

Short-toed Eagle *Circaetus gallicus* population increase in Italy: hypothesis of root causes

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Abstract – This review discusses a hypothesis about the root causes of the increasing trend of the Short-toed Eagle *Circaetus gallicus* population in Italy, such as: the high productivity rate of the Italian population, the withdrawal of farming and the agricultural landscapes exploited as hunting areas for the species, the increasing maturity of woods exploited as new nesting sites, and the immigration from other areas due to the expansion of the species. In addition, this paper provides an evaluation of the potential population increase yearly rate (PPIYR = 9.5%) in Italy.

Key-words: Short-toed Eagle, *Circaetus gallicus*, raptor migration, population monitoring, population trends.

INTRODUCTION

The Short-toed Eagle is a complete migrant species (Zalles & Bildstein 2000), in which at least 90% of all individuals leave the breeding range during the non-breeding season (Kerlinger 1989, Zalles & Bildstein 2000). Some Short-toed Eagles regularly overwinter in Sicily (AA VV 2008).

In Europe the species is classified as: SPEC 3, Status “Rare” (Criteria <10000 pairs), 8400-13000 breeding pairs, with the trend “Small decline” (Birdlife International 2004).

In Spain 2000-3000 pairs are reported with an unknown trend (Marti *et al.* 2003 in Birdlife International 2004). In France the population is considered as “Stable” with 2400-2900 pairs (Thiollay *et al.* 2003 in Birdlife International 2004), but with an apparent strong increase in the last decade (Thiollay & Bretagnolle 2004, Paul 2007).

In Italy the Status is “VU = Vulnerable” (Peronace *et al.* 2012) and “Stable” (Birdlife International 2004), considering the “Criterion = D1” with a population of less than 1000 adult individuals: 700-800 (350-400 pairs) (Brichetti & Fracasso 2003) and no evidence of immigration from other regions is reported (Peronace *et al.* 2012). However, Baghino (2013) and Premuda *et al.* (2015) recently reported significant increasing trends of the species in Italy.

The aim of this review is to discuss the hypothesis about the root causes of the increasing population trends

and to provide an evaluation of the potential population increase yearly rate (PPIYR) in Italy.

MATERIALS AND METHODS

This review is mainly based on results of the studies performed at the Apuane Alps (Lucca, Tuscany) raptor migration watch-site over a ten-year period (Premuda *et al.* 2015), but also at Arenzano (Genova, Liguria) (Baghino *et al.* 2009, Baghino 2013) and Latium (Petretti 2008). In addition, bibliographic references have been consulted to investigate the productivity of the species, the status of agricultural landscapes and woods in Italy, the trends in other geographical regions.

As assumption, the juveniles’ mortality of Short-toed Eagle used is 60%, considering the following percentage: $\geq 50\%$ Pre-adult mortality in raptors (Newton 1979). The potential population increase rate has been evaluated with consideration of the following percentage: $\leq 5\%$ Annual adult mortality rate in the large Eagles (Newton 1979).

The formula used for the calculation of the potential population increase yearly rate is the following: $PPIYR = ((APR - JM) * 100/2) - AAMR$, where: Average Productivity Rate (APR) - Juveniles Mortality (JM) = Juveniles Survival Success * 100/2 individuals per pair = Juveniles Increase Yearly Rate - Annual Adult Mortality Rate

(AAMR) = Potential Population Increase Yearly Rate (PPIYR).

RESULTS AND DISCUSSION

The most recent estimates published show an increasing number of breeding pairs: 350-400 (Brichetti & Fracasso 2003), 480-520 (Baghino & Premuda 2005), 500 (Campora & Cattaneo 2006), 560 (Petretti 2008), 600-700 (Baghino *et al.* 2009), 626-1025 (Premuda *et al.* 2015). The analyzed data collected at the Apuane Alps watch-site show a clear positive trend over the ten-year period studied (2004-2013) (+102.5%, +10.25% yearly average). Two samples of 12-day peak period in spring and autumn over nine years (2005-2013) were compared to validate the trends and the reliability of the counts (Premuda *et al.* 2015).

At the Arenzano watch-site (Genova, Liguria), an increasing trend over spring 2000-2008 was reported based on an analysis of the mean hourly rate (birds/hr) (Baghino *et al.* 2009). In addition, an yearly increase of 11.7% and 6.9% is calculated analyzing standardized data from March 1988-2011 and September 2000-2011, respectively (Baghino 2013).

In Italy at Monti della Tolfa (Latium), Petretti (2008) reported an increase of 26% of the breeding pairs during 19 years, from 11 pairs recorded in 1981 to 15 in 2000 (13.7% over ten years), probably reaching the full carrying capacity of the area.

The possible reasons and root causes for the increasing trend of the species in Italy could be the following:

A) High productivity rate

In Central-Italy (Tuscany and Latium), an average productivity rate of 0.73 is reported in over 166 controlled nests between 1988 and 2007 (Petretti 2008), against for example the 0.51 average rate recorded in France at Cévennes National Park over 22 years (1992-2013) (Malafosse & Malafosse 2013). However, a higher productivity rate of 0.90 is reported from Greece (Ivanowski *et al.* 1997).

Considering the estimated mortality rates, the population increase rate of Central Italy would result as follows (see methods): $PPIYR = ((0.73 - 60\%) * 100 / 2) - 5\% = 9.5\%$.

The high productivity rate (0.73) recorded in Central Italy (Petretti 2008) and the calculated potential population increase yearly rate (9.5%) are potentially compatible with the yearly growth recorded at the Apuane Alps over the 2004-2013 period (10.25% on average). Nevertheless, the breeding success appears to be stable over the last decades. In the western Italian Alps, an average breeding suc-

cess of 0.73 was reported in over 42 controlled nests between 1982 and 1988 (Cattaneo & Petretti 1992), while a rate of 0.74 was recorded over 104 nests (1980-1996) (Cattaneo 1998). For Central Italy, Petretti (1988) had already reported a productivity rate of 0.75 in over 40 nests at Monti della Tolfa (Latium).

The high breeding success and productivity rate recorded regularly over the last decades in Italy might show an unmet carrying capacity of suitable territories. However, this is not sufficient to explain the apparent increase of the Short-toed Eagle population over recent years and other reasons, such as the following, may have contributed.

B) Withdrawal of farming and agricultural landscapes exploited as hunting areas for the species

The presence of open areas for hunting is essential for the Short-toed Eagle (Campora & Cattaneo 2006) and the withdrawal of farming is a well-recognized trend in Europe (EEA 2006). In Italy, the transformation of agricultural farms and the abandon of less suitable and less productive grounds lead to a reduction of 2.5% from 2000 to 2010 (10 years) of the "SAU" ("Superficie Agricola Utilizzata", Exploited Agricultural Surface: arable fields, woody agricultural crops, orchards, meadows, pastures, grasslands) (AGEN.TER 2012). Locally, a reduction of 17.2% of the "SAU" from 1982 to 2010 (28 years) is recorded in the Province of Bologna (AGEN.TER 2012) where the presence of the species increased with summering individuals (Premuda 2010, *pers. obs.*).

Regarding the withdrawal of farming, from 1961 to 2010 (49 years) the SAU in Italy decreased of 26.5% (ISTAT 2011, Fanfani & Spinelli 2012). During about 50 years an agricultural surface large as the whole of the Emilia-Romagna plus Lombardia regions has slowly developed into semi-natural environment, especially in mountain and hilly areas. In lowland areas, however, the agricultural lands have turned into urban, cemented or built areas (about 15-16,000 km², during the 1970-1982, 12-year period) (ISTAT 2011, Fanfani & Spinelli 2012).

For example, in the South Latium mountains (Ausoni and Aurunci Mounts, Latina), a sample of 74.5 km² of public-owned land recorded a 179.4% increase of woodland against the SAU, during the period 1916-1998 (82 years) (Belosi & Lazzari 1997, 2002). However, in these Mediterranean countries fires destroy many hectares of woods and shrubs every summer. In addition, over a 55 km² sample of private woodland in Forlì Province (Northern Apennines), it was recorded that there was an increase of woodland against the SAU of 35-40% in upland areas, and over 105% in low mountain-hilly lands (Belosi *et al.* 1993, 1998, Grapeggia & Molducci 1994).

Landscapes suitable for hunting and rich in prey can support and facilitate the spread of the species and survival of individuals but on the other hand are not sufficient to ensure a stable or increasing population which requires suitable nesting sites for breeding as well. For example, in Northern Apennines (Bologna Province, Emilia-Romagna) over a ten-year period (2000-2009), up to twelve Short-toed Eagles were observed roosting together in a wide open and dry area exploited for hunting but very poor in terms of potential nesting sites; no evidence of breeding was collected (Premuda 2004a, 2010, *pers. obs.*).

C) Increasing maturity of woods exploited as new nesting sites

Macrohabitat plays an important role in nest site selection on birds of prey. Raptors are sensitive to discriminating variables such as distances to human habitation, paved road, water, wetlands, and forest openings, elevation on sea level, slope inclination, slope location, and slope aspect (Bosakowski & Speiser 1994). Mature and old-growth woods are preferred by some species of raptors for nesting (Speiser & Bosakowski 1987). The average tree size (e.g., mean weight, volume, height, diameter) and stand density (e.g., trees per hectare) can represent a model of suitable habitat for raptors nesting in woods (Liliehalm *et al.* 1994).

In Italy, the Short-toed Eagle breeds mainly in conifer or mixed woodlands (Campora & Cattaneo 2006). The selection of the nesting area seems to be mainly related to the remoteness from human settlements (including roads), the availability of roosting site for surveillance over the nest area and the presence of mature evergreen (or deciduous trees covered with ivy *Hedera helix*) (Petretti 2008). Nests are always located on an emergent tree (Campora & Cattaneo 2006) and placed on the top or in lateral branches overlooking steep slopes (Petretti 2008). The remoteness of the area seems to be a key factor for the selection of the nesting area of the Short-toed Eagle in Central-Italy. At Monti della Tolfa (Latium) the nearest wood edge distance from a nest is 380 m and the minimum wood plot size around the tree with the nest is 45.3 Ha (Petretti 2008). Also the maturity of woods seems to be very important for the selection of the tree where the nest is built. At Monti della Tolfa (Latium) the average height of the used tree is 10.20 m with a diameter of the stem of 0.28 m, while the average height of the nest from the ground is 7.12 m (Petretti 2008).

In Italy, over the period 1961-1984 an increase of 9.68% of the forested surface took place thanks to special laws, which planned exceptional plantation of trees (mainly conifers) in areas abandoned by people moving from the mountains to the cities (ISTAT 2010). Later on, the

National Forest Inventory (“Inventario Forestale Nazionale”) performed in Italy first in 1985 and again in 2005, recorded an increase of the biomass of the woods of about 80% in only twenty years, from about 730,000,000 m³ to about 1,300,000,000 m³ (IFN 1985, IFNC 2005). This remarkable augmentation was caused by the abandonment of mountains and less suitable woods for trading, but also derived from new laws that established Public State and Regional Forest (“Foreste demaniali e Boschi regionali”). There were also new regulations for the forest management, which introduced more restrictive limits to the exploitation of woods for firewood (coppice woods), and defined a governance more focused on long-term use of fully grown trees (Hermanin & Belosi 1993, Bertini *et al.* 2013, Belosi *pers. obs.*).

All these factors lead to an increase of the maturity of woods that may become suitable as breeding habitat for a species such as the Short-toed Eagle. After 30-60 years of growth, this process could happen quite rapidly (in few years) when the trees reach a dimension where they could become attractive as nesting sites.

Interestingly, in the Elba Island the Short-toed Eagle has breeding since about 1999. The first pair has nested in small valleys of eastern Elba in mature woods of holly oak *Quercus ilex*. These old coppice woods were no longer cut and exploited for firewood in the last decades. In the past few years the observations of Short-toed Eagles are also increasing in the central area of the island and more recently in western Elba as well. As the Elba Island was always a good hunting area for the species due to open and dry landscapes and richness of prey (snakes), it seems that the trigger for the nesting of the species was the cessation of woodland exploitation and the consequent increase of their maturity and wilderness (G. Paesani *pers. comm.*).

D) Immigration from other areas

High productivity rate, availability of broader hunting territories and new suitable nesting sites are probably not sufficient to explain the Short-toed Eagle population increase in Italy. Considering the circuitous migration of this species in Italy in spring (Premuda 2004b), the wintering areas revealed by satellite tracking (Mellone *et al.* 2011) and the studies carried out in Greece (Panuccio *et al.* 2012), the western origin of the Italian population is evident and it reflects a possible recent colonization (Agostini & Mellone 2008, Baghino 2013, Panuccio *et al.* 2014).

In Spain, despite the fact that the population size is not well known, data from the last atlas suggest a remarkably higher estimate, with increase in some regions (2772 pairs; Mañosa 2003), compared to the previous situation (1700-2100 pairs; De Juana 1989).

In France an apparent strong growth of the Short-toed Eagle population in the last decades has been reported (Thiollay & Bretagnolle 2004, Joubert 2006, 2008, Paul 2007, Malafosse & Malafosse 2008, Savine 2009, Frèze 2011). Interestingly, an immature Short-toed Eagle ringed with coloured rings in France (Cévennes) in 2008 was photographed on 8 September 2009 in Italy (Cuneo, Piedmont). Probably the same bird was observed and photographed again in the same area on 4 August 2010 (Malafosse & Malafosse 2009, 2010, Caula & Beraudo 2014). One possible cause for the increasing trend of the species in Italy may be the immigration from the western European region due to the expansion of the population. The immigration could happen during the spring circuitous migration, when wandering non-breeding birds might follow the breeders that are heading towards their occupied nesting areas, finally reaching the Italian Peninsula from France.

E) The dedicated **hunting** significantly affected the species in the last century (Giglioli 1891, Arrigoni degli Oddi 1929, Martorelli 1960) and the legal protection of raptors in Italy certainly strongly supported the recovery of the population in the last decades (Baghino 2013).

However, the decrease of poaching does not seem to be the main cause of the recent increase of the species, as unfortunately the problem still exists. For example, three out of five young Short-toed Eagles equipped with satellite transmitters in Southern Italy (Basilicata) were shot in Sicily, Spain and Nigeria (Univ. Alicante *unpub. data*, Mellone *et al.* 2011, Parco Gallipoli Cognato Piccole Dolomiti Lucane www.parcogallipolicognato.it). On 20 September 2011, four Short-toed Eagles and two Booted Eagles *Aquila pennata* were released at the Apuane Alps (Capriglia) after being recovered by the “Centro Recupero Rapaci Lipu-Birdlife del Mugello” (hospital for raptors). All the above-mentioned raptors were shot by hunters in Tuscany (Centro Recupero Rapaci Lipu-Birdlife del Mugello *pers. comm.*), as well as an immature Short-toed Eagle killed at the Apuane Alps (Arni, Stazzema) a few years ago (F. Viviani *pers. comm.*). In addition, we also report the shocking news regarding 40 Short-toed Eagles killed in October 2013 in Malta, where illegal hunting of raptors still exists (Galea 2014).

Considering all the above mentioned elements, it is likely that the increase of the Short-toed Eagle population in Italy is not linked to only one root cause but to several concurrent factors contributing to the positive trend (Premuda *et al.* 2015). Probably the most important reasons are: the high productivity rate of the Italian population, the withdrawal of farming and the agricultural landscapes ex-

ploited as hunting areas for the species, the increasing maturity of woods exploited as new nesting sites and the immigration from other areas due to the expansion of the species. Overall, as a recommendation, we suggest to update the population trend Status of the species in Italy to “Increasing”, with “possible immigration from other regions”.

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