Avocetta 41: 85-87 (2017)

Status of the Golden Eagle *Aquila chrysaetos* in Sicily

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Apart from its wide continental distribution in the Palaearctic, Nearctic and, partially, in the African and Indo-malayan regions, the Golden Eagle *Aquila chrysaetos* occurs also in the largest Mediterranean islands (Ferguson-Lees & Christie 2001). The largest population lives in Sardinia (57-70 pairs, Ruiu this volume), 32-37 pairs have been recorded in Corsica (Seguin *et al.* 1998) and 16-22 pairs of the *A. c. homeyeri* subspecies in Crete (Xirouchakis 2001). It has been also listed as vagrant in Cyprus and Malta (BirdLife International 2016), while it became extinct in the Balearics (Viada 2006) and in the Aegean and Ionian islands (Xirouchakis 2001). Presence and breeding in Sicily has been recorded since the early XIX century (e.g. Palazzotto 1801 in Massa 1985). More recently, research on the Golden Eagle in Sicily has been usually focused on breeding phenology and distribution during fieldwork for Regional Atlases of breeding birds (Massa 1985, Lo Valvo *et al*. 1993, AA.VV. 2008), as well as a subject of a PhD thesis and post-doc grant (Di Vittorio 2007, 2011). Such data originating from a specific conservation project in the Madonie Regional Park (Sarà *et al*. 2011) and allowed for some investigation on the species' habitat preferences in the island (Di Vittorio & Sarà 2009, Di Vittorio & López-López 2014). Habitat preference modelling showed how mean altitude and slope in the eagles territory are the most important topographic variables, together with the extension of open habitats (arable land and grasslands), to predict the occurrence of the Golden Eagle in Sicily. Actually, the species occupies most of the northern ridge of the island from west (Trapani mountains) to east (Peloritani Mts). Pairs living in the south-western Sicani Mts are connected to the main range in correspondence to the Palermo mountains, while pairs living on Etna are embedded between the Nebrodi and Peloritani. The Golden Eagle has never been recorded breeding in the south-east corner of the island (Erei and Iblei Mts).

In the present work, we review all the relevant information since the first Regional Atlas of breeding birds (Massa 1985), and we add field data on the species occurrence and site occupancy relative to the period January 2014-December 2016, in order to update the species' status in Sicily. Observations were usually collected during the courtship displays (Dec-Feb), the late brood presence (Jun-Jul), and extended until the post fledging period (Aug-Oct). Eagle sightings were made either on foot or from a vehicle with a mean travel speed of 30 km/h, stopping at vantage points with good view over valleys and cliffs known as breeding sites or potential territories (Andersen 2007). A 10x42 binoculars and a 30-60x spotting scope were used during observations. Whenever possible, and according to Forsman (1999), each sighted eagle was allocated to one of the following age groups: a) juvenile of the year, b) young immatures (2^{nd}-4^{th} plumage), c) old immatures and adults ($\geq 5^{th}$ and older plumages). Old immatures and adults were pooled together as they could not be easily distinguished from distance. Both productivity (number of produced juveniles per territorial pair checked) and nesting success (number of produced juveniles per successful pair) have been calculated by observing chicks in the nest that were about two months old, and/or juvenile birds during their post fledging flights accompanied by their parents (Steenhof & Newton 2007). One of us (GG) scrutinized the database of the Regional Rescue Centre based in Ficuzza (Italian League for Bird Protection, Lipu) for the 2001-2016 period to obtain information about species mortality.

The cross-checking of databases gave 24 breeding ter-

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ritories known since 1979, 13 in western and 11 in eastern Sicily, respectively (Tab. 1).

In the 2014-2016 period, sixteen of them were stable and occupied by territorial and/or breeding pairs, one former stable territory was occupied by a single old adult, two were confirmed as abandoned, and five had not been checked carefully (one of which is a possible double count due to overlap between two close territories). Excluding the deserted and possible double count, and assuming some occupancy in the unchecked sites, the current Golden Eagle population in Sicily should cover 17-21 active territories. This means a slight increase of occupancy with respect to previous estimates, as reported in Tab. 2. A total of 215 breeding attempts were recorded, 161 of which were successful and produced 170 fledglings, thus averaging 1.09 juveniles produced per successful pair and 0.78 juveniles per checked pair in the 1979-2016 period (Tab. 2). Thanks to some successful pairs that were able to produce two juveniles even in years when most other pairs failed (e.g. in 2007-2011), nesting success is > 1 on average. Estimates of productivity based on the number of juveniles produced per checked pair is much more informative about the breeding performances of the species. The 0.65 productivity value in the 2014-16 period was the lowest recorded so far, and could be lined up with the decreasing 1990-2012 trend (Di Vittorio & López-López 2014). Nonetheless, productivity values recorded in Sicily are equivalent to those recorded in the central-eastern Alps (1982-92: 0.61 ± 0.01 in Pedrini & Sergio 2001), in all the alpine chain (1978-94: 0.29 - 0.95 in Pedrini & Sergio 2001), Spain (2008: 0.80 ± 0.14 in Del Moral 2009); and even higher than values recorded in the western Alps (1972-2008: 0.55 ± 0.30 in Fasce *et al*. 2011) or in concerned populations like the Cretan (1996-1999: 0.52 ± 0.05 in Xirouchakis 2001), or the Central West Carpathian (1984-1991: 0.50 ± 0.28 in Kropil & Majda 1996). Seven eagles (4 adults, 3 juveniles) were admitted in the Ficuzza Rescue Centre from 2001 to 2016, yielding an average of 0.44 eagles/year. Assuming that such an indirect rate is representative of real mortality occurring in the field, the estimate should have halved with respect to the value of 0.96 eagles/year reported in the 50 years before 1985 (Massa 1985). Nevertheless, for such a small population, the loss of 4 adults in a relatively short period, and of 5 birds from the same area (Palermo mountains) is absolutely alarming.

In a period of nearly 40 years, only one colonization has occurred (Campo *et al*. 2003), and currently the bulk of the population is 12-14 pairs that reproduce more or less regularly and this would allow for an adequate recruitment. Actually, it is not possible to decide whether the dropping in the population productivity across time is due to intrinsic or extrinsic factors (Newton 1998). In the former case, low productivity would be the regulatory consequence of a density-dependence effect, driven by a territorial behaviour mechanism (Rodenhouse *et al*. 1997); whereas in the latter case, prey abundance, possibly interacting with weather, would be negatively influencing the reproductive rates of the Golden Eagle (Steenhof *et al*. 1997). In large territorial raptors, negative density dependence in breeding performances often occurs; for instance it has been recorded in the increasing population of Golden Eagles in western Alps (Fasce *et al*. 2011).

Together with the Cretan *homeyeri*, the Sicilian Golden Eagle currently presents the less abundant island population of the Mediterranean, and its peculiar state of small and isolated population makes it vulnerable despite every verification about the causes of low productivity.

Mountain Range	Pair	Single	Deserted	NC	Range Sub-total
Madonie	3	1			4
Sicani	2		2§		4
Palermo	4				4
Trapani	1				1
WESTERN SICILY	10	1	2	0	13
Peloritani	3			1(+1)*	4-5
Etna	1			2	3
Nebrodi	2			1	3
EASTERN SICILY	6	0	0	4-5	10-11

Table 1. Geographic distribution of the Golden Eagle in the Sicilian mountain ranges. NC = not checked during the study period, * possible double count due to territorial overlap with another site; § the known dates of desertion are 1996 in one site and 2005 in another one.

Table 2. Number of stable territories occupied by Golden Eagle pairs or singles (plus number of possible other territories) in Sicily; together with breeding performances (± standard error) during the 1979-2016 period.

Period	No. of stable territories	No. of produced juveniles	No. of checked pairs	Nesting success	Productivity	Source
1979-1983	10 (+3)	28	37	1.00	0.76	Massa 1985
1984-1992	13 (+2)	31	30	1.15	1.03	Lo Valvo *et al*. 1993
1993-2006	16 (+1)	91	118	1.03	0.77	AA.VV. 2008
2007-2011	16 (+1)	9	13	1.29	0.69	Sarà *et al*. 2011
2014-2016	17 (+4)	11	17	1.00	0.65	this study
1979-2016	**17 (+7)**	**170**	**215**	**1.09 ± 0.05**	**0.78 ± 0.07**	

The combination of human persecution and reduction in prey availability, as a result of habitat degradation and forest expansion, as a consequence of the abandonment of traditional agro-pastoral practices, have been identified as potential long-term threats in several parts of the distribution area (e.g. Pedrini & Sergio 2001, Xirouchakis 2001). In addition, shooting, poisoning, electrocution and trapping are considered the main causes of non-natural mortality (BirdLife International 2016), and most of them have been detected as causes for the birds admitted in the Ficuzza Regional Rescue Centre.

Therefore, even in the case of a potential population in equilibrium with the current carrying capacity of the island ecosystems, further investigation on post-natal dispersal and mortality and continuous monitoring are necessary to prevent any population collapse.

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