Journal of Biological Research-Thessaloniki **17**: 44 – 50, 2012
J. Biol. Res.-Thessalon. is available online at http://www.jbr.gr
Indexed in: WoS (Web of Science, ISI Thomson), SCOPUS, CAS (Chemical Abstracts Service) and DOAJ (Directory of Open Access Journals)

Abundance of common buzzards (*Buteo buteo*) in olive monocultures in the island of Crete

Olga TZORTZAKAKI[1], Stylianos SIMAIAKIS[2] and Stavros XIROUCHAKIS[2*]

[1] *Department of Biology, University of Crete, P.O. Box 2208, Heraklion 71409, Crete, Greece*
[2] *Natural History Museum of Crete, University of Crete, P.O. Box 2208, Heraklion 71409, Crete, Greece*

Received: 24 February 2011 Accepted after revision: 16 June 2011

In the present study we collected data on the breeding and wintering status of common buzzards that used olive groves in the Mesara basin (112 km^2) in south Crete. An effort was also made to investigate the flying and hunting behavior of wintering individuals. The number of the species territories mapped during spring 2003-2006 ranged from 18-23 producing a breeding density of 5.7 pairs per 100 km^2. Similarly, roadside surveys carried out during winter 2007-2008 generated a mean density of 2.5 individuals km^{-2} or an estimated wintering population of 248-322 individuals. Buzzard numbers peaked in December and February depicting an influx of wintering and migrating birds, respectively. Overall, the species density was lower than those reported for central Europe but rather high when compared to other Mediterranean regions. These differences could be attributed to weather conditions, crop type and the farming methods practiced in olive groves. Hovering buzzards were never recorded whereas soaring was the commonest type of flight behavior. In addition, perching buzzards selected favorably manmade constructions against natural ones. Ground hunting is negligible in Crete, in contrast to north European countries, where suitable perching sites might be scarce in open farmland and snow cover in winter is frequent.

Key words: *Buteo buteo*, road survey, population density, olive groves, Crete.

INTRODUCTION

The common buzzard (*Buteo buteo*) is one of the most widespread and numerous raptors in Europe (BirdLife International, 2004). It inhabits a great variety of landscapes but mainly mosaics of woodland and agricultural areas (Bijlsma, 1997). More specifically, buzzards use plots of open land with cultivations and close to forest patches so as to satisfy both their feeding and nesting requirements (Tucker & Heath, 1994; Kostrzewa, 1996). Overall, the species distribution in the non-breeding season is strongly affected by food availability (Newton, 1998) and weather conditions (Kostrzewa & Kostrzewa, 1991; Elkins, 1995) with the winter being the most critical period (Boano & Toffoli, 2002).

In winter, common buzzards are restricted to open landscapes and primarily farmland where high densities of rodents may occur (Wuczyński, 2003; Walls *et al*., 2004). Their main hunting habitat includes open tracts with low vegetation along with scattered trees and artificial structures, which are used for perching (Pearlstine *et al*., 2006). The species has proved quite indicative for environmental alterations as it is often found in high densities in the wintering quarters (Hiraldo *et al*., 1991; Newton, 1998; Wuczyński, 2005). Moreover, considering that buzzards are one of the most abundant raptors in agrosystems, they could be used as bio-indicators of farming methods and environmental quality. Assessing their local or regional population density, managers could acquire important information on the impact of land use changes on raptors or wildlife in general (Boano & Toffoli, 2002; Sierdsema & van Loon, 2008).

In Greece, the common buzzard is one of the most abundant birds of prey. Its population is estimated at approximately 5000 breeding pairs (Handrinos & Akriotis, 1997). Moreover, a significant influx

* Corresponding author: tel.: +30 2810 393279, fax: +30 2810 324366, e-mail: sxirouch@nhmc.uoc.gr

of individuals originated from Scandinavia and East Europe overstay during the winter in a variety of habitats, showing a distinct preference for coastal wetlands and irrigated farmland (Handrinos & Akriotis, 1997). In Crete, buzzards are resident though their population increases temporally during the winter and the migration periods. In winter, birds presumably from the mainland are mostly attracted to intensively cultivated land such as olive groves and vineyards. As published data on seasonal fluctuations of buzzard populations in SE Europe are scarce (Handrinos, 1987; Eakle, 1994; Sarà, 1996; Nicolov *et al*., 2006), the aims of the present study were to: a) estimate the abundance and density of the species in the southernmost point of its European range and make relevant comparisons (e.g. numbers, hunting behavior and perch-site use) with northern populations and b) assess the significance of the most typical agricultural land in Crete (i.e., olive groves) for its wintering status.

MATERIALS AND METHODS

The study area was located in the Mesara basin (350 km^2) in south-central Crete, which constitutes the most important agricultural area on the island (Fig. 1). It consists of a flat farmland that spreads over 112 km^2 and is covered by extensive and intensively-cultivated olive monoculture (70%) and to a lesser extent by vineyards, orchards, vegetable and cereal fields. The rivers of the basin (Geropotamos and Anapodaris) have been drained because of overpumping for crop irrigation. The natural vegetation consists of Mediterranean garrigue and maquis shrubs which are patchily distributed in the field margins and the mountain foothills bordering the plain. The climate is subhumid Mediterranean, with hot, dry summers and mild winters. Annual precipitation ranges from 300 to 650 mm with 40% occurring during December-January. The average temperature in winter is 12°C and in summer 28°C (Vardavas *et al.*, 1997).

The size of the species breeding population during 2003-2006 was estimated by applying territory mapping (Bibby *et al.*, 2000). To achieve this, fifteen road surveys were carried out during midday hours (when warmed ground facilitated soaring) during early March-late April every year. The routes were not predetermined but random and crossed the flat area of the basin. All birds recorded soaring together or performing undulating display flights were assumed to be paired and territory occupants (Fuller & Mosher, 1981; Sutton & Sutton, 1996). Their position was noted on 1:50000 scale maps (Hellenic Military Geographical Service) with the aid of a Global Positioning System device (Garmin GPSMap 76Csx). In this way, a series of field maps were generated where overlapping buzzard observations produced clusters of records. These clusters were then analyzed for delineating buzzard territories. Sightings of birds in cross-country flights in high altitude over the plain were discarded from the analysis.

In addition, 16 roadside surveys were conducted during 2007-2008 that covered the winter period (late October-January), spring migration (February-March) and the onset of the breeding season (March-April). More specifically, we followed routes at random which totaled 65 km within a narrow strip of the plain with extensive olive grooves (Fig. 1). The routes were selected from the existing road network and contained rural (53.9 km) and secondary dirt roads (11.1 km). This process was pursued in an effort to allow bird sightings to be independent events. Road transects were undertaken ca. every ten days starting when morning mist had been completely diluted at 11:00 am and ended at 16:00 pm. Days of heavy rain that impeded visibility were avoided. The vehicle speed was 40 km h^{-1} or less (Bohall & Collopy, 1984), and all raptors sighted with unaided eye on both sides of the road were recorded by two observers, and identified with the aid of 10×50 binoculars (Williams *et al.*, 2000). Bird behavior and perpendicular distance from the transect line, estimated by a range finder (Rangematic 1000, Forestry Supplies USA), were also noted after short pauses. Buzzard activity was divided into four categories namely soaring, perching, gliding and sitting on the ground. Perching sites were distinguished into natural (trees > 5 m) and artificial (electricity wires, poles and pylons), and their availability was quantified from 12 randomly selected census strips 1 km long and 600 m wide. The latter was determined by the maximum lateral distance (300 m) that perching buzzards were easily spotted with unaided eye. We also considered 200 m segments of electricity wires to be distinct perches as this was measured (by the car odometer) to be the minimum distance between two perching buzzards.

We calculated mean buzzard winter density with the DISTANCE 5.0 software (Thomas *et al*., 2006) using a detection function of perpendicular distances of the birds from the transect line. We analyzed data only for counts with sufficient sample size (i.e. minimum 40 and preferably more than 60 observations)

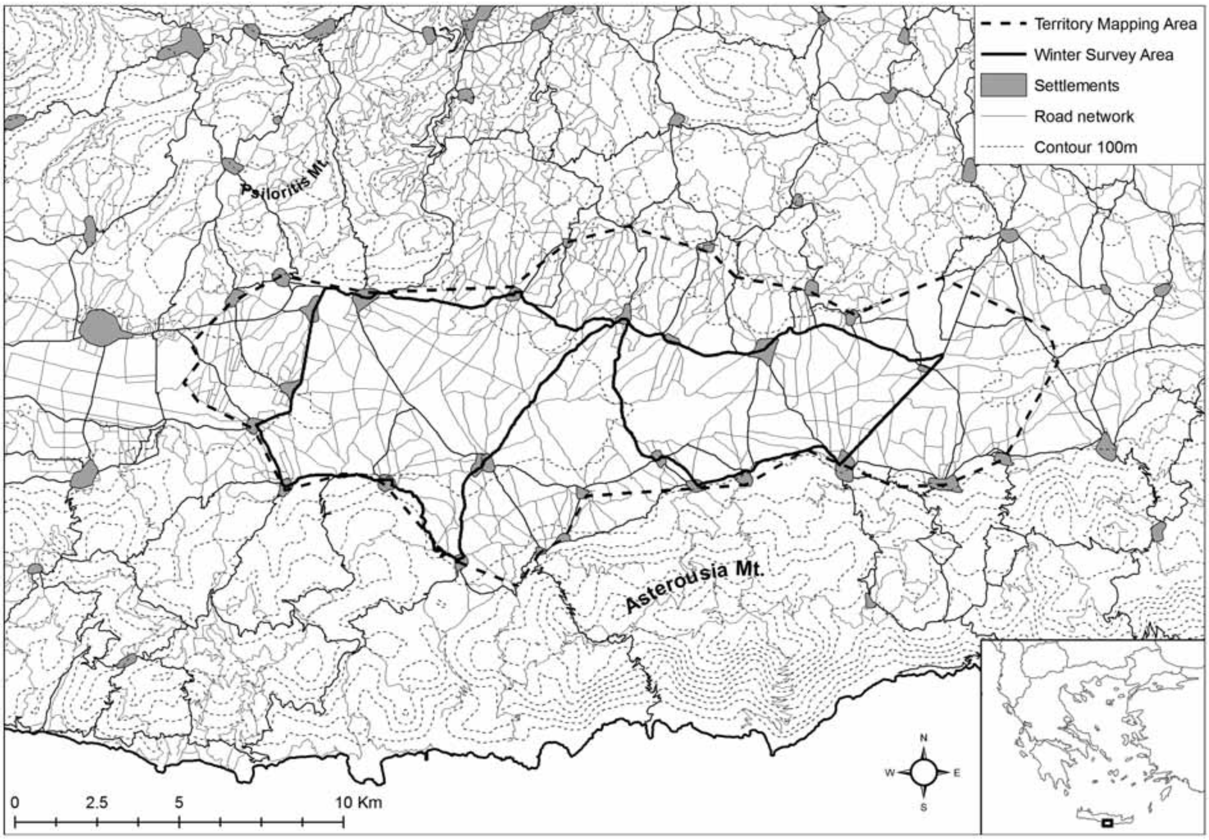

FIG. 1. The study area in the Mesara basin (south Crete) and road network were survey routes were conducted during March-April 2003-2006 and October-April 2007-2008.

while months were treated as strata (Buckland *et al*., 2001; Boano & Toffoli, 2002). Models with different key functions and expansions for adjustment were tested with Akaike's Information Criterion (AIC) and by visual inspection of the detection probability graphs against perpendicular distances (Akaike, 1973; Anderson & Burnham, 1999). The variance of density was estimated empirically by the analytical procedure of the software (Buckland *et al*., 2001; Thomas *et al*., 2006). In addition, we compared the number of buzzard sightings among months by using non-parametric tests. Meanwhile we checked the frequencies of behavioral types and perch substrates in relation to their relative occurrence in the census strips by constructing contingency tables and applying G-tests (Zar, 2007). All analyses were conducted at a 0.05 level of significance by the R-2.8.0 software (R Development Core Team, 2008).

RESULTS

The mean number of buzzard territories that were mapped during the breeding seasons of 2003-2006 was 20 ± 2.5 (range = 18-23). This figure yielded an average breeding density of 5.7 pairs per 100 km^2 and a theoretical home range of 17.5 km^2 per pair. Birds were conspicuous in the periphery of the plain close to hilly outcrops or tree stands near streams and roads. They were spotted mostly during early and mid March though sometimes it was difficult to distinguish territory holders from migratory birds (i.e. > four individuals soaring in the same thermal).

Furthermore in the road surveys conducted from October 2007 to April 2008 we tallied 733 buzzard observations of which 495 (67.5%) were made during winter. More specifically, buzzard numbers fluctuated among winter months peaking in December and February and reached the minima in early January. However, these differences were not significant in frequencies (Friedman's test $\chi^2 = 4.5$, df = 4, $p > 0.05$, Fig. 2) nor in average numbers (Table 1). The majority of birds were recorded within a radius of 150 m from the observers (Fig. 3), while the DISTANCE software showed that the hazard-rate key function with a cosine adjustment was the best fitting model

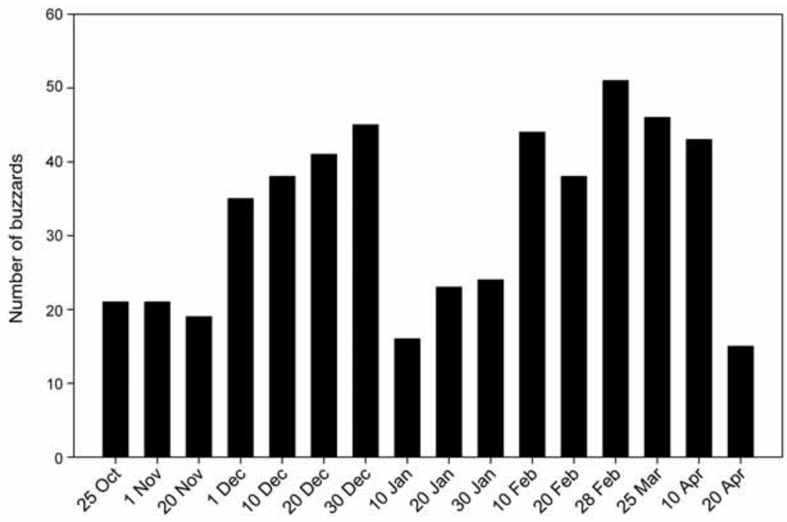

FIG. 2. Number of Common Buzzards recorded in road surveys conducted in Mesara Plain (south Crete) during 2007-2008.

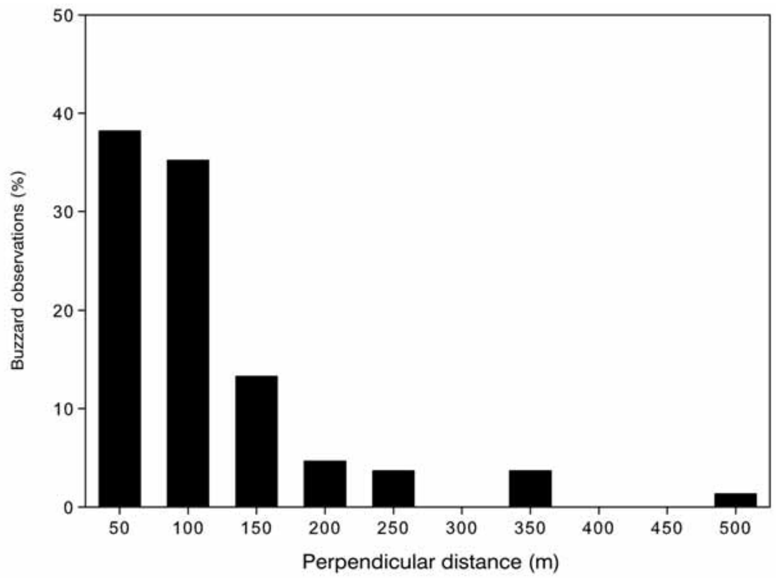

FIG. 3. Distances of buzzard sightings from transect lines in road surveys conducted in the Mesara Plain (south Crete) during 2007-2008.

for detecting the birds. The mean winter density (D_w) was calculated at 2.5 individuals km^{-2} (95% C.I. = 1.4-4.2) and the total wintering population (N_w) at 283 individuals (95% C.I. = 167-479, Table 1). However excluding January because of its small sample sizes (< 60 records) the figures were $D_w = 2.5$ individuals km^{-2} (95% C.I. = 2.2-2.8) and $N_w = 282$ individuals (95% C.I. = 248-322).

Most birds were observed soaring or perching (G-test, $\chi^2 = 520.8$, df = 4, $p < 0.001$) with these types of behavior being more pronounced during winter (G-test, $\chi^2 = 43.9$, df = 8, $p < 0.001$, Table 2). Hovering was never recorded despite the fact that this flight type is quite frequent among buzzards. In addition, artificial and natural substrates were equally available in the study area (G-test, $\chi^2 = 0.30$, df = 1, $p = 0.57$) but buzzards were sighted perching on them disproportionately to their occurrence (G-test, $\chi^2 = 26$, df = 1, $p < 0.05$). In fact birds used electricity poles more often than trees, though no significant differences were noted between months (G-test, $\chi^2 = 12.2$, df = 6, $p = 0.057$, Table 2).

DISCUSSION

The density of territorial buzzards in the Mesara plain, i.e. 5.7 pairs per 100 km^2, was lower than the respective values for regions of higher latitudes (i.e. 8-

TABLE 1. Density (individuals km^{-2}), number of individuals (mean ± s.e.) and 95% confidence intervals of common buzzards wintering in olive groves of Mesara plain (south Crete) during 2007-2008

	December	January	February	Total
No. of buzzard sightings	49 ± 7.87	33.7 ± 6.35	66 ± 6.50	49.5 ± 5.6
Estimated density (D)	2.7 ± 0.17	1.7 ± 0.32	2.9 ± 0.21	2.5
(D) 95% C.I.	2.4-3.1	0.3-8.6	2.5-3.4	2.2-2.8
Estimated no. of individuals (N)	307 ± 19.7	193 ± 36.2	327 ± 24.1	282
(N) 95% C.I.	268-352	39-968	278-385	248-322
Kruskal-Wallis χ^2	4.7			
p	0.09			

TABLE 2. Behavioral types ($n = 733$) and perching substrates ($n = 209$) of wintering buzzards in olive groves in the Mesara plain (south Crete) during 2007-2008

Activity type	Oct-Nov (%)	Dec-Feb (%)	Mar-Apr (%)	Total (%)
Energetic flight	3.3	2.5	1.0	2.3
Soaring	32.8	50.7	72.1	52.9
Gliding	14.8	15.5	16.3	15.6
Perching				28.5
electricity pole	31.1	15.5	4.8	
electricity pylon	4.9	0.8	1.0	
electricity wire	8.2	3.9	–	
tree	4.9	10.4	2.9	
On the ground	–	0.6	1.9	0.8

30 pairs per 100 km^2: Tubbs, 1974; Kostrzewa & Kostrzewa, 1991; Penteriani & Faivre, 1997; Kenward *et al*., 2000; Selas, 2001). However, a low breeding density seems rather normal for a species at the edge of its breeding distribution (e.g. Scandinavia: Hagemeijer & Blair, 1997). In contrast, the range of the winter density was shorter than those described in central Europe, e.g. Germany: 1.0-5.2 individuals km^{-2} (Glutz & Bauer, 1980), 2.4-5.1 individuals km^{-2} (Schröpfer, 1997); France: 1.5-4 individuals km^{-2} (Yeatman-Berthelot, 1991) but wider than those reported for other Mediterranean or Balkan countries, e.g. Italy: 0.18-1.6 individuals km^{-2} (Mostini, 1981; Mingozzi *et al*., 1988; Bordignon, 1998; Boano & Tofoli, 2002) and Bulgaria: 0.34 individuals km^{-2} (Nicolov *et al*., 2006). These differences, apart for methodological inconsistencies might be due to local weather conditions and landscape characteristics (e.g. habitat uniformity, crop type), both of which affect prey abundance and availability (Walls *et al*., 2004). In this framework, the seasonal fluctuation of buzzard numbers in the present study (Fig. 2), apart from the invasion of wintering or migrating birds, most probably reflect a variation in prey abundance that is caused by the existing farming practices. In Crete, olive monocultures remain unplowed in autumn and winter and support high numbers of rodents that feed on olive fruits left over after harvesting namely late November till mid February (Loumou & Giurga, 2003; Allen *et al*., 2006). In contrast olive trees are pruned and thinned during the breeding season (March-April) and ground vegetation is chemically or mechanically removed. This process involves considerable human disturbance and result in a short supply of food, nests, and perching sites.

Common buzzards are known to use a variety of hunting methods depending on climatic and habitat features (Tubbs, 1974). Hunting from a perch is considered to be their main foraging technique, primarily during adverse weather conditions such as fog or rain which impede energetic food searching (Kitowski, 2000). Similarly, hovering which was not recorded in the present study is more frequent in springtime when the weather improves and nesting duties of the breeding pairs commence. In our case, by using the dominant behaviour as a clue for hunting activity (Bildstein, 1987), we conclude that soaring and perching were the species most common techniques for capturing prey. Ground hunting was negligible, inconsistently to other populations in central Europe (Voříšek, 1991; Mülner, 2000; Wuczyński, 2005) most probably because foraging under the canopy of the olive-trees is obstructed. Nevertheless, ground hunting seems more effective in farmland with low vegetation. This type of behavior is most profitable and energy saving in open areas where suitable perching sites are scarce; or during harsh winters when prey detection is impaired by snow cover (Norberg, 1996; Selas, 2001; Wuczyński, 2005).

Overall, our results indicate that the cultivation methods of the olive grooves possess significant implications for the species conservation, especially when considering the importance of agricultural areas for many wintering raptors (Meunier *et al*., 2000; Tella & Forrero, 2000) and the fact that winter is a period of food shortage for most species (Newton, 1998). In the current work these issues were also supported by the observed ratio between territorial to wintering birds (i.e. 1:6). In this context, roadside surveys combined with territory mapping could provide valuable insight to the species status and help us improve future surveys and studies on the population trends.

ACKNOWLEDGEMENTS

We are thankful to our colleagues G. Andreou, G. Iliopoulos and M. Nikolakakis, for their assistance in the fieldwork and technical advice and P. Byholm, V. Bretagnolle and two anonymous reviewers for commenting on an earlier draft of the manuscript. Logistical support was provided by the Natural History Museum of Crete.

REFERENCES

Akaike H, 1973. Information theory and an extension of the maximum likelihood principle. In: Petran B, Csàaki F, eds. *International Symposium of Information Theory, 2nd edition*. Akadèemiai Kiadi, Budapest: 267-281.

Allen HD, Randall RE, Amable GS, Devereux, BJ, 2006. The impact of changing olive cultivation practices on the ground flora of olive groves in the Messara and Psiloritis regions, Crete, Greece. *Land Degradation & Development*, 17: 249-273.

Anderson DR, Burnham KP, 1999. Understanding information criteria for selection among capture-recapture or ring recovery models. *Bird Study*, 46: S14-S21.

Bibby CJ, Burgess ND, Hill DA, 2000. *Bird Census Techniques*. Academic Press, San Diego, USA.

Bijlsma RG, 1997 *Buteo buteo* – Buzzard. In: Hagemeijer WJM, Blair MJ, eds. *The EBCC Atlas of European breeding birds*. T & AD Poyser, London: 160-161.

Bildstein KL, 1987. Behavioral ecology of Red-tailed Hawks (*Buteo jamaicensis*), Rough-legged Hawks (*Buteo lagopus*), Northern Harriers (*Circus cyaneus*) and American Kestrels (*Falco sparverious*) in South Central Ohio. Ohio Biological Survey. Biological Notes No. 18.

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

Boano G, Toffoli R, 2002. A line transect survey of wintering raptors in the western Po Plain of northern Italy. *Journal of Raptor Research*, 36: 128-135.

Bohall PG, Collopy MW, 1984. Seasonal abundance, habitat use, and perch sites of four raptor species in north-central Florida. *Journal of Field Ornithology*, 55: 181-189.

Bordignon L, 1998. *Gli uccelli de Biellese*. Collana Ambiente, Assessorato Tutela Ambientale, Provincia di Biella.

Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L, 2001. *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press, Oxford.

Eakle WL, 1994. A raptor roadside survey in western Turkey and eastern Greece. *Journal of Raptor Research*, 28: 186-191.

Elkins N, 1995. *Weather and Bird Behaviour*. T & AD Poyser, London.

Fuller MR, Mosher JA, 1981. Methods of detecting and counting raptors: a review. *Studies in Avian Biology*, 6: 235-246.

Glutz Von Blotzheim U, Bauer KM, 1980. *Handuch Der Voegel Mitteleuropas. Vol. 4.* Aula Verlag, Wiesbaden.

Hagemeijer EJM, Blair MJ, 1997. *The EBCC Atlas of European breeding birds*. T & AD Poyser, London.

Handrinos G, 1987. The significance of Greece for wintering and migrating raptors. *Ricerche Biologia Selvaggina*, 12: 99-113.

Handrinos G, Akriotis T, 1997. *The Birds of Greece*. Helm-A & C Black, London.

Hiraldo F, Blanco JC, Bustamante J, 1991. Unspecialised exploitation of small carcasses by birds. *Bird Study*, 38: 200-207.

Kenward RE, Walls SS, Hodder KH, Pahkala M, Freeman SN, Simpson VR, 2000. The prevalence of non-breeders in raptor populations: evidence from rings, radio-tags and transect surveys. *Oikos*, 91: 271-279.

Kitowski I, 2000. Numbers and behavior of the common buzzard *Buteo buteo* in the post-breeding season and early spring in the agricultural landscape of the central Lublin region. *Notatki Ornitologiczne*, 41: 265-272.

Kostrzewa A, 1996. A comparative study of nest site occupancy and breeding performance as indicators for nesting habitat quality in three European raptor species.

Ethology Ecology & Evolution, 8: 1-18.

Kostrzewa R, Kostrzewa A, 1991. Winter weather, spring and summer density, and subsequent breeding success of eurasian kestrels, common buzzards and northern goshawks. *The Auk*, 108: 342-347.

Loumou A, Giurga C, 2003. Olive groves: 'The life and identity of the Mediterranean'. *Agriculture and Human Values*, 20: 87-95.

Meunier FD, Verheyden C, Jouventin P, 2000. Use of roadsides by diurnal raptors in agricultural landscapes. *Biological Conservation*, 92: 291-298.

Mingozzi TG, Boano C, Pulcher C, Coll B, 1988. *Atlante degli uccelli nidificanti in Piemonte e Val d'Aosta. Monografia.* Museo Regionale di Scienze Naturali di Torino, Torino.

Mostini L, 1981. La Poiana *Buteo buteo* nella pianura novarese. Notizie sulle presenze ed abitudini. *Gli Ucceli d' Italia*, 6: 67-70.

Mülner B, 2000. Winterliche Bestandsdichten, Habitatpräferenzen und Ansitzwartenwahl von Mäusebussard (*Buteo buteo*) und Turmfalke (*Falco tinnunculus*) im oberen Murtal (Steiermark). *Egretta*, 43: 20-36.

Newton I, 1998. *Population limitation in Birds*. Academic Press, San Diego, California, USA.

Nicolov S, Spasov S, Kambourova N, 2006. Density, number and habitat use of common buzzards (*Buteo buteo*) wintering in the lowlands of Bulgaria. *Buteo*, 15: 39-47.

Norberg UM, 1996. Energetics of flight. In: Carey C, ed. *Avian energetics and nutritional ecology*. Chapman & Hall, New York: 199-249.

Pearlstine EV, Mazzoti FJ, Kelly MH, 2006. Relative distribution and abundance of wintering raptors in agricultural and wetland landscapes of South Florida. *Journal of Raptor Research*, 40: 81-85.

Penteriani V, Faivre B, 1997. Breeding density and landscape-level habitat selection of common buzzards (*Buteo buteo*) in a mountain area (Abruzzo Apennines, Italy). *Journal of Raptor Research*, 31: 208-212

R Development Core Team 2008. *R: a language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna.

Sarà M, 1996. Wintering raptors in the central Mediterranean basin. In: Muntaner J, Mayol J, eds. *Biologia y conservacion de las rapaces Mediterraneas.* Sociedad Española de Ornitología, Madrid: 345-359.

Schröpfer L, 1997. Winter census of birds of prey in the area located to west and south of Plzen city, determined by the line method. *Buteo*, 9: 17-30.

Selas V, 2001. Breeding density and brood size of common buzzard *Buteo buteo* in relation to snow cover in spring. *Ardea*, 89: 471-479.

Sierdsema H, van Loon E, 2008. Filling the gaps: using count survey data to predict bird density distribution patterns and estimate population sizes. *Revista Catalana d' Ornitologia*, 24: 88-99.

Sutton C, Sutton PT, 1996. *How to spot Hawks and Eagles*. Interglobe Beauceville, Quebec, Canada.

Tella JL, Forrero MG, 2000. Farmland habitat selection of wintering lesser kestrels in a Spanish pseudosteppe: implications for conservation strategies. *Biodiversity and Conservation*, 9: 433-441.

Thomas L, Laake JL, Strindberg S, Marques FFC, Buckland ST, Borchers DL, Anderson DR, Burnham KP, Hedley SL, Pollard JH, *et al.*, 2006. Distance 5.0. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews. http://www.ruwpa.st-and.ac.uk/distance/

Tubbs CR, 1974. *The Buzzard*. David & Charles, London.

Tucker GM, Heath FA, 1994. *Birds in Europe: Their conservation status*. Birdlife International Conservation Series No 3, Birdlife International, Cambridge.

Vardavas IM, Papamastorakis J, Fountoulakis A, Manousakis M, 1997. Water resources in the desertification-threatened Mesara Valley of Crete: estimation of potential lake evaporation. *Ecological Modeling*, 102: 363-374.

Vořišek P, 1991. Breeding biology and wintering of the common buzzard (*Buteo buteo* L.). MSc thesis, UK Praha.

Walls S, Kenward R, Holloway G, 2004. How common is the common buzzard, *Buteo buteo*? *Biologist*, 51: 23-26.

Williams CK, Applegate RD, Lutz RS, Rusch DH, 2000. A comparison of raptor densities and habitat use in Kansas cropland and rangeland ecosystems. *Journal of Raptor Research*, 34: 203-209.

Wuczyński A, 2003. Abundance of common buzzard (*Buteo buteo*) in the Central European wintering ground in relation to the weather conditions and food supply. *Buteo*, 13: 11-20.

Wuczyński A, 2005. Habitat use and hunting behavior of common buzzards *Buteo buteo* wintering in south-western Poland. *Acta Ornithologica*, 40: 147-153.

Yeatman-Berthelot D, 1991. *Atlas des oiseaux de France en hiver*. Societe Ornithologique de France, Paris.

Zar J, 2007. *Biostatistical analysis*, *5th Edition.* Prentice Hall, New Jersey, USA.