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Montagu's harrier *Circus pygargus* in the northern Marche region of central Italy: first evidence of a possible population increase

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Abstract – In order to evaluate the status of the Montagu's harrier (*Circus pygarus*) population in the northern Marche region of central Italy, a population which in recent years has been reported to be in a major decline and facing a severe local threat, we surveyed the species' historical occupied territories and their suitable habitat. We recorded 11 Montagu's harrier breeding pairs during 2010 and 12 breeding pairs during the 2011 breeding season. Our results are the first evidence that the population of Montagu's harrier in the study area has increased during the last five years compared to data in the available literature. We characterized breeding habitat in terms of land use composition, proximity to other nests, building structures and altitude. The species seems to prefer breeding in the agricultural landscape, while it mainly chooses to build the nest in patches of uncultivated, shrub and badland vegetation. We also noticed an increase in the altitudinal range of the breeding habitat of the species in the study area. We conclude that these behaviors may represent an improvement for conservation of the species by reducing the effects of nest losses caused by agricultural practices and urban factors.

Key words: *Circus pygargus*, population, Central Italy, breeding habitat, cultivated, natural fields.

INTRODUCTION

The Montagu's harrier, *Circus pygargus*, is a long-distance migrant with a breeding range from North Africa and West and Central Europe to India and a wintering range in Africa and India (Cramp & Simmons 1980, Clarke 1996). The species is a conspicuous, medium-sized raptor which nests on the ground, either solitarily or in loose assemblages (Krogulec & Leroux 1993, Arroyo 1995).

The majority of Montagu's harrier in Western Europe can be found in Spain and France (two-thirds of the total European population, excluding Russia), where 45-90% of pairs breed in cultivated crops and are affected locally by harvesting activities (Simmons 2000, Limiñana *et al*. 2006, Tucker & Heath 1994).

The proportion of Montagu's harrier nests in crops reached 70% in France (Salamolard *et al*. 1999) and 90% in Spain and Portugal (Ferrero 1995). Cereal crops now appear to be the most common nesting habitat for this species in Western Europe.

After a dramatic population decline over recent decades (Arroyo & Bretagnolle 2000), mainly due to habitat loss, environmental contamination by pesticide and direct persecution, the European population of the species has recovered, and its conservation status is currently classified as 'favorable' (BirdLife International 2004), although the species is only present in a few areas (Tucker & Heath 1995, Peronace *et al*. 2012, BirdLife International 2004).

The most recent survey data from Italy estimated the population of Montagu's harrier to be approximately 260-380 pairs (Martelli 1997, BirdLife International 2004) and the species is protected by Law 157/92, as it is considered a vulnerable species in the Italian Red List (Peronace *et al*. 2012).

In Central Italy and particularly in the Marche region the species has been the subject of continuous studies

since 1987 (Pandolfi & Giacchini 1991, Pandolfi & Pino D'Astore 1994, Pandolfi *et al*. 2006, Pandolfi & Tanferna 2009).

According to the most recent literature on the presence of this bird in this area of Italy, the population seems to have been in steady decline since 1995. Data provided by Pandolfi & Tanferna (2009) suggest that in the Marche region the breeding population of this species decreased from 26 breeding pairs in 1990 to only three pairs in 2005. Also, the percentage change in the number of breeding pairs has been strongly negative during the last 20 years, approximately -88%.

The decline of the species is mainly due to breeding in agricultural areas. Mechanized harvesting in farmlands is considered to be a critical factor affecting the reproductive performance of the Montagu's harrier, at least in some areas, such as Spain and Italy (Pomarol 1994, Pandolfi & Giacchini 1991, Arroyo *et al*. 2002). However, food availability, nest-site availability and characteristics, weather factors, ecological competition, social interactions between closely-spaced individuals and human factors are all factors which could affect breeding success (Newton 1979, Arroyo *et al*. 2002).

In this work, we studied the occurrence and distribution of Montagu's harrier, comparing our results with the recent known literature for the species in the northern Marche region (Pandolfi & Tanferna 2009) to estimate the status of this population, which has exhibited a long-term decline and is considered highly endangered. Breeding habitat characteristics were described using GIS analysis and land-use maps.

Evaluation of the harrier's breeding distribution and environmental factors that could affect it is key to understanding the species' population dynamics, improving our knowledge of the species' breeding habitats and establishing effective conservation programs (Arroyo & Bretagnolle 2000, Millon *et al*. 2002).

METHODS

Study Area

This study was conducted in Central-eastern Italy, in the foothills of the Apennines Mountains, in the northern Marche region (43°43.328'N, 12°37.727'E, Fig. 1), at an altitude of 0-1700 m a.s.l. The climate is temperate (Tomaselli *et al*. 1972) and characterized by high spring and summer temperatures and a marked summer drought.

We considered the area historically occupied by this species in the northern Marche region (Pandolfi & Tanferna 2009 and references therein), which has an extent of about 700 km^2 and is characterized by a heterogeneous landscape, where small towns alternate with agricultural areas dominated by farming with intensive cereals, colza and spring-sown crops.

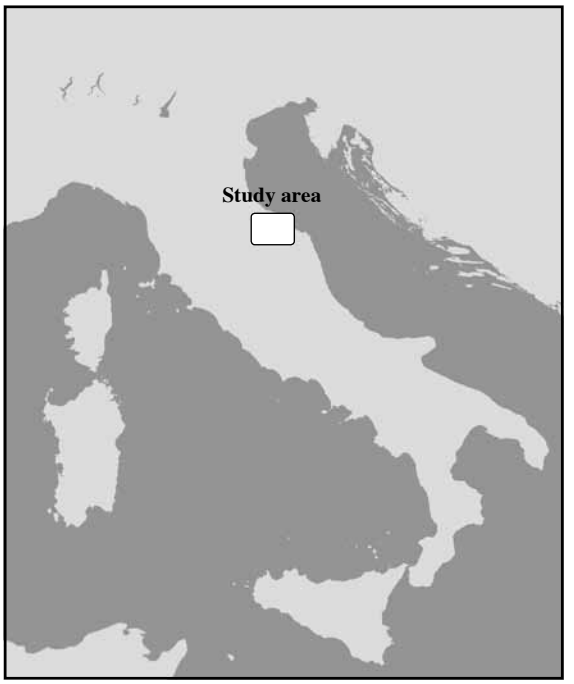

Figure 1. Study Area in north of Marche region (Central Italy).

The area is also hilly, with rolling hills formed by substrates of clay or clay mixed with sand, which are the types of soil that give rise to gullies wherein natural vegetation is typically in the form of shrubs.

Bird counts

We searched for breeding sites in the study area during 2010 and 2011, between mid-April and the end of July, spending between three and five hours each visit.

Nesting sites are located easily via observation of adults during the pre-laying (aerial displays by males), incubating and chick rearing stages (food provisioning carried out by the male).

We classified an area as "occupied" when territorial behavior, courtship or other reproductive behavior were observed. We searched for nests by following adult females after food exchanges.

Some nests were found during the nestling phase and other nests were detected by the presence of chicks fledged. After the chicks fledging, we searched all territories of breeding pairs to detect and confirm nest locations.

Breeding site locations were plotted with GPS.

Breeding habitat characteristics

Using ArcGIS software, 1500 m radius circles were drawn around each nesting site, and this was defined as the "breeding area" (Martelli 1984, Pandolfi & Pino D'Astore 1990, Salamolard 1997, Limiñana *et al*. 2008).

We used the "intersect operator" over the regional land cover map to calculate the land-use composition within each breeding area. We reclassified the original categories of the land-use map into nine groups. Every nesting site was also classified according to the type of substrate where it was placed: cultivated, natural or semi-natural vegetation. The selected environmental parameters are described in Table 1.

Statistical Analysis

All land-use variables were expressed as a percentage of the breeding area. We performed a Chi-square test to compare occurrences of nesting in cultivated vs. natural or semi-natural vegetation. A Mann-Whitney U test was used to compare environmental parameters between 2010 and 2011. The level of significance used was $P < 0.05$.

All tests were performed with the software, SPSS v17.0 (© SPSS Inc., Chicago, IL, USA www.spss.com).

RESULTS

Birds count

We recorded 14 territories occupied by Montagu's harrier during 2010 and 13 during 2011. However, for this study we included only those breeding sites for which we were certain that nesting occurred: 11 breeding sites for 2010 and 12 breeding sites for 2011. The breeding sites ranged in altitude from 217 to 1243 m (altitude range in study area: 0-1686 m).

Breeding habitat characteristics

The most prevalent landscape in breeding sites was agricultural, although there was one case of nesting on the edge of a wooded area and another in uncultivated grasslands at high altitudes. No differences in environmental parameters were found between 2010 and 2011 (all P values > 0.05) and all data were pooled for descriptive statistics (Tab. 2).

Nesting site: cultivated vs. natural vegetation

During the 2010 and 2011 breeding season, Montagu's harrier selected mainly natural vegetation ($\chi^2 = 7.562$, $df = 1$, $p < 0.01$). In 91.3% of cases, nests were built on natu-

Table 1. Breeding habitat characteristics.

Paramaters	Details	
Altitude	elevation of the nesting site, m a.s.l.	
Exposure of nesting site	N-S-W-E, mode value	
Distance to the nearest nest	km	
Minimum distance to the coastline	km	
Minimum distance to the nearest build structure	km	
Land-use	urban, %	(building, production facility, built with infrastructure and processing areas)
	cultivated, %	(non-irrigated crops and crops with trees)
	vineyards, %	(vineyards and orchards)
	forest, %	
	meadows, %	
	shrubs, %	(uncultivated with shrubs, uncultivated with trees, uncultivated with rocks and debris and uncultivated along stream)
	badlands, %	(rocks and accumulation debris, areas in erosion and mining areas)
	water, %	(quarry lakes and lagoons, streams and reservoirs)
	roads, %	(paved and unpaved roads)
Landscape diversity	was calculated applying the Shannon index of diversity (H' = -Σ pix log pi, where pi is the relative proportion of land-use i) from the percentage of land-use typologies; relative richness (number of present land-use typologies in an area in relation to potential typologies) and edge density (m/ha for selected classes of land-use) to the percentage of different land-use categories within each breeding buffer area.	

Table 2. Summary of breeding habitat characteristics of Montagu's harriers in north of Marche region (Central Italy) (N = 23).

Paramaters		MEAN	S D	MIN	MAX
Altitude, m		463.42	305.75	202.50	1220.00
Exposure		S-W			
Distance to the nearest nest, km		5.72	3.75	2.76	14.53
Minimum distance to the coastline, km		24.47	6.91	12.00	40.00
Minimum distance to the nearest build structure, km		0.39	0.28	0.08	1.06
Land use	urban, %	2.52	1.80	0.24	6.07
	cultivated, %	41.19	17.23	4.59	64.77
	vineyards, %	0.84	1.25	0.00	4.11
	forest, %	18.52	16.96	2.37	77.15
	meadows, %	13.77	17.52	1.81	62.09
	shrubs, %	4.63	3.30	0.45	9.89
	badlands, %	15.12	15.58	0.00	45.85
	water, %	1.36	1.52	0.01	6.67
	roads, %	2.05	0.44	1.28	2.79
Landscape diversity	Shannon's diversity	1.56	0.27	0.94	1.93
	relative richness	35.13	5.17	27.50	42.50
	edge density	345.94	65.65	226.02	453.07

ral or semi-natural vegetation (uncultivated, shrubs or badlands). We detected only two cases of nesting in agricultural (cultivated) land, although both cases were near field edges in an area close to abandoned farmland.

DISCUSSION

Our results provide a first update since 2005 about the distribution and number of breeding pairs of Montagu's harrier in the northern Marche region. Although the species is considered of "least concern" (BirdLife International 2004, IUCN 2010), this information is important because Montagu's harrier is nevertheless regarded in Italy as vulnerable (Peronace *et al*. 2012) and locally even endangered (Pandolfi & Tanferna 2009). Furthermore Montagu's harrier is included in Annex I of the European Birds Directive (2009/147/CE), which lists these birds as particularly threatened and subject to special conservation measures.

The most recent survey data on the presence of this raptor in the northern Marche region were collected during 2005 and revealed a strong decreasing population trend. Moreover, the results of Pandolfi & Tanferna from 2009 showed that the percentage change in the number of Montagu's harrier breeding pairs seemed to be strongly negative over the last 20 years, down by -88 % (Fig. 2; Appendix). Despite this, our results suggest that the number of breeding pairs in the long-studied northern Marche region has increased over the last five years (from 3 pairs reported by Pandolfi & Tanferna for 2005 to more than 11-12 pairs). During 2010 and 2011 we found no instances of colonial or semi-colonial breeding, but the mean distance to the nearest nest was nevertheless < 6 km, and in some cases < 3 km. However, during preliminary visits to the study area during the 2008-2009 breeding season, we found some examples of semi-colonialism, with two pairs nesting less than < 300 meters apart.

Studying the same area for a longer period to verify a relative increase of the number of breeding pairs while also considering characteristics of the sites used for nesting would be an interesting topic for the species conservation. As with several other farmland bird species, Montagu's harrier is subject to human pressure due to anthropogenic activities and agricultural intensification causing habitat loss or fragmentation (Arroyo *et al*. 2002, Palomino & Carrascal 2007). Since the 1990s, 70–90% of Montagu's harrier breeding pairs in Western Europe have bred in agricultural habitats (Arroyo *et al*. 2002), increasing the conservation risk for these populations. Dependence on a man-made environment like farmland means that a species is particularly exposed to all the potential changes occurring in this habitat, and rapid changes in these ecosystems can cause the loss of a species in just a few years (Donald *et al*. 2006). Agricultural activities, crop harvesting in par-

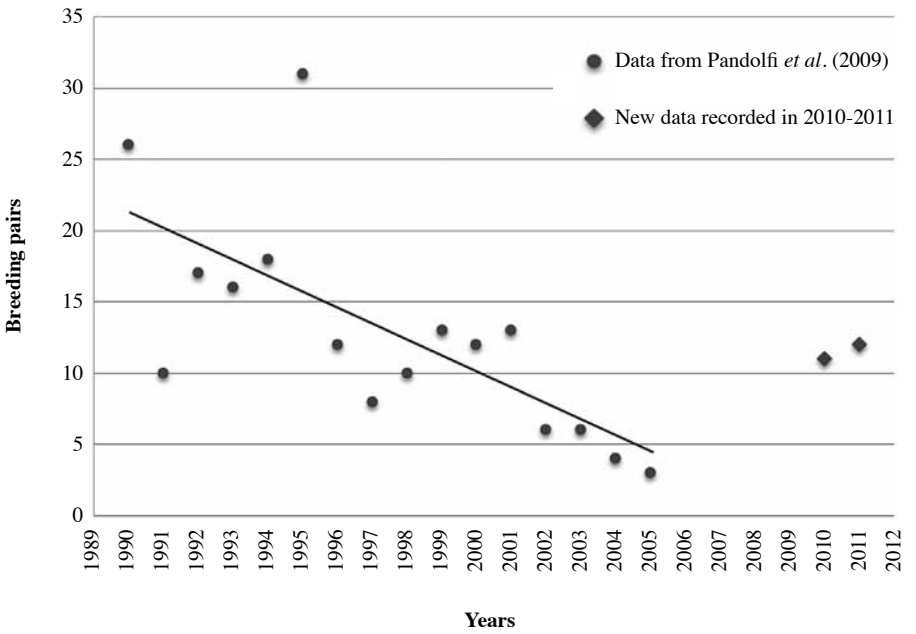

Figure 2. Decrease in number of breeding pairs of Montagu's harriers in Marche region (Central Italy) according to Pandolfi & Tanferna (2009) and new data recorded in 2010-2011.

ticular, may have compromised the reproductive success of pairs of Montagu's harrier during the nestling phase (Arroyo *et al*. 2002) and affected a shift in nesting habitat from cultivated to natural areas.

Indeed, our results show a higher occurrence of the species nesting in natural fields than in farmland or cropland. Selection of natural vegetation for the location of the nest could be the result of a trade-off between nest protection and nest accessibility. Tall vegetation around the nest may provide protection against ground predators and even aerial predators.

Although the species seems to occur more often in low hill landscapes (450-550 m) we also recorded Montagu's harrier nesting at about 800-1300 m a.s.l. These results indicate a relatively higher altitude range of breeding sites than those known for other areas of Central Italy (Pandolfi 1995).

An increase in the number of Montagu's harrier pairs breeding in the Marche region could be due to the use of natural vegetation for nesting, as well as by their relocation to higher areas. So, our studied population could be less susceptible to the effects of nest losses caused by agricultural practices and urbanization, which is mostly observed in low areas. This may have eliminated the highest risks posed by nesting in farmland, which may have been a cause of the previous decline recorded in the populations examined in this region.

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