

Vegetation height selection in Montagu's Harriers *Circus pygargus* breeding in a natural habitat

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The selection of an appropriate site for nesting is of vital importance in birds, especially in ground nesting species as Montagu's Harrier *Circus pygargus*. This raptor mainly uses cereal crops as nesting habitat, although natural vegetation is also used in some European areas. Vegetation height is one of the main factors affecting nest location in cereal crops but there is no data on its importance in natural habitats. In Castellon province (NE Spain), the species uses shrublands as breeding habitat, which provides the opportunity to explore the importance of vegetation height in birds breeding in natural areas. In this study, we compared vegetation height at nests with vegetation height in the surrounding of the nests, and at random points within patches occupied by harriers. Mean vegetation height at nests was 83.5 cm (SD 17.2), which corresponds to observations in other natural vegetation sites and cereal crops. At one metre from nests, the vegetation was higher, with a mean value of 109 cm (SD 16.0). Mean vegetation height at random points was also 109 cm. This contrasts with observations in cereal crops, where nests are located in sites where vegetation height is equal or higher than the surrounding vegetation. In our study area vegetation height seems to play an important role in determining the exact location of nests within a patch, but in terms of vegetation height the areas used by harriers for nesting do not differ from the rest of the patch. This suggests that most sectors of the patches are potentially suitable for nesting, with the selection of shorter vegetation for the exact location of the nest probably resulting of a trade-off between nest protection and nest accessibility. As populations breeding in cereals need human intervention to be sustainable, and in the absence of conservation measures breeding output is higher in natural habitat than in farmland, the protection of populations inhabiting natural habitats may be important for the conservation of the species in a wider context, as they may act as sources of harriers for other areas.

Key words: *Circus pygargus*, habitat selection, Montagu's Harrier, natural vegetation, nesting site, Spain, vegetation height

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Introduction

The selection of an appropriate site for nesting is of vital importance for reproduction in birds. The position of the nest should ensure protection of eggs and fledglings against adverse environmental conditions and predators (Hansell 2000), especially in ground-nesting species (Arroyo *et al.* 2003). These factors may have important management implications.

The Montagu's Harrier *Circus pygargus* is a ground-nesting species that until recently mostly bred in marshes or steppe grasslands (Simmons 2000). However, it is currently most often found breeding in cereal crops (Clarke 1996). This is also true in Spain, where 90% of the breeding pairs use cereals for nesting (Ferrero 1995). Yet, both in Spain and other European countries, some populations still breed in natural habitats (Clarke 1996, García & Arroyo 2003). Studying and protecting these populations is important for the conservation of the species in Europe (Arroyo *et al.* 2004). Contrary to cereal-nesting harriers, Montagu's Harriers nesting in natural habitats are not exposed to threats associated with harvesting (Arroyo *et al.* 2002). These populations are usually more productive (Pandolfi & Giacchini 1991, Arroyo *et al.* 2004, Limiñana *et al.* 2006), and therefore can act as a source for harriers nesting in farmland. One of the most successful populations breeding in a natural habitat within Europe occurs in Castellon province, north-eastern Spain (Limiñana *et al.* 2006, Soutullo *et al.* 2006), where the nesting habitat consists of sclerophyllous Mediterranean shrubland.

As hierarchical processes are known to affect nest site selection (Orians & Wittenberger 1991) differences in vegetation at the nest site and some distance away may indicate that harriers perceive the available vegetation as heterogeneous in terms of microhabitat and suitability for nesting. In cereal crops, the location of Montagu's Harrier nests is to a large extent determined by vegetation height (Claro 2000, Arroyo *et al.* 2003). Nonetheless, studies dealing with habitat structure are scarce in this species, particularly for natural habitats, and generally only describe the vegetation at

the nest (see Arroyo *et al.* 2004). In this paper, we evaluate whether vegetation height also influences the nest location of Montagu's Harriers breeding in natural vegetation. Plant species present at the nests and their relative contribution to plant cover are also recorded. Results are compared with those obtained in other populations.

Study area and methods

Data were collected in 2003 and 2004 in several colonies from inland Castellon province (Fig. 1). The area of the Minimum Convex Polygon comprising all the nests sampled was c. 1050 km² in both years. Limiñana *et al.* (2006) and Soutullo *et al.* (2006) provide details on the population studied and the study area. Vegetation height was measured at 102 nests (51 in 2003 and 51 in 2004, representing each year 50% of the total estimated breeding population in our study area): at the exact nest location and at one m distance from the nest (Sergio *et al.* 2003). Four heights were measured along the edge of the nest cup and at one m from the nest, to calculate mean vegetation height at the cup and at one m distance from it. Percentage of plant cover within a one m² plot including the nest was visually estimated. Finally, in patches occupied by harriers we chose 124 random points within suitable habitat for nesting, at least 30 m distant from each other and from the nests. At each point four vegetation heights were recorded, and mean vegetation height calculated. All patches were comprised of Mediterranean shrubland where the most abundant species are Kermes Oak *Quercus coccifera*, Gorse *Ulex parviflorus* and Rosemary *Rosmarinus officinalis*. Other shrub-like species are frequent, like *Pistacia lentiscus*, *Rhamnus alaternus* and *Erica multiflora*. Herbaceous vegetation was also present, mainly grasses (*Brachipodium* sp.). Vegetation height was always measured in shrub-like species. These species are nearly fully grown at the time harriers arrive at the breeding areas.

Mean vegetation heights at the nest and at one m from the nest in both 2003 and 2004 were compared with mean vegetation height at random points using one-way ANOVAs (one ANOVA to



Figure 1. The study area in Castellon, Spain, with vast shrubland as breeding habitat for Montagu's Harrier (photo R. Limiñana).

compare the height at the nest with the random points, and one to compare the height at one m from the nest with the random points). The Games-Howell post-hoc test for unequal variances (Zar 1999) was then used to conduct all pairwise comparisons and explore between-year differences in vegetation height. Averages are reported ± 1 SD.

Results

Mean vegetation height at nests was 83.5 ± 17.2 cm ($n = 102$), with minimum and maximum values ranging from 39 to 146 cm. At one metre from nests, the vegetation was higher, with a mean value of 109 ± 16.0 cm ($n = 102$). Mean vegetation height at random points was also 109 ± 26.3 cm ($n = 124$). Kermes Oak was present at all Montagu's Harrier nests; this was the only species covering 100% of the plot at several nest sites (Table 1).

Vegetation was significantly higher at random points than at the nests ($F_{2,223} = 35.45$, $P < 0.001$). This was due to differences between ran-

dom points and nests ($P < 0.001$ for both years) but not to between-year differences ($P = 0.872$). In contrast, at one metre from the nests no differences were observed with the vegetation at random points, nor between years ($F_{2,223} = 0.228$, $P = 0.796$).

Table 1. Frequency of occurrence and relative contribution to plant cover (min–max) within 1 m² square plots enclosing Montagu's Harrier nests in Castellón province (Spain) in 2003 and 2004 ($n = 102$).

Species	Occurrence at nests (%)	Proportion of plant cover (%)
<i>Quercus coccifera</i>	100	20–100
<i>Ulex parviflorus</i>	63	4–60
<i>Rosmarinus officinalis</i>	31	5–60
<i>Pistacia lentiscus</i>	17	5–35
<i>Erica multiflora</i>	15	5–25
<i>Rhamnus alaternus</i>	11	5–50
<i>Chamaerops humilis</i>	6	5–15
Other species	2	5–25

Discussion

In our study area vegetation height seems to play an important role in determining the exact location of nests within a patch, but in terms of vegetation height the areas used by harriers for nesting (described as 1 m² square plots including the nest) do not differ from the rest of the patch. This suggests that most sectors of the patches are potentially suitable for nesting. The mean value of vegetation height at nests recorded in our study area was similar to that observed for the species in other natural habitats and in cereals. Heights at nests reported for natural vegetation range from 79 ± 25 cm in meadows in France to 103 ± 41 cm in open shrubland in Kazakhstan; in cereal crops the reported values are similar, being 88 ± 16 cm at nests in France, and 87 ± 22 cm in Portugal in fields where nests were present (Claro 2000, Arroyo *et al.* 2004).

Interestingly, in our study area Montagu's Harriers built their nests where the vegetation was shorter than in the surroundings. In contrast, in cereal crops nests are located in sites where vegetation is of equal height or higher than the surrounding vegetation (Claro 2000, Arroyo *et al.* 2004). Within the shrublands in our study area, the selection of shorter vegetation for the exact location of the nest could be the result of a trade-off between nest protection and nest accessibility. On the one hand, tall vegetation around the nest may provide protection against ground predators and even aerial predators. In contrast, it might have a negative effect on the take-off and landing of the harriers. Also, shrublands are thick and thorny and harriers need gaps in this vegetation to allow nest construction on the ground. That is, harriers may look for gaps of herbaceous vegetation among the shrubs, where vegetation height is below the average vegetation height of the patch. In cereals, vegetation height varies among years and distribution of breeding pairs depends on cereal height (Claro 2000, Arroyo *et al.* 2003). In these areas vegetation height is generally short, providing limited protection. By building nests in places where vegetation height is above average, harriers may be able to increase nest protection.

Moreover, minimum vegetation height seems to be the limiting factor explaining the presence of Montagu's Harrier nests in cereals (Castaño 1995). The fact that vegetation height at Montagu's Harrier nests in cereals is similar to that found in natural vegetation might thus indicate that cereal-nesting harriers select vegetation heights that approximate the heights they would use in natural vegetation.

In our population, the high breeding output and the steady population increase since it was first established in the early 1980s are likely to be related to the characteristics of the breeding habitat they are using (Limiñana *et al.* 2006), as in shrublands nest detection by predators is likely to be smaller than in cereals and nest losses by human activities is non-existent. Populations breeding in cereals need human intervention to be sustainable, and in the absence of conservation measures (and sometimes even with these measures) breeding output in farmland is lower than in natural habitat (Pandolfi & Giacchini 1991, Castaño 1997, Corbacho *et al.* 1997, Koks *et al.* 2001, Millon *et al.* 2002, Limiñana *et al.* 2006). The protection of populations inhabiting natural habitats may thus be important for the conservation of the species in a wider context (Limiñana *et al.* 2006), as they may act as sources of recruits for other areas (Soutullo *et al.* 2006).

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REFERENCES

- Arroyo B.E., Bretagnolle V. & Garcia J.T. 2003. Land use, agricultural practices and conservation of Montagu's Harrier. BOU Proceedings. In: Thompson D.B.A., Redpath S.M. & Marquiss M. (eds). Raptors in a Changing Environment: 449–463. JNCC, Peterborough.
- Arroyo B.E., García J.T. & Bretagnolle V. 2002. Conservation of the Montagu's Harrier (*Circus pygargus*) in agricultural areas. Anim. Conserv. 5: 283–290.
- Arroyo B.E., García J.T. & Bretagnolle V. 2004. Montagu's Harrier *Circus pygargus*. The Birds of the Western Palearctic Update, Vol. 6: 41–55.
- Castaño J.P. 1995. Ecología reproductiva del aguilucho cenizo *Circus pygargus* en el Campo de Montiel. Ph.D. Thesis. Universidad Complutense, Madrid.
- Castaño J.P. 1997. Fenología de puesta y parámetros reproductivos en una población de Aguilucho Cenizo (*Circus pygargus*) en el Campo de Montiel. Ardeola 44: 51–59.
- Clarke R. 1996. Montagu's Harrier. Arlequin Press, Chelmsford.
- Claro J.C. 2000. Ecologia reproductiva do Tartaranhão-caçador *Circus pygargus* (L.) na região de Evora. MSc Thesis. University of Evora.
- Corbacho C., Sánchez J.M. & Sánchez A. 1997. Breeding biology of Montagu's Harrier *Circus pygargus* L. in agricultural environments of southwest Spain; comparison with other populations in the western Palearctic. Bird Study 44: 166–175.
- Ferrero J.J. 1995. La población ibérica de aguilucho cenizo (*Circus pygargus*). Alytes VII: 539–560.
- García J.T. & Arroyo B. 2003. Aguilucho cenizo, *Circus pygargus*. In: Martí R. & Del Moral J.C. (eds). Atlas de las Aves Reproductoras de España: 178–179. Mº Medio Ambiente-SEO, Madrid.
- Hansell M. 2000. Bird nests and construction behaviour. Cambridge University Press, Cambridge.
- Koks B., van Scharenburg K. & Visser E.G. 2001. Grauwe Kiekendieven *Circus pygargus* in Nederland: balanceren tussen hoop en vrees. Limosa 74: 121–136.
- Limifiana R., Surroca M., Miralles S., Urios V. & Jiménez J. 2006. Population trend and breeding biology of Montagu's Harrier *Circus pygargus* in a natural vegetation site in Northeast Spain. Bird Study 53: 126–131.
- Millon A., Bourrioux J.-L., Riols C. & Bretagnolle V. 2002. Comparative breeding biology of Hen Harrier and Montagu's Harrier: an 8-year study in north-eastern France. Ibis 144: 94–105.
- Orians G. & Wittenberger J. 1991. Spatial and temporal scales in habitat selection. Am. Nat. 137: 29–49.
- Pandolfi M. & Giacchini P. 1991. Distribuzione e successo riproduttivo di albanella minore, *Circus pygargus*, nelle Marche. Riv. Ital. Orn. 61: 25–32.
- Sergio F., Pedrini P. & Marchesi L. 2003. Adaptative selection of foraging and nesting habitat by black kites (*Milvus migrans*) and its implications for conservation: a multi-scale approach. Biol. Conserv. 112: 351–362.
- Simmons R.E. 2000. Harriers of the world. Oxford University Press, Oxford.
- Soutullo A., Limifiana R., Urios V, Surroca M. & Gill J.A. 2006. Density-dependent regulation of population size in colonial breeders: Allee and buffer effects in the migratory Montagu's Harrier. Oecologia 149: 549–552.
- Zar J.H. 1999. Biostatistical Analysis. 4th edition. Prentice Hall, New Jersey.

SAMENVATTING

In Europa broeden de meeste Grauwe Kiekendieven *Circus pygargus* tegenwoordig in boerenland, vooral in uitgestrekte graanakkers. Zonder nestbescherming is de kans groot dat deze nesten tijdens de oogst verloren gaan. Op slechts weinig plekken is de Grauwe Kiekendief nog als broedvogel in natuurlijke habitats te vinden. In de provincie Castellón in het noordoosten van Spanje ligt zo'n plek. Het betreft een mediterrane struiklandschap met verspreide boomgroei en een doornige, houtige vegetatie. In 2003 en 2004 werden hier telkens 51 nesten (de helft van het aanwezige aantal territoria) opgespoord. Van elk nest werd op de nestplek en op 1 m afstand van het nest het vegetatietype en de dichtheid en hoogte van de vegetatie opgemeten. Deze gegevens werden vervolgens vergeleken met vegetatieopnames op 124 willekeurige plekken in geschikt broedhabitat. De vegetatie was op de willekeurige punten significant hoger (gemiddeld 109 cm) dan op de nestplek (gemiddelde 83,5 cm), maar week in hoogte niet af van de vegetatie op 1 m afstand van het nest (gemiddeld 109 cm). De vegetatiehoogte op de nestplek in Castellón komt overeen met die in landbouwgewassen en natuurlijke habitats elders in Europa en in Kazakstan. In Castellón viel de keuze van de kiekendieven op gaten in de dichte en doornige vegetatie, omdat ze anders geen grondnest konden bouwen.

De goede broedresultaten en populatieoename in Castellón zijn aanwijzingen dat deze natuurlijke habitat geschikte broedgelegenheid oplevert, mede door geringe predatie en afwezigheid van verliezen door menselijke ingrepen. Zulke habitats kunnen als brongebied fungeren voor broedvogels in landbouwgewassen die alleen jongen tot uitvliegen krijgen bij de gratie van constante bescherming door mensen. Instandhouding en bescherming van natuurlijke broedgebieden is dus van groot belang voor de soort. (RGB)

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