the season, outnumbering females, with the exception of 2003 when, during observations made over the islands of Marettimo and Pantelleria (between western Sicily and Tunisia; Fig. 1), adult females outnumbered adult males in the first ten days of September (Agostini et al. 2004). In late spring and summer 2003 the weather was abnormally warm in Europe and the heat was exacerbated by drought (Wagner 2003), which may have negatively affected prey availability (Redpath et al. 2002) and influenced adult females from migratory populations to leave Europe earlier (Agostini et al. 2004) and perhaps to migrate greater distances than in other

years. In the Western Marsh Harrier, the occurrence of polygyny suggests an imbalance toward females (Kjellén 1992, Clarke 1995, Agostini 2001), and in several populations of this species females outnumber males (Simmons 2000). Thus, it is not unexpected that migration counts involving the passage of those populations reflect this imbalance. However, considerable numbers of adult females and greater numbers of juveniles do not cross the Mediterranean Sea during autumn migration, but winter instead in western and southern Europe, including Spain (Chiavetta 1981, González 1991, Clarke 1995, Handrinos and Akriotis 1997, Agostini and Logozzo 2000, Panuccio et al. 2005b, Corso and Penna in press).

Migration counts and wintering surveys agree, at least in part, with findings of a satellite telemetry study. In particular, Strandberg et al. (2008) reported no distinct differences in timing (departure and arrival dates) of autumn migration among sex and age classes of birds of the population breeding in southern Sweden. These individuals crossed the Mediterranean in September (median 25 September) on a broad front, between Spain and north Africa, mostly between southern Spain and Morocco. Two Western Marsh Harriers crossed the sea between northeastern Spain and Algeria, apparently via the Balearic Islands. Only an adult male summering in Ukraine crossed the central Mediterranean region (Fig. 1). Three birds, one adult female and two juveniles, did not cross the Mediterranean Sea, whereas a third juvenile did cross the Mediterranean but did not cross the Sahara Desert. As suggested by surveys made in the central Mediterranean region during the winter (Agostini and Logozzo 2000, Panuccio et al. 2005b), juveniles tend to migrate shorter distances than adults and adult males to migrate longer distances than adult females, although this difference was not significant in the satellite telemetry study. Finally, four birds tracked for at least two years showed considerable variation in the timing of migration among years, perhaps as a result of breeding success or failure (Strandberg et al. 2008).

A remarkable difference in numbers of adult males and adult females, with adult females outnumbering adult males, has been observed among birds wintering in south-central Italy, as in the Netherlands, Britain, Spain, and Greece (Zijlstra 1987, González 1991, Clarke et al. 1993, Handrinos and Akriotis 1997, Agostini and Logozzo 2000, Underhill-Day 2002, Panuccio et al. 2005b, Corso and Penna in press). Female West-

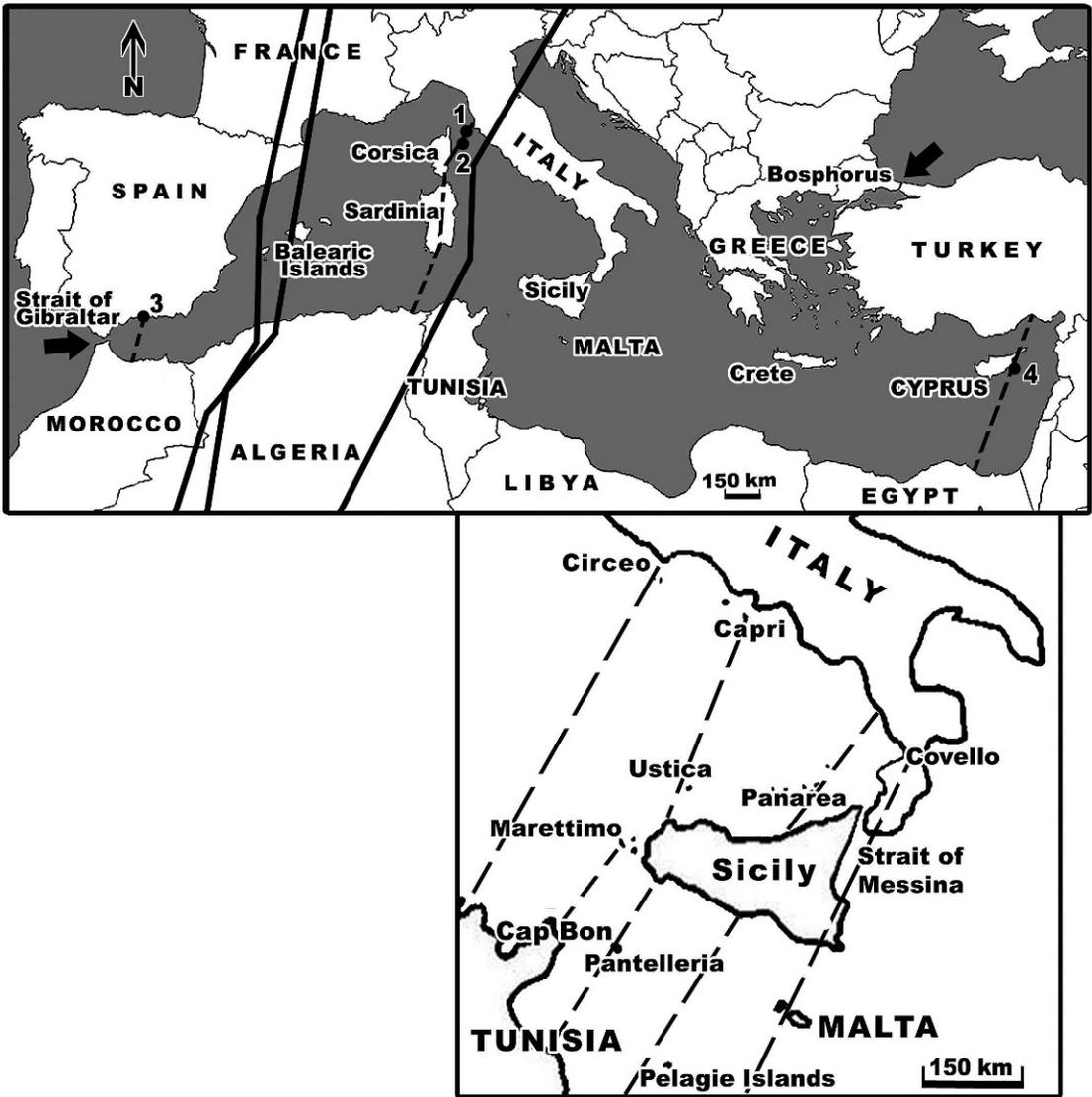


Figure 1. Solid lines: simplified plotted flyways reported by Strandberg et al. (2008) for Western Marsh Harriers (*Circus aeruginosus*) passing through the central Mediterranean and via the Balearic Islands, as estimated using satellite telemetry. Sketched lines: the alternative flyway along the Corsica-Sardinia corridor and the expected autumn routes used by Western Marsh Harriers crossing the Mediterranean Sea as suggested by observations at the following watchsites: Island of Elba (1), 42°46'N, 10°16'E; Island of Pianosa (2), 42°35'N, 10°04'E; site of the radar study near Malaga (3), 36°43'N, 4°06'W; Circeo Promontory, 41°14'N, 13°03'E; Island of Capri, 40°33'N, 14°13'E; Mount Covello (Calabrian Apennines), 38°49'N, 16°24'E; Island of Ustica, 38°42'N, 13°09'E; Island of Panarea, 38°38'N, 15°03'E; Aspromonte National Park (area of the Strait of Messina), 38°13'N, 15°55'E; Island of Marettimo, 37°58'N, 12°03'E; Island of Pantelleria, 36°47'N, 11°59'E; Island of Malta, 35°54'N, 14°26'E; Pelagie Islands (Linosa: 35°53'N, 13°15'E; Lampedusa: 35°30'N, 12°34'E); Cap Greco (4; Cyprus), 34°58'N, 34°04'E.

ern Marsh Harriers, being larger than males, are more likely than males to capture larger prey (waterfowl) and, probably, to tolerate colder temperatures and to fast longer (Newton 1979, Kerlinger 1989, Clarke

1995, Simmons 2000). For this reason, males may have a stronger tendency to migrate earlier and further after leaving their breeding or premigratory stopover areas (Agostini and Logozzo 2000, Agostini et al. 2003,

Panuccio et al. 2005b). This latitudinal segregation of sexes in some populations of Western Marsh Harriers may be explained by Bergmann's rule, which predicts that larger individuals are better adapted to survive in colder climates. Other hypotheses, based on social dominance theory, are less supported by available data, including similar proportions of juveniles and adults in Italy (Panuccio et al. 2005b).

Water Crossings During Migration. The limited data available from satellite telemetry suggest that Western Marsh Harriers can make nonstop crossings over water of 300–550 km or more. For example, one adult male summering in the Ukraine and studied with satellite telemetry crossed the central Mediterranean Sea either via Corsica and Sardinia or directly over water (R. Strandberg et al. 2008; Fig. 1). Although locating birds using satellite telemetry produces large gaps in information in the area around Italy because of an unknown interference (R. Strandberg pers. comm.), it was known that the male passed through central Italy and crossed the Tyrrhenian Sea from a starting point north of Rome, continuing either to the east of or across the island of Sardinia, reaching northern Tunisia, and heading southwest through north Africa toward the Sahara Desert. Thus, this male either made a nonstop powered flight over water of approximately 550 km, avoiding the passage through Corsica and Sardinia, or traveled via the islands, likely with at least one night of rest. When crossing the central Mediterranean during both spring and autumn, Western Marsh Harriers use several small islands to enable soaring flight or as stopover sites for roosting (Sammut 2005, Panuccio and Agostini 2006) and/or hunting (Thake 1983, Frost 1994, Rebassa 1995, Agostini and Logozzo 1998, Jonzén and Pettersson 1999, Agostini et al. 2003, Panuccio et al. 2004, Sammut and Bonavia 2004, Panuccio and Agostini 2006). Western Marsh Harriers are able to cross water bodies during the night and tend to cross the large body of water between western Sicily and central Italy (>300 km; Fig. 1) during weak rather than strong winds, without regard to wind direction, or during windless periods (Panuccio et al. 2002, Panuccio and Agostini 2010). However, a study made simultaneously with radar and direct observations during autumn migration on the southern coast of Spain (Fig. 1) showed that the number of harriers undertaking a shorter sea crossing (approx. 150 km) was similar for all wind directions during periods of weak winds. Conversely, during strong winds (>15 km/h) the number of birds

crossing was higher during tail and lateral winds if the latter provided at least partial tail-wind support (Meyer et al. 2000). Meyer and colleagues suggested that this strategy resulted in shorter crossing times and thus lowered risk of unpredictable weather changes. However, the probability of changing weather (wind) conditions increases with the length of the crossing (see also Meyer et al. 2003). In the case of the central Mediterranean, the flight strategy of Western Marsh Harriers, moving hundreds of kilometers over water in weak or no wind and using islands as stopover sites (Panuccio et al. 2002, Panuccio and Agostini 2010), might be seen as a conservative strategy.

During autumn migration, large numbers of Western Marsh Harriers are seen each season leaving the coasts of Tuscany (central Italy) heading southwest apparently en route to Corsica via the islands of Elba and Pianosa (Fig. 1; Paesani and Politi 2002, Vanni and Paesani 2007). In contrast, Western Marsh Harriers leaving central Italy from the Circeo Promontory (Fig. 1; Latium), south of Tuscany, are expected to cross the sea en route to Africa, flying about 500 km nonstop over water because they face the open sea when heading southwest (Agostini et al. 2001, 2003, Panuccio and Agostini 2010). If the simplified plotted flyway reported by Strandberg et al. (2008) is correct, the male from the Ukraine expended a large amount of energy and maximized its risks relative to the long sea crossing. However, based on the timing of the sea passage, it appears that this bird might have used the Corsica-Sardinia route to Tunisia.

In the western Mediterranean, birds leaving northeastern Spain apparently passed via the Balearic Islands. These birds likely make <300 km of nonstop, powered flight over water during the second stage of that crossing, between the Balearic Islands and northern Africa.

SPRING MIGRATION

Migration Route. There are fewer data on spring migration than on autumn migration. However, available visual observation data indicate that Western Marsh Harriers cross the Mediterranean on a broad front during spring migration (Gensbol 1992, Handrinos and Akriotis 1997, Gustin and Pizzari 1998, Zalles and Bildstein 2000, Agostini 2001, Ferguson-Lees and Christie 2001, Panuccio et al. 2002, Pandolfi and Sonet 2003), as they do during autumn migration.

Migration of Different Sex and Age Classes. Studies in the central Mediterranean (Gustin and Pizzari 1998, Pandolfi and Sonet 2003, Panuccio et al.

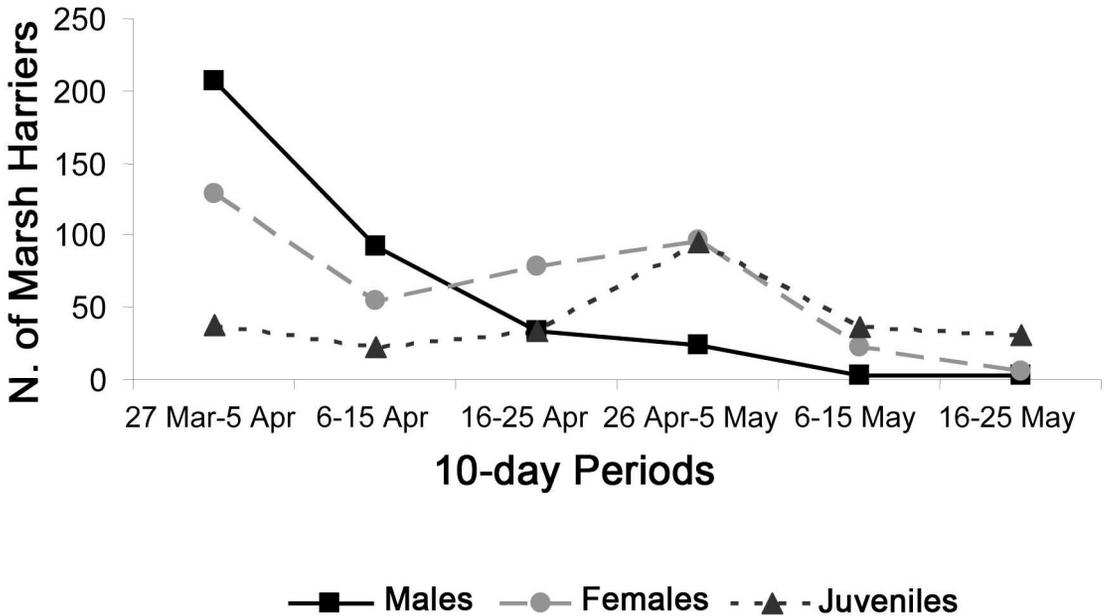


Figure 2. The occurrence of migrating Western Marsh Harriers (*Circus aeruginosus*) over the Strait of Messina, southern Italy, between 27 March and 25 May 2004, during six ten-day periods (M. Panuccio unpubl. data). In this survey, the totals for males, females, and juveniles were derived by multiplying their proportions in the sample of identified individuals in each period, following the method used by Kjellén (1992) in his study on the autumn migration of raptors at the Falsterbo peninsula (Sweden). In particular, to eliminate a bias resulting from the easier identification of the adult males, we estimated the proportion of females and juveniles by dividing unidentified individuals of the group female/juvenile between the two age groups according to their proportions among the identified birds.

2004) and at the Strait of Gibraltar (Finlayson 1992) showed that adult males tended to migrate earlier than adult females in spring (M. Panuccio unpubl. data; Fig. 2). Strandberg et al. (2008) did not report distinct differences in timing (departure and arrival dates) of spring migration between males and females; however, the duration of spring migration tended to be shorter for females. In spring, Western Marsh Harriers tracked by satellite telemetry showed a narrower front of migration over water, concentrating the passage in the area of the Strait of Gibraltar. One bird crossed the sea apparently via Balearic Islands. In contrast with Strandberg et al. (2008) and in agreement with several migration counts, previous investigations have shown that males tend to arrive on the breeding grounds earlier than females (Brown and Amadon 1968 quoted by Kerlinger 1989). We recommend that future research focus on elucidating any differential migration strategies, as well as any effects of those strategies on reproductive fitness.

Among long-distance migrants, adults tend to migrate earlier than juveniles during spring (Kerlinger 1989). In the case of the Western Marsh Harrier, however, observations made at several sites of the central Mediterranean indicate a partial overlap in the migration periods of birds of different ages (Fig. 2; Agostini and Logozzo 2000, Agostini 2001, Panuccio et al. 2004). Perhaps, as suggested in a previous study (Agostini 2001), the tendency of juveniles to migrate shorter distances than adults may explain this partial overlap in their migration periods during spring, a result of the contemporaneous passage of juveniles wintering in the Mediterranean basin and adults wintering in tropical Africa but beginning their northward migration earlier in the season.

POPULATION TRENDS AND CONSERVATION

At the beginning of the second half of the last century, the European population of the Western Marsh Harrier decreased dramatically as a result of shooting, poisoning by pesticides, and habitat loss

including the draining of wetlands (Clarke 1995, del Hoyo et al. 1994). However, recent population data have shown notable increases in northern and eastern Europe, probably because of the increasing adoption of protective measures (del Hoyo et al. 1994, Clarke 1995, BirdLife International 2004). This trend is confirmed by migration counts made in the central Mediterranean (Beaman and Galea 1974, Agostini and Logozzo 1997, Agostini et al. 2003, Sammut and Bonavia 2004). Further conservation efforts may also help protect this species from potential threats posed by illegal harvesting in Malta and the proliferation of wind farms in southern continental Italy (Coleiro et al. 1996, Panuccio et al. 2007).

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LITERATURE CITED

- AGOSTINI, N. 2001. Spring migration in relation to sex and age of Marsh Harriers *Circus aeruginosus* over a central Mediterranean island. *Ardeola* 48:71–73.
- , C. COLEIRO, F. CORBI, G. DI LIETO, F. PINOS, AND M. PANUCCIO. 2001. Comparative study of the autumn migration of Marsh Harriers (*Circus aeruginosus*) at three sites of the central Mediterranean. *Vogelwarte* 41:154–158.
- , ———, AND M. PANUCCIO. 2003. Autumn migration of Marsh Harriers across the central Mediterranean in 2002. *Ring* 25:47–52.
- AND D. LOGOZZO. 1997. Autumn migration of Accipitriformes through Italy en route to Africa. *Avocetta* 21:174–179.
- AND ———. 1998. Primi dati sulla migrazione primaverile dei rapaci Accipitriformi sull'isola di Marettimo (Egadi). *Rivista Italiana di Ornitologia* 68:153–157.
- AND ———. 2000. Migration and wintering distribution of the Marsh Harrier (*Circus aeruginosus*) in southern Italy. *Buteo* 11:19–24.
- , G. PREMUDA, U. MELLONE, M. PANUCCIO, D. LOGOZZO, E. BASSI, AND L. COCCHI. 2004. Crossing the sea en route to Africa: autumn migration of some Accipitriformes over two central Mediterranean islands. *Ring* 26:71–78.
- BEAMAN, M. AND C. GALEA. 1974. Visible migration of raptors over the Maltese Islands. *Ibis* 116:419–431.
- BILDSTEIN, K. 2006. Migrating raptors of the world: their ecology and conservation. Cornell University Press, Ithaca, NY U.S.A.
- BirdLife International. 2004. Birds in Europe: population estimates, trends and conservation status. BirdLife Conservation Series No. 12. BirdLife International, Cambridge, U.K.
- BRICHETTI, P. AND G. FRACASSO. 2003. Ornitologia Italiana. Vol. 1. Perdisa Editore, Bologna, Italy.
- CHIAVETTA, M. 1981. I rapaci d'Italia e d'Europa. Rizzoli, Milano, Italy.
- CLARKE, R. 1995. The Marsh Harrier. Hamlyn, London, U.K.
- , A. BOURGONJE, AND H. CASTELIJNS. 1993. Food niches of sympatric Marsh Harriers *Circus aeruginosus* and Hen Harriers *C. cyaneus* on the Dutch coast in winter. *Ibis* 135:424–431.
- COLEIRO, C., P. PORTELLI, AND N. AGOSTINI. 1996. Autumn migration of Marsh Harriers over Malta. Abstracts of the Second International Conference on Raptors, Urbino, Italy. Raptor Research Foundation.
- CORSO, A., H. LARSSON, J. OTTAVIO, M. VIGANO, AND M. GUSTIN. In press. First data on migration of raptors at the Pelagic Islands, Sicilian Channel. *Atti XV Convegno Italiano di Ornitologia*.
- AND V. PENNA. In press. Aging and sexing of Marsh Harriers *Circus aeruginosus* wintering in Sicily: results of sixteen years of study and an overview of the criteria. *Atti XV Convegno Italiano di Ornitologia*.
- CRAMP, S. AND K.E.L. SIMMONS. 1980. The birds of the western palearctic. Vol. II. Oxford University Press, Oxford, U.K.
- CUTINI, S., C. CARDELLI, AND G. CHIOFALO. 2006. La migrazione post-riproduttiva dei rapaci nel Parco Nazionale dell'Aspromonte (RC). *Infomigrans* 18, Parco Nazionale Alpi Marittime, Valdieri, Italy.
- DEL HOYO, J., A. ELLIOTT., AND J. SARGATAL [EDS.]. 1994. Handbook of the birds of the world, Vol. 2: New World vultures to guineafowl. Lynx Edicions, Barcelona, Spain.
- FERGUSON-LEES, J. AND D.A. CHRISTIE. 2001. Raptors of the world. Helm, London, U.K.
- FINLAYSON, C. 1992. Birds of the Strait of Gibraltar. T. and A.D. Poyser, London, U.K.
- FROST, R. 1994. Observations of autumn raptor migration at Akrotiri salt lake, Cyprus 19 September–9 October 1992. *Royal Air Force Ornithological Society Journal* 23:65–73.
- GENSBOL, B. 1992. Guida ai rapaci diurni d'Europa, Nord Africa e Medio Oriente. Zanichelli, Bologna, Italy.
- GUSTIN, M. AND T. PIZZARI. 1998. Migratory pattern in the genus *Circus*: sex and age differential migration in Italy. *Ornis Svecica* 8:23–26.
- GONZÁLEZ, J.L. 1991. El Aguilucho lagunero *Circus aeruginosus* (L., 1758) en España. Situación, biología de la reproducción, alimentación y conservación. ICONA, Madrid, Spain.
- HANDRINOS, G. AND T. AKRIOTIS. 1997. The birds of Greece. Helm, London, U.K.
- JONZÉN, N. AND J. PETERSSON. 1999. Autumn migration of raptors on Capri. *Avocetta* 23:65–72.
- KERLINGER, P. 1989. Flight strategies of migrating hawks. University of Chicago Press, Chicago, IL U.S.A.
- KJELLÉN, N. 1992. Differential timing of autumn migration between sex and age groups in raptors at Falsterbo, Sweden. *Ornis Scandinavica* 23:420–434.

- MEYER, S.K., R. SPAAR, AND B. BRUDERER. 2000. To cross the sea or to follow the coast? Flight directions and behaviour of migrating raptors approaching the Mediterranean Sea in autumn. *Behaviour* 137:379–399.
- , ———, AND ———. 2003. Sea crossing behaviour of falcons and harriers at the southern Mediterranean coast of Spain. *Avian Science* 3:153–162.
- NEWTON, I. 1979. Population ecology of raptors. T. and A.D. Poyser, London, U.K.
- PAESANI, G. AND P.M. POLITI. 2002. Monitoraggio della migrazione autunnale dei rapaci diurni nell'isola di Pianosa (LI). *Infomigrans* 10, Parco Naturale Alpi Marittime, Valdieri, Italy.
- PANDOLFI, M. AND L. SONET. 2003. Migrazione di rapaci lungo la costa adriatica (Parco Naturale San Bartolomeo, 1998–2001). Fenologia e comportamento delle specie del genere *Circus*. *Avocetta* 27:57–59.
- PANUCCIO, M. AND N. AGOSTINI. 2006. Comments on the roosting behaviour of Marsh Harrier during migration. *British Birds* 99:367–368.
- , ———, AND B. MASSA. 2002. Crossing the Tyrrhenian Sea: spring migration of Marsh Harriers (*Circus aeruginosus*), sex classes and relation to wind conditions. *Vogelwaarte* 41:271–275.
- , ———, AND ———. 2004. Spring raptor migration over Ustica, southern Italy. *British Birds* 97:400–403.
- , ———, AND U. MELLONE. 2005a. 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.
- , B. D'AMICIS, E. CANALE, AND A. ROCCELLA. 2005b. Sex and age ratios of Marsh Harriers *Circus aeruginosus* wintering in central-southern Italy. *Avocetta* 29:13–17.
- , N. AGOSTINI, G. LUCIA, U. MELLONE, J. ASHTON BOOTH, S. WILSON, G. CHIATANTE, AND S. TODISCO. 2007. Le Serre Catanzaresi: Important Bird Area (IBA) per la migrazione autunnale dei rapaci. Page 68 in Proceedings of the XIV Italian Ornithological Congress.
- AND ———. 2010. Comparison of the water-crossing behavior of Western Marsh Harriers (*Circus aeruginosus*) and European Honey Buzzards (*Pernis ptilorhynchus*) during autumn migration. *Chinese Birds* 1:30–35.
- REBASSA, M. 1995. La migració postnupcial de rapinyaires a l'illa de Cabrera: trets generals. *Anuari Ornitològic de les Balears* 1995.
- REDPATH, S.M., B. ARROYO, B. ETHERIDGE, F. LECKIE, K. BOUWMAN, AND S.J. THIRGOOD. 2002. Temperature and Hen Harrier productivity: from local mechanisms to geographical patterns. *Ecography* 25:533–540.
- REIHMANNIS, J. 2005. Main migratory direction of Marsh Harriers *Circus aeruginosus*: an analysis of recovery data of specimens ringed in Latvia from 1925 to 2004. *Acta Universitatis Latviensis* 691:51–57.
- ROTH, T. AND A. CORSO. 2007. Cyprus – the autumn 2005 raptor migration at the southeast peninsula (terminating at Cape Greco). *Sandgrouse* 29:79–90.
- SAMMUT, M. 2005. Marsh Harriers roosting in trees. *British Birds* 98:314–316.
- AND E. BONAVIA. 2004. Autumn raptor migration over Buskett, Malta. *British Birds* 97:318–322.
- SIMMONS, R.E. 2000. Harriers of the world: their behaviour and ecology. Oxford Ornithology Series, Oxford, U.K.
- SPAAR, R. AND B. BRUDERER. 1997. Migration by flapping or soaring: flight strategies of Marsh, Montagu's and Pallid harriers in southern Israel. *Condor* 99:458–469.
- SPINA, F. AND S. VOLPONI. 2008. Atlante della Migrazione degli Uccelli in Italia. I. Non-Passeriformi. Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). Tipografia CSR, Rome, Italy.
- STRANDBERG, R., H.G. KLAASSEN, M. HAKE, P. OLOFSSON, K. THORUP, AND T. ALERSTAM. 2008. Complex timing of Marsh Harrier *Circus aeruginosus* migration due to pre- and post-migratory movements. *Ardea* 96:159–171.
- SULTANA, J. AND C. GAUCI. 1982. A new guide to the birds of Malta. Ornithological Society, Valletta, Malta.
- THAKE, M.A. 1983. Marsh Harrier migration through Malta in autumn in relation to weather. *Il Merill* 22:1–6.
- UNDERHILL-DAY, J. 2002. Marsh Harrier *Circus aeruginosus*. Pages 225–226 in C.V. Wernham, M.P. Toms, J.H. Marchant, J.A. Clark, G.M. Siriwardena, and S.R. Baillie [EDS.], The migration atlas: movements of the birds of Britain and Ireland. T. and A.D. Poyser, London, U.K.
- VANNI, L. AND G. PAESANI. 2007. La migrazione post-riproduttiva sull'Isola d'Elba (LI) Parco nazionale Arcipelago toscano. *Infomigrans* 20, Parco Naturale Alpi Marittime, Valdieri, Italy.
- WAGNER, A.J. 2003. Mean circulation highlights and climate anomalies March through August 2003. Mariners Weather Log 47,2. http://vos.noaa.gov/MWL/fall_03/circulation.shtml (last accessed 19 June 2009).
- ZALLES, J. AND K. BILDSTEIN. 2000. Raptor watch: a global directory of raptor migration sites. BirdLife International Conservation Series No. 9. BirdLife International, Cambridge, U.K.
- ZIJLSTRA, M. 1987. Bruine Kiekendief *Circus aeruginosus* in Flevoland in de winter. *Limosa* 60:57–62.

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