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TERRITORIAL PAIRS, TEMPORARY SETTLEMENT AREAS
AND POTENTIALLY SUITABLE BREEDING SITES FOR GOLDEN
EAGLE *AQUILA CHRYSAETOS* IN THE ERNICI-SIMBRUINI
COMPLEX (CENTRAL APENNINE, ITALY):
PRELIMINARY RESULTS

SUMMARY

Ernici-Simbruini complex in Central Apennine (Italy) is a regional protected area extended about 700 km², with a significant level of biodiversity. Despite the presence of wide grasslands and distributed crags and cliffs, only two territorial Golden eagle pairs are known, while two additional known territories as occupied in the past remain vacant. After a preliminary collection of Golden eagle sightings and partitioning of the Ernici-Simbruini complex based on the habitat characteristics, focalised field activities led to the individuation of a third territorial pair, and its territory has been consequently delimited. Further nine Temporary Settlement Areas (TSA) together with three Potentially Suitable Breeding Sites (PSBS) have been identified, as habitats used by adults, subadults and juveniles.

Key words. Territorial pairs, Temporary Settlements Areas, Potentially Suitable Breeding Sites, Adults, Subadults.

RIASSUNTO

Coppie territoriali, aree di presenza temporanea e potenziali aree riproduttive di Aquila reale Aquila chrysaetos nel complesso degli Ernici-Simbruini (Appennino Centrale – Italia): risultati preliminari. Il complesso degli Ernici-Simbruini nell'Appennino centrale (Italia) è un'area protetta regionale estesa per circa 700 km², con un significativo livello di biodiversità. Nonostante l'ampia presenza di praterie, pareti e dirupi, sono note solo due coppie territoriali di Aquila reale, mentre altri due territori noti in passato sono attualmente non occupati. Dopo la raccolta preliminare degli avvistamenti di Aquile reali e la suddivisione del complesso degli Ernici-Simbruini in base alle caratteristiche dell'habitat, attività di campo focalizzate hanno portato all'individuazione di una terza coppia territoriale, il cui territorio è stato conseguentemente definito. Sono state inoltre identificate nove aree di insediamento temporaneo (TSA) e tre siti di riproduzione potenzialmente idonei (PSBS), come habitat utilizzati da adulti, subadulti e giovani.

Parole chiave. Coppie territoriali, Siti di insediamento temporaneo, Siti riproduttivi potenzialmente idonei, Adulti, Subadulti.

INTRODUCTION

In Italy, from early '90s of the last century, a continuous increase of Golden eagle population has been noticed in the central Apennine (MAGRINI *et al.*, 2013; ARTESE *et al.*, 2017; BORLENGHI, 2017). A similar trend has also been reported for northern Apennines (SCHIASI *et al.*, 2013; NARDELLI, 2017), as well as for all sectors of the Alps (FASCE & FASCE, 2017).

This general trend, moreover still in progress, has requested a wide pool of floaters and several vacant or potentially suitable breeding sites (PSBS) with the adequate carrying capacity. While most vacant sites in the Apennines are well localised (DI CARLO, 1980), very little is instead known about habitats used by floaters. Another topic evenly little studied is the process followed by Golden eagles when selecting a territory for nesting and breeding, rarely observed in its full evolution.

In the Ernici-Simbruini mountainous complex there were 4 or 5 nesting areas, of which only one resulted occupied by a Golden eagle breeding pair (DI CARLO, 1980). Later on, the number of breeding Golden eagle pairs became two (BORLENGHI & CORSETTI, 1996), with a third breeding pair suggested more recently as possible but without any indication of individuated nesting areas (ARTESE *et al.*, 2017), but with the remaining one or two known nesting areas still resulting as vacant. Moreover, very little has been reported about the presence and behaviour of the species in the wide likely suitable areas of the complex. A similar situation of potentially suitable habitats not occupied by Golden eagle has been studied in Spain, suggesting that failing to occupy can be determined by human or competitor species presence, in that case Bonelli's eagle *Aquila fasciata* (LÒPEZ-LÒPEZ *et al.*, 2007). In Scotland vacant territories have been observed merged into occupied ones, thus hindering their occupation by another Golden eagle pair (WHITFIELD *et al.*, 2006).

OBJECTIVES

The aim of this study is to start individuating the presence of new pairs, areas suitable for nesting (PSBS – potentially suitable breeding site) and of areas used for hunting and recovery by floaters (TSA – temporary settlement area) inside the Ernici-Simbruini complex, in particular by collecting the presence and observing adult and subadult Golden eagles' behaviour.

STUDY AREA

The Ernici-Simbruini mountainous complex is one of the widest natural habitats in central Apennines, quite fully under administrative regional pro-

tection from the early '80s of last century, with the presence of peaks exceeding 2,000 m, wide grasslands and numerous sites with crags and cliffs suitable for Golden eagle nesting, surrounded by Beech forest *Fagus sylvatica*, covering most of the complex.

The study area is included in two Sites of Community Importance, IT6050008 (Simbruini and Ernici mounts, 520.99 km²) and IT7110207 (Simbruini mounts, 198.86 km²) for a total extension of 719.85 km².

Among mammals are present Brown bear *Ursus arctos marsicanus*, Wolf *Canis lupus*, Red deer *Cervus elaphus*, Roe deer *Capreolus capreolus*, Wild boar *Sus scrofa*, Fox *Vulpes vulpes* and Hare *Lepus europaeus*; among birds of prey Griffon vulture *Gyps fulvus* (reintroduced), Buzzard *Buteo buteo*, Goshawk *Accipiter gentilis*, Sparrowhawk *Accipiter nisus*, Peregrine falcon *Falco peregrinus* and Kestrel *Falco tinnunculus*; additionally, are present Raven *Corvus corax*, Hooded crow *Corvus cornix* and Alpine chough *Pyrrhocorax graculus*, while reptiles are represented by Rat snake *Hierophis viridiflavus* and Viper *Vipera aspis* (<http://www.parcomontisimbruini.it/pagina.php?id=23>). Finally, the complex can be considered quite isolated, being not connected by high altitude ridges to further mountains: the nearest, partly included in a National Park, is parallel to the eastern study area dorsal at a mean distance of 10 km. All other mountainous habitats which include breeding Golden eagle pairs are at wider distances of 15-25 km.

MATERIALS AND METHODS

Golden eagle sightings available in the area up to 2019 were collected and geo-referenced. On this introductory set of sightings, a preliminary evaluation was focused on partitioning the study area in sections. Section perimeters and extensions, to be considered qualitative, have been proposed by means of maps analyses and, where available, data about preferred prey presence looking in particular for high grounds and grasslands above 700-800 m (SPINETTI, 2018).

In central Apennines Golden eagle seems nesting only on crags or cliffs as nests on trees are not reported (DI CARLO, 1980; SPINETTI, 2018). Therefore, the PSBSs proposed in the study area include crags or cliffs, further to high altitude grassland for hunting (SPINETTI, 2018).

The TSAs instead include wide grasslands, typically used by floaters (CARO *et al.*, 2011). Grasslands still represent the preferential hunting habitat, even though some part of the species diet in the Apennine more recently comprises to certain extent prey also living in the forest or on the trees, such

as young Wild boar *Sus scrofa* and Dormouse *Glis glis* (FORCONI & DANCALI, 2005).

Then, on the base of maps and the introductory Golden eagle sightings available up to 2019, a plan of standing and traveling field checks has been decided, so to:

- Correcting or confirming the proposed extensions of the two known breeding territories and the two known vacant sites;
- Individuating and delimiting the extension of possible breeding sites (PSBS);
- Individuating and delimiting possible area for hunting and resting of floaters (TSA);
- Individuating several standing points of sighting spread on the study area;
- Verifying if the proposed TSAs are used not only by floaters but also by territorial adults, in particular if these proposed TSAs are close to the relevant breeding areas;
- Further to the introductory sightings and the direct sightings obtained during standing and traveling field checks, all the sightings of the species available in the study area, in particular if accompanied by photos or videos, were geo-referenced in the various sections (occupied, vacant, PSBS and TSA);
- Splitting up all the sightings for eagle age, as adult and non-adult (1-5 years).

Each section has been visited at least two times or more when the presence of Golden eagles has been observed, in particular in proposed PSBS sections. Any point of sightings was at least 800m far from known nests, crags or cliffs.

The sightings are not used to quantify the number of Golden eagles present in the study area, they are not demographic data, but simply the number of sightings available.

RESULTS

The Ernici part, extending around 200 Km², has been divided in four sections (N–P) covering about 160 Km², while the Simbruini part, extending around 500 Km², has been divided in twelve sections (A–L), covering about 390 Km² and finally on the west of section A2 and on the east of section I, following the presence and observed routes of floaters, two other sections have been added (R and S) (Table 1 and Fig. 1).

Table 1.
List of the sections proposed within the study area.

	Kind of section	Km²
N	Nesting site of one historical pair	31.8
O	Vacant site, historically known	51.0
M	Area for resting and hunting (TSA)	20.1
P	Area for resting and hunting (TSA), with PSBS features	54.8
A	Nesting site of one historical pair	58.5
A1	Possible vacant site with known nest	27.0
A2	Hypotised possible breeding site (PSBS)	22.4
A3	Area for resting and hunting (TSA)	25.9
B	Nesting site of a new territorial pair, one nest found, initially a PSBS	55.5
B1	Vacant site, historical nest known	15.8
B2	Area for resting and hunting (TSA)	29.0
E	Area for resting and hunting (TSA)	13.2
F	Initially an area for resting and hunting (TSA), modified in 2022 into a PSBS	44.8
G	Area for resting and hunting (TSA)	22.8
I	Area for resting and hunting (TSA)	49.4
L	Hypotised possible breeding site (PSBS)	20.0
R	Area for resting and hunting (TSA)	34.2
S	Area for resting and hunting (TSA)	17.4

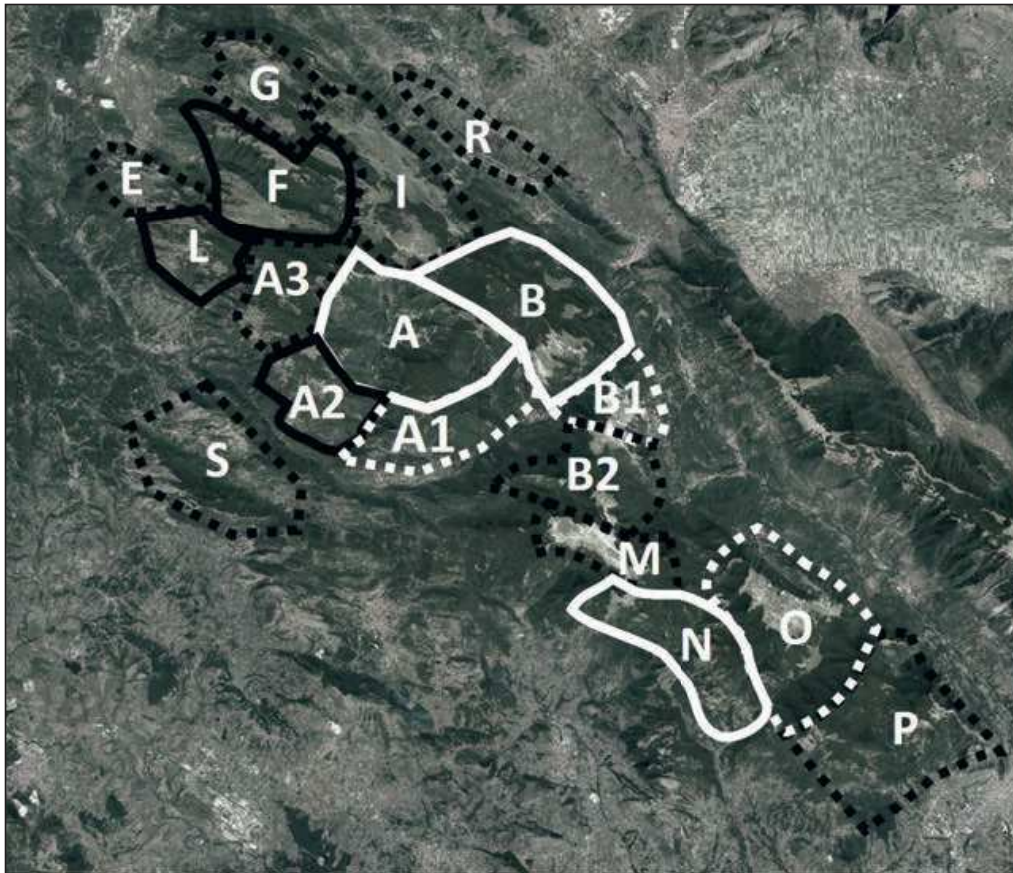


Fig. 1 — Perimeters of the sections located in the Ernici-Simbruini complex: occupied (white), vacant (dotted white), potentially suitable breeding site (PSBS, black), resting and hunting area (TSA, dotted black).

Sections grouped for characteristics are shown in Table 2.

Table 2.

Sections located within the complex Ernici-Simbruini grouped for characteristics.

	<i>Occupied</i>	<i>Vacant</i>	<i>PSBS</i>	<i>TSA</i>	<i>Total</i>
Ernici	1	1		2	4
Simbruini	2	2	3	5	12
Further				2	2
Total	3	3	3	9	18
Km²	145.8	66.8	87.2	266.8	566.6

Of the more than one hundred Golden eagle sightings collected in the study area, only 75 were considered, avoiding all the doubtful ones. The sightings cover a period from 2007 up to October 2022, of which 43 (57%) registered in the last three years (Fig. 2). These more recent sightings have been mainly collected during about 160 focused standing or traveling field checks, carried out by a team of six experienced field naturalists.

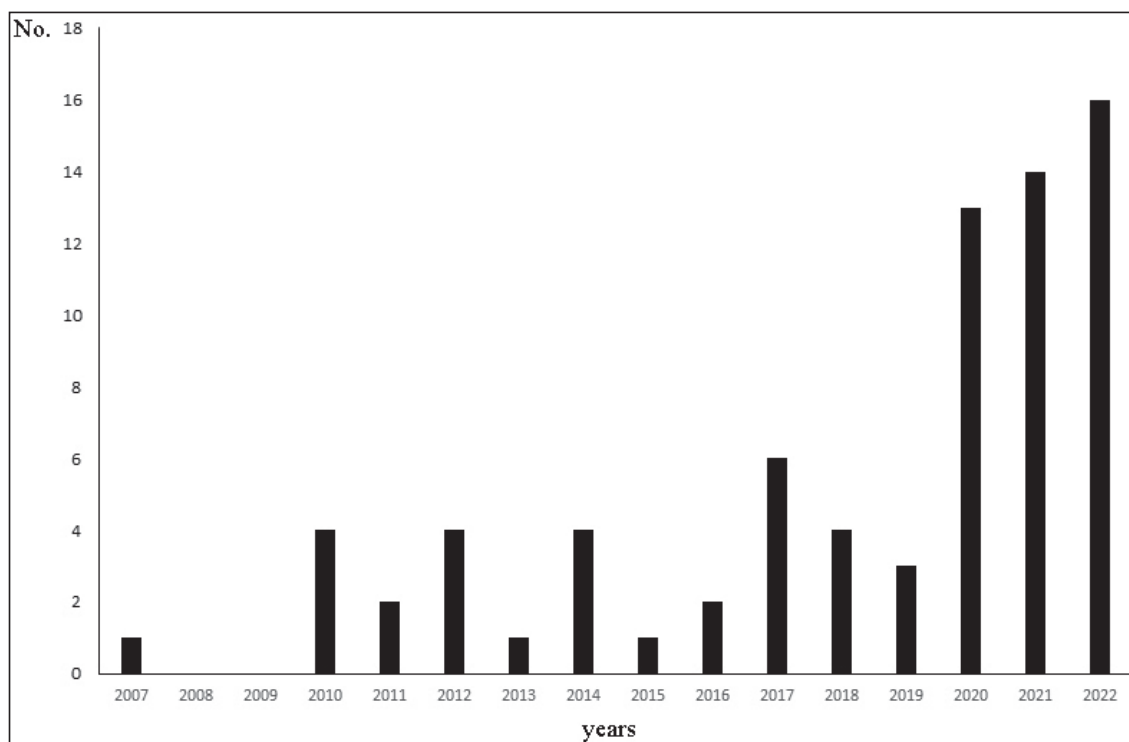


Fig. 2 — Temporal evolution of Golden eagle sightings in Ernici-Simbruini complex.

The 75 sightings have been grouped first by following the kind of individual or pairs observed (adults and/or non-adult) and geo-referenced in the

relevant sections, then following the kind of section (Table 2), as presented in Table 3.

Table 3.

*Sightings grouped for the characteristics of observed eagles and site features.
In brackets sightings 2020-2022.*

	<i>Site occupied</i>	<i>Site vacant</i>	<i>PSBS</i>	<i>TSA</i>	<i>Totals</i>
<i>1 pair of adults</i>	11 (9)	3 (2)	3 (2)	1 (1)	18 (14)
<i>1 adult</i>	6 (5)	6 (4)	7 (5)	17 (5)	36 (19)
<i>1 or 2 adults + juv.</i>	6 (3)	0	0	0	6 (3)
<i>1 or 2 non-adults (1-5 years)</i>	1 (0)	0	6 (4)	8 (4)	15 (8)
Total	24 (17)	11 (6)	16 (11)	24 (10)	75 (44)

Pairs of adult Golden eagles have been observed preferentially in sections with known nests (occupied or vacant sections), while non-adults (juveniles or subadults) have been observed in PSBS or TSA sections, with a statistically significant difference: X^2 (with Yates correction) = 11.84; $p = 0.0006$. The same result has been obtained considering only the sightings in the 2020-2022 period: X^2 (with Yates correction) = 9.63; $p = 0.0019$. Differently from pairs of adult Golden eagles, adult individuals, instead, have mainly been observed in PSBS and TSA sections, with a statistically significant difference: X^2 (with Yates correction) = 6.83; $p = 0.0089$.

Considering only the most recent sightings in the 2020-2022 period, the difference instead did not result statistically significant: X^2 (with Yates correction) = 2.11; $p = 0.1463$. There is no statistically significant difference between sightings of single adults referred in the preliminary period (up to 2019) and observed in the study period: X^2 (with Yates correction) = 2.35; $p = 0.12$.

DISCUSSION

Partitioning the study area in sections with limited extensions has allowed to grouping the sightings collected up to 2019, so to plan the visit in the period 2020-2022. The efforts for obtaining clear Golden eagle sightings was higher than expected, maybe due to the wideness and complexity of the areas under monitoring.

Nevertheless, excluding December, Golden eagles have been observed during every month, independently of the presumed eagle age and this confirms the importance of the Ernici-Simbruini complex for the species; in comparison, Golden eagles are observed in the Aurunci Natural Park only during autumn and winter, very rarely in spring and summer, even though with higher monitoring efforts (CORSETTI & MAROZZA, 2022).

The fifteen sightings of non-adults (Table 3), of which fourteen have been registered from 2014 and seven in the last two years, although not fully referable to fifteen different Golden eagles, are presumed to be mainly immigrations, because in the relevant dates all the territorial eagles known before the start of the study were in adult plumage, and the known pairs were reported with a productivity close to zero (BORLENGHI *et al.*, 2022). The different density of adult sightings observed in the TSA alone, 12 up to 2019 and only 5 in the 2020-2022 period, can be explained with the increase of breeding pairs recorded in Lazio region (BORLENGHI, 2017).

Pairs of adults are 24% of the total sightings, mostly registered in the sections with known nests or their adjoining ones. These last sections (A2, A3, B2, F, L and M, Table 1), even if used by pairs of adult eagles, seem not all merged in the home range of the relevant pairs, because most of these sections have been used also by juv. and subadults, confirming the hypothesis of being habitats with PSBS or TSA characteristics.

In particular, the three PSBS sections (A2, F and L in Table 1), are the only where sightings of pairs of adults, single adult individuals and single or pairs of non-adult individuals have been recorded. It is very difficult to discriminate if some of the twenty-five adult sightings registered in PSBS or TSA sections could be floaters or, instead, territorial adults. Presumably, one of those adults was that one sighted from February 2021 as the new female in the territorial pair occupying section A.

Inside section B, initially a PSBS proposed section, a further territorial pair was continuously observed from February 2020 on. The modification from a PSBS to a new further occupied section was confirmed by the discovery of a previously unknown nest localised in the middle of the section. Considering that this pair is formed by two adults, it is assumed that this pair has been occupying the section B since some years, following the observation that new habitat colonisation is mainly done by mixed pairs (SCHIASI *et al.*, 2013). This assumption has been confirmed by independent local witnesses, suggesting to date back the presence of this pair at least since middle '90s of the last century. Observed routes of the pair occupying section B let confirm that the adjoining B1 section, a vacant site 7 km far with a known nest, is merged in the B section, in line with what observed in Scotland (WHITFIELD *et al.*, 2006). Similarly, also O section, another vacant territory, seems merged into

the N occupied section, following the observed presence of adult individuals visiting this section but coming back to the N one.

This suggests that complex effects could participate in determining availability of suitable territories (WHITFIELD *et al.*, 2007) may be determined by the density of prey. The absence of sightings of territorial disputes between adults in sections borders, together with the routes observed for pairs or territorial adults, suggests that the three home ranges (namely: A, B+B1 and N+O sections in Table 1), do not show significant overlaps, in presence of nearest neighbour distances of 10-15 km.

CONCLUSIONS

The localisation of the territorial pairs, including the observed merging of the existing vacant sites within occupied active territories and the presence of several identified PSBSs still not transformed into occupied territories after more than thirty years of habitat protection, is contrasting the presence of immigrant adult and subadult eagles floating the area. A possible scenario is the presence of threats impacting the expected wider presence of territorial pairs in the Ernici-Simbruini complex. Examples of possible threats have been directly observed or collected during the numerous field checks carried out over the last three years. The first is the overflight of the study area, both by helicopters and small planes. These flyovers (typically training purposes by departments of the armed forces and firefighters), observed more frequently than eagle sightings, carried out along the day and also at low altitudes, have been registered also on grassland areas normally used by territorial Golden eagle pairs. Another concern is the use of poisoned bites. Although prohibited, it is, unfortunately, a serious problem in the study area. After the reports in section F of poisoned bites killing eleven dogs and two truffle dogs in 2016 and 2019, in 2021, in a section B prairie, used for hunting by the last eagle pair discovered, poisoned bites killed several Foxes, Wolves, Cattle and Horses. The last threat is poaching, a hateful phenomenon, anything but eradicated, even after several decades of Park rangers' interventions.

As it has been demonstrated that these kinds of persecutions can have a very significant impact on the presence and mortality of floaters (WHITFIELD & FIELDING, 2017), and although episodes with direct impact on the eagles in the study area are not reported, unfortunately they cannot be excluded due to the extension of the study area and the wide presence of forest in any sections (Fig. 1). Presumably, the increase of park rangers' staff, connected to continuous presence in particular in the TSA (Table 1, sections A3, B2, E, I, M and P) should allow Golden eagle presence in the study area to respond

positively, increasing the territorial pairs up to the expected level. In the following years the study will focus in particular on PSBSs.

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REFERENCES

- ARTESE C., ALLAVENA S., BALIVA S., BERNONI M., BORLENGHI F., CARFAGNINI M., CIRILLO M., DAMIANI G., DI BENEDETTO S., LALLI G., MORINI P., PELLEGRINI M., PINCHERA F. & RICCI F., 2017. Status of the Golden Eagle *Aquila chrysaetos* in Abruzzo. *Avocetta*, 41: 77-80.
- BORLENGHI F., 2017. The Golden Eagle *Aquila chrysaetos* in the Apennines of the Lazio region (Central Italy): updates on its status. *Avocetta*, 41: 73-75.
- BORLENGHI F., CIANCONI M.M. & SORACE A., 2022. Il disturbo antropico come fattore limitante per la riproduzione dell'aquila reale (*Aquila chrysaetos*). Pp. 25-37 in: Corsetti L., Brunelli M. & Borlenghi F. (a cura di), Gli Uccelli rapaci nel Lazio – status, distribuzione, ecologia e conservazione. *Edizioni Belvedere*, Latina, 112 pp.
- BORLENGHI F. & CORSETTI L., 1996. L'aquila reale *Aquila chrysaetos* nel Lazio meridionale (Italia Centrale): status, protezione e conservazione. *Alula*, 3 (1-2): 37-47.
- CARO J.S., ONTIVEROS D., PIZARRO M. & PLEGUEZUELOS J.M., 2011. Habitat features of settlement areas used by floaters of Bonelli's and Golden Eagles. *Bird Conserv. Int.*, 21: 59–71.
- CORSETTI L. & MAROZZA L., 2022. Gli uccelli rapaci rupicoli del Lazio meridionale: aggiornamenti sullo status. Pp. 49-59 in: Corsetti L., Brunelli M. & Borlenghi F. (a cura di), Gli Uccelli rapaci nel Lazio – status, distribuzione, ecologia e conservazione. *Edizioni Belvedere*, Latina, 112 pp.
- DI CARLO E.A., 1980. Indagine preliminare sulla presenza passata ed attuale dell'Aquila reale, *Aquila chrysaetos*, sugli Appennini. *Uccelli Italia*, 5: 263-283.
- FASCE P. & FASCE L., 2017. A comment about meeting's results. Pp. 93-95 in: Fasce P., Fasce L. & Gustin M. (eds.), *Avocetta*, 41 (2).
- FORCONI P. & DANCALI S., 2005. Alimentazione dell'aquila reale *Aquila chrysaetos* in un'area dell'Appennino centrale. *Avocetta*, 29: 183.
- MAGRINI M., PERNA P., ANGELINI J., ARMENTANO L. & GAMBARO C., 2013. Andamento della popolazione di Aquila reale *Aquila chrysaetos* in un'area dell'Appennino Centrale tra il 1979 e il 2012. In: Mezzavilla F. & Scarton F. (a cura di), Atti Secondo Convegno Italiano Rapaci Diurni e Notturni. *Quaderni Faunistici*, 3.
- NARDELLI R., 2017. Trend and status of the Golden Eagle *Aquila chrysaetos* breeding population in the northern Apennines: Results from 20-years of monitoring. *Avocetta*, 41: 63-68.
- SCHIASSI S., BATTAGLIA A., BONORA M., CAMPORA M., COTTALASSO R., DEL CHIARO L., MENDI M., PASTORINO A., PEDRELLI M., RICCI U., SESTI L. & NARDELLI R., 2013. Monitoring of Golden Eagle *Aquila chrysaetos* breeding pairs in the Northern Apennines (1997-2012). In: Mezzavilla F. & Scarton F. (a cura di), Atti Secondo Convegno Italiano Rapaci Diurni e Notturni. *Quaderni Faunistici*, 3.
- SPINETTI M., 2018. L'Aquila reale – Biologia, etologia e conservazione. *Cogestree edizioni*.
- WHITFIELD D.P. & FIELDING A.H., 2017. Analyses of the fates of satellite tracked Golden Eagles in Scotland. *Scott. Nat. Heritage Report*, No. 982.

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- WHITFIELD D.P., FIELDING A.H., GREGORY M.J.P., GORDON A.G., MCLEOD D.R.A., HAWORTH P.F., 2007. Complex effects of habitat loss on Golden Eagles *Aquila chrysaetos*. *Ibis*, 149: 26-36.
- WHITFIELD D.P., FIELDING A.H., MCLEOD D.R.A., HAWORTH P.F. & WATSON J., 2006. A conservation framework for the Golden eagle in Scotland: Refining condition targets and assessment of constraint influences. *Biol. Conserv.*, 130: 465-480.

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