

Citizen science project to monitor wildlife: a first census of wintering Booted Eagle *Hieraetus pennatus* in Sicily

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Abstract - Citizen science can represent an effective tool for large-scale data collection and can be used to improve scientific knowledge and define species distribution ranges before proper planning of related conservation strategies. A regional census of wintering Booted Eagle *Hieraetus pennatus* in Sicily, never achieved before, was organized by GAM (Gruppo Aquila Minore - Booted Eagle Group) on 12 January 2020, involving 90 people from several organizations. A total of 112 wintering individuals have been recorded for the whole region, collecting related data about their colour morph, habitat preference and altitude. A regional estimate of 180-220 wintering individuals was calculated, also considering previous data collected during counts carried out in some selected sample areas during December 2019 and January 2020.

Key words: Citizen science, counting, raptors, wintering population.

Riassunto - Progetto di scienza partecipata per il monitoraggio della fauna selvatica: un primo censimento dell'aquila minore *Hieraetus pennatus* svernante in Sicilia.

La Citizen science può rappresentare uno strumento efficace per la raccolta dati su larga scala e può essere utilizzata per migliorare le conoscenze scientifiche e definire gli areali di distribuzione delle specie in relazione alle strategie di conservazione. Un censimento regionale dell'Aquila minore *Hieraetus pennatus* svernante in Sicilia, mai realizzato prima d'ora, è stato organizzato dal GAM (Gruppo Aquila Minore) il 12 gennaio 2020, coinvolgendo 90 persone di diverse organizzazioni. Sono stati censiti un totale di 112 individui in tutta la regione, raccogliendo dati relativi al morfismo, alla preferenza dell'habitat e all'altitudine. È stato stimato un totale di 180-220 individui svernanti, tenendo

in considerazione anche conteggi precedentemente effettuati in alcune aree campione durante i mesi di dicembre 2019 e gennaio 2020.

Parole chiave: Citizen Science, conteggio, GAM, rapaci, popolazione svernante.

INTRODUCTION

Estimating population size is the starting point for planning wildlife conservation strategy and management (Surdo & Massa, 2020). Wildlife data related to large geographical areas can be collected by scientists also through "Citizen Science", an approach that involves the participation of volunteers, amateur naturalists, etc. (Kloetzer, 2021). It offers the opportunity of expanding aims and scope of research activities, improving the capacity to collect scientific data (Cohn, 2008) and also reducing the cost-effective surveys, as it allows to cover a high number of sites at different times of the year (Tulloch *et al.*, 2013). Citizen Science has been proven to be particularly effective with birds (Löhmus, 2011; Nugent, 2018; Gilling *et al.*, 2019).

The Booted Eagle *Hieraetus pennatus* was considered in the past years as a trans-Saharan migratory species, with only a few individuals known to overwinter in Southern Europe (Zalles & Bildstein, 2000), North Africa (Thévenot *et al.*, 2003; Isenmann *et al.*, 2005), and, since '90s, Mediterranean coasts of Spain and southern France (Sunyer & Vinuela, 1996; Isenmann, 1993). In Italy, the species is currently considered as a regular migrant and regular wintering (Brichetti & Fracasso, 2018), mainly in Sicily (Massa *et al.*, 2021), where an increase in the number of individuals was observed from 1980s (Iapichino & Massa, 1989; Iapichino, 1993; Ciaccio & Priolo, 1997) and even more pronounced in the early 1990s (Lo Valvo *et al.*, 1993; Corso & Iapichino, 1998; Corso, 2005). A counting of wintering Booted eagles in Sicily was carried out on 12 January 2020 (Figs. 1-2) with the cooperation of many volunteers of non-profit associations such as GAM (Gruppo Aquila Minore, complete list of participants and further information available on: <http://www.ssn.it/GAM.html>), LIPU (Lega Italiana Protezione Uccelli), AFNI (Associazione Fotografi Naturalisti Italiani) Sicily, "Fauna Siciliana" Facebook Group, Centro di Educazione Ambientale ODV, Gruppo Tutela Rapaci, SSSN (Sicilian Society of Natural Sciences) and CEA of Messina.

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Fig. 1 - Booted Eagle, dark morph, 12 January 2020. / Aquila minore, morfismo scuro, 12 gennaio 2020. (Photo: / Foto: A. Lauricella).



Fig. 2 - Booted Eagle, light morph, 12 January 2020. / Aquila minore, morfismo chiaro, 12 gennaio 2020. (Photo: / Foto: F. Greco).

MATERIAL AND METHODS

Raptor-count has been used by citizen scientists (ornithologists, biologist, naturalists, birdwatchers, nature photographers, students, etc.) to collect data and therefore to estimate the number of wintering Booted eagles in Sicily and some of its minor islands. A total of 90 volunteers have been involved, most of whom were part of birdwatching societies, universities or relevant organizations with a basic background on field work and birdwatching. Moreover, all volunteers have been trained to correctly identify booted eagle in its three different morphisms, through a preliminary formation using informative sheets. The collaborators, cumulatively, travelled 1200 km by car, collecting more than 245 hours of field observations.

The counts have been made using binoculars, telescopes and digital cameras, by means of different techniques, such as transects covered on foot or by car, observation from fixed points of interest (usually open areas with wide and good view or from the top of mountains and hills), observations near already known roost sites, etc.

The social media Facebook played a central role in creating a virtual community about the topic, especially in groups such as “Fauna Siciliana” (with more than 19,000 members), which has been used to spread the initiative and to recruit volunteers. AFNI (Associazione Fotografi Naturalisti Italiani) launched a “photo-contest” about booted eagle photos taken during the day of monitoring in order to encourage participation. A field data sheet has been used on the field, with a unified format, including the observer’s identity, details of counting (start time, duration, distance travelled), information on birds (gps point and geographic location, number, behaviour), habitat (wetland, urban, fields, forest) and an additional parallel counting of Feral pigeon *Columba livia domestica*, for a further use of data. Observers have uploaded their data on www.ornitho.it, an online citizen science database for biodiversity, where data are collected, organized and reviewed by experts. Only data documented by photos, or collected by observers with tested experience, have been taken into account. To reduce the likelihood of double counts, both moult pattern and colour morphs were recorded whenever possible. Birds were not aged on the basis of moult patterns and silhouette (Clark, 2010; Forsman, 2016) as skills beyond the citizen science project were required for this purpose.

RESULTS AND DISCUSSION

In total, 112 wintering individuals of booted eagle were recorded, in 45 different UTM squares on a total of 93 investigated UTM squares (Fig. 3), and then with a density of 1,2 ind./ UTM square. Our precise counting is quite close to the last available estimate of 132-157 ind. wintering in Sicily in 2004-2005 (Baghino *et al.*, 2007) and confirms a sharp increase of the species during the winter in the last decades. Until to '90, indeed, an average of only 5 individuals per year was reported for eastern Sicily (Grussu & Corso, 1998; Corso & Iapichino, 1998), whereas we now report no less than 44 individuals for the same area (24 for the province of Catania, 15 for the province of Ragusa and 5 for Siracusa).

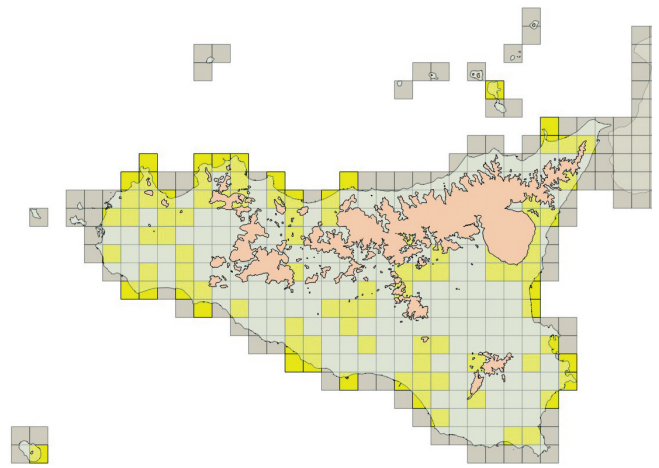


Fig. 3 - The map includes all 93 UTM squares investigated on 12 January 2020 (including the squares where the species has not been observed/recorded). Darkest/reddish areas indicate elevations above 700 m a.s.l. / La mappa include tutti i 93 quadrati UTM indagati il 12 gennaio 2020 (compresi i quadrati in cui la specie non è stata osservata/registrata). Le aree più scure/rossastre indicano altitudini superiori a 700 m s.l.m.

Data collected are related to 65 different data sheets with at least 1 individual recorded, up to a maximum of 11 individuals observed together (Average 1.77; Std. Error 0.21; Stand. Dev. 1.67). In addition, 72 data sheets related to no observed individuals have been evaluated. All density data are represented on the map of figure 4.

The frequency of two-colours morph observed in the 112 individuals recorded, shows a high preponderance of the light form in 73.2% of the total observations, with only the remaining 26.8% related to a dark / reddish morph. Comparing these morphism frequencies with those collected by Baghino *et al.* (2007) by means of the Fisher’s Test, it appears that there are no relevant differences, being P (no assoc.): 0,69362.

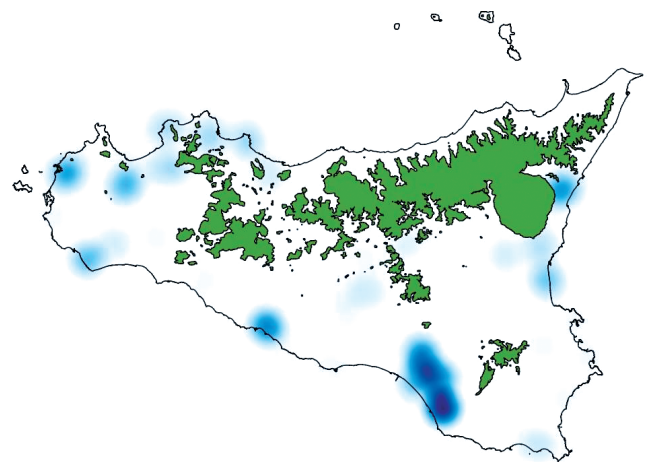


Fig. 4 - Records of Booted eagles in Sicily on the basis of the census of 12 January 2020. Green areas indicate elevation above 700 m a.s.l.; the blue halos indicate a higher number of booted eagles observed in relation to the colour intensity. / Record di aquile minori in Sicilia sulla base del censimento del 12 gennaio 2020. Le aree verdi indicano quote superiori a 700 m s.l.m.; gli aloni blu indicano un numero maggiore di aquile minori osservate in relazione all’intensità del colore.

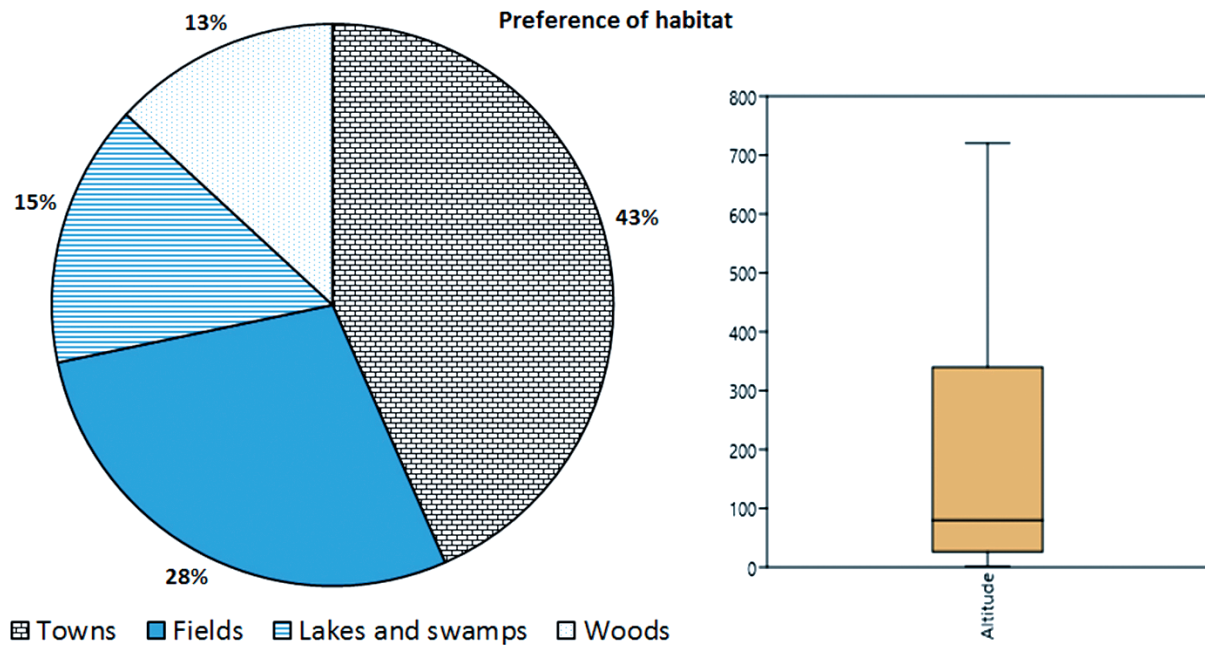


Fig. 5 - Habitat type frequency of wintering *H. pennatus* in Sicily on the basis of 112 individuals counted on 12 January 2020 and related altitude (in meter) box plot on the right. / Frequenza del tipo di habitat di *H. pennatus* svernante in Sicilia sulla base di 112 individui contati il 12 gennaio 2020 e relativo *box plot* di altitudine (in metri) sulla destra.

Most of the observations are related to urban and suburban areas (Fig. 5).

From the box plot analysis (Fig. 5) the species has never been found above 700 m a.s.l., thus, it is therefore possible to elaborate a new map of Sicily ranging in this altitude limit and in this case the coverage of this census is quite enhanced.

Although this survey covered all Sicilian provinces and main towns, investigation coverage has been relatively deficient in north-eastern and central Sicily, with no records for the province of Messina, probably due to the predominance of wooded areas and mountain ranges, that are not preferential wintering habitat for the species. Despite this fact, the gap between field observations and population estimates may be filled by means of increased survey effort and coverage of more areas, which evidenced the great contribution of citizen science to the census of species.

In December 2019 and in January 2020, some eagles were also observed in some UTM squares, not covered by our census of 12 January 2020 (Tab. 1, Fig. 6).

In addition, 25-30 individuals were observed in the natural reserve "Riserva Naturale Pino d'Aleppo" (Vittoria, UTM VA58), instead of the 11 individuals recorded during the census. Therefore, taking into account these additional data and considering all the potentially suitable but not covered UTM squares, we can reasonably estimate a population of no less than 180-220 booted eagles wintering in Sicily per winter in recent years.

It is established that the most of booted eagles wintering in Italy come from the Iberian population, through the route that follows the coasts of Spain, France and Italy (Panuccio *et al.*, 2022). Given that many juvenile eagles were observed during the post-reproductive migration that

preceded this census, in autumn 2019, but not in such high numbers as in 2018, it is presumed that, in some years, wintering individuals in Sicily can be expected to be as much as double the 180-220 estimated in this study. On the other hand, indeed, counts of migratory eagles in Versilia and on the Strait of Messina (Calabrian side) reporting, respectively, 556 and 119 juvenile eagles observed in autumn 2019 (Premuda, 2020; Cento *et al.*, 2020), are completely in line with our winter census results in Sicily.

CONCLUSION

Such a short-term study is not sufficient to provide an accurate estimate of population size and trends. More reliable estimates would probably require more than 5 years of data collection and 15-20 years to obtain much more robust data and then, consequently, more realistic conclusions (Conway & Timmermans, 2005). Using long term data collection and analysis would be a promising avenue for next future works with the aim of accurately estimating the wintering population and its trend. Citizen science has a long history in the ecological sciences and has made substantial contributions to science, education and society (Löhms, 2011), but, despite this, in Italy its value is still underappreciated. Thanks to this approach, operating consistently and at a broad geographic scale, even with a single winter monitoring, we collected a great deal of occurrence and abundance data. We also provide a first effective count, never done before in Sicily, and, on the basis of this, we also provided an estimate of Sicilian wintering Booted eagle population, highlighting once more the usefulness of citizen science for collecting data, providing information for management and conservation of species and habitats.



Fig. 6 - Booted eagles, 12 January 2020. / Aquile minori, 12 gennaio 2020. (Photo: / Foto: L. Salvaggio).

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REFERENCES

- Baghino L., Premuda G., Gustin M., Corso A., Mellone U. & Cardelli C., 2007 – Exceptional wintering and spring migration of the booted eagle *Hieraetus pennatus* in Italy in 2004 and 2005. *Avocetta*, 31: 57-62.
- Brichetti P. & Fracasso G., 2018 – The Birds of Italy. 1. Anatidae-Alcidae. *Edizioni Belvedere*, Latina.
- Cento M., Agostini N., Gustin M. & Dell'Omo G., 2020 – Osservatorio dello Stretto Rapporto Autunno 2019. In: La migrazione post-nuziale del 2019: alcuni record. *Infomigrans, Ente Aree Protette Alpi Marittime*, Valdieri (CN), 44: 2-3.
- Ciaccio A. & Priolo A., 1997 – Avifauna della foce del Simeto, del lago di Lentini e delle zone umide adiacenti (Sicilia, Italia). *Il Naturalista siciliano*, 21 (3-4): 309-413.

- Clark W. S., 2010 – Guida ai rapaci d'Europa, Nord Africa, Medio Oriente. *Muzzio Editore*.
- Cohn J. P., 2008 – Citizen Science: Can Volunteers Do Real Research? *BioScience*, 58 (3): 192-197. <<https://doi.org/10.1641/B580303>>
- Conway C. J. & Timmermans S. T., 2005 – Progress toward developing field protocols for a North American marsh bird monitoring program. In: Bird conservation implementation and integration in the Americas. Proceedings of the third international partners in flight conference. 2002 March 20-24; Albany Asilomar, California. Ralph C.J., Rich T. D. (eds.). *US Department of Agriculture Forest Service, Pacific Southwest Research Station*, Albany, 2: 997-1005.
- Corso A., 2005 – Avifauna di Sicilia. *L'Epos*, Palermo.
- Corso A. & Iapichino C., 1998 – I rapaci svernanti in Sicilia negli anni 1990-1997. *Ahula*, 5 (1-2): 125-130.
- Forsman D., 2016 – Flight Identification of Raptors of Europe, North Africa and the Middle East. *Bloomsbury, Helm Identification Guide*.
- Gillings S., Balmer D. E., Caffrey B. J., Downie I. S., Gibbons D. W., Lack P. C., Reid J. B., Sharrock J. T. R., Swann R. L. & Fuller R. J., 2019 – Breeding and wintering bird distributions in Britain and Ireland from citizen science bird atlases. *Global Ecology and Biogeography*, 28 (7): 866-874. <<https://doi.org/10.1111/geb.12906>>
- Grussu M. & Corso A., 1998 – Sardegna e Sicilia: due aree privilegiate in Italia per lo svernamento dell'avifauna. *Aves ichnusae*, 1 (1): 85-86.
- Iapichino C. (red.), 1993 – Rapporto ornitologico - Sicilia 1987-1989. *Il Naturalista siciliano*, 17 (1): 149-168.
- Iapichino C. & Massa B., 1989 – The Birds of Sicily. B.O.U. Check-list No. 11. *British Ornithologists Union*, London.
- Isenmann P., 1993 – Oiseaux de Camargue. *Société Française d'Ornithologie*, Paris.
- Isenmann P., Gautier T., El Hili A., Azafzaf H., Dlensi H. & Smar M., 2005 – Oiseaux de Tunisie. *Société Française d'Ornithologie*, Paris.
- Kloetzer L., Lorke J., Roche J., Golumbic Y., Winter S. & Jõgeva A., 2021 – Learning in Citizen Science. In: The Science of Citizen Science. Vohland K., Land-Zandstra A., Ceccaroni L., Lemmens R., Perelló J., Ponti M., Samson R. & Wagenknecht K. (eds). *Springer*: 283-308. <https://doi.org/10.1007/978-3-030-58278-4_15>
- Lõhmus A., 2011 – The role of citizen science in ornithology. *Estonian Journal of Ecology*, 60 (2): 83-87. <<https://doi.org/10.3176/eco.2011.2.01>>
- Lo Valvo M., Massa B. & Sarà M. (red.), 1993 – Uccelli e paesaggio in Sicilia alle soglie del terzo millennio. *Naturalista siciliano*, XVII (suppl.): 1-373.
- Massa B., Ientile R., Aradis A. & Surdo S., 2021 – One hundred and fifty years of ornithology in Sicily, with an unknown manuscript by Joseph Whitaker. *Biodiversity Journal*, 12 (1): 27-89. <<https://doi.org/10.31396/Biodiv.Jour.2021.12.1.27.89>>
- Nugent J., 2018 – Citizen Science: Birds, Binoculars, and Biodiversity. *Science Scope*, 41 (5): 16-18. <https://doi.org/10.2505/4/ss18_041_05_16>
- Panuccio M., Mellone U. & Agostini N. (eds), 2022– Migration strategies of birds of prey in Western Palearctic. *CRC Press*.
- Premuda G., 2020 – Versilia-Alpi Apuane: Campo rapaci autunno 2019. In: La migrazione post-nuziale del 2019: alcuni record. *Infomigrans, Ente Aree Protette Alpi Marittime*, Valdieri (CN), 44: 11-13.
- Sunyer C. J.-R. & Viñuela J., 1996 – Invernada de rapaces (O. Falconiformes) en España Peninsular e Islas Baleares. In: Biología y Conservación de las Rapaces Mediterráneas, 1994. Muntaner J. & J. Mayol (eds.). *Sociedad Española de Ornitología*: 361-370.
- Surdo S. & Massa B., 2020 – Aggiornamento sulla nidificazione della Tartaruga marina *Caretta caretta* (Reptilia Cheloniidae) in Sicilia. Riflessioni sul valore della Citizen science. *Naturalista sicil.*, S. IV, XLIV (1-2): 115-126.
- Thévenot M., Vernon R. & Bergier P., 2003 – Booted Eagle. In: The Birds of Morocco. An annotated Checklist. *British Ornithologists' Union and British Ornithologists' Club, the Natural History Museum*, Tring, 20: 141-143.
- Tulloch A. I. T., Possingham H. P., Joseph L. N., Szabo J. & Martin T. G., 2013 – Realising the full potential of citizen science monitoring programs. *Biological Conservation*, 165: 128-138. <<https://doi.org/10.1016/j.biocon.2013.05.025>>
- Zalles J. & Bildstein K. L., 2000 – Raptor watch: a global directory of raptor migration sites. *BirdLife Conservation Series*, 9.