Breeding seabirds of the Sicilian islands: distribution and abundance within the Marine Strategy Framework Directive monitoring program

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Abstract - Four marine bird species breeding in the circum-Sicilian islands were monitored during 2021-2024 with the aim of updating data on distribution, breeding success, and population size for the EU Marine Strategy Directive (MSFD 2008/56/CE). Counts allowed to assess population sizes, in terms of breeding pairs, for Audouin's Gull (91-160), Scopoli's Shearwater (14,825-15,925), Yelkouan Shearwater (610-720), and Mediterranean Storm Petrel (3,030-3,050). However, for the latter two species, data could provide underestimates, as some breeding sites, located in poorly accessible areas, require further research.

Key words: distribution, breeding success, population size, *Calonectris diomedea*, *Puffinus yelkouan*, *Hydrobates pelagicus melitensis*, *Ichthyaetus audouinii*.

Riassunto - Gli uccelli marini nidificanti nelle isole della Sicilia: distribuzione e abbondanza nell'ambito della Direttiva Quadro sulla Strategia per l'Ambiente marino.

Nell'ambito delle attività previste dalla Direttiva Quadro sulla Strategia per l'Ambiente Marino (MSFD-2008/56/CE), durante il periodo 2021-2024, è stato condotto un programma di monitoraggio di quattro specie di uccelli marini nidificanti nelle isole circumsiciliane, con lo scopo di aggiornare le informazioni relative a distribuzione, successo riproduttivo e abbondanza delle popolazioni. Le indagini hanno permesso di quantificare le popolazioni di Gabbiano corso (91-160 coppie), Berta maggiore (14825-15925), Berta minore mediterranea (610-720) e Uccello delle tempeste mediterraneo (3030-3050); per le ultime due specie è probabile che le consistenze siano sottostimate poiché alcuni siti riproduttivi, localizzati in luoghi difficilmente accessibili, richiedono ricerche più approfondite.

Parole chiave: distribuzione, successo riproduttivo, stima di popolazione, *Calonectris diomedea*, *Puffinus yelkouan*, *Hydrobates pelagicus melitensis*, *Ichthyaetus audouinii*.

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INTRODUCTION

The European Union's (EU) Marine Strategy Framework Directive (MSFD, 2008/56/EC) is a complex legislation aiming to achieve Good Environmental Status and sustainable use of marine resources of the sea around Europe (Long, 2011). It is based on a holistic, ecosystem-based approach and uses descriptors of the marine environment to assess state, impact, and pressures. Member States have to regularly report on marine biodiversity and establish and/or integrate monitoring programs and activities. Against this background, monitoring seabirds plays an important role since this group, also protected by the Birds Directive 09/147, could reflect environmental changes in the marine system. Marine birds are among the most threatened faunal groups at the global level (Croxall *et al*., 2012; Paleczny *et al*., 2015; Dias *et al*., 2019). The populations of many species show a significant decline, caused by direct or indirect disturbance and alteration of both pelagic and terrestrial habitats, where they spend most of their lives or where they breed, respectively (Lewison *et al*., 2012; Spatz *et al*., 2014). The main threats are pollution (Burger & Gochfeld, 2004), depletion of trophic resources (Karpouzi *et al*., 2007), intentional or accidental captures (Anderson & Keith, 1980; Montevecchi, 2002), anthropogenic disturbance at breed-

ing sites (Soldatini *et al*., 2015; Cianchetti-Benedetti *et al*., 2018), predation by introduced or invasive species (Jones *et al*., 2008), and the effects of climate change (Grémillet & Boulinier, 2009). In most cases, these factors involve vast geographic areas (Jodice & Suryan, 2010), and conservation actions therefore require as broad and shared a strategy as possible.

Three species of Procellariiformes occur in the circum-Sicilian islands: Scopoli's Shearwater *Calonectris diomedea* (Scopoli, 1769), Yelkouan Shearwater *Puffinus yelkouan* (Acerbi, 1827), and Mediterranean Storm Petrel *Hydrobates pelagicus melitensis* (Schembri, 1843), while the Audouin's Gull *Ichthyaetus audouinii* (Payraudeau, 1826) occurs in a tiny coastal islet of south-eastern Sicily.

Previous information on the distribution and population size of Procellariiformes has been summarized by Baccetti *et al*. (2009), in the regional atlases (Massa, 1985; Lo Valvo *et al*., 1993; Ientile & Massa, 2008) and especially in the recent review of the avifauna of the circum-Sicilian islands (Massa *et al*., 2015). An update of the state of knowledge for Aeolian seabirds and the Linosa colony of Scopoli's Shearwater was provided respectively by Lo Cascio (2016) and Dell'Omo (2020), while Di Gangi *et al*. (2024) gave the first data about the Lampione population of the latter species; Vento & Pedone (2022) and Vento & Cusmano (2022) reported new records of Scopoli's Shearwater for Lipari and Yelkouan Shearwater for Ustica, respectively. Ientile *et al*. (2016) documented the occurrence of a breeding colony of Audouin's Gull on the islet of Vendicari in Eastern Sicily.

In 2021, *Istituto Superiore per la Protezione e la Ricerca Ambientale* (ISPRA) and the SAAF Department of the University of Palermo established an agreement for implementing a monitoring program for Descriptor 1 – Biodiversity (Avifauna) and gathering data for the MS criteria D1C2 (abundance), D1C3 (demographic parameters), and D1C4 (distribution). The present paper summarizes the results of the 4-year monitoring (2021-2024) concerning the distribution, the estimated size, and the reproductive success of the Sicilian populations of the four target species.

MATERIALS AND METHODS

Study area

The circum-Sicilian islands (Fig. 1) have a wide latitudinal range extending from Lampedusa, Pelagie Archipelago (at 35°30'N), in the south, to Strombolicchio, Aeolian Archipelago (at 38°50'N), in the north. They include 14 main islands and many islets, which can be grouped into three main archipelagos (Aeolian, Egadi, and Pelagie), while Ustica and Pantelleria are rather isolated. Overall, they occupy an area of approximately 285 km^2. Procellariiformes were observed on 17 islands (Tab. 1), while Audouin's Gull occurred on the small coastal islet of Vendicari (SE Sicily) only (Figs. 2-5). For the latter species, to investigate the possible occurrence of additional breeding sites, field surveys were extended to Isola Lachea and Scoglio della Madonnina, Isola dei Porri, Isola delle Correnti, Isola di Capo Passero and the Faraglioni di Siracusa.

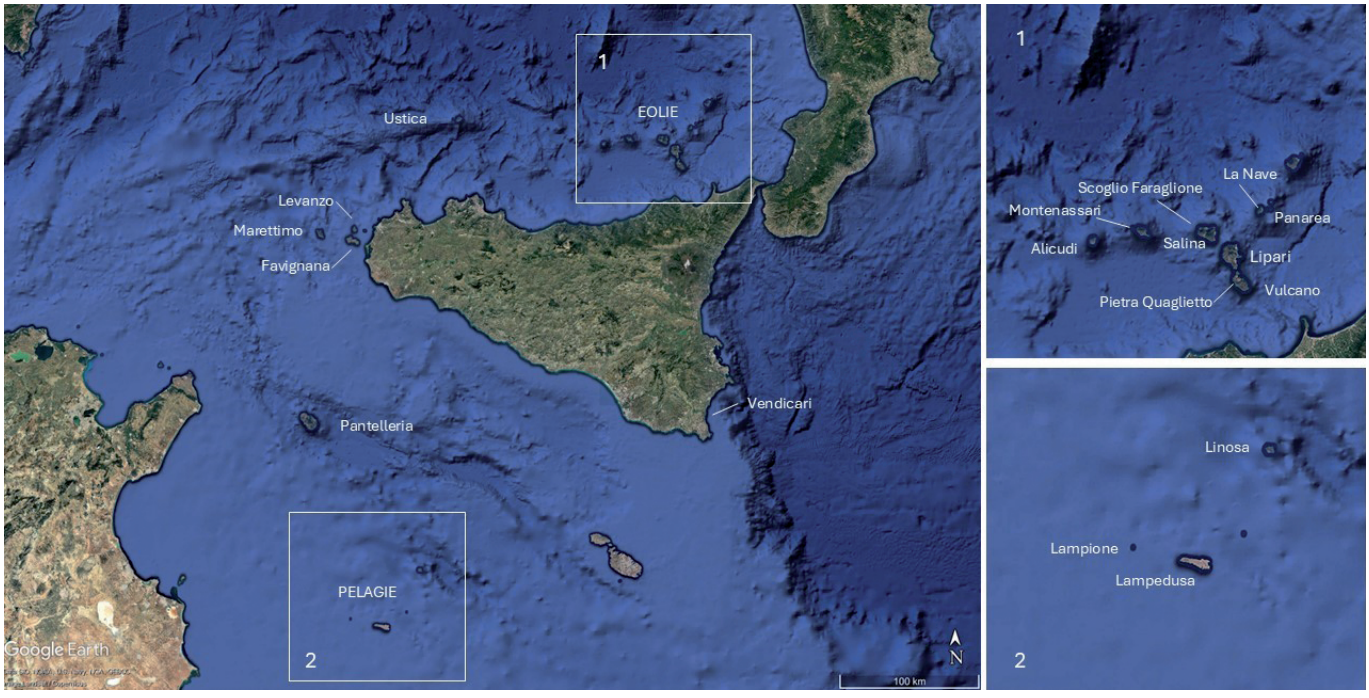

Fig. 1 – The circum-Sicilian islands (modified from Google Earth). / Le isole circum-siciliane (modificato da Google Earth).

Monitoring activity

The field work was carried out according to the national guidelines produced for the Italian National System for Environmental Protection (SNPA) (Pezzo *et al*., 2024) and by using two main methods: i) acoustic/direct localization and count of nesting areas, ii) counting of rafts (evening gatherings off the colonies) for shearwaters.

Acoustic surveys were performed both from land and sea, during the evening hours and in the absence of moonlight, considering the number of call contacts per unit of time for males, females, or indeterminate individuals. Since 2022, acoustic detection was also done by using passive recorders ("Wildlife Acoustics" with an integrated microphone model "Song Meter Micro") placed in strategic points after having set the frequency at 44.1 kHz, and duration of each audio file, 30 minutes every hour from sunset to sunrise (cf. Buxton & Jones, 2012; Oppel *et al*., 2014).

Rafts of shearwaters were counted both from land and the sea, at least 3 hours before sunset (cf. Karris *et al*., 2017). Observations were carried out using binoculars or telescopes, by counts performed at five-minute intervals until sunset, and considering the maximum value obtained during each series.

Once the nesting sites were located, nest density was estimated, when possible, through a direct search of the nests or in a different manner, depending on the species; cliffs, caves, and burrows were inspected searching for traces, droppings, adults, or chicks. For shearwaters, nests were repeatedly visited in order to assess reproductive success, expressed as fledgings/eggs %.

To avoid human disturbance of the colony, for Audouin's Gull a drone was used, taking photos from different height (100, 75 and 65 m above ground level) (cf. Rush *et al*., 2018; Valle & Scarton, 2021); the images were analyzed to identify the incubating adults; from the final count we excluded uncertain or non-breeding individuals (standing birds were identified from the shadow cones on the ground).

In order to improve the overall knowledge about the studied populations, some observations gathered in different periods from those defined by the SNPA protocol have also been included in the results.

RESULTS

Scopoli's Shearwater (Fig. 6)

Lipari: calls of individuals of this species, repeatedly heard during 2022-2023 surveys, suggest at least the occurrence of 1-2 pairs on the cliffs near Perciato (S coast); rafts ranging from 40 to 180 individuals were seen two miles off the E coast in early September 2023.

Salina: calls of 10-12 individuals were heard in 2021 at Punta Marcello (W coast). The occurrence of a small colony at Capo Faro, previously reported by Massa *et al*. (2015), was not confirmed.

Tab. 1 – Distribution and estimated population abundance of Scopoli's and Yelkouan Shearwaters, Mediterranean Storm Petrel and Audouin's Gull monitored during 2021-2024 in the circum-Sicilian islands. ND, undetermined figure. / Distribuzione e stima della popolazione di Berta maggiore, Berta minore, Uccello delle tempeste e Gabbiano corso monitorati delle isole circum-siciliane nel 2021-2024. ND, consistenza non determinata.

Island	Coordinates	*C. diomedea*	*P. yelkouan*	*H. pelagicus*	*H. audouinii*
Lipari	38°29'13"N 14°56'06"E	1-2	-	-	-
Salina	38°33'47"N 14°50'20"E	10-12	-	-	-
Vulcano	38°23'21"N 14°58'22"E	16	-	-	-
Alicudi	38°32'25"N 14°21'11"E	5-10	-	-	-
Panarea	38°38'12"N 15°03'57"E	1-2	ND	-	-
Scoglio Faraglione	38°34'45"N 14°48'03"E	10-15	-	5-6	-
Pietra Quaglietto	38°23'59"N 14°56'18"E	3-6	-	-	-
Montenassari	38°34'55"N 14°31'37"E	-	-	20-40	-
La Nave	38°38'48"N 15°03'51"E				
Ustica	38°42'18"N 13°10'31"E	50-80	ND	-	-
Favignana	37°55'26"N 12°19'26"E	50	50	-	-
Marettimo	37°58'08"N 12°03'31"E	200	ND	3,000	-
Levanzo	37°59'56"N 12°20'05"E	100	ND	-	-
Pantelleria	36°47'17"N 11°59'39"E	3,000	400-500	-	-
Lampedusa	35°30'54"N 12°34'30"E	150-200	160-170	1-2	-
Linosa	35°51'57"N 12°52'05"E	11000-12000	-	-	-
Lampione	35°33'06"N 12°19'15"E	230	ND	5	-
Vendicari	36°47'29"N 15°06'18"E	-	-	-	91-160

Scoglio Faraglione: estimated consistence is 10-15 pairs; among nests inspected (N=4), all were successful in 2021 and 2022 (100%) while one of four failed in 2023 (66%).

Vulcano: 16 pairs counted along the W coast between Cala Formaggio and Spiaggia Lunga; rafts of a maximum of 50 individuals were regularly seen off the E coast of the island in late August and early September 2023.

Pietra Quaglietto: estimated consistence is 3-6 pairs.

Alicudi: the occurrence of this species found on the W coast in 2021 (15-10 pairs) was not confirmed in the following years; also, another site near the power station (SE coast) (A. Corso, pers. com.) was not confirmed by recent surveys.

Panarea: only 1 pair found at Punta Scritta (W coast), but the consistence could be underestimated.

Scoglio La Nave: estimated consistence is 1-2 pairs.

Lampedusa: acoustic sessions in 2021 near Albero Sole recorded between 150 and 180 individuals (mainly males) and a few individuals at Capo Ponente, while rafts observed from the land in the same locality counted up to 120 individuals (in 2021) and 133 (in 2023).

Linosa: rafts ranging from a few hundred to several thousand individuals were regularly observed under suit-

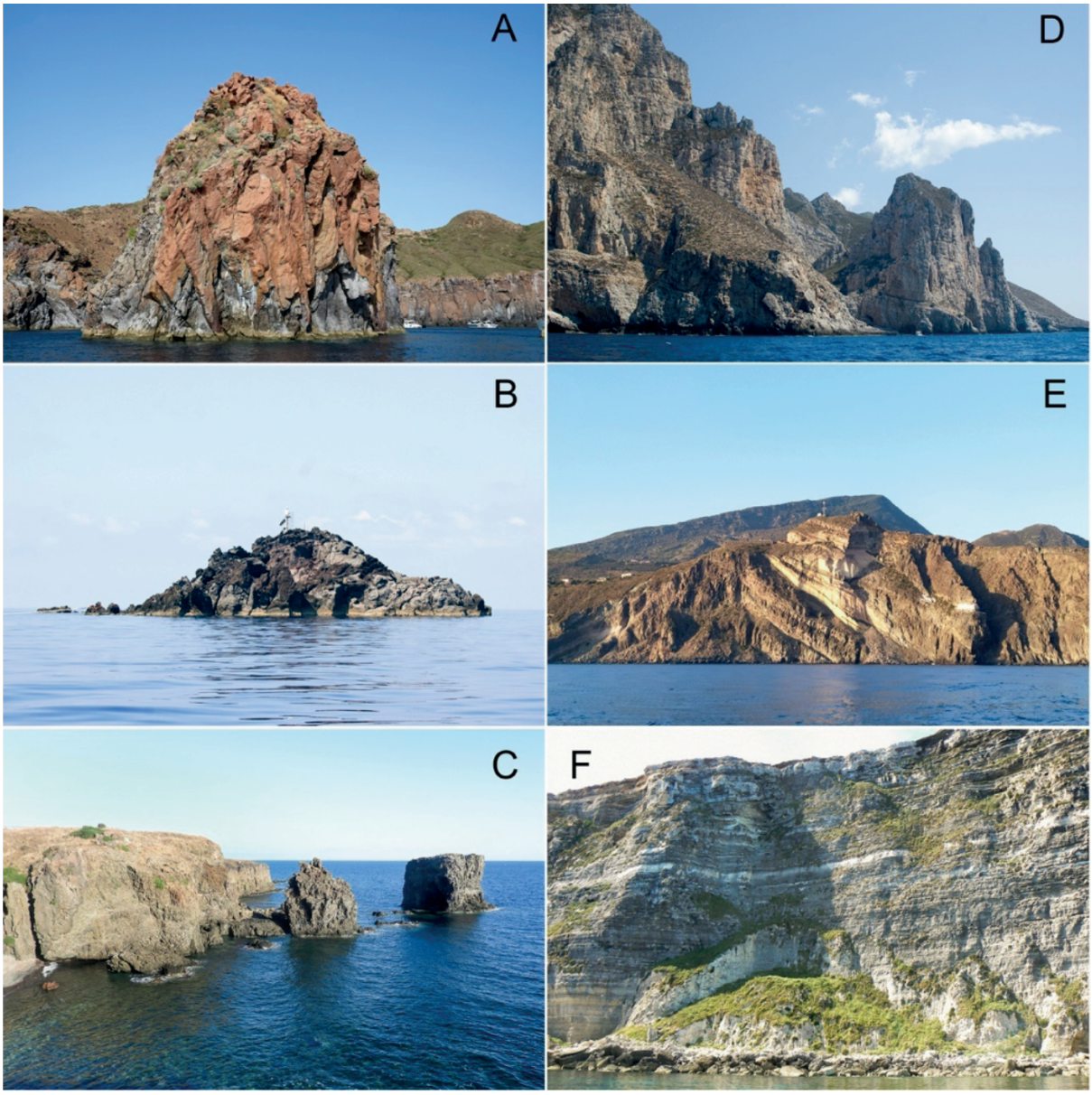

Fig. 2 – Some important sites for breeding seabirds in the circum-sicilian islands: A) Pietra Quaglietto Islet (near Vulcano, Aeolian Islands); B) Montenassari Islet (near Filicudi, Aeolian Islands); C) the Faraglioni of Ustica; D) west coast of Marettimo (Egadi Islands); E) the coast of Punta Limarsi, Pantelleria; F) north coast of Lampedusa. / Alcuni importanti siti per la nidificazione degli uccelli marini nelle isole circum-siciliane: A) Pietra Quaglietto (vicino Vulcano, Isole Eolie); B) Scoglio Montenassari (vicino Filicudi, Isole Eolie); C) i Faraglioni di Ustica; D) costa occidentale di Marettimo (Isole Egadi); E) costa di Punta Limarsi, Pantelleria; F) costa settentrionale di Lampedusa.

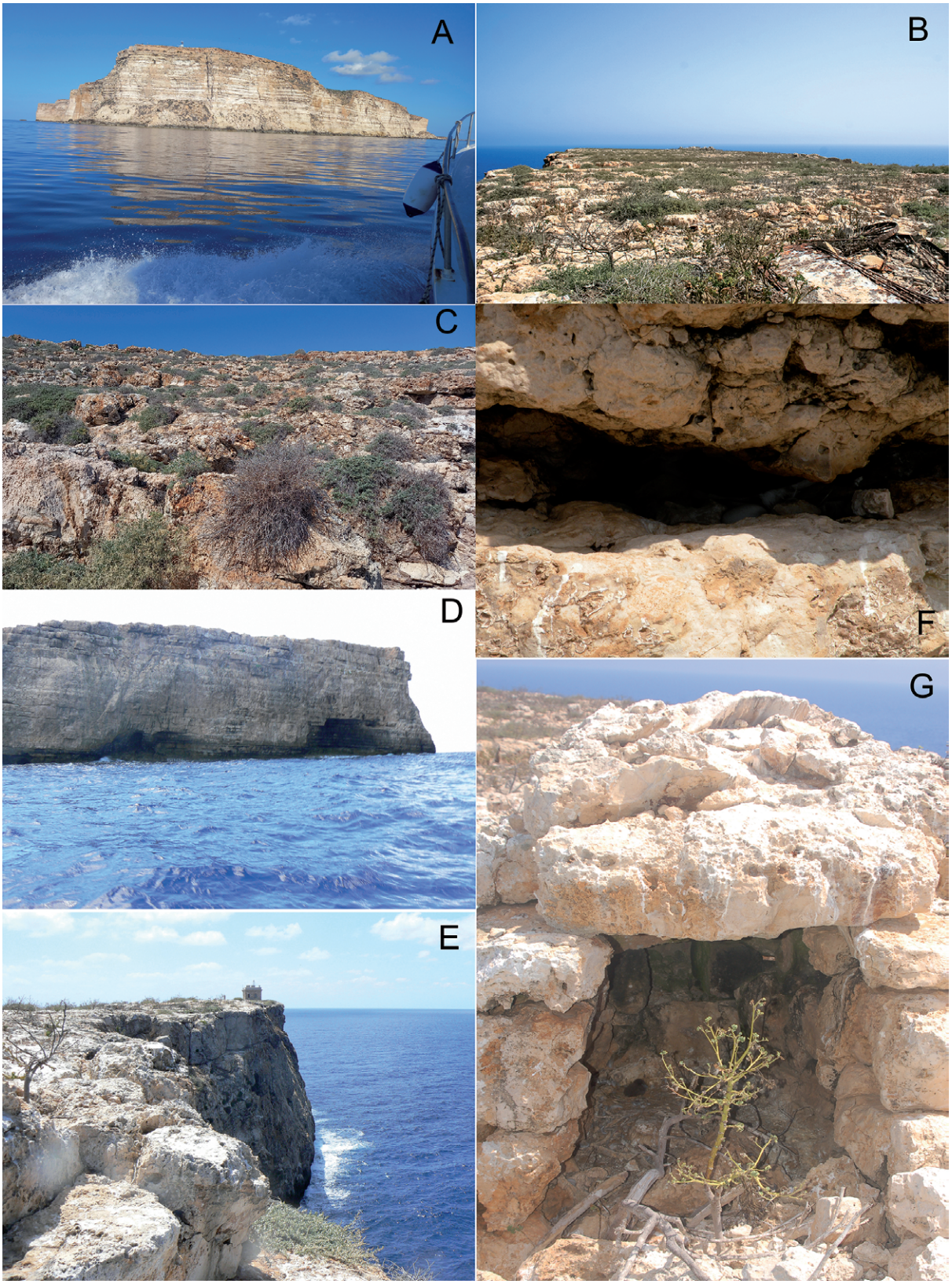

Fig. 3 – The islet of Lampione in the Sicilian Channel. A) image from the east, arriving by boat; B and C) the flat top of the islet; D) western view of the islet; E) the flat top in the direction of the lighthouse; F) a natural fracture in the rock, in which the Scopoli's Shearwaters breed; G) a structure of probably Roman origin, under which the Scopoli's Shearwaters has bred. / L'isolotto di Lampione nel Canale di Sicilia. A) immagine da est, arrivando con la barca; B e C) il piano roccioso dell'isolotto; D) visione occidentale dell'isolotto; E) il piano sommitale in direzione del faro; F) una frattura naturale della roccia, in cui nidificano le Berte maggiori; G) una struttura di origine probabilmente romana, sotto cui ha nidificato la Berta maggiore.

Fig. 4 – Above: the islet of Vendicari, where a colony of Audouin's Gulls breeds, taken with a drone; below: detail of the area of the islet where Audouin's Gulls breed. / Sopra: l'isolotto di Vendicari, ove nidifica una colonia di Gabbiani corsi, ripreso con un drone; sotto: particolare della zona dell'isolotto dove si riproducono i Gabbiani corsi.

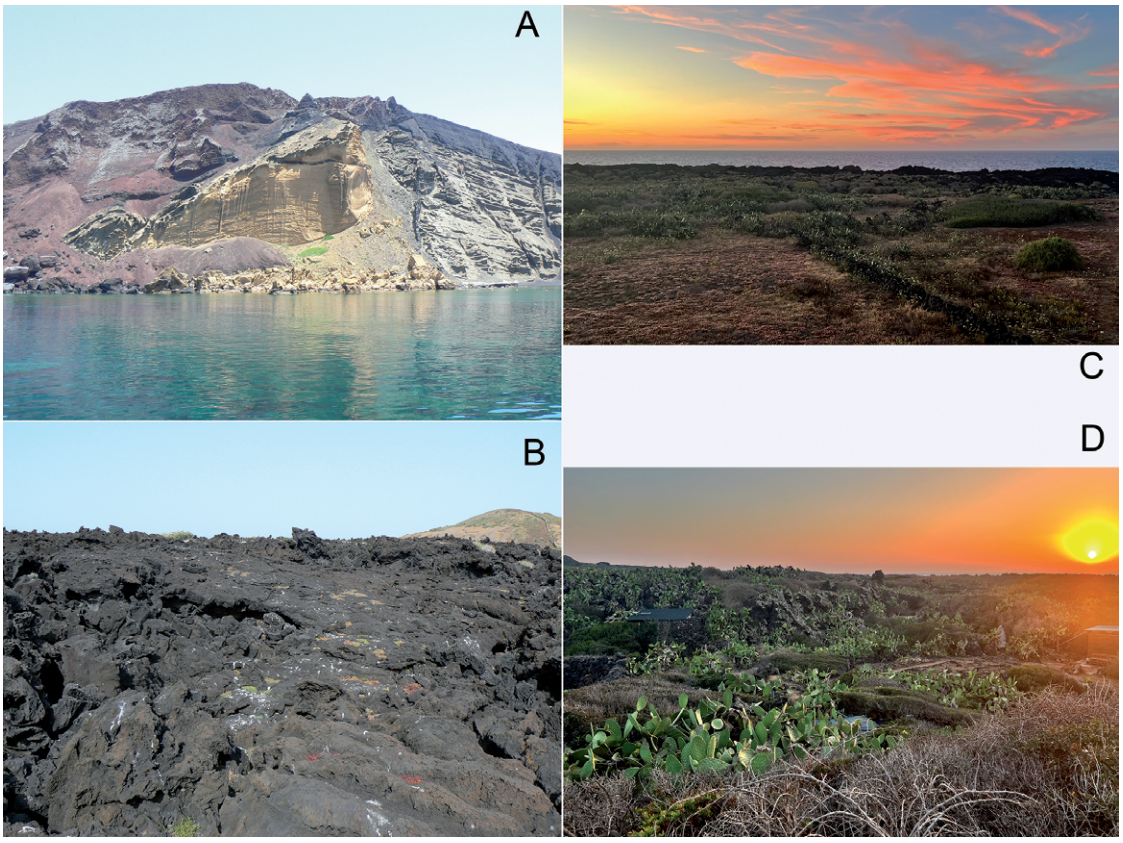

Fig. 5 – Landscape of Linosa (Pelagie Islands). A) Cala Ponente; B, C, D) loc. Mannarazza and Scasciati, where thousands of Scopoli's Shearwaters breed. / Paesaggi di Linosa (Isole Pelagie). A) Cala Ponente; B, C, D) loc. Mannarazza e Scasciati, dove nidificano migliaia di coppie di Berta maggiore.

Fig. 6 – Scopoli's Shearwater *Calonectris diomedea*. A) adult in flight in the sea at Linosa (photo by T. Puma); B) hatching adult at Linosa; C) pair in the nest at Linosa; D) chick about one month old at Linosa. / Berta maggiore *Calonectris diomedea*. A) adulto in volo nel mare di Linosa (foto di T. Puma); B) adulto in cova a Linosa; C) coppia nel nido a Linosa; D) pulcino di circa un mese a Linosa.

able weather and sea conditions (maximum number in 2022: 12,000 individuals off the coast at Pozzolana); estimated reproductive success was 68% in 2021 (514 nests, 391 eggs and 265 fledglings), 64.5% in 2022 (480 nests, 366 eggs and 236 fledglings), 86% in 2023 (468 nests, 325 eggs and 280 fledglings) and 70% in 2024 (425 nests, 383 eggs and 270 fledglings).

Lampione: censuses done during an 8-year monitoring of this population (Di Gangi *et al*., 2024), including also three years during the present project, provided an estimated consistence of about 230 pairs. In 2024, the estimated reproductive success was 61.5% (72 nests, 52 eggs, and 32 fledglings).

Pantelleria: rafts were regularly observed along most of the coastal perimeter in 2022-2024 (except for the N and NW sectors), although the larger ones were concentrated in the S sector (between Punta Spadillo and Suvaki). The estimated number is 3000 pairs; nesting also takes place in moderately anthropized areas (e.g., near Scauri cemetery), while it was not possible to confirm the presence in the inner areas of the island (plateau above the cliffs) as previously observed (Massa *et al*., 2015; T. La Mantia, unpubl. data). In early September 2024, an acoustic recording provided only a few individuals in the two localities of Martingana and Balata dei Turchi.

Favignana: in 202, an estimated around 50 pairs, mainly localized between Cala Trapanese and Grotta degli Innamorati; their occurrence was, however, not confirmed during the acoustic session in May 2023.

Marettimo: about 200 pairs occurring both in the N and S sector, near Punta Galera, all inaccessible.

Levanzo: acoustic sessions provided an estimate of about 100 pairs, mainly localized in Cala Faraglione, Grotta del Genovese, Cala Tramontana, and Faro; groups of <10 individuals were repeatedly observed off the same coast.

Ustica: in 2022 and 2023, acoustic sessions provided an estimate of 50-80 pairs, localized particularly in the NE area; only single individuals were observed off the coast. All results are summarized in Tab. 1.

Yelkouan Shearwater (Fig. 7**)**

Aeolian Islands: in winter 2022 and 2023, single individuals or small groups (max 5-6) have been regularly observed in the channel between Salina and Filicudi, and especially off the S coast of Panarea. A raft of about 40 in-

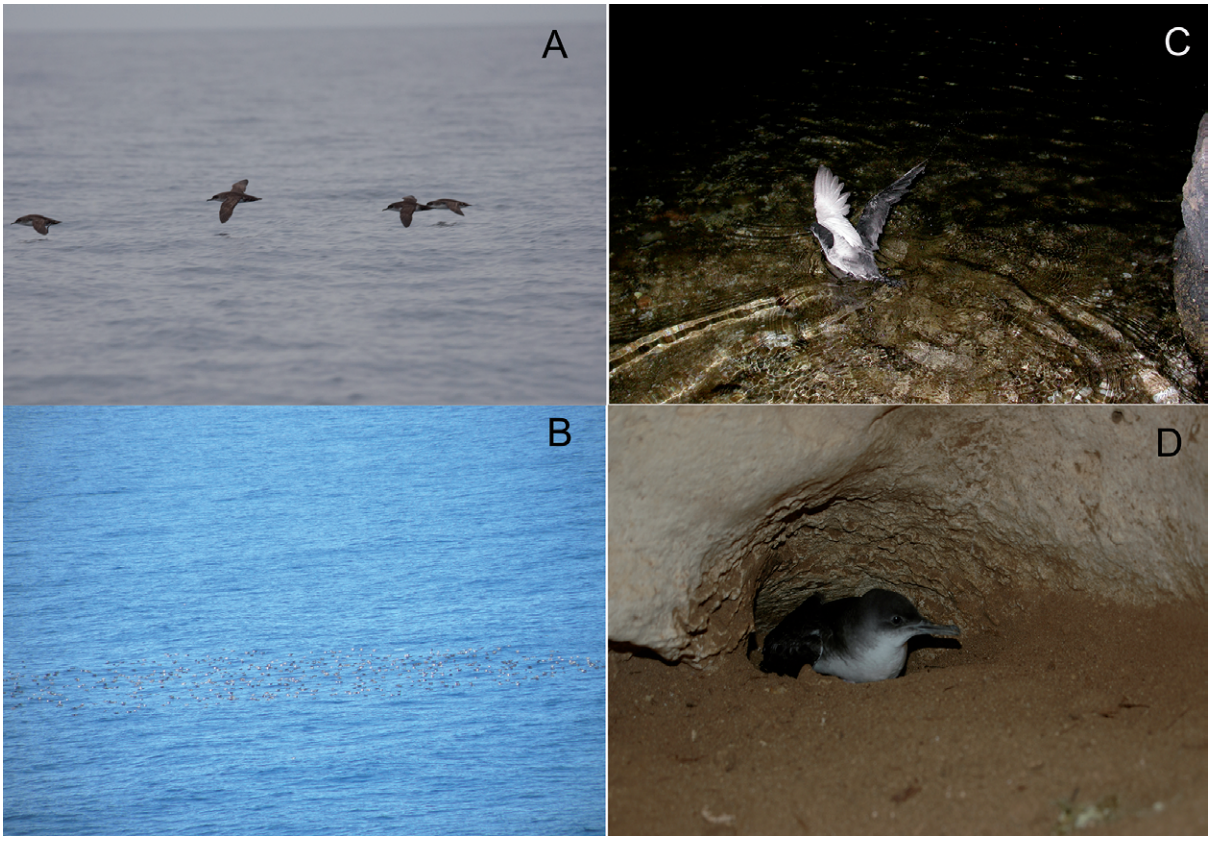

Fig. 7 – Yelkouan Shearwater *Puffinus yelkouan*. A) part of a group of a few dozen off Lampedusa; B) a conspicuous raft in the sea between Lampedusa and Lampione in February (photo by E. Prazzi); C) a freshly fledged individual in late June on Marettimo island (photo by C. Soldatini); D) adult hatching in a cavity at Lampedusa in April. / Berta minore *Puffinus yelkouan*. A) parte di un gruppo di alcune decine al largo di Lampedusa; B) un cospicuo stormo nel mare tra Lampedusa e Lampione in febbraio (foto di E. Prazzi); C) un individuo appena involato alla fine di giugno nell'isola di Marettimo (foto di C. Soldatini); D) adulto in cova in aprile in una buca a Lampedusa.

dividuals was observed off the SE coast of Panarea on the late afternoon of 29th January 2024. This sighting may suggest the occurrence of a not-yet-localized breeding population on this island. In contrast, surveys have not confirmed the presence of the nesting colony on Salina between Rinella and Lingua, which was recorded until 2014 (Massa *et al*., 2015; Lo Cascio, 2016).

Lampedusa: rafts of 700-800 individuals were counted during the first half of June 2021; their consistence seems lower than that recorded in 2020 for the same island (2260 individuals off the N coast: B. Massa, unpubl. data). At Punta Ruperta, 12 nesting adults were found on the 28th February 2022; in the same site, 20 individuals had previously been counted (B. Massa, unpubl. data). Acoustic sessions also provided an estimate of about 150 individuals, localized at Albero Sole, Capo Grecale, Grotta del Bue Marino, Punta Alaimo, Punta Cappellone, and Capo Ponente. Moreover, during the acoustic sessions in September 2022, 2 individuals were contacted; this latter data sounds interesting as usually in this period, the majority of the populations of this species migrate massively to south-eastern Europe. In 2024, 25 hatching adults have been found during a first survey carried out on the 28th March; the 6th May, 2 hatching adults, 12 pulli, 4 died pulli, and 7 abandoned eggs.

Lampione: seven carcasses found in 2021 suggest that the species could breed on the islet, as well as potential predation episodes by Yellow-legged Gull *Larus michahellis*.

Pantelleria: several calls of Yelkouan Shearwater were recorded during Scopoli's Shearwater censuses done in 2022, although with lower frequency and density compared to the latter species. Acoustic records together with the number of individuals observed during sea surveys around the island (often mixed with Scopoli's Shearwaters in rafts offshore) allow for an estimate of at least 400-500 pairs.

Favignana: single individuals were repeatedly spotted in the channel between this island and Levanzo; recording sessions provided vocalizations of some individuals, allowing an estimate of around 50 pairs.

Marettimo: acoustic sessions confirmed the occurrence of the species, especially at Punta Bassana, although the exact number of individuals could not be determined.

Levanzo: the species was first detected in 2022 on Levanzo near Cala Faraglione during acoustic sessions; although the number of individuals could not be estimated, these records support the information gathered by local elders about the occurrence of nests in the rabbit burrows.

Ustica: acoustic sessions carried out in May 2022 indicate the occurrence of the species near Punta Omo Morto; further studies are required to confirm nesting and estimate population size.

Mediterranean Storm Petrel (Fig. 8)

Scoglio Faraglione: 4 and 5 nests were found respectively in 2022 and 2023, while a maximum of 7 individuals were seen approaching the cliff; the estimated consistence is 5-10 pairs; nests were in very narrow burrows, and this prevented estimating the reproductive success.

Scoglio Montenassari: in 2021, 10 hatching adults and 2 nests with abandoned eggs were found in early July (also 6 adults seen approaching the colony area); only 6 pulli were counted in August, while eggs in the other nests were probably abandoned; estimated reproductive success was 50%. In 2022, 13 hatching adults and 4 pulli in July; 1 month later, 3 hatching adults and 9 pulli, while the other nests were clearly abandoned; estimated reproductive success was 68%. In 2023, 4 hatching adults, 3 pulli, and 1 abandoned egg in July; 2 hatching adults, 11 pulli (2 nestlings with almost complete plumage and a hint of supra-caudal band), and 2 abandoned eggs in August; due to adverse weather conditions, it was not possible to estimate the reproductive success. Further data were gathered on the 13th August 2024: 11 pulli (3 fledglings) and 2 abandoned nests, apart from 3 adults approaching the cave. Most of the colony is inaccessible; the estimated consistence is 20-40 pairs.

Lampedusa: in 2021, the species was found in a cave near Punta Cappellone (1 and 2 adults respectively on the 11th and 31st August). No surveys were instead done in the other known site of the island, where a small colony has been found (Massa, 2009).

Lampione: during a survey from sea in 2022, 5 individuals were seen approaching a cave on the N slope of the islet. However, no birds were revealed by acoustic sessions. This species has been previously confirmed as breeding (Lo Cascio & Pasta, 2012; Massa *et al*., 2015).

Marettimo: a decrease of nest density in the most accessible part of the main colony was observed during the monitoring program; it is likely that some of the breeding pairs have moved to innermost areas, perhaps due to anthropic disturbance on the main site. Marettimo holds different colonies of this species, but only one is accessible; previous data provided a consistence of 3000 pairs for the island (Albores-Barajas *et al*., 2012). In 2021, 2023 and 2024, the main colony was visited, and the ringing activity continued (overall, in ca. 40 years, more than 6000 individuals have been ringed). Interestingly, on the 31st August 2021, an individual ringed 28 years before (in 1993) was found; additionally in 2023, four individuals have been recovered, respectively ringed in 2002 as adult (>21 years old), in 2000 as pullus (23 years old), in 1997 as pullus (26 years old) and in 1993 as adult (>30 years old). It is known that Procellariiformes are long-lived birds, but very little data from the Mediterranean Storm Petrel longevity is available. Concerning the subspecies *pelagicus* from the Atlantic, a maximum longevity of 40 years is known (Thomas, 2024).

Audouin's Gull (Fig. 9)

Vendicari: in 2021, 162 hatching adults were observed in May; up to 450 adults and at least 31 chicks were ob-

served in June. An accurate count of yuveniles and chicks was not possible as the colony occupied the innermost part of the islet, covered by dense shrub vegetation. In 2022, the colony occupied a peripheral area compared to the previous year and was more exposed to wave action; during the first visit, 109 nests were found, while during a further visit (at the beginning of July), only 20 young (10 fledglings) were found, and several nests appear to have been abandoned; reproductive success was very low. In early May 2023, 91 adults were counted on the nests: the adverse weather conditions, especially heavy rain and storms, flooded the nests and entirely compromised the reproductive success. In late May 2024, 107 hatching adults were found in the rocky peripheral area of the islet, while in late June, 15 fledglings and about 25 dead pulli were observed, together with several abandoned eggs.

Two individuals ringed in Spain were found at Vendicari in 2021 (R. Ientile, unpublished data): this data confirms previous observations of individuals from the Ebro river delta in Catalonia (Ientile *et al*., 2016).

A search for breeding sites of the species on other coastal islets in SE Sicily has yielded negative results.

Fig. 8 – Mediterranean Storm petrel *Hydrobates pelagicus melitensis*. A) adults entering a Marettimo cave at night; B) adult in flight; C) adult just outside the cave as it exploits luminescent organisms to forage; D) adult with chick about one month old; E) several adults in the nest and approaching it. / Uccello delle tempeste mediterraneo *Hydrobates pelagicus melitensis*. A) adulti che entrano di notte in una grotta di Marettimo; B) adulto in volo; C) adulto appena fuori della grotta mentre sfrutta organismi luminescenti per foraggiarsi; D) adulto con pulcino di circa un mese di età; E) diversi adulti nel nido e mentre vi si avvicinano.

Fig. 9 – Audouin's gull *Ichthyaetus audouinii*. A) breeding colony in Vendicari islet; B) adults in Vendicari lagoon; C, D) adults, in ventral and dorsal view, respectively, near the Vendicari colony. / Gabbiano corso *Ichthyaetus audouinii*. A) colonia in nidificazione nell'isolotto di Vendicari; B) adulti nella laguna di Vendicari; C, D) adulti, rispettivamente da sotto e da sopra, nei pressi della colonia di Vendicari.

DISCUSSION AND CONCLUSIONS

The use of acoustic recorders has proven to be an excellent tool for obtaining first-hand data on the presence of seabirds. It also casually allowed to record the night song of a cricket in Pantelleria, which was unknown to science, described as *Acheta pantescus* (Massa *et al*., 2022).

The monitoring activities carried out between 2021 and 2024 have provided a significant update, especially regarding the distribution of the Procellariiformes in the study area. The overall size of the circum-Sicilian populations has been estimated at 14,825-15,925 breeding pairs for the Scopoli's Shearwater, 610-720 for the Yelkouan Shearwater and 3,030-3,050 for the Mediterranean Storm Petrel; for these last two species, however, this is an underestimated figure since for some of the breeding sites it has not yet been possible to assess their actual size.

The counts at rafts for Scopoli's Shearwater in Linosa (about 12,000 individuals) indicate a lower figure than that suggested earlier (Massa *et al*., 2015). The control of black rat *Rattus rattus* carried out during the Life Project "Pelagic Birds" has reduced the predation upon eggs of this species (Rannisi *et al*., 2013; Massa & La Mantia, 2015). The breeding population in Lampione, estimated at 230 pairs, had a low reproductive success related to predation by gulls (Di Gangi *et al*., 2024). Pantelleria hosts Italy's second largest colony after Linosa; although recent observations do not confirm the species occurrence in the inner areas, breeding sites have been found in moderately anthropized places (e.g., the village of Scauri). Scopoli's Shearwater was also confirmed for Lipari, where it was recorded at the same time by Vento & Pedone (2022). In this regard, it should be noted that surveys in the Aeolian Islands are often difficult because nests are mostly located on almost inaccessible landslides or mounds of boulders.

Another general consideration concerns rafts, which were observed only near large colonies (e.g., Linosa, Pantelleria) or in sites where high nest densities are recorded (Lampione), while in the Egadi and Aeolian Islands, only small groups or single individuals were contacted near the breeding areas during the late-afternoon hours. However, an exception is represented by large rafts observed near Lipari and Vulcano in summer 2023.

Yelkouan Shearwater was found as a breeding species on Pantelleria for the first time and confirmed for Favig-

nana and Levanzo; it is likely occurring with small populations also on Lampione and Panarea, while it has not been confirmed for some previously known sites (Salina between Rinella and Lingua, Linosa at Fili: see Moltoni & Frugis, 1967; Moltoni, 1970; Massa *et al*., 2015, Lo Cascio, 2016). In 2022, it was also contacted in Ustica, where Vento & Cusmano (2022) estimated in the same year a presence of 6 pairs; historical records for this island (Ajola, 1959) seem to be supported by two specimens caught in Ustica in 1959 and 1966 and kept in the collections of the Regional Museum of Terrasini. Concerning Lampedusa, data obtained during the census done in the most suitable months (February-April, according to Borg *et al*., 2014) provided lower numbers than those previously reported by Corso *et al*. (2009). However, in the coming years, we will continue to carefully monitor this species in the study area.

Mediterranean Storm Petrel is confirmed for Lampione, where its breeding was supposed on the basis of historical observations (Moltoni, 1970; La Mantia *et al*., 2002) and findings of some dead individuals (Lo Cascio & Pasta, 2012; Massa *et al*., 2015), while the small colonies of Scoglio Faraglione and Montenassari resulted larger than previously estimated (Lo Cascio, 2007; Massa *et al*., 2015); furthermore, a new breeding site was found on Lampedusa, in addition to that already discovered by Massa (2009). Marettimo hosts the second largest colony in the Mediterranean: our data are consistent with previous estimates, carried out in 2011 (3000 pairs, cf. Albores-Barajas *et al*., 2012), although a probable displacement of breeding pairs to the innermost parts of the main colony of the island has been observed.

Finally, Audouin's Gull population has shown a gradual increase, rising from 50-60 pairs found in 2010-2011 (Ientile *et al*., 2016) to a maximum of 160 counted during the last years. However, the adverse weather conditions seem to have severely affected the reproductive success in 2022 and 2023.

The project also highlighted the main threats to these populations. Shearwaters are exposed to rat predation, particularly on inhabited islands, a well-known issue at the national level (Baccetti *et al*., 2016; Capizzi *et al*., 2019). Other sources of disturbance are anthropogenic, such as egg collection by humans, the presence of tourists (especially on small islands), or tourist visits to sea grottoes. Fortunately, the collection of eggs for food purposes has almost completely disappeared, and even on Linosa, the last island where this habit was widespread, it has been considerably reduced thanks to the efforts of volunteers and forestry police.

Although during the present study the main cause of the low reproductive success of Audouin's Gull was the occurrence of storms in spring, disrespectful visitors may easily land on the islet of Vendicari, disturbing the hatching adults.

Another example of anthropic disturbance is that observed in the main colony of storm petrels in Marettimo: local boats enter in the grotto (up to 30 on a single morning) during tourist excursions, despite boatmen being aware of the occurrence of the species; the boat noise affects the colony and determines a gradual displacement of nesting birds to the least accessible part of the cave. A similar case occurred at Grotta del Cammello, where Krapp (1970) found the species nesting on cliff ledges, while today only a few pairs occupy holes and rock crevices in inaccessible areas (Albores-Barajas *et al*., 2008).

In light of these results, the urgency of adopting more effective control measures to reduce direct anthropogenic disturbance at the colonies is emphasized, especially where even small variations in pressure level can determine a significant negative impact.

Monitoring activities planned for the next year in the framework of the MSFD-2008/56/CE will also be extended to some coastal sites of Sicily where Procellariiformes have been occasionally observed, in order to verify the possible occurrence of breeding populations.

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