Avocetta 32: 13-20 (2008)

Spring raptor migration along the Adriatic coast (Italy): a comparative study over three sites

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Abstract – Daily observations were carried out from 23 April to 7 May 2005 over three sites along the Adriatic coast: Mount Conero, Mount San Bartolo (Marche region) and the Po Delta (Emilia-Romagna region), where 1849, 658 and 337 raptors were counted respectively. In addition, two watch-points in the Mount Conero area were both monitored from 20 April to 20 May 2004, in order to determine the percentage of the migrating raptors starting to cross the Adriatic Sea. Marsh harrier, honey buzzard and red-footed falcon (the latter in Conero and S. Bartolo sites) were the most frequently observed migrating raptors species. The low correlation among the different migration peaks over the three sites seems to show that raptors perform coasting behaviour only partially during spring migration along the part of the Adriatic coast studied. Furthermore, the importance of the Mount Conero as geomorphologic reference sites seems confirmed, since a fraction of the migrating raptors apparently cross the Adriatic Sea towards the Balkans. Nevertheless, further researches are needed at the Mount Conero in order to better quantify the risk of re-counting.

Riassunto – *La migrazione primaverile dei rapaci lungo la costa adriatica (Italia): uno studio comparativo in tre siti*. Dal 23 aprile al 7 maggio 2005 sono state effettuate osservazioni giornaliere in tre siti lungo la costa adriatica: Monte Conero, Monte San Bartolo (Marche) e delta del Po (Emilia-Romagna), dove sono stati contati rispettivamente 1849, 658 e 337 rapaci. Inoltre, due punti d'osservazione nell'area del Monte Conero sono stati monitorati dal 20 aprile al 20 maggio 2004, allo scopo di determinare la percentuale di rapaci che cominciano l'attraversamento del mare Adriatico. Il falco di palude, il falco pecchiaiolo e il falco cuculo (quest'ultimo nei siti del Conero e S. Bartolo) sono le specie di rapaci in migrazione maggiormente osservate. Come testimoniato dalle poche correlazioni esistenti tra i differenti picchi di migrazione rilevati nei tre siti, i rapaci mostrano solo parzialmente il comportamento di costeggiare, durante la migrazione primaverile, la zona di litorale adriatico oggetto di studio. Sembra inoltre confermata l'importanza del Monte Conero quale sito di riferimento geomorfologico, perché una parte dei rapaci apparentemente migra attraverso il mare Adriatico verso i Balcani. Tuttavia, altre ricerche sono necessarie nell'area del Monte Conero allo scopo di quantificare meglio il rischio di riconteggio in questo sito.

Coastlines are important in shaping the migration pathways and can influence the orientation of birds (Kerlinger 1989, Zalles and Bildstein 2000). In addition, most raptors are usually reluctant to cross water barriers (Kerlinger 1985, Panuccio *et al.* 2002, 2004a, Agostini *et al.* 1994a, 1994b, 2005), because of the risks of a long flight over water surfaces and because of the high energetic costs of powered flight over water, where thermals are almost absent and soaring flight can rarely be exploited. Thus, it often results in a coasting behaviour of migrating raptors (Kerlinger 1989).

The Italian Peninsula and its coastlines are involved in the raptor spring migration (Cramp and Simmons 1980, Zalles and Bildstein 2000, Agostini 2002, 2003, Premuda 2004a) and several migration sites along the Adriatic coast are known: Capo d'Otranto (Gustin 1989a, Gustin and Pizzari 1998, Premuda *et al.* 2004), the Gargano promontory (Premuda 2004b), Mount Capodarco (Panuccio *et al.* 2004), Mount Conero (Gustin 1989b, 1995, Borioni 1993, 1995, Gustin *et al.* 2002, 2003, Gustin and Sorace 2004), Mount San Bartolo (Pandolfi and Sonet 2001, 2003, 2006) and the Po Delta (Premuda 2007).

Some authors suggest the possibility of double-counts affecting the record of migrating raptors at the Piangrande watch-point of the Mount Conero site, (Agostini and Panuccio 2003a, Panuccio *et al.* 2004b), as recorded at the Circeo and at the Cap Bon promontory (Agostini *et al.* 1994a, 1994b, Agostini and Panuccio 2003b), considering

Ricevuto 26 aprile 2006, accettato dopo revisione 15 maggio 2008

also that birds (mainly honey buzzards) migrating alone or in small flocks tend to stop the migration on reaching water surfaces (Panuccio *et al.* 2002, 2004a, Agostini *et al.* 1994b, 2005).

The aim of this study is to compare the passage of migrating raptors among three different sites along the Adriatic coast during the spring migration to evaluate the importance of coasting behaviour in the different species. In addition, the role of Mount San Bartolo and above all Mount Conero as starting point for raptors migrating across the Adriatic Sea towards the Balkans was investigated.

STUDY AREA AND METHODS

The study area covers three sites along the Adriatic coast (for a total of 180 km) of the Central and Northern Italian Peninsula. The Conero promontory is a mountain about 580 m a.s.l., on the coastline S of Ancona (Marche). The two watch-points used were Gradina del Poggio (W of Mount Conero inland) and Monte dei Corvi (NW of Mount Conero on the coastline), both in the Conero Regional Natural Park. Gradina del Poggio was used (both in 2004 and 2005) to detect inland raptors reaching the Mount Conero site, limiting double counts. Monte dei Corvi was monitored (in 2004) to record a sample in order to determine the percentage of raptors undertaking the crossing of the Adriatic Sea towards the Balkans.

The site of Piangrande, located on Mount Conero, was no longer used because, due to the growing trees limiting the view around the watch-point, the risk of double-counts, suggested by Agostini and Panuccio (2003b), has increased over the last years and may have affected observations of Gustin *et al.* (2002) with double-counts, mainly of birds flying towards ESE.

The Mount San Bartolo Regional Natural Park is situated N of Pesaro (Marche). Observations were made at an altitude of 178 m a.s.l., at a high coastal site.

At the Po Delta Regional Natural Park, the observation site was located at very low altitude (5 m a.s.l.), between Taglio della Falce and Porticino-Valle Canneviè sites, close to Codigoro (Ferrara - Emilia Romagna), in the south of the Po delta and between water surfaces such as Valle Bertuzzi and Sacca di Goro. To limit double counts, hunting individuals (mainly of genus *Circus*) were not counted; in addition there was particular attention to observe specific characters (mainly moult pattern) to identify individuals coming back from the N (not counted).

During 2004, Gradina del Poggio and Monte dei Corvi watch-points were both monitored from 20 April to 20 May, with 310 and 300 hours of daily observations respectively. During 2005, daily observations were carried out from 23 April to 7 May (the only exception being 30 April, at San Bartolo). A total of 119, 88 and 120 hours of observations were carried out at the Mount Conero (Gradina del Poggio), Mount San Bartolo and Po Delta sites respectively. At the Mount Conero and Po Delta sites, time from 09:00 to 17:00 was always covered, while at San Bartolo from 4 to 8 hours per day were covered.

For each observation, time (hh:mm), species, number of individuals, sex and age (whenever possible), flight direction of birds (incoming and outgoing) were recorded. In addition, weather conditions were noted on an hourly basis. The data recording was aided by binoculars, telescopes and compasses.

Characters used in identifying raptors (in particular *Circus pygargus* / *C. macrourus* and *Falco tinnunculus* / *F. naumanni*) were those provided by Clark (1999) and Forsman (1999). χ^2 and Contingency tables were used.

RESULTS

During the visual counts performed in 2004 over the two watch-points at the Conero site, 2399 and 1206 raptors were recorded at Gradina del Poggio and Monte dei Corvi respectively ($\chi^2 = 54.8$, d.f. = 1, $P < 0.001$).

At Monte dei Corvi 333 (27.6%) raptors were seen undertaking the sea crossing towards the Balkans (Tab. 1). The incoming direction was: 236 (70.9%), 47 (14.1%), and 27 individuals (8.1%) from SW, S and SE respectively (6.9% from other directions), while the outgoing direction was: 157 (48.0%), 113 (34.6%) and 31 individuals (9.5%) towards NE, N and NW respectively (7.9% other directions). 45.7% of the honey buzzards and 14.6% of the marsh harriers were observed starting to cross the Adriatic Sea. Regarding honey buzzards, the average of the group dimension was 3.83 ± 7.23 (SD), while the solitary birds were 103 (20.8%).

During the visual counts performed over the three sites in 2005, 16 species of migrating raptors were observed: 15 at Conero, 11 at Po Delta and 10 at the San Bartolo site (Tab. 2).

Considering the total number of migrating raptors observed, the Accipitridae were the most common at the Conero (70%) and the Po Delta (85%); on the contrary San Bartolo had the highest percentage of Falconidae (62%) (Tab. 2).

At the Conero (Gradina del Poggio), San Bartolo and Po Delta sites, 15.5, 7.5 and 2.8 raptors/hour were recorded respectively ($\chi^2 = 8{,}10$, d.f. = 2, $P < 0.05$). The most frequent species of migrating raptors observed were

the marsh harrier *Circus aeruginosus*, the honey buzzard *Pernis apivorus*, (with the maximum counts recorded at the Conero, with 588 and 494 individuals respectively) and the red-footed falcon *Falco vespertinus* (with 262 individuals at San Bartolo).

The daily number of migrating raptors observed showed different peaks at the Conero site on 24 and 25 April with 229 and 274 raptors and on 2 and 4 May with 192 and 312 respectively. A similar peak at the beginning of May occurred both at San Bartolo on 2 May with 225 raptors counted and at the Po Delta on 3 May with 132 (Fig. 1).

The hourly number of migrating raptors recorded showed a clear peak in the afternoon (N = 414 at 16:00-17:00) at the Conero (Gradina del Poggio), whereas the peaks on the other sites were around midday: N = 129 at 12:00-13:00 at San Bartolo (with a second peak of N = 102 at 16:00-17:00) and N = 95 at 11:00-12:00 at the Po Delta (Fig. 2).

The marsh harrier had three peaks at the Conero (median 29 April) on 24 April, 2 and 4 May; two peaks at Mount San Bartolo (median 27 April) on 24 April and 2 May; a single peak at the Po Delta (median 2 May) on 3 May (Fig. 3).

The honey buzzards had two peaks at the Conero (median 4 May) on 25 April and 4 May with a single peak both at Mount San Bartolo (median 5 May) on 5 May and at the Po Delta (median 3 May) on 3 May (Fig. 4). The recorded percentage of honey buzzards migrating alone was 22% (N = 121), 17.3% (N = 9) and 38% (N = 27) at the Conero (Gradina del Poggio watch-point), San Bartolo and Po Delta sites respectively.

The red-footed falcon showed a very concentrated passage at the beginning of May, with the peak at Mount San Bartolo (185 individuals) and at Mount Conero (65 individuals) on 2 May; at Po Delta site the species was very scarcely recorded (Tab. 2).

Table 1. Migrating raptors observed over the two watch-points at Conero between 20 April and 20 May 2004 and individuals undertaking the sea crossing – *Rapaci in migrazione registrati nei due punti di osservazione del Conero tra il 20 aprile e il 20 maggio 2004 e individui che cominciano ad attraversare il mare.*

	Species	**Gradina del Poggio**	**Monte dei Corvi**	**Monte dei Corvi (*)**
honey buzzard	*Pernis apivorus*	1654	519	237 (45.7%)
black kite	*Milvus migrans*	16	8	0
red kite	*Milvus milvus*	4	2	0
short-toed eagle	*Circaetus gallicus*	8	3	0
marsh harrier	*Circus aeruginosus*	252	226	33 (14.6%)
hen harrier	*Circus cyaneus*	6	7	1 (14.3%)
pallid harrier	*Circus macrourus*	11	3	0
montagu's harrier	*Circus pygargus*	28	35	5 (14.3%)
	Circus sp.	64	3	1 (33.3%)
sparrowhawk	*Accipiter nisus*	30	27	0
common buzzard	*Buteo buteo*	116	80	5 (6.25%)
golden eagle	*Aquila chrysaetos*	1	1	0
	Aquila sp.	3	0	0
osprey	*Pandion haliaetus*	5	5	1 (20%)
lesser kestrel	*Falco naumanni*	5	1	0
kestrel	*Falco tinnunculus*	57	44	0
	F. tinnunculus/naumanni	8	7	0
red-footed falcon	*Falco vespertinus*	37	37	0
hobby	*Falco subbuteo*	39	35	1 (2.8%)
saker	*Falco cherrug*	1	0	0
	Falco sp.	15	13	4 (30.8%)
	Accipitridae/Falconidae	38	149	45 (31.6%)
	TOTAL	**2399**	**1206**	**333 (27.6%)**

(*) Individuals crossing the sea

Table 2. Species of migrating raptors observed over the three sites between 23 April and 7 May 2005 – *Specie di rapaci in migrazione osservati nei tre siti tra il 23 aprile e il 7 maggio 2005.*

	Species	Conero (*)	San Bartolo	Po Delta
honey buzzard	*Pernis apivorus*	**494**	**44**	**71**
black kite	*Milvus migrans*	4	5	4
red kite	*Milvus milvus*	1	1	1
short-toed eagle	*Circaetus gallicus*	1	0	0
marsh harrier	*Circus aeruginosus*	**588**	**133**	**162**
hen harrier	*Circus cyaneus*	2	0	0
pallid harrier	*Circus macrourus*	4	0	0
montagu's harrier	*Circus pygargus*	40	15	30
	C. pygargus/macrourus	8	0	8
	Circus sp.	63	21	2
sparrowhawk	*Accipiter nisus*	13	3	3
common buzzard	*Buteo buteo*	70	0	7
	Accipitridae	0	25	0
osprey	*Pandion haliaetus*	4	1	0
lesser kestrel	*Falco naumanni*	1	0	0
kestrel	*Falco tinnunculus*	136	91	26
	F. tinnunculus/naumanni	36	0	0
red-footed falcon	*Falco vespertinus*	**208**	**262**	**8**
hobby	*Falco subbuteo*	44	14	8
peregrine falcon	*Falco peregrinus*	0	0	1
	Falco sp.	52	43	5
	Accipitridae/Falconidae	80	0	1
	Total	**1849**	**658**	**337**
	Total Accipitridae	1292	248	288
	Total Falconidae	557	410	49

(*) Gradina del Poggio watch-point

DISCUSSION

The number of species and individuals recorded underlines the importance of the three sites for the observation of the raptor spring migration, in particular the Conero promontory, which is classified as Important Bird Area (n. 085) for large congregations of raptors during migration (Heath and Evans 2000).

The period of the survey is in line with the higher number of the marsh harriers recorded compared to the honey buzzards, which continue (for example at the Conero promontory) to migrate significantly during May (Gustin *et al.* 2002, 2003).

The migrating raptors observed show a number of different peaks over the three sites. Apparently only the 2 May peak at the Conero site has correlation with the other site peaks, probably involving birds migrating along the coast, maybe due to the incoming atmospheric perturbation, which took place during the following days. The missing correlation between the raptor passage in the studied sites both on 25 April and 4 May, could be explained by the habits of a portion of the raptors to cross the Adriatic Sea leaving from the Conero promontory (Gustin *et al.* 2002, Gustin and Sorace 2004), as partially observed during the sample period in 2004 at the Monte dei Corvi site. Possibly some raptors, such as common buzzards, recorded at the Conero, passed inland and were not detected at the San Bartolo site, as already observed in the Pesaro province, at Montecicardo (Pandolfi and Sonet 2006).

The percentage of solitary migrating honey buzzards recorded at the three sites was in line with previous studies: San Bartolo 12.4% (Pandolfi and Sonet 2006), the Conero

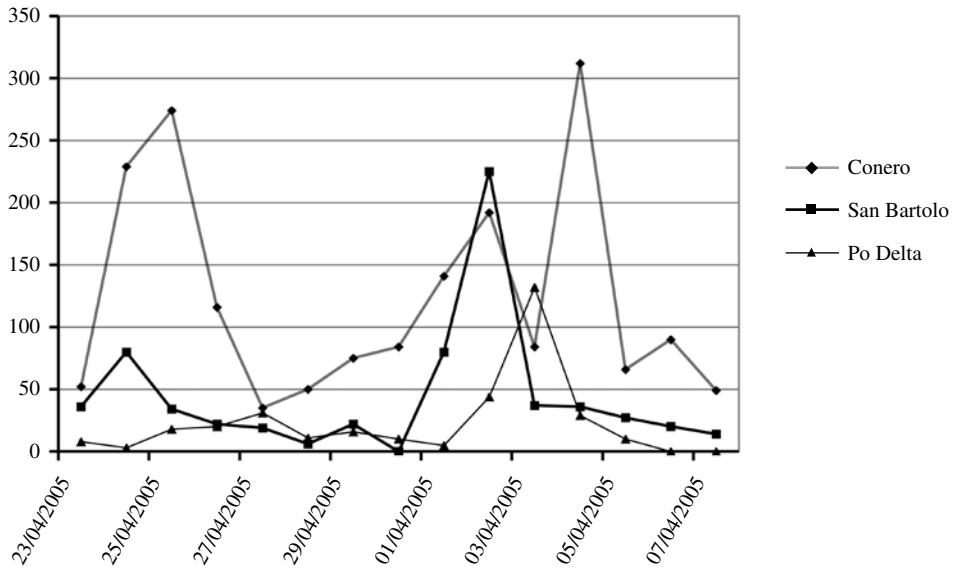

Figure 1. Daily number of migrating raptors in 2005 – *Numero giornaliero di rapaci in migrazione nel 2005.*

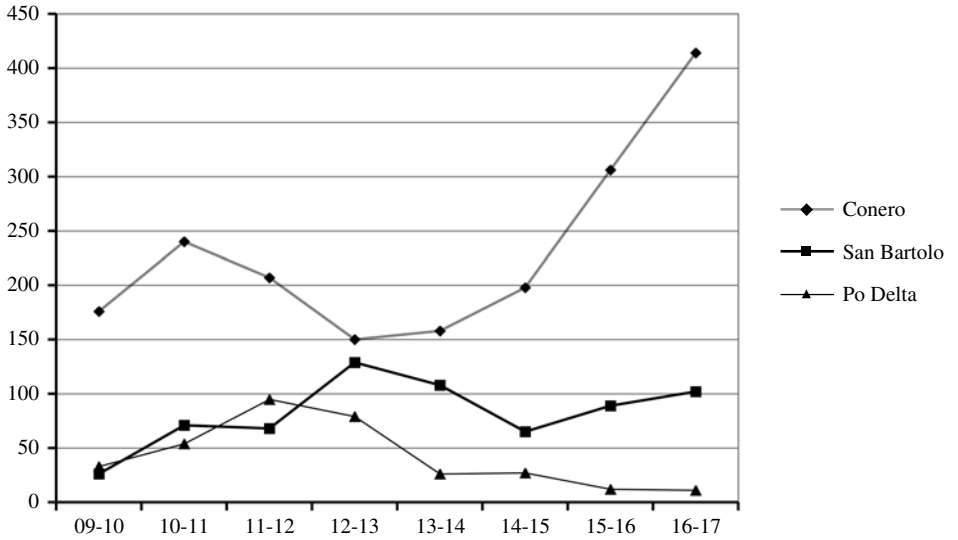

Figure 2. Hourly number of migrating raptors in 2005 – *Numero orario di rapaci in migrazione nel 2005.*

29.1% in 2004 and 11.5% in 2005 (Gustin 2005, 2006), with the exception of 52% in 1999 (Gustin *et al.* 2002), suggesting possible double counts (mainly of birds heading E-SE) during that year, where the observation point was located at Piangrande (no longer used in all the other studies made at Conero).

The peak recorded at the Conero in the afternoon, could be related to the fact that the Conero promontory is well known as a roosting site (158 raptors observed roosting in 1999-2000, Gustin unpubl.), where raptors were seen to stop overnight before crossing the Adriatic Sea towards the Balkans (Gustin *et al*. 2003). In most cases, roosting birds at Mount Conero were likely not double counted, because of the inland position of the observation post used (Gradina del Poggio), which allows detecting the incoming raptors and because birds flying above the Mount Con-

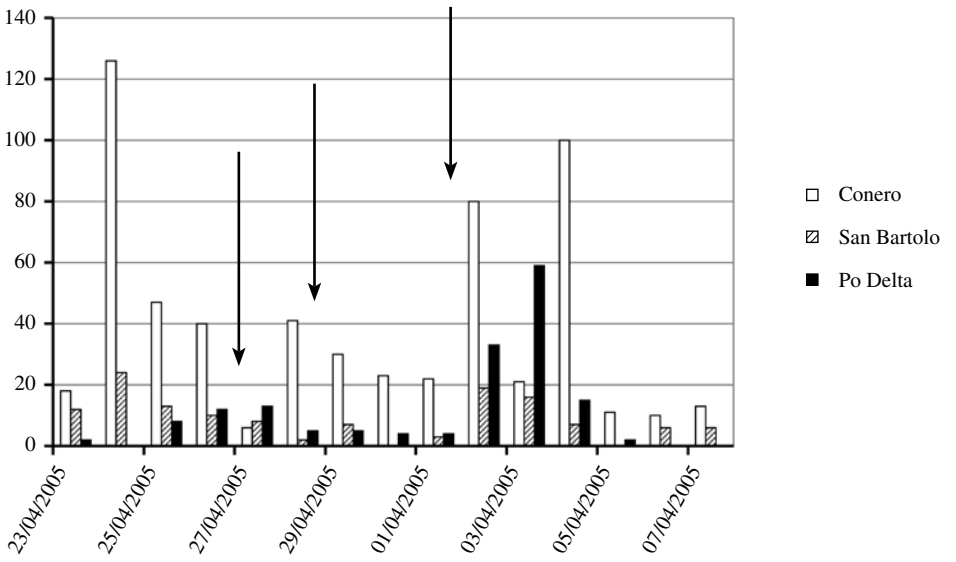

Figure 3. Daily number and median (arrow) of marsh harrier *Circus aeruginosus* passing for single study area (San Bartolo, Conero, Po Delta) in 2005 – *Numero giornaliero e mediana di passaggio di falco di palude* Circus aeruginosus *per singola area di studio (San Bartolo, Conero, Delta del Po) nel 2005.*

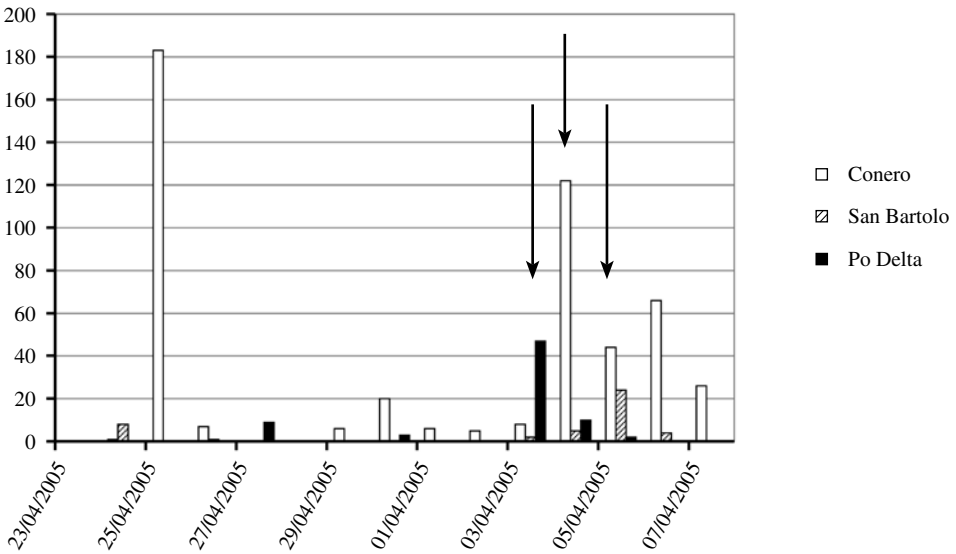

Figure 4. Daily number and median (arrow) of honey buzzard *Pernis apivorus* passing for single study area (Po Delta, Conero, San Bartolo) in 2005 – *Numero giornaliero e mediana di passaggio del falco pecchiaiolo* Pernis apivorus *per singola area di studio (Delta del Po, Conero, San Bartolo) nel 2005.*

ero were not counted. At the other two sites, roosting was not evident. For example, despite the presence of large woods such as the "Bosco Mesola", at the Po Delta watchpoint we did not see any roosting raptor.

Only the marsh harrier peak on 2-3 May was recorded at the three sites, despite the lower numbers recorded at San Bartolo and the Po Delta.

The peak of 24 April was observed at Conero and Mount San Bartolo only, whereas the peak of 4 May at the Conero was not recorded at the other sites. In addi-

tion, both honey buzzard peaks at the Conero on 25 April and at the Po Delta on 3 May were also not recorded at the other sites; on the contrary, it seems there is a connection between the peaks on 4 May at Conero and the day after at Mount San Bartolo.

The significant passage of the red-footed falcon, which was concentrated at the beginning of May over the Conero promontory and Mount San Bartolo did not involve the Po Delta watch-point, probably because birds crossed the sea before or passed inland and were not detected.

The analysis of the raptors migrating directly through the Adriatic Sea towards the Balkans, with the 2004 counts in Mount Conero and the results of 9 year of observations at the Mount San Bartolo (1998-2005: 15142 raptors followed, 5.9% of the Accipitridae - N = 12333 - and the 5.1% of the Falconidae - N = 3209 - headed towards the sea; Pandolfi and Sonet 2006) have shown that a fraction of raptors start to cross the Adriatic sea from the two coastal mountains. In fact, during 2004, 27.6% of raptors at Monte dei Corvi and 5.8% at San Bartolo, during 2005, were seen undertaking the sea crossing.

It could be argued that Mount Conero's height (580 m a.s.l. vs. 178) and size attracts a significant number of birds migrating toward the sea. This NE migration can be a factor in the reduced number of raptors observed migrating on a S-N gradient along the Italian coast, nevertheless the possibility of double counts at Conero cannot be excluded, due to the morphology of the site.

In summary, the low correlation among the different peaks over the three sites apparently shows that raptors perform coasting behaviour only partially during spring migration along the Adriatic coast studied. In addition, the importance of the Conero promontory seems confirmed as a geographic reference for raptors migrating across the Adriatic Sea towards the Balkans.

Nevertheless, further researches are needed at the Mount Conero (where most raptors seem to start the sea crossing), identifying a suitable watch-point which allows to detect raptors undertaking the Adriatic sea crossing, in order to quantify or minimize the risk of re-counting at Conero.

Acknowledgements – We wish to thank: the Ente Parco Naturale Monte Conero (AN) for the economic support, Francesca Zintu, Alberto Sorace and Daniele Iavicoli; the Ente Parco Naturale Monte San Bartolo (PU) and all the volunteers of the San Bartolo's camp; the volunteers of the Po Delta's camp: Roberto Raneri, Stefano Donello, Catia Fabbri, Mario Bonora, Leo Golinucci, Giorgio Leoni, Franco Roscelli, Michele Scaffidi, Luciano Ruggieri, Andrea Nicoli, Paolo Casali, Menotti Passarella, Patrizio Gigli.

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