

# Population size and breeding success of the Scopoli's Shearwater on Lampione Islet

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## Abstract

The islet of Lampione, located in the archipelago of the Pelagie islands (Sicily channel), is known to be the Italian southernmost breeding site for the Scopoli's Shearwater *Calonectris diomedea*. So far, there was little information on the number of Shearwaters attending the islet and on the status of this breeding population. Therefore, during an eight-year study period, we determined the active nests used by the birds and assessed the annual breeding success of the population on a subset of study nests. Counts of the active nests and of the birds attending the rafts at sea revealed a breeding population of approx. 230 pairs, which makes the islet the fifth-largest breeding colony among the Italian islands. Breeding success on Lampione ranged from 39.7% and 70.8% and was about 30% lower compared to that measured in the nearby colony of Linosa. Breeding failure on Lampione in 2018 was mainly due to predation on chicks by Yellow-legged Gulls *Larus michaellis*, but predation was later reduced by improving the concealing of existing burrows and the construction of artificial nests. We also observed intraspecific competition for nest sites. Our findings show the importance of the islet of Lampione, and of the Pelagie archipelago, for the conservation of this species.

**Keywords:** *Calonectris diomedea*, Scopoli's Shearwater, breeding success, Pelagie islands, Italy

## INTRODUCTION

The first record of Shearwaters on the Lampione islet dates back to 1872, when H.E. Giglioli observed them breeding on the ground (Giglioli 1889-1890; 1907). A century later, Moltoni (1970), confirmed the presence of these birds breeding in burrows. The two authors did not assess the size of the breeding population, which was estimated to be 300-400 pairs later by Massa & Lo Valvo (1986), who visited the islet several times. However, in a subsequent review of the Shearwaters breeding on Italian islands, Baccetti et al. (2009) reported an estimate of 50 breeding pairs on Lampione, a number later confirmed by Lo Cascio & Pasta (2012). More recently, Massa et al. (2015) estimated the presence of 200 breeding pairs during three autumn visits to the islet (to ring the chicks) and other irregular visits from 1980 to 2010. Because these estimates are very different from each other, they should be taken with caution. In fact, on the one hand, early estimates based on the breeding pairs might have been carried out when the species was more abundant; on the other hand, estimates based on the number of chicks ringed pre-fledging might have underestimated the number of breeding pairs. Indeed, the latter estimates did not consider the failures during the early stages of the breeding season (i.e. incubation, hatching, and chicks' growth).

Given the differences in previous population estimates and the conservation status of this species, it was important to determine its population size on Lampione using a relatively more robust approach. The Scopoli's Shearwater is included in the Birds Directive (2009/147/EC) and, although it is listed in the IUCN Red List as "Least concern", is considered in "moderate decrease" in the southern Mediterranean (BirdLife International, 2021). The aims of the present study were to (1) carry out a precise census of the breeding population, including counting and geo-referencing all the accessible active nests (i.e. nests with an incubating adult) to assess the size of the colony, and (2) evaluate the breeding success by monitoring the breeding pairs during a period of six years. This latter parameter can inform about the health status of the population and in case reveal whether the population is in good condition or is facing a decline.

## MATERIALS AND METHODS

### Study area

The islet of Lampione (35°33' 2.3898 N, 12°19' 6.096 E) is the southernmost Italian land in the Sicily channel, about 18 km South West of Lampedusa Island (Fig.1). The islet belongs to the *Oriented Nature Reserve of the Linosa and Lampione islands* instituted in 2000, which is part of the Marine Protected Area of the Pelagie islands within the Special Conservation Area ITA040002 (<https://www.gazzettaufficiale.it/eli/id/2016/01/12/16A00078/sg>).

The surface of the islet is only 3.6 ha. The west side of the islet is characterised by cliffs 40 m high, the top has a relatively flat surface, while the eastern side declines gently with a slope towards the sea. The islet, which is part of the continental African platform (like the nearby Lampedusa) and originated from dolomitic carbonates, is covered by non-arboreal Mediterranean vegetation and it is a breeding site for the Scopoli's Shearwater (hereafter shearwater), the Eleonora's Falcon *Falco eleonorae*, and the Yellow-legged Gull (Lo Cascio

& Pasta 2012), and is visited by Peregrine Falcons *Falco peregrinus*. [INSERT FIG. 1 ABOUT HERE]

### **Monitoring of the nests**

The study was carried out by means of repeated visits to Lampione over a 6-year period, from 2018 to 2023. The islet is not inhabited by humans and the only artificial structure, apart from some Roman archaeological remains, is a small lighthouse powered by solar panels. Therefore, the islet was reached from Lampedusa by boat when the sea conditions were suitable to dock. Based on the timing of the breeding events recorded on the nearby Linosa island (< 60 km North East; where approx. 500 nests/year have been monitored in the last 16 years; Dell’Omo 2020), we reached the Lampione colony during incubation (lasting between late May and mid-July on Linosa), hatching (lasting between mid-July and early August) and fledging (lasting between mid and late October). Because of the difficulties in reaching the islet, we carried out single visits in each of these phases when it was most useful to collect the breeding data. In 2016 and 2017, we carried out a single visit in early October, when chicks were almost fully grown up, but they had not started to fledge yet. Starting from 2018, the colony was visited every year both at the beginning of the incubation phase and at fledging. The visit at the beginning of the incubation phase was carried out in early June. By this time, all the females have laid their single egg, and it is early enough in the incubation that we were unlikely to underestimate the number of breeding birds due to egg failures (i.e. the eggs had not failed yet or, if they did, we could still find shell remains). The visits during the incubation phase (June) allowed us to count the number of active nests (nests with an incubating adult), while those during the fledging phase (early October) allowed to us assess the breeding success, i.e. the ratio between the number of birds ready to fledge and the number of active nests (see Tab. 1 for a summary of nest visits). We assumed that the chicks found shortly pre-fledging during the October visit survived until fledging. Fledging occurs between October 14<sup>th</sup> and November 2<sup>nd</sup> on Linosa (own unpublished data). We also tried to determine the causes of the breeding failures: at hatching, we assessed egg failure (e.g. egg unhatched, abandoned or broken) and, at fledging, we assessed chicks’ mortality (chick missing from a previously active nest).

In 2018, during the visit in the incubation phase, a careful inspection of the islet was carried out by a team of four people to detect all the accessible active nests. The team could easily move on the surface of the islet, but the cliff could not be inspected. All the nests found were geo-referenced using a portable Global Positioning System logger.

In 2018, the 58 active nests in the lower part of the islet (a relatively flat area convenient to monitor) were numbered with metal labels and considered “study nests” for subsequent monitoring. In the same year, during the visit at fledging, we discovered several carcasses of chicks predated by Gulls in the vicinity of their nests (see below). To reduce such predation, during the same visit we improved the concealment of 16 of the 58 nests (i.e. by narrowing and lengthening the entrance and hiding the nest with stones and vegetation) and we

constructed and labelled 25 artificial nests (i.e. by digging a burrow with a narrow and deep entrance). This increased the number of study nests to 83. Breeding success was calculated from 2018 onwards, i.e. from when the islet was visited both during the incubation phase and shortly before fledging. We assumed that the values obtained from the study nests were representative of the colony's breeding success. These study nests are about 30% of the whole number of nests on the islet. Because of the small size of Lampione and the relatively similar geological features on its whole accessible surface (excluding the cliff), we believe that the study nests are a good representation of the whole colony. The breeding success, computed on the study nests, does not represent the total number of chicks fledged from the Lampione colony (i.e. the productivity of the colony), but it is useful for comparison over time and with the breeding success of the colony on Linosa.

### **Raft counts**

In addition to the visits listed in Tab. 1, in late June 2018, we spent an entire day (until sunset) on Lampione to count the birds attending the rafts at sea formed at a short distance from the islet. The weather conditions during the raft counts were characterised by extremely low wind, which generally induces the birds to remain in proximity to the breeding colony during daylight instead of moving away to forage (own observation). We could observe two separate rafts that occurred during the same afternoon at a short distance from each other on the northern side of the islet. Observations of the rafts were carried out with binoculars (8x30 and 10x40).

## **RESULT**

### **Consistency of the breeding population**

In 2018, we counted 210 active nests (Fig. 1). We estimated that another 20 nests were on the cliff. Therefore, the search of all the nests on the islet resulted in approx. 230 breeding pairs. The counting of the birds at the rafts in the same year yielded about 650 Shearwaters from two rafts of approx. 250 and 400 birds simultaneously observed at the same time of the day. In the following years, the monitoring of the study nests resulted in the number of active nests slightly fluctuating from year to year. Such fluctuations, in turn, might have occurred also in the rest of the colony around the estimated number of 230 pairs.

### **Breeding success**

During the visits in 2016 and 2017, at least 40 and 44 birds fledged from the study nests, respectively. In these years, the breeding success could not be computed because we did not carry out visits during the incubation phase and, as such, we did not record the number of eggs laid. The breeding success calculated in 2018-2023 on the study nests ranged between 39.7% and 70.8%. Although the breeding success fluctuated over the years (Tab. 2), after 2018 it never fell below 50%. Specifically, in 2018, the overall failure was > 60% with 80% of the cases of failure most likely related to chick predation by Gulls (Tab. 3). Predation,

confirmed by the finding of numerous carcasses in the vicinity of the nests (Fig. 2), was attributed to Gulls because on the island there are no mammals. We also excluded predation by Peregrine Falcons and Eleonora's Falcons (the only two other potential predators) because there were no signs of their feeding habits (e.g. unplugged feathers). In the following years, after the artificial improvement of the existing nests and the addition of the artificial nests, the breeding success slightly increased, likely as a consequence of reduced Gull predation. The breeding success reached 70.8% in 2022 (the highest success over the whole period). In 2023, no predation by Gulls was detected in any of the nests monitored on the islet (Tab. 3). In 2021 and 2023, there were fewer eggs laid and we recorded a lower breeding success (Tab. 2), due to many cases of egg abandonment (Table 3).

## DISCUSSION

The available information on the Shearwaters breeding on the islet of Lampione was scarce and gathered opportunistically. This study represents the first that determined the size of the Scopoli's Shearwaters' breeding population and evaluated the breeding success.

The population size assessed during our monitoring of Lampione - about 230 breeding pairs - was slightly higher than that one more recently estimated by Massa et al. (2015). Such a difference is probably because Massa and colleagues based their estimates on the chicks found at fledging, which does not reflect the eggs laid at the beginning of the season because of eggs' failure and chicks' deaths occurred before the visits. Our counting of the birds at the rafts carried out during the incubation phase, provides additional information which seems to agree with the nest counts. In fact, if we assume that all the non-incubating partners were at the rafts, and we subtract these 230 birds (one partner from each pair) from the approx. 650 birds observed at the rafts, the approx. 420 remaining birds may be non-breeders, accounting for 47.7% of the population. This percentage of non-breeders is similar to that suggested for the same species by Karris et al. (2017) and observed for the Cory's Shearwater *Calonectris borealis* (Mougin et al., 2000), thus supporting the reliability of our counts. Therefore, our counts of the incubating birds should be considered the most appropriate to estimate the number of Scopoli's Shearwater breeding pairs on Lampione. This new picture makes the Shearwater population of Lampione the fifth largest breeding colony among the 58 colonies of Scopoli's Shearwaters present on the small Italian islands reported by Baccetti et al. (2009). Excluding Pantelleria, which is 2,113 times larger than Lampione, it would be the fourth-largest breeding colony in Italy. It might be that the number of Shearwaters has changed over the last years after the rat eradication projects carried out on several Italian islands (Capizzi et al. 2010). In any case, the pairs counted on Lampione add to those of the nearby colony of Linosa, the largest European colony less than 60 km northeast of Lampione (the second in the Mediterranean after Zembra Island in Tunisia, Du Rau et al. 2015) and confirm the importance of the Pelagie archipelago as a breeding hotspot for Shearwaters in the Mediterranean.

Compared to the breeding success measured on Linosa during the same period (2018-2023), the breeding success on Lampione was, in general, much lower. Lampione is one of the few rat-free Italian small islands inhabited by Shearwaters (only six islands out of 64, Baccetti et al. 2009), while rats are present on Linosa. Therefore, the lower success measured on the

islet indicates that Gull predation represented an important cause of mortality. If we extend the numbers of chicks predated in the study nests to the whole breeding population of Lampione, such numbers should be tripled. In this study, we did not formally relate Gull predation with nest characteristics because our main concern was to improve chicks' survival rather than conducting an experimental study. Previous studies considered the height and depth of the burrow in assessing predation risk. However, these features were not always related to predation events (e.g. Rodríguez et al. 2022). In our case, we were dealing with avian predators (Gulls), which can spot the entrance of the nest when flying above the islet and grab the chick if the burrow is not deep enough. Therefore, our amelioration of the existing nests and the construction of new ones was aimed at reducing the visibility of the nests from above and Gulls' access to the burrows. We believe that, thanks to our interventions, predation by Gulls was severely reduced in the following years and apparently disappeared in 2023. There could be, however, other reasons for the lower breeding success measured on Lampione compared to Linosa. For example, on Lampione, there may be relatively more intense competition for the nest sites. Indeed, we found three nests with two eggs in each, which eventually failed (personal observations). On Linosa, where a much larger population has been monitored in the last 16 years, not a single nest with two eggs has ever been found (G. Dell'Omo, personal observations). Lampione is made of carbonate rocks and the surface is smooth, with fewer burrows suitable for nesting compared to Linosa. On the other hand, Linosa is characterised by lava rocks with deep burrows, providing a relatively larger number of suitable nesting sites. Therefore, on Lampione, actions aimed at increasing the availability of suitable burrows could offer a larger number of nesting sites. This would reduce intraspecific competition while, at the same time, protecting the chicks of Shearwaters from Gulls. In conclusion, in this study we provided a robust estimate of the size of the breeding population and of the breeding success of Scopoli's Shearwaters on the islet of Lampione, revealing the importance of this area.

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Early view



**Table 1.** Visits carried out over a 6-year study period on the islet of Lampione to monitor the nests of Scopoli's Shearwater during the four main phases of the breeding season.

Year	Early incubation	Hatching	Early chick rearing	Before fledging
2016				X
2017				X
2018	X			X
2019	X		X	X
2020	X	X		X
2021	X		X	X
2022	X		X	X
2023	X	X		X

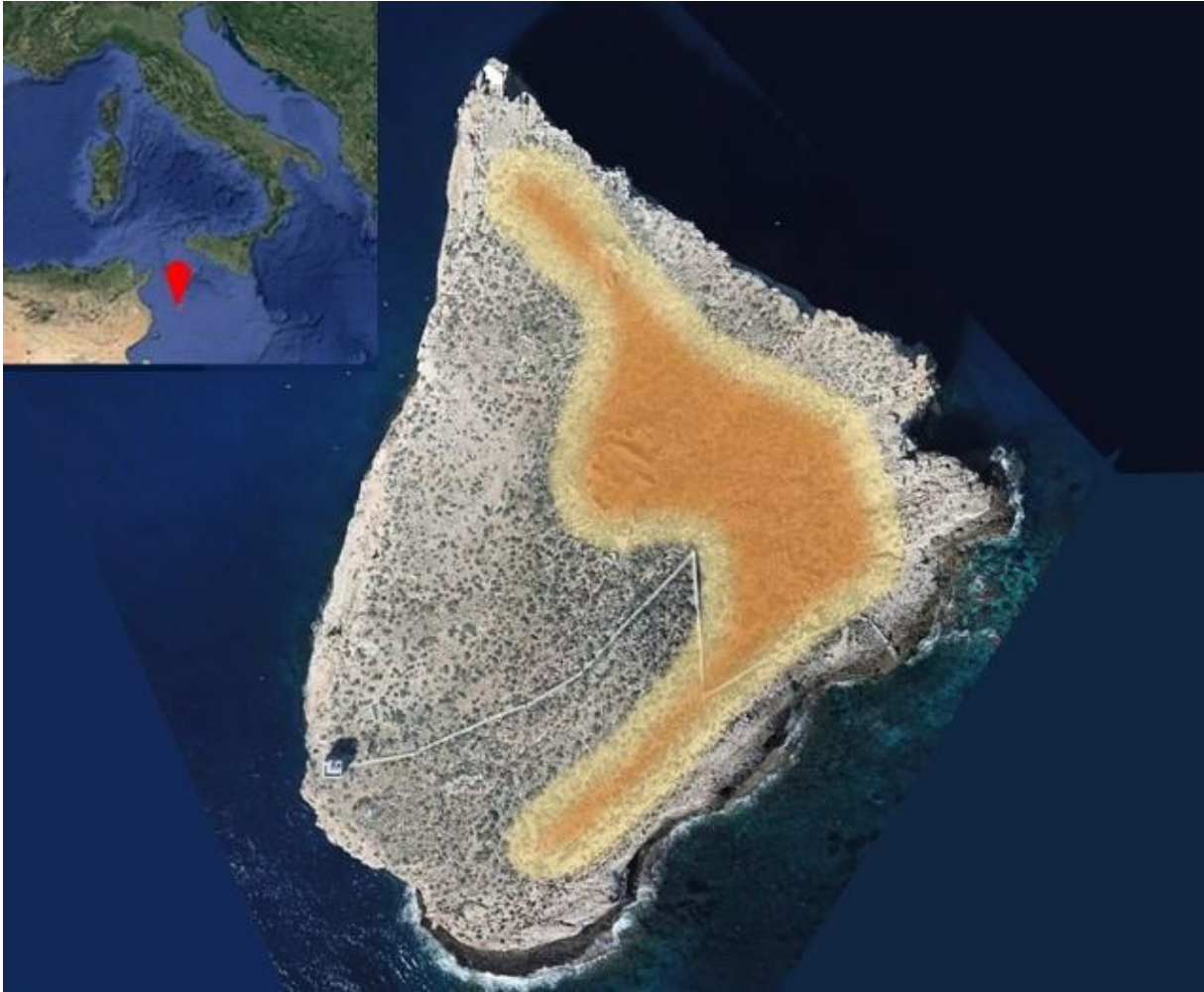
**Table 2.** Scopoli's Shearwaters' breeding success on the islet of Lampione. Breeding success is compared with that measured in the study nests monitored on Linosa Island during the same period.

Lampione	2018	2019	2020	2021	2022	2023
<b>N active nests</b>	58	70	70	46	79	48
<b>N fledglings</b>	23	41	38	23	56	28
<b>N total nests failed</b>	35	29	32	23	23	20
<b>% breeding success</b>	39.7	58.6	54.3	50.0	70.8	58.3
<b>% failure</b>	60.3	41.4	45.7	50.0	29.2	41.7
Linosa	2018	2019	2020	2021	2022	2023
<b>N active nests</b>	424	388	419	391	366	325
<b>% breeding success</b>	71.2	61.6	79.5	67.8	64.5	86

**Table 3.** Causes of breeding failure in Scopoli's Shearwaters' nests on the islet of Lampione.

<sup>1</sup> Proportion of failures related to egg failure (e.g. egg unhatched, abandoned or broken); <sup>2</sup> Proportion of failures related to predation by Gulls.

Year	Overall failure (%)	Egg failure <sup>1</sup> (%)	Chick predation <sup>2</sup> (%)	Unknown (%)
2018	60.3	5.7	80	14.3
2019	41.4	10.3	51.7	38
2020	45.7	6.3	50	43.7
2021	50	21.7	4.4	73.9
2022	29.2	13.1	6.9	80
2023	41.7	55	0	45



**Figure 1.** Position of Lampione islet in the Sicily channel (top left) and aerial photograph of the islet, obtained with a drone, showing the area occupied by the Shearwater nests.



**Figure 2.** Some of the Shearwater chicks killed by Yellow-legged Gulls before fledging (early October 2018).

Early